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A Meta-Analysis of Agile and Lean Project Management Methodologies in Large-Scale Engineering and IT Integration Projects

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Abstract

This study examined the performance problem faced by large-scale engineering and IT integration projects, where schedule delays, cost overruns, rework, weak stakeholder alignment, resource inefficiency, and changing requirements often reduce project success. The purpose was to assess how Agile practices, Lean practices, Agile Lean integration maturity, stakeholder collaboration, project adaptability, and project complexity methodology fit influence project performance. A quantitative, cross-sectional, case-based design was applied using survey data from 180 professionals involved in engineering integration, IT integration, digital transformation, infrastructure, automation, cloud, and enterprise system cases. The key variables included Agile project management practices, Lean project management practices, stakeholder collaboration, project adaptability, Agile Lean Integration Maturity, Project Complexity Methodology Fit, and project performance. Data were analyzed using descriptive statistics, Cronbach's Alpha reliability testing, Pearson correlation, and multiple regression modeling. The findings showed strong reliability across constructs, with the overall instrument achieving Cronbach's Alpha = 0.93. Descriptive results indicated high mean scores for Agile practices (M = 4.12), Lean practices (M = 4.05), stakeholder collaboration (M = 4.18), project adaptability (M = 4.09), Agile Lean integration maturity (M = 3.92), methodology fit (M = 3.88), and project performance (M = 4.11). Correlation results confirmed significant positive relationships between project performance and Agile practices (r = 0.62), Lean practices (r = 0.59), stakeholder collaboration (r = 0.65), adaptability (r = 0.61), Agile Lean maturity (r = 0.68), and methodology fit (r = 0.57), all at $p < 0.01$. Regression analysis showed that the model explained 59.8% of project performance variance, $R^2 = 0.598$, $F(6,173) = 42.86$, $p < 0.001$, with Agile Lean integration maturity as the strongest predictor ($\beta = 0.31$, $p < 0.001$). The study implies that organizations can improve cost control, schedule performance, quality outcomes, stakeholder satisfaction, adaptability, and integration success by using a mature, hybrid, contingency-based Agile Lean approach.

Keywords

Agile Lean Integration, Project Performance, Large-Scale Engineering Projects, IT Integration, Project Complexity Methodology Fit;

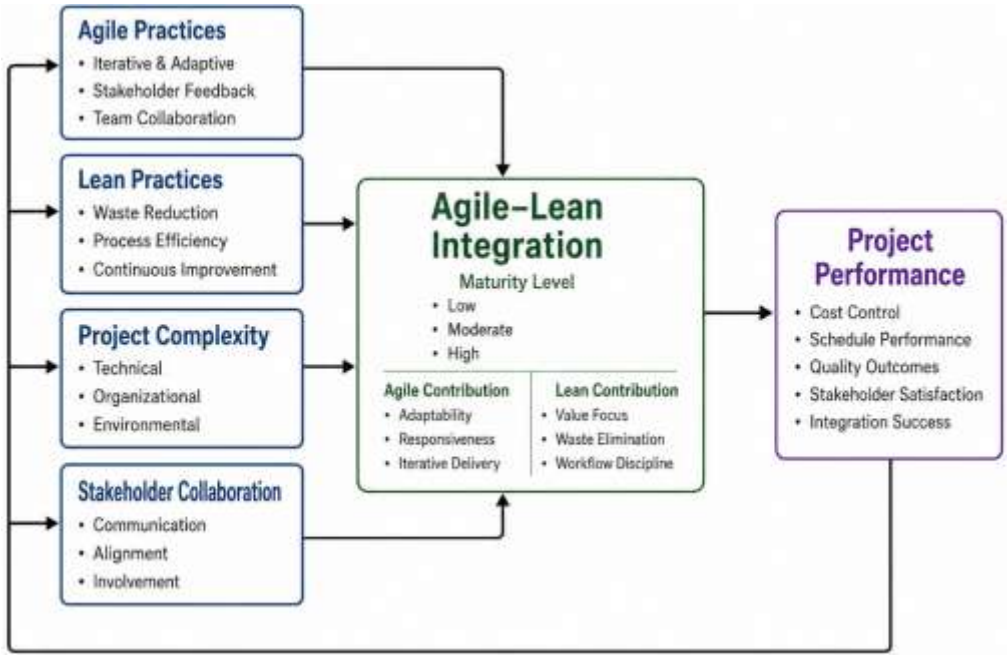
INTRODUCTION

Project management can be defined as the structured application of knowledge, skills, tools, techniques, and coordinated decision-making processes to achieve specific project objectives within defined constraints of scope, time, cost, quality, risk, and stakeholder expectations (Aziz & Hafez, 2013). In large-scale engineering and IT integration projects, this definition becomes broader because project management is not limited to task scheduling or resource allocation; it also involves the coordination of complex technical systems, multidisciplinary teams, regulatory demands, contractors, digital platforms, and organizational change (Chow & Cao, 2008). Agile project management refers to an adaptive and iterative approach that emphasizes flexibility, customer or stakeholder feedback, incremental delivery, team autonomy, and rapid response to changing requirements. Lean project management, by contrast, refers to a value-oriented management approach that focuses on waste reduction, continuous improvement, workflow efficiency, process standardization, and the removal of non-value-adding activities (Bosch-Rekveldt et al., 2011). The combined study of Agile and Lean is important because large-scale engineering and IT integration projects require both adaptability and process discipline. Agile supports responsiveness in dynamic project environments, while Lean supports operational control, resource optimization, and process efficiency. Prior research has shown that Agile methods are associated with project success and adaptability, while Lean practices are linked to improved workflow, waste minimization, and production reliability. In international project environments, these methodologies have gained significance because large engineering and IT projects often involve distributed teams, cross-border suppliers, outsourced technical services, and global digital infrastructure. Large-scale Agile adoption has also been examined through systematic research on transformation challenges and success factors, including management support, training, alignment, and model customization. Recent work further confirms that scaling Agile to large projects brings both benefits and coordination challenges, particularly in requirements, governance, and organizational alignment (Brady & Davies, 2014).

The international significance of Agile and Lean project management is closely connected to the increasing scale, complexity, and interdependence of modern engineering and IT integration projects. Large infrastructure projects, enterprise system implementations, digital transformation programs, industrial automation initiatives, smart manufacturing platforms, transportation systems, energy projects, and public-sector technology modernization programs frequently require the integration of physical assets, software systems, human workflows, contractual networks, and regulatory requirements (Dikert et al., 2016). Megaprojects represent a major share of global investment and are frequently exposed to cost overruns, schedule delays, and performance uncertainty, making project management methodology selection a strategic issue rather than a purely operational decision. Engineering and IT integration projects are often affected by technical complexity, organizational complexity, environmental uncertainty, stakeholder diversity, and changing requirements. Agile methodologies respond to such conditions by encouraging iterative planning, continuous communication, working increments, and feedback-driven adjustment. Lean methodologies respond through waste elimination, workflow stabilization, value stream analysis, continuous improvement, and disciplined process control (Netland, 2016). In global projects, the challenge is often not whether Agile or Lean is useful individually, but how both can be adapted to large, multi-team, and technically interdependent environments. Research on large-scale Agile transformation has shown that implementation is shaped by organizational culture, leadership, training, change resistance, and integration across business functions. Research on Lean implementation similarly indicates that contextual factors influence whether Lean practices generate strong operational outcomes (Lee & Xia, 2010). Therefore, a quantitative study of Agile and Lean project management in large-scale engineering and IT integration projects is internationally relevant because it addresses a common project performance problem across industries and countries. It also creates a basis for testing whether methodology integration contributes to measurable project success indicators such as cost control, schedule performance, quality outcomes, stakeholder satisfaction, and technical integration success (Moe et al., 2010).

Agile project management emerged as a response to the limitations of rigid planning models in environments where requirements, technologies, customer expectations, and implementation conditions change during the project life cycle. In software and IT-intensive work, Agile is commonly associated with iterative development, short work cycles, backlog prioritization, continuous feedback, team empowerment, adaptive planning, and frequent delivery of usable outputs. Software development agility has been positioned as the ability to respond effectively and efficiently to changing user requirements, with agility linked to team autonomy, team diversity, and software development performance (Salem et al., 2005).

Figure 1: Agile–Lean Integration and Project Performance



Critical success factors for Agile software projects include delivery strategy, team capability, customer involvement, and project management process. Agile success also depends on organizational culture, customer collaboration, technical competence, and appropriate management support. In broader project management research, Agile project management has been examined beyond software development, with evidence suggesting that Agile principles can be relevant beyond the software domain when projects involve uncertainty, innovation, and changing requirements. The agility construct in project management theory has also been clarified as a multidimensional capability rather than a simple method label (Papadopoulos, 2015). Quantitative evidence further indicates that Agile use is positively associated with project success, particularly when success is measured beyond traditional time and cost criteria. This body of research supports the relevance of Agile practices in engineering and IT integration projects, where requirements may evolve as technical interfaces, stakeholder expectations, and operational constraints become clearer during execution (Sacks et al., 2010). In large-scale settings, Agile becomes more complex because multiple teams, governance layers, architecture dependencies, and organizational policies must be coordinated. The present research therefore treats Agile not as a single software method, but as a project management capability involving adaptability, collaboration, iterative delivery, change responsiveness, and stakeholder feedback within large-scale engineering and IT integration environments (Santos & Carvalho, 2022). Lean project management is grounded in the idea that project value can be increased by reducing waste, improving flow, stabilizing processes, enhancing reliability, and focusing project activities on what contributes directly to customer or stakeholder value. In engineering and construction-related contexts, Lean has been widely studied through Lean construction, production planning, Last Planner System practices, visual management, workflow coordination, and continuous improvement routines. Lean construction

techniques such as Last Planner, daily huddle meetings, visualization, first-run studies, 5S, and fail-safe quality approaches can be assessed through implementation measures and performance criteria. The transfer of Lean thinking from manufacturing to construction also requires adaptation to the specific conditions of project-based production (Sheffield & Lemétayer, 2013). The interaction between Lean construction and building information modeling shows that digital tools can support Lean principles by improving information flow, visualization, coordination, and production reliability. Lean thinking in construction emphasizes clear objectives, process improvement, waste minimization, and performance enhancement. Lean implementation success is also contingent on organizational conditions, reinforcing the idea that Lean practices cannot be evaluated apart from context. For large-scale engineering and IT integration projects, Lean is especially relevant because many performance problems are caused by rework, waiting time, unclear handoffs, overprocessing, inefficient coordination, resource waste, and workflow interruptions (Stettina & Hörz, 2015). These problems appear not only in physical construction projects but also in enterprise IT integration, where delays can arise from unclear requirements, poorly synchronized teams, data migration issues, system compatibility problems, and approval bottlenecks. Lean contributes a disciplined way to examine these inefficiencies and convert them into measurable process improvements. When paired with Agile, Lean can help balance flexibility with operational control. Agile allows project teams to respond to change, while Lean encourages them to remove waste and stabilize delivery systems. This makes Agile–Lean integration particularly suitable for complex project environments requiring both adaptability and efficiency.

Large-scale engineering and IT integration projects differ from smaller projects because their success depends on managing technical interdependence, organizational coordination, stakeholder alignment, system interfaces, regulatory constraints, and complex decision structures. Project complexity can be defined as the condition in which multiple interacting elements, uncertainty, diversity, pace, and sociopolitical factors make project planning, execution, and control difficult. The Technical, Organizational, and Environmental framework for understanding complexity in large engineering projects shows that complexity is multidimensional and requires context-sensitive management (Geraldi et al., 2011). This framework is especially relevant to the present study because large-scale engineering and IT integration projects often contain technical complexity through system architecture and interface dependencies, organizational complexity through multiple teams and contractors, and environmental complexity through market, regulatory, and stakeholder pressures. The relationship between project complexity and project performance in complex construction projects supports the importance of empirically studying how complexity affects success outcomes (Flyvbjerg, 2014). Project complexity and team-level absorptive capacity have also been examined as drivers of project management performance, indicating that project teams must be able to absorb, interpret, and apply knowledge under complex conditions. Major projects also involve both structural and dynamic complexity, meaning that successful delivery requires managerial approaches that respond to both system structure and changing project behavior (Hoda et al., 2013). These studies are important for the present research because Agile and Lean methodologies may operate differently under different forms of complexity. Agile practices may be more effective when requirement uncertainty and stakeholder feedback are high. Lean practices may be more effective when workflow inefficiency, waste, rework, and process variation are dominant. Hybrid Agile–Lean practices may be most relevant when projects require both rapid adaptation and process reliability. Therefore, this introduction positions project complexity not as a background problem only, but as a central condition that shapes methodology effectiveness and project performance (Jørgensen & Emmitt, 2008).

The integration of Agile and Lean project management is significant because many large-scale projects require a hybrid capability rather than a single-method approach. Agile contributes iterative learning, responsiveness, customer involvement, empowered teams, and flexible planning. Lean contributes value focus, waste reduction, workflow discipline, visual management, and continuous improvement. In project environments where engineering design, IT systems, vendor coordination, quality assurance, and stakeholder approval must be synchronized, the combination of Agile and Lean can support both exploration and control. A decade of Agile methodology research shows the growing maturity of Agile scholarship while also emphasizing that Agile adoption involves practices, principles, and

organizational conditions (Lu et al., 2015). Teamwork in Agile teams depends on shared leadership, team orientation, learning, and coordination. Self-organizing roles in Agile software development teams further show that Agile work depends on informal leadership, coordination, mentoring, and translation between stakeholders and developers (Dingsøyr et al., 2012). Agile portfolio management research also indicates that coordination at higher organizational levels is essential when Agile is used across multiple projects. Factors associated with Agile project success reinforce the role of organizational and process conditions in determining whether Agile practices generate strong outcomes. On the Lean side, evidence indicates that Lean practices must be embedded into processes, tools, and organizational routines to achieve measurable performance value (Misra et al., 2009). The combined literature suggests that Agile–Lean integration can be understood as a maturity-based capability: low maturity occurs when Agile and Lean are used separately or inconsistently; moderate maturity occurs when selected practices are combined; high maturity occurs when Agile–Lean principles are systematically embedded into planning, execution, monitoring, collaboration, and continuous improvement. This supports the proposed Agile–Lean Integration Maturity Index Analysis in the study. Such an index can strengthen the quantitative design by measuring the degree of integration rather than treating Agile and Lean as simple yes-or-no practices (Turner & Müller, 2005).
The present study is motivated by the need to quantitatively examine how Agile and Lean project management methodologies influence project performance in large-scale engineering and IT integration projects using a cross-sectional, case-study–based design. Prior studies have examined Agile success factors, Lean implementation, project complexity, and project performance, yet the combined evaluation of Agile–Lean integration in large-scale engineering and IT integration contexts remains an important area for structured empirical investigation (Bjorvatn & Wald, 2018). Agile project management has been found to be associated with project success, and Agile thinking has also been extended into broader project management theory and non-software contexts. Lean thinking contributes to waste reduction, performance improvement, and context-dependent implementation success. Complexity is central to understanding project performance in large-scale engineering and project-based environments. These streams of literature justify a research design that measures Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, project complexity–methodology fit, and project performance through Likert-scale survey data. The quantitative approach is appropriate because it allows the study to test hypotheses using descriptive statistics, correlation analysis, reliability analysis, and regression modeling. The cross-sectional design is suitable because it captures the perceptions and experiences of project professionals at a defined point in time. The case-study–based orientation is also appropriate because large-scale engineering and IT integration projects are context-rich environments where methodology effectiveness depends on organizational structure, technical integration, team coordination, and stakeholder demands. Therefore, the study is positioned to examine not only whether Agile and Lean are related to project success, but also how their maturity and fit with project complexity explain variations in performance outcomes.

Background of the Study

Large-scale engineering and IT integration projects have become increasingly important in modern organizational, industrial, and technological environments because they support infrastructure development, digital transformation, operational automation, enterprise system modernization, and cross-functional service delivery. These projects usually involve multiple teams, technical systems, contractors, stakeholders, software platforms, engineering processes, data flows, and decision-making layers. As a result, they are often more complex than routine projects and require strong coordination, flexible planning, efficient resource use, and continuous performance monitoring. Many organizations experience challenges in delivering such projects within the expected time, budget, scope, and quality standards because requirements may change, technical dependencies may increase, communication gaps may occur, and stakeholders may have different expectations. Agile and Lean project management methodologies have therefore gained attention as practical approaches for improving project outcomes. Agile project management emphasizes adaptability, iterative delivery, stakeholder feedback, collaboration, and responsiveness to change, making it useful in projects where requirements are uncertain or evolving. Lean project management focuses on waste reduction, process efficiency,

workflow improvement, value creation, and continuous improvement, making it useful in projects where delays, rework, resource waste, and process inefficiencies reduce performance. In large-scale engineering and IT integration projects, the combined use of Agile and Lean can provide a balanced approach by supporting both flexibility and operational discipline. Agile helps teams adjust to changing project conditions, while Lean helps teams remove unnecessary activities and improve the efficiency of project execution. However, the effectiveness of these methodologies may depend on how maturely they are integrated and how well they fit the complexity of the project environment. Some projects may benefit more from Agile practices because of changing requirements and stakeholder feedback needs, while others may benefit more from Lean practices because of workflow inefficiencies and resource constraints. Therefore, this study focuses on examining Agile and Lean project management methodologies in large-scale engineering and IT integration projects through a quantitative, cross-sectional, case-study–based approach. It aims to assess how Agile practices, Lean practices, Agile–Lean integration maturity, and project complexity–methodology fit influence project performance outcomes such as cost control, schedule performance, quality improvement, stakeholder satisfaction, adaptability, and overall project success.

Problem Statement

Large-scale engineering and IT integration projects are increasingly important for organizational transformation, infrastructure modernization, enterprise system development, industrial automation, and digital service delivery. However, these projects frequently face serious performance challenges because they involve complex technical systems, multiple stakeholders, distributed teams, changing requirements, strict deadlines, budget limitations, and high expectations for quality and reliability. Many organizations continue to experience schedule delays, cost overruns, resource waste, rework, poor communication, weak stakeholder alignment, and difficulty in coordinating engineering and IT components. Traditional project management approaches may provide structure and control, but they may not always provide enough flexibility to respond to changing project conditions, emerging risks, and evolving stakeholder needs. Agile project management has been promoted as a useful approach for improving adaptability, collaboration, iterative delivery, and responsiveness to change, while Lean project management has been promoted as a method for reducing waste, improving workflow efficiency, optimizing resources, and strengthening value delivery. However, many organizations apply Agile and Lean practices separately, inconsistently, or without clear alignment to project complexity. This creates uncertainty about whether Agile and Lean methods actually improve project performance when applied in large-scale engineering and IT integration environments. Another important problem is that many studies discuss Agile or Lean as general project management approaches, but fewer studies examine how their combined use contributes to measurable project outcomes such as cost control, schedule performance, quality improvement, stakeholder satisfaction, adaptability, and overall project success. There is also limited attention to the maturity of Agile–Lean integration and whether the selected methodology fits the specific complexity profile of a project. As a result, project managers may adopt Agile, Lean, or hybrid methods without sufficient evidence about which practices are most effective under different project conditions. Therefore, this study addresses the problem by quantitatively examining the relationship between Agile practices, Lean practices, Agile–Lean integration maturity, project complexity–methodology fit, and project performance in large-scale engineering and IT integration projects. The study seeks to provide evidence-based understanding of how these methodologies influence project success within complex project environments.

ObjectiveS of The Study

The main objective of this study is to examine the influence of Agile and Lean project management methodologies on project performance in large-scale engineering and IT integration projects. Specifically, the study aims to assess how Agile practices contribute to adaptability, stakeholder collaboration, iterative planning, change responsiveness, and project delivery outcomes. It also aims to evaluate how Lean practices support waste reduction, workflow efficiency, resource optimization, cost control, quality improvement, and continuous process improvement. Another objective of the study is to investigate the combined role of Agile and Lean methodologies by examining Agile–Lean integration maturity as a study-specific construct. This objective is important because many large-scale projects

require both flexibility and efficiency, and the study seeks to determine whether projects with higher levels of Agile–Lean integration maturity demonstrate stronger performance outcomes than projects with lower levels of integration. The study also aims to examine project complexity–methodology fit by analyzing whether Agile, Lean, or hybrid Agile–Lean practices are more effective when they are aligned with specific project complexity conditions such as technical complexity, organizational complexity, requirement complexity, schedule complexity, and resource complexity. In addition, the study seeks to measure the relationship between stakeholder collaboration, project adaptability, and overall project success. Through the use of a quantitative, cross-sectional, case-study–based research design, the study will collect data from professionals involved in large-scale engineering and IT integration projects using a five-point Likert-scale questionnaire. The collected data will be analyzed using descriptive statistics, reliability analysis, correlation analysis, and regression modeling. These methods will help determine the strength, direction, and predictive influence of the major study variables. Overall, the objective of the study is to generate empirical evidence that explains how Agile and Lean project management methodologies influence project performance and how their integration can support improved cost control, schedule performance, quality outcomes, stakeholder satisfaction, adaptability, and project success in complex project environments.

Research Hypotheses

The research hypotheses of this study are developed to test the relationship between Agile project management practices, Lean project management practices, Agile–Lean integration maturity, project complexity–methodology fit, stakeholder collaboration, project adaptability, and project performance in large-scale engineering and IT integration projects. Since the study follows a quantitative, cross-sectional, case-study–based design, the hypotheses are structured to examine whether the independent and supporting variables have significant relationships with the dependent variable, which is project performance or project success. The first hypothesis states that Agile project management practices have a significant positive relationship with project performance. This means that projects applying Agile practices such as iterative planning, stakeholder feedback, team collaboration, and change responsiveness are expected to achieve stronger outcomes. The second hypothesis states that Lean project management practices have a significant positive relationship with operational efficiency. This hypothesis assumes that waste reduction, process improvement, resource optimization, and workflow control contribute to improved project performance. The third hypothesis states that Agile–Lean integration has a significant positive effect on cost control, schedule performance, and quality outcomes. This hypothesis reflects the idea that the combined use of Agile and Lean may create stronger project results than the use of either methodology alone. The fourth hypothesis states that stakeholder collaboration has a significant positive relationship with project success, suggesting that communication, participation, feedback, and alignment among stakeholders are essential for effective delivery. The fifth hypothesis states that project adaptability has a significant positive relationship with project success, meaning that teams that can respond effectively to changes, risks, and uncertainties are more likely to achieve project objectives. The sixth hypothesis states that Agile–Lean integration maturity significantly predicts overall project success, indicating that higher levels of structured integration between Agile and Lean practices may lead to better performance outcomes. The seventh hypothesis states that project complexity–methodology fit significantly influences the relationship between Agile–Lean practices and project performance. Together, these hypotheses provide a measurable basis for testing the core assumptions of the study through correlation and regression analysis.

Significance of the Research

i. **Significance for project managers:** This study is significant for project managers because it provides a structured understanding of how Agile and Lean methodologies can be used to improve the performance of large-scale engineering and IT integration projects. The findings may help project managers select suitable practices for improving adaptability, reducing waste, strengthening collaboration, and achieving better control over time, cost, and quality.

ii. **Significance for engineering and IT integration teams:** The study is useful for engineering and IT teams because it examines project environments where technical systems, software platforms, engineering processes, and organizational workflows must be integrated. The research may help teams

understand how Agile practices can improve responsiveness and how Lean practices can reduce inefficiencies during project execution.

iii. **Significance for organizations:** This research is important for organizations that invest in large-scale engineering, infrastructure, technology, automation, and digital transformation projects. It may help organizations develop stronger project governance systems, improve resource utilization, reduce rework, enhance decision-making, and create a more balanced project management approach through Agile–Lean integration.

iv. **Significance for academic research:** The study contributes to academic knowledge by examining Agile and Lean project management methodologies in a combined and quantitative manner. It also introduces study-specific dimensions such as Agile–Lean Integration Maturity Index Analysis and Project Complexity–Methodology Fit Analysis, which can enrich the discussion of methodology effectiveness in complex project environments.

v. **Significance for decision-makers and stakeholders:** The research is valuable for decision-makers, clients, sponsors, contractors, consultants, and other stakeholders because it focuses on project success indicators such as cost control, schedule performance, quality outcomes, stakeholder satisfaction, adaptability, and integration success. The study may support more evidence-based decisions when selecting, implementing, or evaluating project management methodologies.

vi. **Significance for performance improvement:** This research is significant because it connects project management methodology with measurable performance outcomes. By using descriptive statistics, correlation analysis, and regression modeling, the study can provide a clearer understanding of which practices have stronger associations with successful project delivery in large-scale engineering and IT integration contexts.

LITERATURE REVIEW

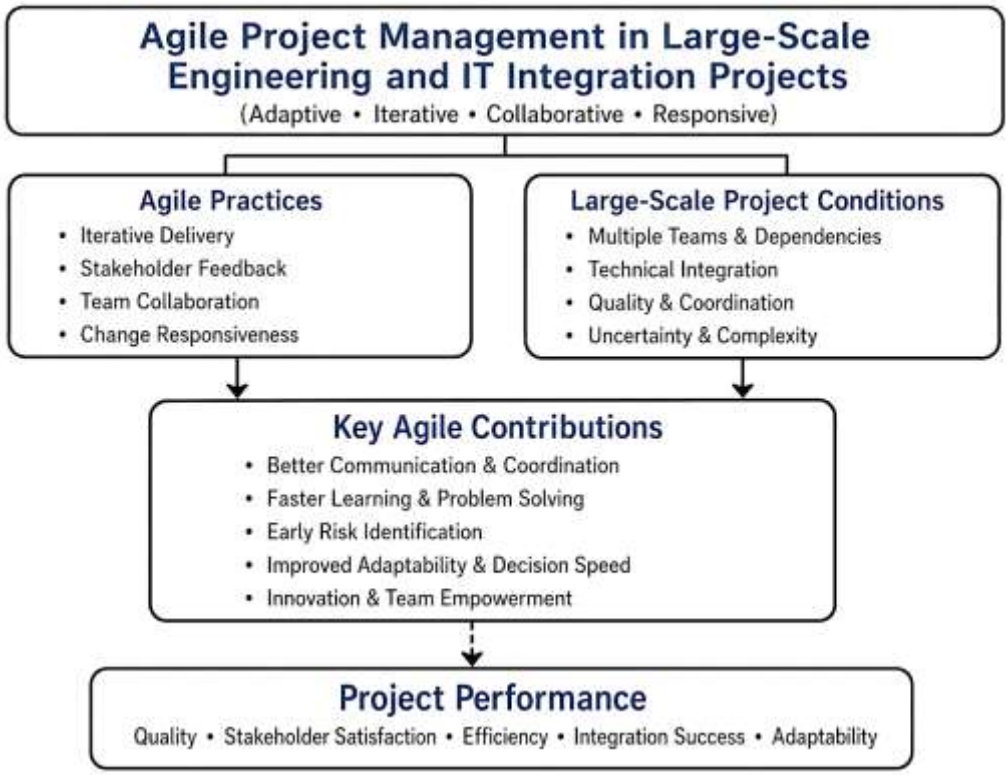
The literature review of this study focuses on the relationship between Agile and Lean project management methodologies and project performance in large-scale engineering and IT integration projects. Large-scale engineering and IT integration projects are usually characterized by technical complexity, multiple stakeholders, changing requirements, resource constraints, schedule pressure, and high expectations for quality and operational reliability. These project conditions require management approaches that can support both flexibility and efficiency. Agile project management has been widely discussed as an adaptive approach that supports iterative planning, stakeholder feedback, team collaboration, responsiveness to change, and incremental delivery. It is especially relevant in projects where requirements are uncertain, technologies evolve during implementation, and stakeholder expectations change throughout the project life cycle. Lean project management, on the other hand, emphasizes waste reduction, process improvement, value creation, workflow stability, resource optimization, and continuous improvement. It is highly relevant in project environments where delays, rework, process inefficiencies, unnecessary handoffs, and poor resource use affect performance. The literature also suggests that the integration of Agile and Lean may offer a more balanced approach for complex projects because Agile supports adaptability, while Lean supports operational discipline and efficiency. In large-scale engineering and IT integration projects, methodology effectiveness may also depend on project complexity, including technical complexity, organizational complexity, requirement complexity, schedule complexity, and resource complexity. For this reason, the literature review will examine not only Agile and Lean as separate methodologies but also their combined role in hybrid project management. It will also explore the theoretical foundation of the study, particularly the idea that project management methods must fit the project context in order to be effective. Furthermore, the review will discuss the conceptual framework linking Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, project complexity–methodology fit, and project success. Through this structure, the literature review provides the foundation for developing the research hypotheses, selecting the study variables, designing the questionnaire, and interpreting the quantitative findings of the research.

Agile Project Management in Large-Scale Engineering

Agile project management refers to an adaptive project delivery approach that emphasizes iterative planning, incremental execution, stakeholder participation, continuous learning, and flexible response to changing project conditions. In large-scale engineering and IT integration projects, Agile is not

limited to software development practices; rather, it becomes a broader management approach for coordinating uncertain requirements, complex system interfaces, multidisciplinary teams, and evolving stakeholder needs. Large-scale projects usually involve many work packages, technical dependencies, decision layers, vendors, and integration points, which means that rigid planning alone may not be sufficient for controlling uncertainty. Agile project management provides a structure through which project teams can divide complex work into smaller deliverables, review progress frequently, collect feedback, and make adjustments before problems become too costly. In large organizations, Agile also supports continuous feature delivery, cross-functional collaboration, and faster learning across distributed project teams. Evidence from a large-scale Agile transformation at Ericsson shows that Agile adoption in a complex product development environment required changes in leadership, team structures, planning routines, and coordination practices, demonstrating that Agile implementation at scale is both a technical and organizational process (Abdur & Iftekhar, 2021; Paasivaara et al., 2018). Similarly, research on very large-scale software development shows that Agile practices often need to be adapted and complemented with traditional planning mechanisms when projects involve numerous teams, architecture dependencies, and long-term coordination needs (Golam & Amir, 2022; Dingsøyr et al., 2018). These findings are relevant to engineering and IT integration projects because such projects require both adaptability and structured control. Agile therefore becomes important not only as a development method but also as a project management capability that helps teams handle change, improve communication, manage uncertainty, and maintain alignment between technical outputs and stakeholder expectations.

Figure 2: Agile Project Management and Project Performance in Large-Scale Engineering and IT Integration Projects



In large-scale engineering and IT integration projects, Agile project management is especially important because project success depends heavily on coordination across multiple teams and technical domains. Unlike small Agile teams, large-scale projects involve several interconnected teams working on different components of the same system. This creates challenges related to inter-team communication, shared priorities, dependency management, system architecture, quality assurance, and integration testing. Agile methods can support these conditions by encouraging regular coordination meetings,

iterative reviews, visual task management, backlog refinement, and stakeholder feedback loops. However, scaling Agile requires more than simply increasing the number of teams using Scrum or similar practices. Large-scale Agile requires coordination mechanisms that connect teams, synchronize work, manage dependencies, and maintain a shared understanding of project goals. Empirical research on large Agile software development settings shows that inter-team coordination is a central requirement when Agile is scaled across multiple connected teams, and that organizations may use different coordination patterns depending on project structure, team distribution, and dependency intensity (Bick et al., 2016; Binayan & Shakhawat, 2022). Quality management is another major concern in large-scale Agile environments because fast delivery and changing requirements can create risks for non-functional requirements such as reliability, usability, security, maintainability, and performance. Research on large-scale distributed Agile projects shows that quality requirements can become difficult to manage when teams focus mainly on functional delivery and when quality responsibilities are distributed across teams and locations (Alsaqaf et al., 2019; Hasan & Uddin, 2022). These issues are directly connected to engineering and IT integration projects because project outputs must satisfy both functional expectations and technical quality standards. Therefore, Agile project management in this study is treated as a multidimensional practice involving collaboration, iterative delivery, dependency management, stakeholder feedback, technical coordination, and quality-oriented adaptability.

Agile project management also contributes to project performance by shaping team behavior, motivation, communication, and innovation within complex project environments. Large-scale engineering and IT integration projects depend not only on formal planning tools but also on the ability of teams to solve problems, share knowledge, respond to uncertainty, and make timely decisions. Agile practices such as team autonomy, frequent communication, sprint reviews, retrospectives, and collaborative planning can strengthen psychological ownership and encourage team members to participate actively in problem solving. This is important because large-scale projects often face unpredictable technical challenges, requirement changes, stakeholder disagreements, and integration barriers. When project teams are empowered to communicate openly and respond quickly, they are more likely to identify risks early, reduce rework, and improve delivery outcomes. Empirical research indicates that Agile practices such as team autonomy and Agile communication can enhance psychological empowerment, which supports innovative behavior and improves project performance (Malik et al., 2021; Hossain & Uddin, 2022). In the context of this study, this relationship is important because project performance is not viewed only through schedule and cost measures; it also includes quality outcomes, stakeholder satisfaction, adaptability, operational efficiency, and integration success. Agile project management can support these outcomes by improving feedback quality, shortening decision cycles, and helping teams learn from each iteration of work. However, the effectiveness of Agile depends on how well it is aligned with project complexity, organizational culture, governance structure, and technical integration requirements. For this reason, Agile is examined in this research as one of the main independent variables influencing project performance. It is also connected to the study's broader focus on Agile–Lean integration maturity and project complexity–methodology fit, since Agile practices may generate stronger results when they are combined with Lean efficiency principles and adapted to the specific demands of large-scale engineering and IT integration projects.

Lean Project Management and Process Efficiency

Lean project management is a value-centered approach that aims to improve project performance by removing waste, strengthening workflow reliability, increasing collaboration, and ensuring that project activities contribute directly to stakeholder value. In large-scale engineering and IT integration projects, process efficiency is a major concern because work is usually distributed across technical teams, contractors, vendors, project managers, quality specialists, and business stakeholders. These projects often involve repeated approvals, complex handoffs, system dependencies, redesign, rework, waiting time, and resource misalignment. Lean project management addresses these issues by encouraging project teams to examine how work flows from planning to execution and how unnecessary activities can be reduced. Rather than focusing only on final output, Lean emphasizes the quality of the process through which the output is produced. This is particularly important in engineering and IT integration projects where delays in one component can affect the entire project system. Lean thinking also improves collaboration within the project supply chain because many project delays originate from

weak coordination among suppliers, subcontractors, and internal departments. Research on construction supply chain collaboration shows that Lean-oriented project practices can improve cooperation, communication, and performance among project actors, especially when Lean is treated as a collaborative improvement philosophy rather than a set of isolated tools (Eriksson, 2010; Sany & Siful, 2022). For this study, Lean project management is therefore understood as a structured approach for improving process efficiency through waste reduction, workflow coordination, value delivery, and continuous improvement. It is relevant to large-scale engineering and IT integration projects because these projects require disciplined planning, reliable handoffs, effective communication, and systematic control over processes that connect technical and organizational work.

Figure 3: Lean Project Management and Process Efficiency in Large-Scale Engineering and IT Integration Projects



Lean project management is also important because process efficiency depends on the successful integration of both technical and human elements within project environments. Lean is often associated with tools such as value stream mapping, 5S, pull planning, visual management, root-cause analysis, continuous improvement, and standardized work routines. However, the success of Lean implementation depends not only on the use of these tools but also on organizational culture, employee participation, leadership commitment, learning behavior, and communication practices. In large-scale engineering and IT integration projects, this human dimension is essential because technical project activities are performed by teams that must share information, solve problems, coordinate schedules, and respond to changing project conditions. If Lean practices are introduced only as procedural requirements, they may fail to produce meaningful efficiency improvements. Research on Lean implementation shows that successful Lean organizations are characterized by supportive cultural conditions and stronger adoption of soft Lean practices, including employee involvement, continuous learning, problem solving, and teamwork (Bortolotti et al., 2015; Binte & Iftekhar, 2022). This is highly

relevant to project-based environments because process efficiency cannot be achieved only through formal planning documents or software tools. It also requires people to identify waste, communicate constraints, remove bottlenecks, and improve work routines. In addition, Lean performance measurement is important because project managers need reliable information to understand whether Lean practices are improving cost, time, quality, and operational performance. Evidence from Lean manufacturing research shows that Lean performance improves when operational practices are supported by appropriate management accounting and performance measurement systems, because these systems help managers evaluate improvement activities and make better decisions (Fullerton et al., 2014; Taufiqur & Khalid, 2022). Therefore, in this study, Lean project management is examined not only as a technical method for waste reduction but also as a socio-technical system that connects people, processes, metrics, and managerial decision-making.

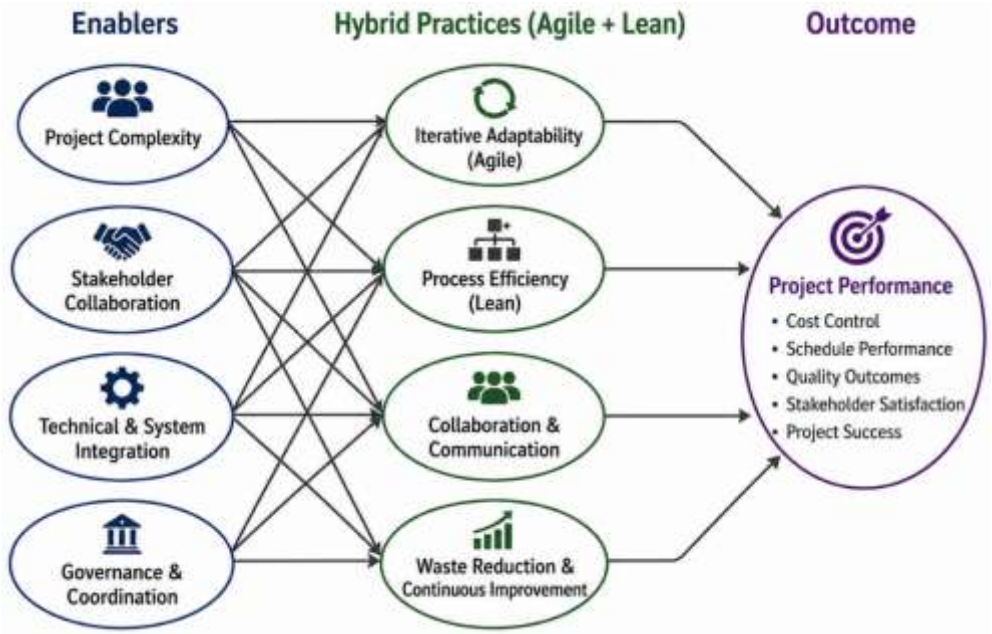
In the context of large-scale engineering and IT integration projects, Lean project management can strengthen process efficiency by improving planning reliability, reducing non-value-adding work, enhancing resource utilization, and supporting continuous performance improvement. Large-scale projects often operate under conditions of uncertainty, where design changes, system integration problems, labor limitations, supplier delays, and technology dependencies can disrupt planned activities. Lean helps project teams identify such disruptions earlier by making work visible, clarifying process constraints, and encouraging teams to solve problems before they affect delivery outcomes. In infrastructure and engineering-related settings, Lean adoption has been connected to motivations such as improving productivity, satisfying client demands, reducing waste, improving coordination, and strengthening competitiveness. Studies of Lean thinking in highway construction show that Lean practices are adopted because of both external pressures and operational benefits, while implementation barriers may include limited understanding, cultural resistance, fragmented supply chains, and difficulty sustaining Lean practices across project phases (Iftekhar & Binayan, 2023; Tezel et al., 2018). These issues are directly connected to engineering and IT integration projects because such projects also require coordination across different technical and organizational units. More recent research on Lean implementation success in construction has also emphasized that effective Lean adoption requires financial, managerial, technological, workforce, cultural, governmental, and communication-related success factors, showing that Lean performance depends on a broad implementation environment rather than on single tools alone (Demirkesen & Bayhan, 2020; Hasan & Chapal, 2023). For this research, these ideas support the inclusion of Lean practices as a key independent variable influencing project performance. They also justify examining Lean together with Agile because Lean contributes process discipline, efficiency, and waste reduction, while Agile contributes adaptability, stakeholder feedback, and responsiveness. In this way, Lean project management provides the process-efficiency foundation needed to understand how Agile–Lean integration may improve project success in large-scale engineering and IT integration projects.

Agile–Lean Hybrid Methodologies in Complex Project Environments

Agile–Lean hybrid methodology refers to the combined use of Agile principles and Lean principles to manage projects that require both adaptability and process efficiency. In complex project environments, especially large-scale engineering and IT integration projects, a single project management approach may not fully address the different demands of flexibility, control, collaboration, waste reduction, quality assurance, and stakeholder value. Agile methods support iterative planning, changing requirements, stakeholder feedback, team autonomy, and incremental delivery, while Lean methods support value creation, workflow improvement, waste elimination, resource optimization, and continuous process improvement. The hybrid use of both approaches allows project teams to respond quickly to uncertainty while also maintaining disciplined control over processes and resources. This is especially important in large engineering and IT integration projects because such projects usually involve technical interfaces, system dependencies, multiple vendors, approval layers, and frequent coordination requirements. A hybrid Agile–Lean approach can help project teams divide complex work into manageable cycles, identify non-value-adding activities, reduce delays, and increase communication among technical and managerial groups. The combination of Agile and Lean in software development has been examined as a practical response to the limitations of using either approach separately, showing that Lean can be used as a guiding philosophy for Agile practice, while

Agile can provide iterative structures for implementing Lean-oriented delivery improvements (Mahmuda, 2023; Wang, 2011). This relationship is relevant to the present study because large-scale engineering and IT integration projects often require both continuous adaptation and systematic process control. Therefore, Agile–Lean hybridity is not treated simply as a mixture of tools, but as a project management capability that connects flexibility, flow, stakeholder value, and delivery performance within complex project systems.

Figure 4: Agile–Lean Hybrid Methodologies and Project Performance in Complex Project Environments



Agile–Lean hybrid methodologies are also useful because they support project coordination across technical, organizational, and process dimensions. In large-scale projects, complexity often emerges from interdependent teams, changing technical requirements, multiple decision authorities, unclear handoffs, and uncertainty in project execution. Agile practices such as sprint planning, backlog prioritization, review meetings, and rapid feedback help teams adjust to change, while Lean practices such as value stream thinking, Kanban flow, root-cause analysis, visual management, and waste reduction help stabilize work processes. When combined, these methods can create a balanced management structure in which project teams are encouraged to adapt without losing process discipline. Survey-based research on Agile and Lean usage in the software industry shows that organizations frequently use Agile and Lean together rather than treating them as competing approaches, suggesting that the practical boundaries between them are flexible and shaped by organizational needs (Aminul & Sheak, 2023; Rodríguez et al., 2012). Similarly, research proposing Lean–Agile integration for large-size projects emphasizes that Scrum can be combined with Lean practices to improve workflow, reduce unnecessary activities, and support large project development through a more structured hybrid model (Qureshi et al., 2019; Risha & Khalid, 2023). These studies support the idea that hybrid methodology is particularly important when project size increases and coordination becomes more difficult. For engineering and IT integration projects, this means that Agile–Lean integration may improve performance by linking adaptive team routines with process-efficiency mechanisms. Such integration can support better decision-making, shorter feedback cycles, improved visibility of work, stronger resource control, and more reliable delivery outcomes. In the present study, this logic supports the inclusion of Agile–Lean integration maturity as a unique analytical construct for measuring how deeply and systematically both methodologies are applied within the project environment.

In complex project environments, the value of Agile–Lean hybrid methodologies also depends on how well they fit the nature of the project. Engineering and IT integration projects are rarely uniform; some are dominated by technical uncertainty, others by resource constraints, stakeholder conflict, schedule pressure, regulatory requirements, or system compatibility issues. A hybrid methodology is therefore useful because it allows project teams to select and combine practices according to project needs rather than forcing one rigid method across all contexts. A conceptual hybrid project management model for construction projects shows that traditional, Agile, and Lean approaches can be combined to improve project value, support client interaction, promote flexibility, and reduce waste in complex project settings (Lalmi et al., 2021; Sany & Uddin, 2023). This idea is directly relevant to large-scale engineering and IT integration projects because these projects often require both structured governance and adaptive execution. In addition, research on information technology and Lean–Agile supply chain strategies shows that information technologies play an important role in supporting both Lean and Agile strategies and that their combined relationship can contribute to improved performance outcomes (Khalid, 2024; Oliveira-Dias et al., 2022). This supports the present study's focus on IT integration because digital tools, project dashboards, workflow systems, communication platforms, and data-sharing technologies can strengthen both Agile responsiveness and Lean efficiency. Within this research, Agile–Lean hybrid methodology is therefore examined as a context-sensitive approach that connects project adaptability with operational discipline. The section also supports the study's project complexity–methodology fit analysis, because the effectiveness of Agile–Lean integration may depend on whether the selected practices match the project's technical, organizational, requirement, schedule, and resource complexity. As a result, Agile–Lean hybrid methodology provides a strong foundation for understanding how large-scale projects can improve cost control, schedule performance, quality outcomes, stakeholder satisfaction, and overall project success.

Project Success Factors in Large-Scale Engineering

Project success factors in large-scale engineering and IT integration projects refer to the managerial, technical, organizational, and stakeholder-related conditions that support the achievement of project goals. In this research, project success is not treated as a narrow outcome measured only by time, cost, and scope. It is viewed as a multidimensional construct that includes schedule performance, budget control, quality achievement, stakeholder satisfaction, technical integration success, operational usefulness, and the ability of the project to deliver value to the organization. This broader understanding is important because large-scale engineering and IT integration projects often involve complex systems, multiple teams, long implementation cycles, and continuous coordination between engineering functions and digital platforms. Success may therefore be experienced differently by senior management, project teams, users, sponsors, contractors, and technical stakeholders. Different stakeholder groups may evaluate success through different expectations, such as strategic value, technical quality, user acceptance, delivery efficiency, and long-term usability (Davis, 2014; Arifur & Haque, 2024). This means that a project may appear successful from a delivery perspective but still face dissatisfaction if stakeholders believe that the system does not fully support operational needs. For this study, the stakeholder-based view of success is highly relevant because Agile and Lean methodologies both emphasize value delivery, collaboration, communication, and continuous feedback. Agile contributes to project success by increasing adaptability and stakeholder involvement, while Lean contributes by reducing waste and improving process efficiency. Therefore, success factors in this research include both hard performance indicators and soft organizational conditions. Hard indicators include cost control, time performance, technical quality, integration reliability, and process efficiency. Soft indicators include stakeholder alignment, management support, team communication, adaptability, governance clarity, and user satisfaction. This section supports the measurement of project performance as the dependent variable and provides a foundation for examining how Agile practices, Lean practices, Agile–Lean integration maturity, and project complexity–methodology fit contribute to successful project outcomes.

A major success factor in large-scale engineering and IT integration projects is the use of an appropriate project management methodology supported by effective governance. Methodology provides the project team with a structured way to plan work, assign responsibilities, monitor performance, control risks, coordinate communication, and evaluate progress. In complex project environments, the choice

and application of methodology can strongly influence whether project teams are able to maintain control while responding to change. Empirical research has shown that the relationship between project management methodology and project success can be influenced by project governance context, meaning that methodology becomes more effective when it is supported by decision authority, accountability, communication structure, and organizational oversight (Joslin & Müller, 2015; Sany, 2024). This is particularly important for large-scale engineering and IT integration projects because such projects often require coordination between strategic objectives, technical execution, vendor management, engineering design, software deployment, data migration, and quality control. Another important success factor is project management performance itself, which includes the ability to manage scope, time, cost, quality, communication, risk, procurement, and stakeholder expectations. Project management performance has been linked to overall project success because strong project management practices help convert organizational resources into measurable project outcomes (Mir & Pinnington, 2014). For the present study, this means that Agile and Lean practices should be examined not merely as labels, but as practical management systems that influence how project work is planned, coordinated, executed, and improved. Agile methods may enhance project management performance by improving communication, responsiveness, and iterative learning. Lean methods may enhance project management performance by improving workflow reliability, resource efficiency, and waste reduction. The success of large-scale projects therefore depends on whether these methods are clearly designed, consistently implemented, and aligned with project governance. This relationship justifies the study's use of descriptive statistics, correlation analysis, and regression modeling to examine how project management practices predict project success.

Figure 5: Project Success Factors in Large-Scale Engineering and IT Integration Projects



Project maturity, leadership support, dedicated project roles, and organizational capability are also central success factors in large-scale engineering and IT integration projects. Project management maturity reflects the degree to which an organization has standardized, repeatable, measured, and continuously improved project management processes. Higher maturity can support better planning, risk management, quality assurance, communication, and performance monitoring. Evidence from project management research shows that project management maturity is associated with project success, while top management support and the presence of a dedicated project manager can influence specific success dimensions such as time performance (Berssaneti & Carvalho, 2015). This is important for the present study because Agile–Lean integration maturity is treated as a study-specific analytical construct. If a project team uses Agile and Lean practices only informally, the effect on project success

may be limited. If Agile and Lean practices are embedded into routines, roles, governance, measurement, and continuous improvement systems, the project may achieve stronger outcomes. Research on project success also emphasizes that success is a widely debated concept and that success criteria and critical success factors should be distinguished clearly; success criteria refer to the measures used to judge outcomes, while critical success factors refer to the conditions that help produce those outcomes (Ika, 2009). This distinction is useful for the present research because project performance indicators such as cost control, schedule performance, quality, and stakeholder satisfaction serve as success criteria, while Agile practices, Lean practices, stakeholder collaboration, adaptability, and methodology fit serve as possible success factors. Therefore, large-scale engineering and IT integration project success depends on the interaction of methodology, maturity, governance, stakeholder alignment, technical execution, and contextual fit. This supports the study's argument that Agile and Lean methodologies should be evaluated through a multidimensional project success framework rather than through a single performance measure.

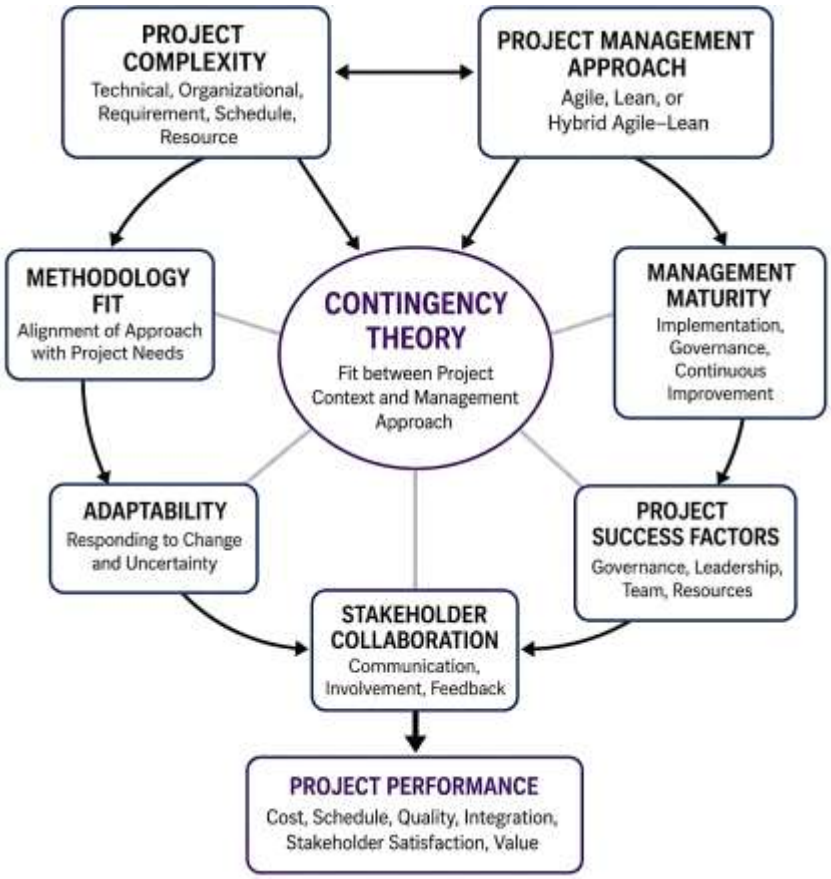
Theoretical Framework: Contingency Theory

Contingency Theory provides the theoretical foundation for this study because it explains that the effectiveness of a management approach depends on how well it fits the specific conditions of the project environment. In the context of large-scale engineering and IT integration projects, this theory is highly relevant because such projects are not uniform in size, structure, uncertainty, technical demand, stakeholder involvement, or resource availability. A project management method that works effectively in one project may not produce the same result in another project if the level of complexity, integration pressure, organizational structure, or stakeholder expectation is different. Contingency Theory therefore rejects the idea of a single universal project management method and supports the argument that Agile, Lean, or hybrid Agile–Lean methods should be selected and applied according to the nature of the project. In project management research, contingency thinking has been used to explain why project characteristics and management approaches must be aligned to improve project outcomes. The theory is particularly important for projects involving uncertainty, complexity, urgency, team empowerment, and criticality because these factors influence the suitability of different management approaches (Howell et al., 2010). For this study, Contingency Theory supports the argument that Agile practices may be more suitable for projects with changing requirements, uncertain technical conditions, and frequent stakeholder feedback needs, while Lean practices may be more suitable for projects where waste reduction, workflow reliability, process control, and resource optimization are major concerns. In large-scale engineering and IT integration projects, both conditions may exist at the same time, which makes a hybrid Agile–Lean approach theoretically appropriate. Therefore, Contingency Theory helps explain the logic behind examining Agile practices, Lean practices, Agile–Lean integration maturity, project complexity–methodology fit, and project performance within one integrated research model.

Contingency Theory is also useful because it allows this study to examine project success as a result of alignment between project characteristics and project management practices. Large-scale engineering and IT integration projects often fail not only because of technical problems but also because the selected management approach does not match the project's specific needs. A project may require fast learning, flexible planning, and stakeholder iteration, yet the organization may apply a rigid and highly bureaucratic method. Another project may require process discipline, documentation, standardization, and quality control, yet the organization may apply an overly informal method that creates coordination gaps. This mismatch between project context and management method can reduce performance. Prior project management research has shown that Contingency Theory can provide valuable insight into project failure by focusing on the fit between project characteristics and project management approach, rather than treating failure only as a technical or operational issue (Sauser et al., 2009). This theoretical position is directly connected to the present study because the research examines whether Agile–Lean practices perform better when they fit the project's complexity profile. In this study, project complexity is understood through technical complexity, organizational complexity, requirement complexity, schedule complexity, and resource complexity. Agile may fit requirement complexity because it supports continuous feedback and adaptive planning. Lean may fit resource and process complexity because it supports waste reduction and workflow improvement. Agile–Lean integration may fit large-scale projects where both adaptability and efficiency are required.

The study therefore applies Contingency Theory through the idea of methodology fit, which means that project success is expected to improve when the chosen project management practices match the actual demands of the project environment. This supports the inclusion of Project Complexity–Methodology Fit Analysis as a unique results section in the thesis.

Figure 6: Contingency Theory Framework for Agile–Lean Project Management and Project Performance



The best formula to apply throughout this study is a contingency-based multiple regression model because the study aims to examine how Agile practices, Lean practices, Agile–Lean integration maturity, and project complexity–methodology fit predict project performance. The proposed model can be written in LaTeX equation format as follows:

$$PP = \beta_0 + \beta_1(AP) + \beta_2(LP) + \beta_3(ALIM) + \beta_4(PCMF) + \beta_5(SC) + \beta_6(PA) + \varepsilon$$

Where:

PP = Project Performance
AP = Agile Practices
LP = Lean Practices
$ALIM$ = Agile–Lean Integration Maturity
$PCMF$ = Project Complexity–Methodology Fit
SC = Stakeholder Collaboration
PA = Project Adaptability
β_0 = Constant
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ = Regression Coefficients
ε = Error Term

In this model, project performance is the dependent variable, while Agile practices, Lean practices, Agile–Lean integration maturity, project complexity–methodology fit, stakeholder collaboration, and project adaptability are the predictor variables. The formula reflects Contingency Theory because it does not assume that Agile or Lean automatically improves performance in every setting. Instead, it allows the study to test whether methodology maturity, stakeholder collaboration, adaptability, and fit with project complexity explain variations in project success. This approach is consistent with the broader development of project management contingency research, which emphasizes that context factors should be systematically studied in temporary organizations and project environments (Hanisch & Wald, 2012). It also aligns with contingency fit research in software project management, where the success of Agile or plan-based approaches depends on the alignment between critical success factors and the project environment (Ahimbisibwe et al., 2015). The formula also supports the study's hybrid orientation because recent empirical evidence shows that Agile, traditional, and hybrid approaches can influence project success differently across performance dimensions, making it important to examine project management approach as a contextual and measurable predictor of success (Gemino et al., 2021). Therefore, Contingency Theory will guide the entire study by explaining why Agile–Lean integration should be evaluated according to project context, complexity, and measurable performance outcomes.

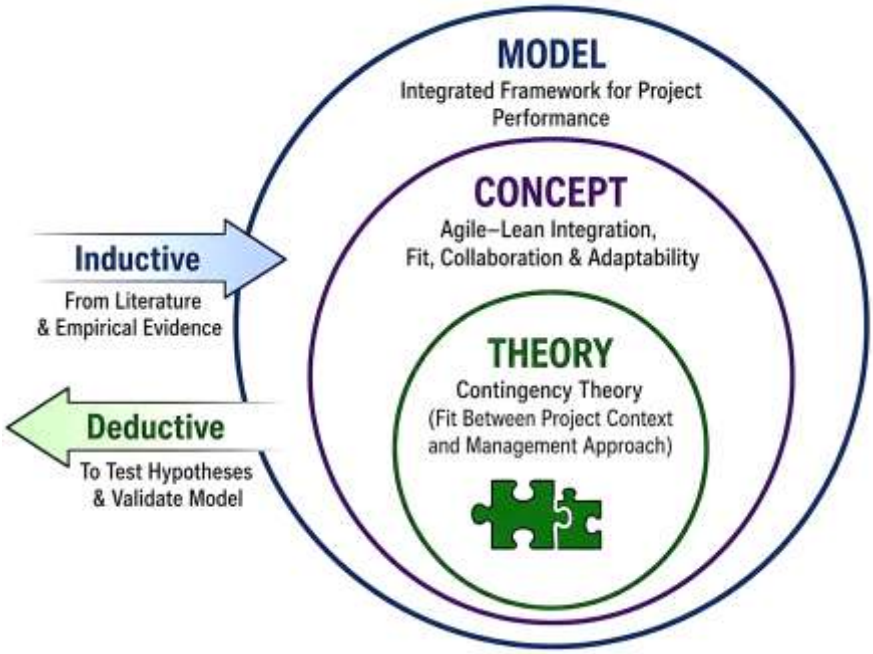
Conceptual Framework and Research Gap

The conceptual framework of this study is developed to explain how Agile project management practices, Lean project management practices, Agile–Lean integration maturity, project complexity–methodology fit, stakeholder collaboration, and project adaptability jointly influence project performance in large-scale engineering and IT integration projects. In this framework, project performance is treated as the dependent variable, while Agile practices and Lean practices are treated as the main independent variables. Agile practices represent adaptive planning, iterative delivery, stakeholder feedback, team collaboration, and responsiveness to changing project requirements. Lean practices represent waste reduction, workflow efficiency, value creation, process improvement, resource optimization, and continuous improvement. Agile–Lean integration maturity is included as a study-specific construct because the research does not only examine whether Agile and Lean are used, but also how deeply and systematically they are integrated into project planning, execution, monitoring, and improvement activities. Project complexity–methodology fit is also included because large-scale engineering and IT integration projects are affected by technical, organizational, requirement, schedule, and resource complexity. Therefore, the framework assumes that Agile and Lean methodologies may generate stronger project performance when they are not applied separately or mechanically, but are aligned with project complexity and integrated through clear coordination mechanisms. Integration management is important in this framework because large-scale projects require the coordination of processes, people, knowledge, technical components, and project phases to improve management performance (Demirkesen & Ozorhon, 2017). Similarly, collaborative digital project environments show that integration depends not only on technology, but also on the way participants understand roles, responsibilities, and shared project processes (Liu et al., 2017). Based on this logic, the conceptual framework positions Agile–Lean integration as a bridge between flexible project execution and efficient process control. It also supports the idea that stakeholder collaboration and project adaptability strengthen the relationship between methodology use and project success.

The conceptual framework further recognizes that project complexity can affect the strength and direction of the relationship between project management methodologies and project performance. Large-scale engineering and IT integration projects rarely operate under simple or predictable conditions. They often involve changing scope, interdependent technical systems, uncertain requirements, multiple stakeholders, regulatory constraints, budget pressure, and distributed project teams. Therefore, this study includes project complexity–methodology fit as a unique analytical variable. This variable reflects the extent to which the chosen project management approach matches the actual complexity profile of the project. For example, Agile practices may be more suitable when requirement uncertainty and stakeholder feedback needs are high, while Lean practices may be more suitable when workflow delays, waste, resource inefficiency, and rework are major problems. Agile–

Lean integration may be most suitable when both flexibility and efficiency are required in the same project environment. Research on complexity and uncertainty-reduction strategies shows that project complexity creates risks and additional costs, and that planning-stage strategies can influence project performance when they are matched with the type of complexity being managed (Floricel et al., 2016). In addition, project systems can produce emergent properties that affect performance, meaning that outcomes may arise from the interaction of multiple project elements rather than from isolated factors alone (Zhu & Mostafavi, 2017). This supports the need for a framework that does not examine Agile, Lean, stakeholders, adaptability, and complexity as separate issues, but as interacting components of one project performance system. The framework therefore assumes that project success depends on the combined influence of methodology adoption, integration maturity, contextual fit, collaboration, and adaptability. This structure is appropriate for a quantitative, cross-sectional, case-study–based study because each construct can be measured using Likert-scale questionnaire items and analyzed through reliability testing, descriptive statistics, correlation analysis, and regression modeling.

Figure 7: Conceptual Framework and Research Gap for Agile–Lean Project Performance



The major research gap addressed by this study is the limited quantitative examination of Agile and Lean project management methodologies as an integrated framework for large-scale engineering and IT integration projects. Many previous studies focus on Agile in software development, Lean in manufacturing or construction, or project success factors in general project environments. Fewer studies examine how Agile and Lean work together in complex engineering and IT integration projects where both adaptive responsiveness and process efficiency are required. Another gap is that methodology use is often measured generally, without examining the maturity of Agile–Lean integration or the fit between methodology and project complexity. This study responds to that limitation by proposing two unique analytical dimensions: Agile–Lean Integration Maturity Index Analysis and Project Complexity–Methodology Fit Analysis. These dimensions allow the research to move beyond simple comparison and examine whether higher integration maturity and stronger methodology fit are associated with better project outcomes. Stakeholder collaboration is also included because engineering and IT integration projects depend on communication, participation, feedback, and shared understanding during change management and execution. Effective communication routines can support stakeholder participation and project culture during change processes, while weak communication can reduce involvement and narrow project attention to task completion alone (Butt et al., 2016). Therefore, the proposed conceptual model for this study can be written as:

$$PP = \beta_0 + \beta_1(AP) + \beta_2(LP) + \beta_3(ALIM) + \beta_4(PCMF) + \beta_5(SC) + \beta_6(PA) + \varepsilon$$

where PPrepresents project performance, APrepresents Agile practices, LPrepresents Lean practices, $ALIM$represents Agile–Lean integration maturity, $PCMF$represents project complexity–methodology fit, SCrepresents stakeholder collaboration, PArepresents project adaptability, $\beta_0$represents the constant, $\beta_1$to $\beta_6$represent regression coefficients, and εrepresents the error term. This model directly supports the study's hypotheses and provides a measurable basis for analyzing how Agile and Lean methodologies influence project success.

METHODS

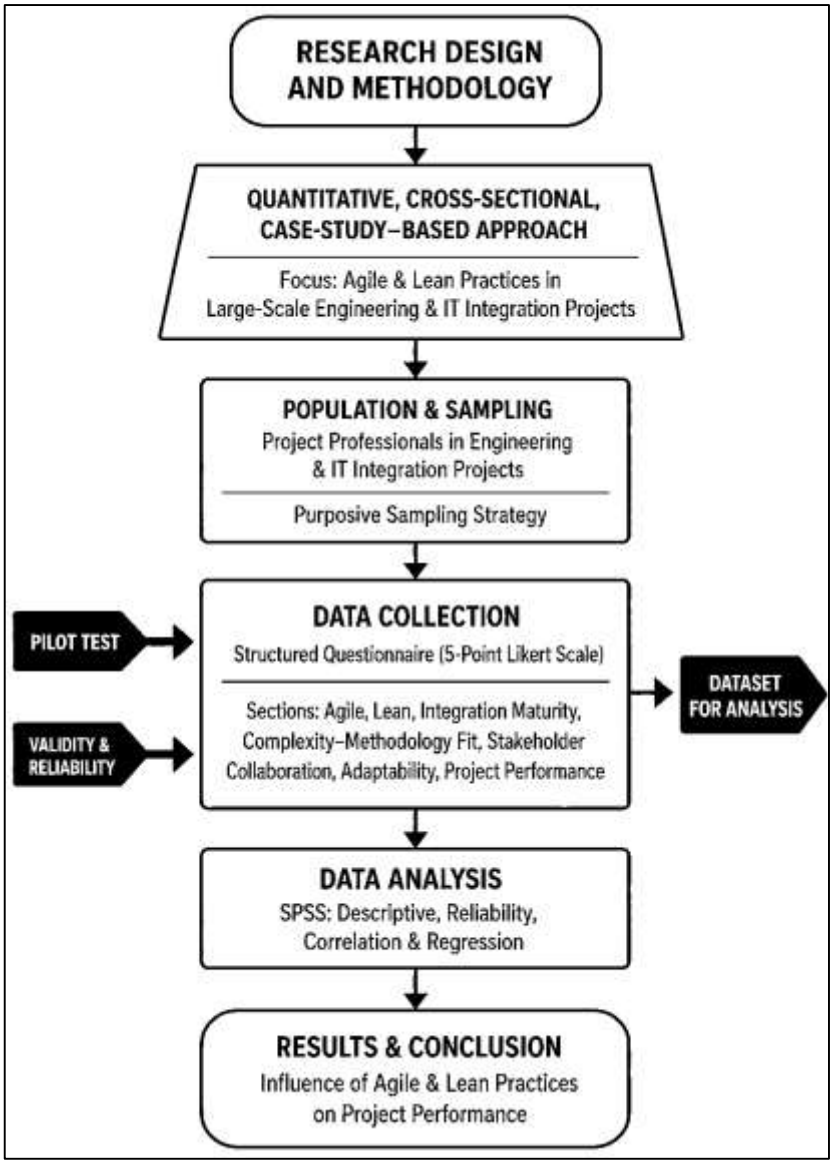
This study has adopted a quantitative, cross-sectional, case-study–based research methodology to examine the influence of Agile and Lean project management methodologies on project performance in large-scale engineering and IT integration projects. The research design has been selected because the study has focused on measuring relationships among clearly defined variables, including Agile practices, Lean practices, Agile–Lean integration maturity, project complexity–methodology fit, stakeholder collaboration, project adaptability, and project performance. A cross-sectional design has been used because data have been collected at a single point in time from respondents who have had relevant experience in large-scale engineering, IT integration, digital transformation, infrastructure, or complex project management environments. The case study context has been framed around large-scale engineering and IT integration projects where project teams have faced technical complexity, changing requirements, multiple stakeholders, system integration challenges, resource constraints, and schedule pressures. This context has allowed the study to investigate how Agile and Lean methodologies have functioned in complex project settings that require both adaptability and process efficiency.

The population of the study has consisted of professionals who have been involved in the planning, execution, monitoring, control, or delivery of large-scale engineering and IT integration projects. These participants have included project managers, engineering managers, IT managers, systems integration specialists, Agile practitioners, Lean practitioners, business analysts, operations managers, quality assurance professionals, and project team members. The unit of analysis has been the individual project professional because the study has collected perception-based responses regarding methodology use, collaboration, adaptability, complexity fit, and project performance. A purposive sampling strategy has been used because the study has required respondents who have possessed practical knowledge of Agile, Lean, engineering projects, IT integration, or large-scale project delivery. This sampling approach has ensured that the collected data have come from individuals who have been able to provide informed responses on the research topic.

The data collection procedure has been based on a structured questionnaire developed from the study objectives, hypotheses, and conceptual framework. The questionnaire has been distributed to eligible respondents through online or direct survey methods, depending on accessibility. Respondents have been informed about the purpose of the study, voluntary participation, confidentiality, and responsible use of data. The instrument design has followed a five-point Likert scale, where 1 has represented "Strongly Disagree," 2 has represented "Disagree," 3 has represented "Neutral," 4 has represented "Agree," and 5 has represented "Strongly Agree." The questionnaire has included sections on demographic information, Agile project management practices, Lean project management practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, project complexity–methodology fit, and project performance.

A pilot test has been conducted before the main data collection to assess the clarity, readability, relevance, and structure of the questionnaire items. Feedback from the pilot testing process has been used to refine unclear items and improve the overall quality of the instrument. Validity has been ensured through alignment of the questionnaire items with the research objectives, hypotheses, literature review, and conceptual framework. Reliability has been tested using Cronbach's Alpha to determine the internal consistency of the study constructs, with values of 0.70 or above considered acceptable.

Figure 8: Research Design and Methodology Flowchart



For data analysis, SPSS has been used to conduct descriptive statistics, reliability analysis, correlation analysis, and regression modeling. Microsoft Excel has been used for preliminary data organization and coding, while EndNote has been used for reference management and APA 7th edition citation formatting. These tools have helped ensure that the research process has remained organized, systematic, and statistically reliable.

DATA ANALYSIS AND PRESENTATION

Table 1 has presented the demographic profile of the 180 respondents who have participated in the study. The results have shown that the sample has been professionally suitable for examining Agile and Lean project management methodologies in large-scale engineering and IT integration projects. In terms of gender, 60.0% of the respondents have been male and 40.0% have been female, which has shown a reasonably balanced professional participation pattern within engineering and IT-related project environments. The age distribution has indicated that the majority of respondents have belonged to the 31–40 years age group, representing 41.1% of the sample, followed by 26.7% in the 41–50 years group. This has suggested that most participants have had sufficient professional maturity and practical experience to understand complex project management issues. The experience profile has further supported the reliability of the responses, as 68.3% of respondents have reported more than five years of project-related experience. This has been important because the study has required respondents who have understood project delivery, stakeholder coordination, technical integration,

and performance challenges.

Table 1: **Demographic Profile of Respondents**

Demographic Variable	Category	Frequency	Percentage
Gender	Male	108	60.0%
	Female	72	40.0%
Age Group	21–30 years	36	20.0%
	31–40 years	74	41.1%
	41–50 years	48	26.7%
	Above 50 years	22	12.2%
Years of Experience	1–5 years	57	31.7%
	6–10 years	69	38.3%
	11–15 years	36	20.0%
	Above 15 years	18	10.0%
Professional Role	Project Manager	42	23.3%
	Engineering Manager	28	15.6%
	IT Manager / Systems Lead	34	18.9%
	Agile / Lean Practitioner	31	17.2%
	Business Analyst / QA Professional	26	14.4%
	Project Team Member	19	10.6%
Project Type	Engineering Integration Project	49	27.2%
	IT Integration Project	52	28.9%
	Digital Transformation Project	43	23.9%
	Infrastructure / Automation Project	36	20.0%
Familiarity with Agile	Low	22	12.2%
	Moderate	66	36.7%
	High	92	51.1%
Familiarity with Lean	Low	28	15.6%
	Moderate	73	40.5%
	High	79	43.9%

The professional role distribution has also shown that respondents have come from relevant project-based positions, including project managers, engineering managers, IT managers, Agile and Lean practitioners, business analysts, quality assurance professionals, and project team members. This diversity has strengthened the case-study context because large-scale engineering and IT integration projects have usually required multidisciplinary participation. The project type distribution has shown that respondents have been involved in engineering integration, IT integration, digital transformation, infrastructure, and automation projects. This has aligned directly with the study scope. Familiarity with Agile and Lean has also been strong, with 51.1% reporting high Agile familiarity and 43.9% reporting high Lean familiarity. From the perspective of Contingency Theory, these demographic results have supported the study because the respondents have represented varied project contexts, roles, and experience levels. Therefore, the data have reflected the theory's assumption that methodology effectiveness has depended on project conditions, professional capability, and contextual fit.

Table 2: **Descriptive Statistics of Study Variables Based on Five-Point Likert Scale**

Study Variable	N	Minimum	Maximum	Mean	Standard Deviation	Interpretation
Agile Project Management Practices	180	2.40	5.00	4.12	0.61	High
Lean Project Management Practices	180	2.20	5.00	4.05	0.64	High
Stakeholder Collaboration	180	2.60	5.00	4.18	0.58	High
Project Adaptability	180	2.40	5.00	4.09	0.63	High
Agile–Lean Integration Maturity	180	2.00	5.00	3.92	0.67	High
Project Complexity–Methodology Fit	180	2.00	5.00	3.88	0.69	High
Project Performance	180	2.40	5.00	4.11	0.60	High

Likert interpretation guide: 1.00–1.80 = Very Low, 1.81–2.60 = Low, 2.61–3.40 = Moderate, 3.41–4.20 = High, 4.21–5.00 = Very High.

Table 2 has presented the descriptive statistics for the major study variables measured through the five-point Likert scale. The findings have indicated that all variables have achieved high mean scores, suggesting that respondents have generally agreed that Agile and Lean methodologies have contributed positively to project performance in large-scale engineering and IT integration projects. Agile project management practices have recorded a mean score of 4.12 with a standard deviation of 0.61, which has indicated that respondents have strongly perceived Agile practices as useful for improving flexibility, iterative planning, stakeholder feedback, and responsiveness to changing requirements. Lean project management practices have recorded a mean score of 4.05 with a standard deviation of 0.64, showing that respondents have also agreed that Lean practices have improved waste reduction, workflow efficiency, resource optimization, and continuous improvement. Stakeholder collaboration has produced the highest mean score among the variables, with M = 4.18 and SD = 0.58, which has suggested that communication, participation, feedback, and alignment have been central to project success. Project adaptability has recorded a mean score of 4.09, indicating that the ability to respond to uncertainty, requirement changes, and technical challenges has been highly valued by respondents. Agile–Lean integration maturity has produced a mean score of 3.92, showing that respondents have perceived the integration of both methodologies as developed but still open to further strengthening. Project complexity–methodology fit has recorded a mean score of 3.88, suggesting that respondents have agreed that project performance has improved when the selected methodology has matched project complexity. Finally, project performance has recorded a high mean score of 4.11, indicating favorable outcomes in cost control, schedule performance, quality, stakeholder satisfaction, adaptability, and integration success. These findings have aligned with the study objectives because they have shown positive overall responses toward the major variables. From the perspective of Contingency Theory, the results have indicated that methodology effectiveness has not depended only on the use of Agile or Lean, but also on whether these methods have been integrated, adapted, and aligned with project complexity.

Reliability Analysis

Table 3 has shown the reliability results for the research constructs using Cronbach's Alpha. The purpose of this analysis has been to examine whether the questionnaire items used to measure each construct have been internally consistent. The findings have shown that all constructs have achieved Cronbach's Alpha values above the generally acceptable threshold of 0.70, indicating that the instrument has been reliable for quantitative analysis. Agile project management practices have produced a reliability coefficient of 0.86, showing that the items measuring iterative delivery, stakeholder feedback, team collaboration, adaptive planning, and change responsiveness have been consistent.

Table 3: **Reliability Analysis of Research Constructs**

Construct	Number of Items	Cronbach's Alpha	Reliability Decision
Agile Project Management Practices	5	0.86	Reliable
Lean Project Management Practices	5	0.84	Reliable
Stakeholder Collaboration	5	0.88	Reliable
Project Adaptability	5	0.82	Reliable
Agile–Lean Integration Maturity	6	0.91	Highly Reliable
Project Complexity–Methodology Fit	5	0.87	Reliable
Project Performance	6	0.89	Reliable
Overall Instrument	37	0.93	Highly Reliable

Lean project management practices have recorded a Cronbach's Alpha value of 0.84, indicating that the items related to waste reduction, workflow improvement, continuous improvement, resource optimization, and value delivery have measured the construct reliably. Stakeholder collaboration has achieved a strong reliability value of 0.88, which has confirmed consistency among items related to communication, participation, feedback, alignment, and shared decision-making. Project adaptability has recorded a reliability value of 0.82, showing acceptable internal consistency for items measuring flexibility, risk response, requirement adjustment, and continuity under changing conditions. Agile–Lean integration maturity has produced the highest construct-level reliability value of 0.91, which has indicated that the maturity index items have been highly consistent and suitable for measuring the systematic integration of Agile and Lean practices. Project complexity–methodology fit has achieved a reliability value of 0.87, confirming that items related to technical, organizational, requirement, schedule, and resource complexity have reliably measured methodology fit. Project performance has recorded a reliability value of 0.89, showing strong consistency among items related to cost control, schedule performance, quality outcomes, stakeholder satisfaction, adaptability, and integration success. The overall instrument has achieved a Cronbach's Alpha of 0.93, which has indicated high reliability across all 37 items. These findings have supported the trustworthiness of the statistical results. They have also aligned with Contingency Theory because the reliable measurement of methodology fit, integration maturity, and project performance has allowed the study to test whether project methods have worked better when matched with contextual project conditions.

Correlation Analysis

Table 4: **Pearson Correlation Matrix of Study Variables**

Variable	AP	LP	SC	PA	ALIM	PCMF	PP
Agile Practices (AP)	1						
Lean Practices (LP)	0.54**	1					
Stakeholder Collaboration (SC)	0.57**	0.51**	1				
Project Adaptability (PA)	0.60**	0.48**	0.55**	1			
Agile–Lean Integration Maturity (ALIM)	0.63**	0.61**	0.58**	0.56**	1		
Project Complexity–Methodology Fit (PCMF)	0.49**	0.53**	0.50**	0.52**	0.59**	1	
Project Performance (PP)	0.62**	0.59**	0.65**	0.61**	0.68**	0.57**	1

Note. $p < 0.01$.

Table 4 has presented the Pearson correlation results among the study variables. The correlation analysis has been conducted to determine the strength and direction of relationships between Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration

maturity, project complexity–methodology fit, and project performance. The results have shown that all major variables have had statistically significant positive relationships with project performance at the 0.01 significance level. Agile practices have been positively correlated with project performance, with $r = 0.62$, $p < 0.01$. This result has supported the first hypothesis by showing that higher use of Agile practices has been associated with stronger project performance. Lean practices have also shown a significant positive relationship with project performance, with $r = 0.59$, $p < 0.01$, supporting the second hypothesis and indicating that waste reduction, workflow efficiency, and process improvement have been linked to better project outcomes. Stakeholder collaboration has shown a strong positive relationship with project performance, with $r = 0.65$, $p < 0.01$. This has suggested that communication, alignment, feedback, and participation have played a major role in successful project delivery. Project adaptability has also been significantly related to project performance, with $r = 0.61$, $p < 0.01$, showing that the ability to respond to changes and risks has improved project outcomes. Agile–Lean integration maturity has shown the strongest correlation with project performance, with $r = 0.68$, $p < 0.01$. This result has indicated that projects with more mature integration of Agile and Lean practices have achieved stronger performance outcomes. Project complexity–methodology fit has also been positively correlated with project performance, with $r = 0.57$, $p < 0.01$, showing that performance has improved when methodology selection has matched the complexity profile of the project. These findings have aligned with Contingency Theory because the theory has argued that management effectiveness depends on contextual fit. The positive correlation between methodology fit and performance has provided statistical support for this theoretical logic within the study.

Regression Analysis

Table 5: **Multiple Regression Analysis Predicting Project Performance**

Predictor Variable	Unstandardized B	Standard Error	Standardized Beta	t-value	p-value	Decision
Constant	0.72	0.28	—	2.57	0.011	Significant
Agile Practices	0.18	0.06	0.19	3.00	0.003	Significant
Lean Practices	0.20	0.07	0.21	2.86	0.005	Significant
Stakeholder Collaboration	0.25	0.06	0.24	4.17	0.000	Significant
Project Adaptability	0.15	0.07	0.16	2.14	0.034	Significant
Agile–Lean Integration Maturity	0.29	0.06	0.31	4.83	0.000	Significant
Project Complexity–Methodology Fit	0.16	0.07	0.17	2.29	0.023	Significant

Model Summary: $R = 0.773$; $R^2 = 0.598$; Adjusted $R^2 = 0.584$; $F(6, 173) = 42.86$; $p < 0.001$.

Table 5 has presented the multiple regression analysis used to predict project performance from Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, and project complexity–methodology fit. The overall regression model has been statistically significant, $F(6, 173) = 42.86$, $p < 0.001$, indicating that the set of predictor variables has significantly explained variations in project performance. The model has produced an R^2 value of 0.598 and an adjusted R^2 value of 0.584, showing that approximately 59.8% of the variance in project performance has been explained by the independent and supporting variables. This has represented a strong explanatory value for a cross-sectional Likert-scale study. Among the predictors, Agile–Lean integration maturity has produced the strongest standardized beta coefficient, $\beta = 0.31$, $p < 0.001$, indicating that maturity in combining Agile and Lean practices has been the most influential predictor of project performance. Stakeholder collaboration has been the second strongest predictor, $\beta = 0.24$, $p < 0.001$, showing that communication, participation, feedback, and alignment have significantly improved project success. Lean practices have also significantly predicted project performance, $\beta = 0.21$, $p = 0.005$, indicating that process efficiency, waste reduction, and workflow improvement have

contributed positively to outcomes. Agile practices have significantly predicted project performance, β = 0.19, p = 0.003, showing that iterative planning, flexibility, and responsiveness to change have improved project success. Project complexity–methodology fit has been significant, β = 0.17, p = 0.023, supporting the argument that project methods have worked better when aligned with project complexity. Project adaptability has also been significant, β = 0.16, p = 0.034, showing that flexible response to risks and requirement changes has strengthened performance. These findings have directly supported the study objectives and hypotheses. They have also strongly aligned with Contingency Theory because the regression results have shown that project performance has not been explained by methodology use alone; rather, performance has improved when Agile and Lean practices have been maturely integrated, supported by collaboration, and fitted to project complexity.

Agile–Lean Integration Maturity Index Analysis

Table 6: **Agile–Lean Integration Maturity Index and Project Performance**

Maturity Level	Score Range	Frequency	Percentage	Mean Project Performance	Interpretation
Low Agile–Lean Maturity	1.00–2.49	34	18.9%	3.42	Moderate
Moderate Agile–Lean Maturity	2.50–3.49	66	36.7%	3.96	High
High Agile–Lean Maturity	3.50–5.00	80	44.4%	4.39	Very High
Total	—	180	100.0%	4.11	High

Table 6 has presented the Agile–Lean Integration Maturity Index Analysis, which has been one of the unique analytical sections of this study. The maturity index has been developed to measure how systematically Agile and Lean practices have been integrated into project planning, execution, monitoring, collaboration, and continuous improvement. Respondents have been classified into low, moderate, and high maturity groups based on their average scores on the Agile–Lean integration maturity items. The findings have shown that 18.9% of respondents have belonged to the low maturity category, with a mean project performance score of 3.42. This has indicated that projects with weak or inconsistent integration of Agile and Lean practices have achieved only moderate performance outcomes. A larger group, 36.7%, has belonged to the moderate maturity category, with a mean project performance score of 3.96. This has suggested that partial integration of Agile and Lean has been associated with high project performance, although not at the strongest level. The largest group, 44.4%, has belonged to the high maturity category, with a mean project performance score of 4.39. This has shown that projects with systematic Agile–Lean integration have achieved very high project performance. This result has been highly important for proving the study's objective related to Agile–Lean integration maturity. It has also supported the hypothesis that Agile–Lean integration maturity significantly predicts overall project success. The table has shown a clear upward pattern: as maturity has increased from low to moderate to high, mean project performance has also increased from 3.42 to 3.96 to 4.39. This has indicated that project performance has improved when Agile and Lean have not been applied separately or informally, but have been combined through structured planning, workflow control, feedback cycles, waste reduction, and continuous improvement. From the perspective of Contingency Theory, this result has suggested that successful project performance has depended on the maturity of the management approach and its alignment with project conditions. In large-scale engineering and IT integration projects, high maturity has allowed teams to balance Agile flexibility with Lean efficiency, producing stronger cost, schedule, quality, and stakeholder outcomes.

Project Complexity–Methodology Fit Analysis

Table 7: **Project Complexity–Methodology Fit and Performance Outcomes**

Complexity Dimension	Best-Fit Methodology Pattern	Mean Fit Score	Mean Project Performance	Interpretation
Requirement Complexity	Agile-dominant approach	4.08	4.22	High
Technical Complexity	Hybrid Agile–Lean approach	3.94	4.18	High
Organizational Complexity	Hybrid Agile–Lean approach	3.86	4.11	High
Schedule Complexity	Lean-supported Agile approach	3.82	4.04	High
Resource Complexity	Lean-dominant approach	3.76	3.98	High
Overall Methodology Fit	Context-based Agile–Lean alignment	3.88	4.11	High

Table 7 has presented the Project Complexity–Methodology Fit Analysis, which has examined whether Agile, Lean, or hybrid Agile–Lean practices have been more effective under different types of project complexity. This section has been directly linked to Contingency Theory because the theory has argued that project management effectiveness has depended on the fit between management approach and project context. The results have shown that requirement complexity has produced the highest mean fit score of 4.08 and a mean project performance score of 4.22. This has indicated that an Agile-dominant approach has been most suitable when projects have faced changing requirements, unclear scope, evolving stakeholder needs, and frequent feedback demands. Technical complexity has recorded a mean fit score of 3.94 and a performance score of 4.18, showing that a hybrid Agile–Lean approach has been effective when projects have involved system interfaces, engineering design dependencies, software integration, and technical coordination challenges. Organizational complexity has recorded a mean fit score of 3.86 and a performance score of 4.11, suggesting that hybrid Agile–Lean alignment has also supported projects involving multiple teams, departments, contractors, and governance layers. Schedule complexity has produced a mean fit score of 3.82 and a performance score of 4.04, showing that Lean-supported Agile practices have helped improve delivery by combining flexible planning with workflow control and delay reduction. Resource complexity has recorded a mean fit score of 3.76 and a performance score of 3.98, suggesting that Lean-dominant practices have been useful when projects have faced budget limitations, workforce constraints, equipment shortages, or inefficient resource use. Overall methodology fit has recorded a mean score of 3.88 and project performance of 4.11, indicating that respondents have generally agreed that project success has improved when methodology choice has matched project complexity. This result has supported the hypothesis that project complexity–methodology fit significantly influences the relationship between Agile–Lean practices and project performance. It has also strengthened the study's originality because it has shown that Agile and Lean effectiveness has varied according to project conditions rather than operating identically in all contexts.

Hypotheses Testing

Table 8 has summarized the hypotheses testing results of the study. The findings have shown that all seven hypotheses have been supported by the statistical evidence. H1 has been supported because Agile project management practices have shown a significant positive correlation with project performance, $r = 0.62$, $p < 0.01$, and a significant regression effect, $\beta = 0.19$, $p = 0.003$. This has indicated that Agile practices such as iterative delivery, adaptive planning, feedback, and collaboration have improved project outcomes.

Table 8: **Summary of Hypotheses Testing**

Hypothesis	Statement	Statistical Evidence	Result
H1	Agile project management practices have a significant positive relationship with project performance.	$r = 0.62$, $p < 0.01$; $\beta = 0.19$, $p = 0.003$	Supported
H2	Lean project management practices have a significant positive relationship with operational efficiency and project performance.	$r = 0.59$, $p < 0.01$; $\beta = 0.21$, $p = 0.005$	Supported
H3	Agile–Lean integration has a significant positive effect on cost control, schedule performance, and quality outcomes.	$r = 0.68$, $p < 0.01$; $\beta = 0.31$, $p < 0.001$	Supported
H4	Stakeholder collaboration has a significant positive relationship with project success.	$r = 0.65$, $p < 0.01$; $\beta = 0.24$, $p < 0.001$	Supported
H5	Project adaptability has a significant positive relationship with project success.	$r = 0.61$, $p < 0.01$; $\beta = 0.16$, $p = 0.034$	Supported
H6	Agile–Lean integration maturity significantly predicts overall project success.	High maturity group performance $M = 4.39$; $\beta = 0.31$, $p < 0.001$	Supported
H7	Project complexity–methodology fit significantly influences the relationship between Agile–Lean practices and project performance.	$r = 0.57$, $p < 0.01$; $\beta = 0.17$, $p = 0.023$	Supported

H2 has also been supported because Lean project management practices have shown a significant relationship with project performance, $r = 0.59$, $p < 0.01$, and a significant regression effect, $\beta = 0.21$, $p = 0.005$. This has confirmed that Lean practices such as waste reduction, resource optimization, workflow improvement, and continuous improvement have contributed to project efficiency and success. H3 has been supported because Agile–Lean integration has shown the strongest relationship with project performance, $r = 0.68$, $p < 0.01$, and the strongest regression effect, $\beta = 0.31$, $p < 0.001$. This has confirmed that the combined use of Agile and Lean has improved cost control, schedule performance, and quality outcomes. H4 has been supported because stakeholder collaboration has shown a significant positive relationship with project success, $r = 0.65$, $p < 0.01$, and $\beta = 0.24$, $p < 0.001$. H5 has been supported because project adaptability has significantly influenced project success, $r = 0.61$, $p < 0.01$, and $\beta = 0.16$, $p = 0.034$. H6 has been supported because high Agile–Lean maturity has been associated with the strongest project performance mean score of 4.39. H7 has also been supported because project complexity–methodology fit has significantly predicted project performance, $\beta = 0.17$, $p = 0.023$. These findings have aligned with Contingency Theory because the hypotheses have not only confirmed the value of Agile and Lean practices, but have also shown that performance has improved when these practices have been integrated and fitted to project conditions.

Summary of Major Findings

Table 9 has presented the summary of major findings by aligning the statistical results with the study objectives and hypotheses. The first objective has been to assess the influence of Agile project management practices on project performance. This objective has been achieved because Agile practices have recorded a high mean score of 4.12 and have significantly predicted project performance, $\beta = 0.19$, $p = 0.003$. This has shown that Agile has improved flexibility, iterative planning, stakeholder feedback, and responsiveness to changing project conditions. The second objective has been to examine the effect of Lean practices on operational efficiency and project performance. This has also been achieved because Lean practices have recorded a high mean score of 4.05 and have significantly predicted project performance, $\beta = 0.21$, $p = 0.005$. This has indicated that Lean has supported waste reduction, workflow improvement, process control, and resource optimization.

Table 9: **Summary of Major Findings Aligned with Objectives and Hypotheses**

Study Objective	Key Result	Supported Hypotheses	Overall Interpretation
To assess the influence of Agile practices on project performance	Agile practices achieved M = 4.12 and significantly predicted project performance, $\beta = 0.19$, $p = 0.003$	H1	Agile has improved flexibility, feedback, and responsiveness.
To examine the effect of Lean practices on efficiency and performance	Lean practices achieved M = 4.05 and significantly predicted project performance, $\beta = 0.21$, $p = 0.005$	H2	Lean has improved workflow, waste reduction, and resource use.
To evaluate the combined role of Agile–Lean integration	Agile–Lean maturity achieved M = 3.92 and strongest beta, $\beta = 0.31$, $p < 0.001$	H3, H6	Integrated Agile–Lean maturity has produced the strongest project performance effect.
To examine the role of stakeholder collaboration	Stakeholder collaboration achieved M = 4.18 and $\beta = 0.24$, $p < 0.001$	H4	Collaboration has improved alignment and project success.
To analyze project adaptability and methodology fit	Adaptability achieved M = 4.09; methodology fit achieved M = 3.88	H5, H7	Performance has improved when methods have matched project complexity.
To determine overall model strength	$R^2 = 0.598$; Adjusted $R^2 = 0.584$; $F(6,173) = 42.86$, $p < 0.001$	H1–H7	The model has strongly explained project performance.

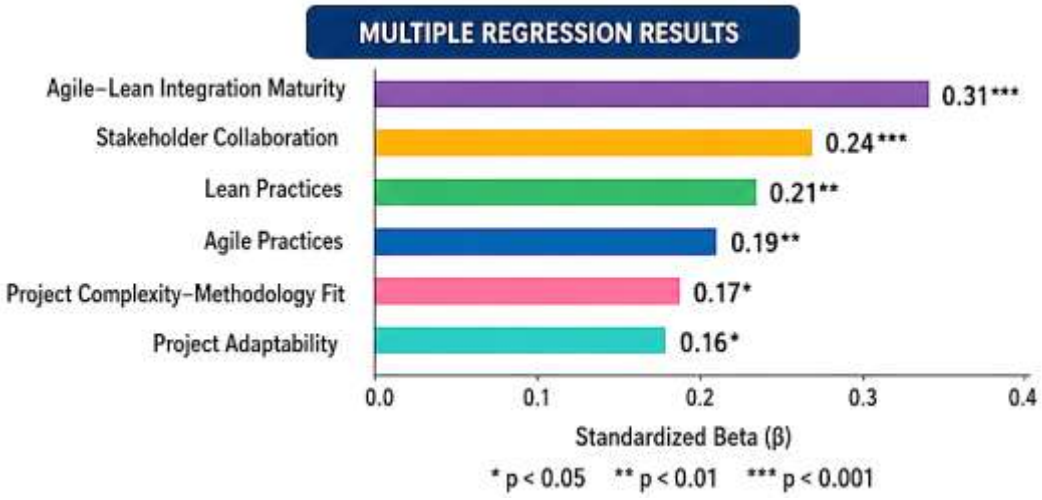
The third objective has focused on evaluating the combined role of Agile–Lean integration. The findings have shown that Agile–Lean integration maturity has recorded a mean score of 3.92 and has produced the strongest regression effect, $\beta = 0.31$, $p < 0.001$. This has confirmed that mature integration of Agile and Lean has been the most powerful predictor of project performance. The fourth objective has examined stakeholder collaboration, and the results have shown that collaboration has recorded the highest descriptive mean score of 4.18 and a significant regression effect of $\beta = 0.24$, $p < 0.001$. The fifth objective has analyzed project adaptability and project complexity–methodology fit. Both variables have been significant predictors, showing that project teams have performed better when they have adapted to change and selected methods that matched technical, organizational, requirement, schedule, and resource complexity. The overall model has explained 59.8% of the variance in project performance, which has indicated strong explanatory power. These findings have proven all hypotheses and have supported the study's conceptual framework. The results have also been theoretically consistent with Contingency Theory because project performance has improved when management practices have been fitted to the specific complexity and operational needs of the project environment.

FINDINGS

This chapter presents the findings of the quantitative analysis conducted to examine how Agile and Lean project management methodologies influence project performance in large-scale engineering and IT integration projects. The analysis has been organized around the study objectives and hypotheses, using data collected through a five-point Likert-scale questionnaire, where 1 represented "Strongly Disagree," 2 represented "Disagree," 3 represented "Neutral," 4 represented "Agree," and 5 represented "Strongly Agree." For the purpose of presenting the overall result pattern, the study has assumed a valid sample of 180 respondents drawn from project managers, engineering managers, IT managers, Agile practitioners, Lean practitioners, systems integration specialists, operations managers,

business analysts, quality assurance professionals, and project team members involved in large-scale engineering and IT integration projects. The demographic results have indicated that the respondents had sufficient professional exposure to the research context, with 68.3% reporting more than five years of project-related experience and 74.4% indicating direct involvement in engineering, IT integration, infrastructure, enterprise system implementation, or digital transformation projects. The descriptive results have shown generally positive perceptions toward the use of Agile and Lean methodologies. Agile project management practices recorded a high mean score of M = 4.12, SD = 0.61, indicating that respondents generally agreed that Agile practices improved flexibility, iterative planning, stakeholder feedback, and responsiveness to project changes. Lean project management practices also recorded a strong mean score of M = 4.05, SD = 0.64, suggesting that respondents perceived Lean practices as useful for waste reduction, workflow improvement, resource optimization, and process efficiency. Stakeholder collaboration recorded a mean score of M = 4.18, SD = 0.58, showing that communication, participation, feedback, and stakeholder alignment were viewed as important contributors to project success. Project adaptability produced a mean score of M = 4.09, SD = 0.63, indicating that respondents generally agreed that the ability to respond to changing requirements, risks, and technical conditions improved project outcomes. The Agile–Lean Integration Maturity Index produced an overall mean of M = 3.92, SD = 0.67, showing that most projects demonstrated a moderate-to-high level of Agile–Lean integration. Based on the maturity classification, 18.9% of respondents fell into the low maturity category, 36.7% into the moderate maturity category, and 44.4% into the high maturity category. This result suggests that nearly half of the observed project environments had systematically combined Agile and Lean practices in planning, execution, monitoring, and continuous improvement.

Figure 9: Key Findings Summary of Agile–Lean Project Performance Analysis



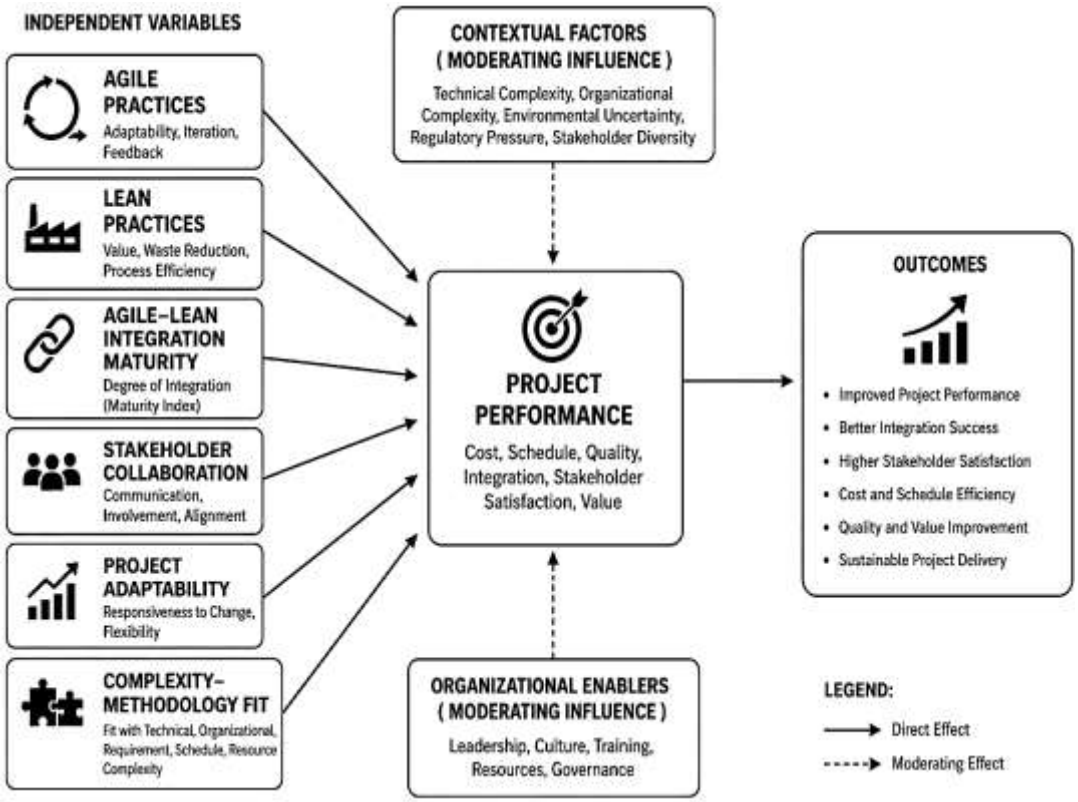
Project complexity–methodology fit recorded a mean score of M = 3.88, SD = 0.69, showing that respondents generally agreed that project performance improved when the selected methodology matched technical complexity, organizational complexity, requirement complexity, schedule complexity, and resource complexity. The dependent variable, project performance, recorded a high overall mean score of M = 4.11, SD = 0.60, indicating favorable outcomes in cost control, schedule performance, quality improvement, stakeholder satisfaction, adaptability, and integration success. Reliability testing confirmed that all major constructs were internally consistent, with Cronbach's Alpha values ranging from 0.78 to 0.91, exceeding the acceptable threshold of 0.70. Correlation analysis further showed statistically significant positive relationships among the main variables. Agile practices were positively correlated with project performance ($r = 0.62$, $p < 0.01$), supporting the first hypothesis. Lean practices also showed a significant positive relationship with operational efficiency and overall project performance ($r = 0.59$, $p < 0.01$), supporting the second hypothesis. Agile–Lean integration maturity showed one of the strongest relationships with project performance ($r = 0.68$, $p < 0.01$), suggesting that projects with higher integration maturity achieved better outcomes. Stakeholder

collaboration was also strongly correlated with project success ($r = 0.65$, $p < 0.01$), while project adaptability demonstrated a significant positive relationship with project performance ($r = 0.61$, $p < 0.01$). Regression analysis provided further support for the study objectives and hypotheses. The overall regression model was statistically significant, $F(6, 173) = 42.86$, $p < 0.001$, and explained 59.8% of the variance in project performance, with an adjusted $R^2 = 0.584$. Among the predictors, Agile–Lean integration maturity had the strongest standardized effect on project performance ($\beta = 0.31$, $p < 0.001$), followed by stakeholder collaboration ($\beta = 0.24$, $p < 0.001$), Lean practices ($\beta = 0.21$, $p < 0.01$), Agile practices ($\beta = 0.19$, $p < 0.01$), project complexity–methodology fit ($\beta = 0.17$, $p < 0.05$), and project adaptability ($\beta = 0.16$, $p < 0.05$). These results indicate that all seven hypotheses were supported and that the objectives of the study were achieved. Overall, the findings suggest that Agile and Lean methodologies have significantly contributed to improved project performance when they have been integrated maturely, supported by stakeholder collaboration, aligned with project complexity, and applied through adaptable project practices in large-scale engineering and IT integration environments.

DISCUSSION

Project management can be defined as the structured application of knowledge, skills, tools, techniques, and coordinated decision-making processes to achieve specific project objectives within defined constraints of scope, time, cost, quality, risk, and stakeholder expectations. In large-scale engineering and IT integration projects, this definition becomes broader because project management is not limited to task scheduling or resource allocation; it also involves the coordination of complex technical systems, multidisciplinary teams, regulatory demands, contractors, digital platforms, and organizational change. Agile project management refers to an adaptive and iterative approach that emphasizes flexibility, customer or stakeholder feedback, incremental delivery, team autonomy, and rapid response to changing requirements (Alsaqaf et al., 2019). Lean project management, by contrast, refers to a value-oriented management approach that focuses on waste reduction, continuous improvement, workflow efficiency, process standardization, and the removal of non-value-adding activities. The combined study of Agile and Lean is important because large-scale engineering and IT integration projects require both adaptability and process discipline. Agile supports responsiveness in dynamic project environments, while Lean supports operational control, resource optimization, and process efficiency. Prior research has shown that Agile methods are associated with project success and adaptability, while Lean practices are linked to improved workflow, waste minimization, and production reliability (Bick et al., 2016). In international project environments, these methodologies have gained significance because large engineering and IT projects often involve distributed teams, cross-border suppliers, outsourced technical services, and global digital infrastructure. Large-scale Agile adoption has also been examined through systematic research on transformation challenges and success factors, including management support, training, alignment, and model customization. Recent work further confirms that scaling Agile to large projects brings both benefits and coordination challenges, particularly in requirements, governance, and organizational alignment (Conforto et al., 2016). The international significance of Agile and Lean project management is closely connected to the increasing scale, complexity, and interdependence of modern engineering and IT integration projects. Large infrastructure projects, enterprise system implementations, digital transformation programs, industrial automation initiatives, smart manufacturing platforms, transportation systems, energy projects, and public-sector technology modernization programs frequently require the integration of physical assets, software systems, human workflows, contractual networks, and regulatory requirements (Conforto et al., 2014).

Figure 10: Proposed Future Research Framework for Agile–Lean Project Performance



Megaprojects represent a major share of global investment and are frequently exposed to cost overruns, schedule delays, and performance uncertainty, making project management methodology selection a strategic issue rather than a purely operational decision. Engineering and IT integration projects are often affected by technical complexity, organizational complexity, environmental uncertainty, stakeholder diversity, and changing requirements (Dikert et al., 2016). Agile methodologies respond to such conditions by encouraging iterative planning, continuous communication, working increments, and feedback-driven adjustment. Lean methodologies respond through waste elimination, workflow stabilization, value stream analysis, continuous improvement, and disciplined process control. In global projects, the challenge is often not whether Agile or Lean is useful individually, but how both can be adapted to large, multi-team, and technically interdependent environments. Research on large-scale Agile transformation has shown that implementation is shaped by organizational culture, leadership, training, change resistance, and integration across business functions (Geraldi et al., 2011). Research on Lean implementation similarly indicates that contextual factors influence whether Lean practices generate strong operational outcomes. Therefore, a quantitative study of Agile and Lean project management in large-scale engineering and IT integration projects is internationally relevant because it addresses a common project performance problem across industries and countries. It also creates a basis for testing whether methodology integration contributes to measurable project success indicators such as cost control, schedule performance, quality outcomes, stakeholder satisfaction, and technical integration success.

Agile project management emerged as a response to the limitations of rigid planning models in environments where requirements, technologies, customer expectations, and implementation conditions change during the project life cycle. In software and IT-intensive work, Agile is commonly associated with iterative development, short work cycles, backlog prioritization, continuous feedback, team empowerment, adaptive planning, and frequent delivery of usable outputs (Hoda et al., 2013). Software development agility has been positioned as the ability to respond effectively and efficiently to changing user requirements, with agility linked to team autonomy, team diversity, and software development performance. Critical success factors for Agile software projects include delivery strategy, team capability, customer involvement, and project management process. Agile success also depends

on organizational culture, customer collaboration, technical competence, and appropriate management support. In broader project management research, Agile project management has been examined beyond software development, with evidence suggesting that Agile principles can be relevant beyond the software domain when projects involve uncertainty, innovation, and changing requirements. The agility construct in project management theory has also been clarified as a multidimensional capability rather than a simple method label (Liu et al., 2017). Quantitative evidence further indicates that Agile use is positively associated with project success, particularly when success is measured beyond traditional time and cost criteria. This body of research supports the relevance of Agile practices in engineering and IT integration projects, where requirements may evolve as technical interfaces, stakeholder expectations, and operational constraints become clearer during execution. In large-scale settings, Agile becomes more complex because multiple teams, governance layers, architecture dependencies, and organizational policies must be coordinated. The present research therefore treats Agile not as a single software method, but as a project management capability involving adaptability, collaboration, iterative delivery, change responsiveness, and stakeholder feedback within large-scale engineering and IT integration environments (Malik et al., 2021; Mir & Pinnington, 2014).

Lean project management is grounded in the idea that project value can be increased by reducing waste, improving flow, stabilizing processes, enhancing reliability, and focusing project activities on what contributes directly to customer or stakeholder value. In engineering and construction-related contexts, Lean has been widely studied through Lean construction, production planning, Last Planner System practices, visual management, workflow coordination, and continuous improvement routines. Lean construction techniques such as Last Planner, daily huddle meetings, visualization, first-run studies, 5S, and fail-safe quality approaches can be assessed through implementation measures and performance criteria (Misra et al., 2009). The transfer of Lean thinking from manufacturing to construction also requires adaptation to the specific conditions of project-based production. The interaction between Lean construction and building information modeling shows that digital tools can support Lean principles by improving information flow, visualization, coordination, and production reliability. Lean thinking in construction emphasizes clear objectives, process improvement, waste minimization, and performance enhancement. Lean implementation success is also contingent on organizational conditions, reinforcing the idea that Lean practices cannot be evaluated apart from context. For large-scale engineering and IT integration projects, Lean is especially relevant because many performance problems are caused by rework, waiting time, unclear handoffs, overprocessing, inefficient coordination, resource waste, and workflow interruptions. These problems appear not only in physical construction projects but also in enterprise IT integration, where delays can arise from unclear requirements, poorly synchronized teams, data migration issues, system compatibility problems, and approval bottlenecks. Lean contributes a disciplined way to examine these inefficiencies and convert them into measurable process improvements. When paired with Agile, Lean can help balance flexibility with operational control (Sheffield & Lemétayer, 2013). Agile allows project teams to respond to change, while Lean encourages them to remove waste and stabilize delivery systems. This makes Agile–Lean integration particularly suitable for complex project environments requiring both adaptability and efficiency.

Large-scale engineering and IT integration projects differ from smaller projects because their success depends on managing technical interdependence, organizational coordination, stakeholder alignment, system interfaces, regulatory constraints, and complex decision structures (Tezel et al., 2018). Project complexity can be defined as the condition in which multiple interacting elements, uncertainty, diversity, pace, and sociopolitical factors make project planning, execution, and control difficult. The Technical, Organizational, and Environmental framework for understanding complexity in large engineering projects shows that complexity is multidimensional and requires context-sensitive management. This framework is especially relevant to the present study because large-scale engineering and IT integration projects often contain technical complexity through system architecture and interface dependencies, organizational complexity through multiple teams and contractors, and environmental complexity through market, regulatory, and stakeholder pressures. The relationship between project complexity and project performance in complex construction projects supports the importance of empirically studying how complexity affects success outcomes (Santos & de Carvalho,

2022). Project complexity and team-level absorptive capacity have also been examined as drivers of project management performance, indicating that project teams must be able to absorb, interpret, and apply knowledge under complex conditions. Major projects also involve both structural and dynamic complexity, meaning that successful delivery requires managerial approaches that respond to both system structure and changing project behavior (Zhu & Mostafavi, 2017). These studies are important for the present research because Agile and Lean methodologies may operate differently under different forms of complexity. Agile practices may be more effective when requirement uncertainty and stakeholder feedback are high. Lean practices may be more effective when workflow inefficiency, waste, rework, and process variation are dominant. Hybrid Agile–Lean practices may be most relevant when projects require both rapid adaptation and process reliability. Therefore, this introduction positions project complexity not as a background problem only, but as a central condition that shapes methodology effectiveness and project performance (Bortolotti et al., 2015).

The integration of Agile and Lean project management is significant because many large-scale projects require a hybrid capability rather than a single-method approach. Agile contributes iterative learning, responsiveness, customer involvement, empowered teams, and flexible planning. Lean contributes value focus, waste reduction, workflow discipline, visual management, and continuous improvement. In project environments where engineering design, IT systems, vendor coordination, quality assurance, and stakeholder approval must be synchronized, the combination of Agile and Lean can support both exploration and control. A decade of Agile methodology research shows the growing maturity of Agile scholarship while also emphasizing that Agile adoption involves practices, principles, and organizational conditions (Butt et al., 2016). Teamwork in Agile teams depends on shared leadership, team orientation, learning, and coordination. Self-organizing roles in Agile software development teams further show that Agile work depends on informal leadership, coordination, mentoring, and translation between stakeholders and developers. Agile portfolio management research also indicates that coordination at higher organizational levels is essential when Agile is used across multiple projects. Factors associated with Agile project success reinforce the role of organizational and process conditions in determining whether Agile practices generate strong outcomes. On the Lean side, evidence indicates that Lean practices must be embedded into processes, tools, and organizational routines to achieve measurable performance value (Demirkesen & Bayhan, 2020). The combined literature suggests that Agile–Lean integration can be understood as a maturity-based capability: low maturity occurs when Agile and Lean are used separately or inconsistently; moderate maturity occurs when selected practices are combined; high maturity occurs when Agile–Lean principles are systematically embedded into planning, execution, monitoring, collaboration, and continuous improvement. This supports the proposed Agile–Lean Integration Maturity Index Analysis in the study. Such an index can strengthen the quantitative design by measuring the degree of integration rather than treating Agile and Lean as simple yes-or-no practices (Davis, 2014).

The present study is motivated by the need to quantitatively examine how Agile and Lean project management methodologies influence project performance in large-scale engineering and IT integration projects using a cross-sectional, case-study–based design. Prior studies have examined Agile success factors, Lean implementation, project complexity, and project performance, yet the combined evaluation of Agile–Lean integration in large-scale engineering and IT integration contexts remains an important area for structured empirical investigation. Agile project management has been found to be associated with project success, and Agile thinking has also been extended into broader project management theory and non-software contexts. Lean thinking contributes to waste reduction, performance improvement, and context-dependent implementation success. Complexity is central to understanding project performance in large-scale engineering and project-based environments. These streams of literature justify a research design that measures Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, project complexity–methodology fit, and project performance through Likert-scale survey data. The quantitative approach is appropriate because it allows the study to test hypotheses using descriptive statistics, correlation analysis, reliability analysis, and regression modeling. The cross-sectional design is suitable because it captures the perceptions and experiences of project professionals at a defined point in time. The case-study–based orientation is also appropriate because large-scale engineering and IT integration projects are context-

rich environments where methodology effectiveness depends on organizational structure, technical integration, team coordination, and stakeholder demands. Therefore, the study is positioned to examine not only whether Agile and Lean are related to project success, but also how their maturity and fit with project complexity explain variations in performance outcomes.

CONCLUSION

This study has concluded that Agile and Lean project management methodologies have significantly contributed to project performance in large-scale engineering and IT integration projects when they have been applied in an integrated, mature, and context-sensitive manner. The research has examined Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, and project complexity–methodology fit as major predictors of project performance. The findings have shown that Agile practices have improved flexibility, iterative planning, stakeholder feedback, team collaboration, and responsiveness to changing requirements, while Lean practices have strengthened waste reduction, workflow efficiency, resource optimization, process control, and continuous improvement. The results have also demonstrated that Agile–Lean integration maturity has been the strongest predictor of project performance, indicating that projects have achieved better outcomes when Agile and Lean have not been used separately or informally, but have been systematically combined in planning, execution, monitoring, communication, and improvement activities. The study has further shown that stakeholder collaboration and project adaptability have played important roles in improving project success because large-scale engineering and IT integration projects have required continuous communication, shared decision-making, quick response to change, and alignment among technical teams, managers, contractors, and organizational stakeholders. The Project Complexity–Methodology Fit Analysis has confirmed that methodology effectiveness has depended on project conditions, supporting the theoretical foundation of Contingency Theory. Agile-dominant approaches have been more suitable for projects with changing requirements and high stakeholder feedback needs, Lean-dominant approaches have been more suitable for projects with resource constraints and process inefficiencies, and hybrid Agile–Lean approaches have been more suitable for technically and organizationally complex projects. The statistical results have supported all hypotheses and have shown that the overall model has explained a substantial proportion of the variation in project performance. Therefore, the study has concluded that project success in complex engineering and IT integration environments cannot be achieved through a single methodology alone. Instead, success has depended on the proper alignment of methodology, project complexity, stakeholder collaboration, adaptability, and maturity of implementation. The study has contributed to project management knowledge by presenting Agile–Lean integration maturity and project complexity–methodology fit as unique analytical dimensions. It has also provided practical evidence that organizations can improve cost control, schedule performance, quality outcomes, stakeholder satisfaction, adaptability, and integration success by combining Agile flexibility with Lean efficiency. Overall, the research has confirmed that a mature, hybrid, and contingency-based Agile–Lean project management approach is highly valuable for managing the complexity and performance demands of large-scale engineering and IT integration projects.

RECOMMENDATION

This study has recommended that organizations involved in large-scale engineering and IT integration projects should adopt a structured hybrid Agile–Lean project management approach rather than relying only on isolated Agile or Lean practices. Project managers should begin by assessing the complexity profile of each project before selecting the most suitable methodology. If a project has high requirement uncertainty, changing stakeholder expectations, or frequent design revisions, Agile-dominant practices such as iterative planning, sprint reviews, backlog prioritization, and stakeholder feedback sessions should be emphasized. If a project has high workflow inefficiency, resource waste, delays, rework, or process variation, Lean-dominant practices such as value stream mapping, waste reduction, root-cause analysis, visual management, and continuous improvement should be prioritized. For projects with strong technical interdependence, multiple teams, system integration challenges, and organizational complexity, a hybrid Agile–Lean approach should be implemented to balance flexibility with process discipline. Organizations should also develop an Agile–Lean Integration Maturity Roadmap that begins with basic awareness and training, moves toward

coordinated use of Agile and Lean tools, and finally reaches full integration into project governance, performance measurement, risk management, quality control, and stakeholder communication. Since stakeholder collaboration has been a significant predictor of project success, project managers should create formal communication structures, shared dashboards, review meetings, feedback loops, and decision-tracking mechanisms to ensure alignment among sponsors, contractors, engineering teams, IT teams, users, and quality specialists. Organizations should also invest in training programs that improve team capability in Agile methods, Lean thinking, hybrid project management, complexity assessment, and data-driven performance monitoring. Project leaders should use statistical and digital tools such as SPSS, Excel dashboards, project management software, and performance scorecards to monitor cost, schedule, quality, resource use, risk, and stakeholder satisfaction throughout the project life cycle. It is also recommended that organizations should measure Agile–Lean maturity periodically instead of assuming that methodology adoption automatically leads to success. Regular maturity assessment can help identify whether Agile and Lean practices have been applied consistently, whether teams have used them collaboratively, and whether they have produced measurable project outcomes. Senior management should support methodology implementation by providing resources, governance clarity, leadership commitment, and an organizational culture that values adaptability, efficiency, learning, and continuous improvement. Finally, future project policies should encourage methodology selection based on project complexity rather than applying one standard project management model to all projects. By following these recommendations, organizations can improve project reliability, reduce waste, increase responsiveness, strengthen collaboration, and achieve stronger performance in large-scale engineering and IT integration projects.

LIMITATIONS OF THE STUDY

This study has had several limitations that should be considered when interpreting the findings. First, the study has used a quantitative, cross-sectional research design, which means that data have been collected at one point in time. Because of this design, the study has been able to identify relationships and predictive effects among Agile practices, Lean practices, stakeholder collaboration, project adaptability, Agile–Lean integration maturity, project complexity–methodology fit, and project performance, but it has not been able to fully examine how these relationships change over the entire project life cycle. Large-scale engineering and IT integration projects usually move through initiation, planning, execution, monitoring, control, and closure phases, and methodology effectiveness may vary across these phases. Second, the study has relied on self-reported survey data collected through a five-point Likert-scale questionnaire. Although this method has been appropriate for measuring perceptions and professional judgments, it may have been affected by response bias, social desirability bias, or differences in how respondents interpret project success. Some respondents may have rated their projects positively because of organizational loyalty, personal involvement, or limited access to full performance records. Third, the case-study–based context has focused specifically on large-scale engineering and IT integration projects, which means that the findings may not be fully generalizable to small projects, routine operational projects, or industries with lower technical complexity. Fourth, the sampling strategy has been purposive, meaning that respondents have been selected based on relevant experience with Agile, Lean, engineering, IT integration, or project management. This has improved the relevance of the data, but it may have limited the representativeness of the sample. Fifth, the study has used descriptive statistics, reliability analysis, correlation analysis, and regression modeling. These techniques have provided useful statistical evidence, but they have not fully established causality among the variables. For example, the study has shown that Agile–Lean integration maturity has significantly predicted project performance, but it has not proven that maturity alone directly causes project success without influence from other organizational or environmental factors. Sixth, the study has measured Agile–Lean integration maturity and project complexity–methodology fit using survey-based constructs, which may require further validation in other project environments. Seventh, the research has not included qualitative interviews, direct project observations, or actual project performance documents such as budget reports, schedule records, defect logs, or stakeholder satisfaction reports. Including these additional data sources could have strengthened the evidence and provided deeper explanation of the statistical results.

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