DEVELOPING AN AGILE-ORIENTED PROJECT MANAGEMENT FRAMEWORK FOR MALAYSIAN CONSTRUCTION INDUSTRY

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By

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ABSTRACT

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Persistent issues in the construction industry—including delays, cost overruns, coordination breakdowns, and limited adaptability—highlight the need for more responsive project management approaches. While Agile methods have demonstrated benefits in managing uncertainty and enhancing collaboration in other industries, their systematic integration within construction remains underexplored, particularly in Malaysia. The absence of validated Agile-oriented practices, limited empirical evidence on their alignment with Agile values and principles, and a lack of understanding of demographic influences underscore a clear research gap and justify the need for this study. The research objectives are to (i) identify common construction project management practices in Malaysia, (ii) examine their alignment with Agile values and Agile principles, (iii) investigate their relationships with project performance, (iv) analyse differences in these practices across practitioner demographics, and (v) develop an Agile-oriented construction project management framework. This study adopted a positivist research philosophy and employed a quantitative research design. Data were collected using a structured questionnaire encompassing Agile values and principles, construction project management practices, and project performance, which was administered to construction practitioners in Malaysia ($n = 252$). Data preparation involved reliability and validity assessments, followed by descriptive analysis, exploratory factor analysis (EFA), Spearman correlation, Kruskal–Wallis with Dunn-Bonferroni post-hoc tests, and cluster analysis to segment practitioners by agility orientation. The EFA revealed eight Agile-oriented common practices: Resilient Team, Transparent Environment, Progressive Assessment, Adaptive Development, Bespoke Processes, Pragmatic

Delivery, Continuous Refinement, and Engaging Stakeholders. Strong positive correlations demonstrated that all eight practices align with Agile values, Agile principles, and project performance. Significant differences were observed across profession, industry experience, designation level, and business nature. Cluster analysis further identified "More Agile" and "Less Agile" practitioner groups, with quantity surveyors, less-experienced practitioners, non-managerial roles, contractors, infrastructure project involvement, and small-to-medium firms exhibiting higher agility orientation. These findings informed the development of an integrated Agile-oriented construction project management framework that links common practices, Agile constructs, project performance, and demographic tendencies. Overall, the study provides empirical evidence that Agile-oriented practices are present within Malaysian construction workflows and can meaningfully enhance project performance when aligned with Agile thinking. The proposed framework contributes theoretical advancement to the Agile-construction domain and offers practical guidance for improving adaptability, collaboration, and delivery effectiveness in the Malaysian construction industry.

Keywords: Agile-Oriented Construction Project Management; Malaysian Construction Industry; Project Performance; Practitioner Demographics; Framework Development

Subject Area: HD9715-9717.5 Construction Industry

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DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: Tung Yew Hou

Date: 6 January 2026

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LIST OF ABBREVIATIONS

AP	Agile principles
APM	Agile project management
AV	Agile values
CFA	Confirmatory factor analysis
CI	Confidence interval
CLT	Central limit theorem
CMB	Common method bias
CP	Common practices
CPM	Construction project management
d	Cohen's effect size
EFA	Explanatory factor analysis
KMO	Kaiser-Meyer-Olkin
K-W	Kruskal-Wallis
LA	Less Agile
M	Mean
MA	More Agile
MED	Median
MR	Mean rank
M-W	Mann-Whitney
N	Number
P	Practices in CPM
PCA	Principal component analysis
PM	Project management
PMBOK®Guide	A Guide to the Project Management Body of Knowledge
PP	Project performances
r	Spearman's rank coefficient of correlation
r^2	Coefficient of determination
SBOK®Guide	A Guide to the Scrum Body of Knowledge
SD	Standard deviation
Sig.	Significance
SPSS	Statistical package for the social sciences

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Project management has evolved substantially over the past century. In its early stages, it relied heavily on the intuition and experience of practitioners, but the increasing scale and complexity of projects created a need for more structured approaches. One of the earliest formal methodologies was the waterfall model, originating in mid-20th-century manufacturing and construction. This linear, sequential process emphasizes comprehensive upfront planning, detailed documentation, and a clear understanding of requirements before execution (PMI, 2017a).

In the early 2000s, the limitations of the waterfall approach—particularly its rigidity in dynamic and technology-driven environments—prompted the emergence of Agile methodologies within the software development industry. Agile introduced iterative and incremental cycles, prioritising collaboration, customer feedback, and adaptability to changing requirements. Its emphasis on flexibility and continuous improvement has made it highly effective in sectors where uncertainty and rapid change are common, especially software development (Beck et al., 2001).

The construction industry has traditionally depended on the waterfall approach due to its predictable and structured nature. Construction projects involve multiple stakeholders — architects, engineers, contractors, and clients — whose responsibilities are typically organised in sequential phases. This linear structure offers a clear roadmap, reduces miscommunication, and supports adherence to predefined scope and objectives (Marques et al., 2023). However, the rigidity of the waterfall method has been widely criticised. Construction projects often face unforeseen challenges such as weather disruptions, supply delays, and evolving client requirements. Because waterfall relies on fixed plans and limited flexibility once construction begins, such variations frequently lead to delays, cost overruns, and dissatisfaction when the final outcome diverges from client expectations (Serrador & Pinto, 2015).

In contrast, the IT sector has embraced agile as its dominant management paradigm. Agile frameworks such as Scrum and Kanban use short development cycles and continuous client engagement to ensure projects evolve in alignment with user needs. These features enable teams to manage complexity, respond rapidly to changes, and deliver value incrementally — factors that contribute to high levels of customer satisfaction (Dingsøyr et al., 2012).

Despite its strengths, the waterfall method continues to present significant challenges in construction. One persistent issue is its limited capacity to accommodate change once execution begins. Addressing unforeseen conditions — such as design errors, regulatory revisions, or unexpected site constraints — often requires revisiting completed phases, increasing both time and cost (Lalmi et al., 2021). Another limitation is the minimal client involvement during construction. When feedback opportunities are concentrated in the early stages, the final product may not fully reflect the client's evolving needs, increasing the likelihood of disputes (Azhar, 2011). Furthermore, the requirement for detailed upfront planning places heavy demands on time and resources; in many real-world projects, complete and accurate information may not be available during the early phases (Love et al., 2017).

Given the challenges of the waterfall method, the construction industry is exploring the integration of agile practices into project management. While a full transition from waterfall to agile is unlikely due to the physical and regulatory constraints of construction, selective adoption of agile practices has potential to improve outcomes (Conforto et al., 2014b). One promising area is the planning and design stage, where iterative and collaborative design cycles could help refine requirements early, reduce costly rework, and align outcomes more closely with client expectations (Koskela et al., 2007).

Agile ideas may also enhance scheduling and resource management. Breaking projects into smaller, manageable components enables teams to prioritise critical activities and adapt more effectively to disruptions. This approach supports responsiveness in the face of delays, resource shortages, or emerging constraints (Owen et al., 2006). Additionally, increased client engagement throughout the project lifecycle, a core agile principle, can strengthen trust, enhance transparency, and improve overall satisfaction (Eriksson & Westerberg, 2011).

1.2 Problem Statement

The construction industry in Malaysia remains a vital contributor to national development, yet it continues to face persistent project performance challenges, including delays, cost overruns, poor coordination, and inefficient project delivery processes (Shedu et al., 2014). These problems are reinforced by the industry's long-standing reliance on traditional project management approaches such as the waterfall method, which emphasises sequential planning and fixed requirements. While effective for stable environments, this method often fails to accommodate the dynamic and uncertain nature of construction projects, where design changes, unforeseen site conditions, and shifting stakeholder needs frequently occur (Wysocki, 2019; Siegel, 2019).

Global evidence highlights the severity of these performance issues. McKinsey reports that 98% of megaprojects exceed their budgets by more than 30% and 77% experience delays of at least 40% (Changali et al., 2015). More recent findings from CIDB (2023a) and KPMG (Armstrong et al., 2023) show similar trends locally, indicating systemic weaknesses in communication, risk management, and project coordination. These longstanding challenges underscore the need for more adaptive and collaborative project delivery approaches.

While Agile emerged from software development, its adaptive philosophy has shown relevance to construction contexts where complexity, uncertainty, and stakeholder dynamics prevail. Although construction projects often begin with well-defined scopes, the realities of design coordination, regulatory compliance, and client-driven change demand adaptive management behaviours. Hence, rather than viewing Agile as unsuitable from the outset, it should be understood as a complementary philosophy that enriches traditional construction project management through flexibility, collaboration, and continuous value delivery (Conforto et al., 2014b).

Agile, which emphasises iterative development, stakeholder engagement, and rapid response to change, has gained substantial success in software, IT, and manufacturing industries. Its principles—continuous feedback, early value delivery, and collaborative decision-making—appear highly relevant to the complexities of construction projects (Cesarotti et al., 2019). However, despite its potential, the application of Agile practices in construction remains limited and poorly understood globally, and even more so in Malaysia (Albuquerque et al., 2020; Chia et al., 2022). Evidence from the 17th State of Agile Report by Digital.ai (2023) reinforces this point: among 788 respondents across multiple industries—technology (26%), financial services (17%), professional services (7%), healthcare and pharma (7%), government (7%), industrial manufacturing (6%), insurance (5%), telecommunications (4%), retail (3%), and transportation (3%)—construction was notably absent or minimally represented. This indicates that Agile adoption continues to be concentrated in technology-driven sectors, with limited penetration into construction. Furthermore, a persistent lack of awareness and understanding of Agile concepts among construction practitioners, combined with the scarcity of empirical research exploring its applicability to construction environments, continues to hinder wider adoption

(Owen & Koskela, 2006; Ribeiro & Fernandes, 2010). Although Agile has gained significant attention in IT, software, and product development sectors, scientific research on its application within the construction industry remains limited. Existing studies predominantly emphasise software development, while construction-related research continues to rely heavily on traditional project management approaches (Conforto et al., 2016; Ozorhon et al., 2022). In addition, the construction sector's rigid contractual structures, sequential workflows, and fragmented supply chains further restrict the integration of Agile principles into practice (Owen et al., 2006; Dikert et al., 2016). As a result, empirical validation of Agile concepts in construction settings is scarce, with most publications being conceptual, exploratory, or limited to small-scale illustrative case studies. In Malaysia, this gap is even more prominent, as local research has primarily focused on technological innovations such as Building Information Modelling (BIM) and Industrialised Building System (IBS) (Zairul, 2021; CIDB, 2023b), with far less attention given to Agile in construction (Tung et al., 2022; Tung et al., 2024). Therefore, the assertion that scientific research on Agile within construction is lacking is strongly supported by both global and regional evidence of underrepresentation and limited empirical investigation.

The research problem addressed in the research is the applicability of Agile practices. It remains unclear which Agile practices are commonly adopted in Malaysian construction industry, how these practices align with Agile values and principles, and how they influence project performance. Furthermore, the extent to which practitioner demographics such as profession, experience, designation, business nature, project type, and company size influence the adoption of Agile practices is not well understood. The inclusion of demographic group analysis addresses a gap in Agile-oriented construction research, as most prior studies focus on organisational or methodological factors rather than practitioner characteristics (Conforto et al., 2016; Rigby et al., 2018). Given the multidisciplinary nature of construction, professionals such as quantity surveyors, engineers, architects, and project managers differ in decision-making styles and collaboration cultures, which may influence their receptiveness to Agile concepts. Examining these demographic variations introduces a novel perspective that links Agile adoption to human and professional diversity, offering theoretical extension and practical insights. This approach contributes to knowledge by identifying which practitioner groups are more agile-oriented, supporting more targeted strategies to improve industry-wide agility (Conforto et al., 2014a).

Several critical research gaps that limit the advancement of Agile-oriented practices in construction are revealed. First, there is no validated set of Agile-oriented practices specifically tailored to the construction context (Chia et al., 2022). Second, prior studies have not examined how these practices align with the core Agile values and the twelve Agile principles (Chia et al., 2022). Third, empirical evidence linking Agile-oriented practices to construction project performance is limited (Ozorhon et al., 2022). Fourth, no research has investigated how practitioner demographics—such as profession, experience, designation, company size, or project type—shape or differentiate Agile-oriented behaviours within the construction workforce (Tung et al., 2024). Finally, there is currently no integrated framework that combines Agile-oriented practices, Agile values and principles, project performance, and practitioner characteristics to guide industry adoption (Ciric et al., 2018). Together, these gaps highlight the need for a comprehensive empirical study tailored to the Malaysian construction industry.

Although prior studies have discussed Agile approaches in construction, they have largely remained conceptual or method-focused and have not empirically examined agility as a set of operational construction project management practices. Existing research has rarely validated the alignment of such practices with Agile values and principles, nor tested their relationship with construction project performance, while practitioner-level demographic differences in agile orientation remain under-explored. Accordingly, this study addresses these gaps by formulating research questions that examine (i) the common construction project management practices adopted in Malaysia, (ii) their alignment with Agile values and principles, (iii) their relationship with project performance, (iv) demographic-based differences in agile orientation among practitioners, and (v) the integration of these elements into an Agile-oriented construction project management framework. These research questions are operationalised through corresponding research objectives, as presented in Sections 1.3 and 1.4.

1.3 Research Questions

Seven (7) research questions are formulated for this research as follows:

i) What are the common practices for construction project management in Malaysia?

ii) How do the common practices align with agile values?

iii) How do the common practices align with agile principles?

iv) What is the relationship between common practices and project performance?

v) Which practitioner demographics contribute to differences in common practices?

vi) Which practitioner groups demonstrate higher or lower agile orientation based on common practices adoption?

vii) How can common practices, agile values, agile principles, project performance, and practitioner demographics be integrated into a framework for agile-oriented construction project management?

1.4 Research Aim and Objectives

This research aims to develop an empirically grounded Agile-oriented construction project management framework for the Malaysian construction industry. The following research objectives underpinned the study:

i) To identify common practices for construction project management in Malaysia.

This objective focuses on understanding the current project management practices widely used in the Malaysian construction industry. It will help establish a baseline of existing practices before exploring their relationship with agile approaches.

ii) To investigate the alignment of common practices with agile values and agile principles.

Agile values, such as stakeholder interaction, value delivery, customer collaboration, and responding to change, may align or contrast with existing construction project management approaches. Agile principles emphasize adaptability, continuous improvement, and stakeholder involvement. This objective seeks to determine how well agile values and principles align with existing construction practices in Malaysia.

iii) To investigate the relationships between common practices and project performance.

This objective will assess the impact of existing construction practices on these project performances when agile approaches are applied in the construction industry. It will explore the potential benefits of agile approaches in this sector.

iv) To examine differences in common practices across practitioner demographics.

This objective aims to identify specific demographic factors that influence practitioners' openness to or preference for agile practices. It will help in understanding which groups are more likely to embrace agile approaches, and identifying these trends will provide insights into which groups are more open to agile adoption.

v) To develop an agile-oriented project management framework for the construction industry.

This objective aims to develop an integrated framework that combines empirical common practices, Agile values and principles, project performance, and practitioner demographic influences. This framework provides a holistic guide for applying agile-oriented approaches in construction project management.

1.5 Outline of the Report

This study was structured into six chapters: introduction, literature review, research methodology, analysis and findings, discussions, and conclusion and recommendations. Chapter One presents an overview of Agile approaches and establishes the research problem underpinning this study. It also formulates seven research questions, which in turn inform the development of the corresponding research objectives.

Chapter Two clarifies the concept of agility and provides an overview of Agile approaches, including the Agile Manifesto and its underlying values and principles, with specific reference to their relevance in construction projects. The chapter further reviews construction project management practices and project performance, examining how Agile-oriented thinking has been interpreted and applied within a traditionally predictive industry. Through this synthesis, key gaps in existing knowledge are identified, leading to the development of the study's conceptual framework.

Chapter Three outlines the research methodology adopted to address the research aim and objectives derived from the identified research gaps. It explains the underlying research philosophy and approach, justifies the use of a quantitative research design, and details the data collection method, sampling strategy, and questionnaire development. The chapter also describes the procedures for data preparation and analysis, including reliability and validity assessments and the statistical techniques employed to examine relationships, differences, and patterns within the data.

Chapter Four presents the results of the data analysis conducted in this study. It reports the descriptive characteristics of the respondents, followed by the empirical findings derived from the statistical analyses. These include the identification of common practices through exploratory factor analysis, the examination of relationships between Agile values and principles, common practices, and project performance, as well as comparisons across practitioner demographic groups. The chapter also presents the results of the cluster analysis used to distinguish varying levels of agility orientation among practitioners.

Chapter Five discusses the findings presented in the previous chapter by interpreting them in relation to the research objectives and the existing literature. The chapter explains the identified common construction project management practices and examines their alignment with Agile values and principles, as well as their relationships with project performance. Differences observed across practitioner demographic groups and agility-oriented clusters are also analysed and contextualised.

Chapter Six concludes the study by synthesising the key findings in relation to the research aim and objectives. It presents the overall conclusions of the research, highlights the theoretical and practical contributions to Agile-oriented construction project management, and outlines the implications for industry practitioners and policymakers. The chapter also acknowledges the limitations of the study and proposes directions for future research, before offering final concluding remarks on the applicability of Agile-oriented practices within the Malaysian construction industry.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provided an overview of the Agile concept in Section 2.2, followed by a discussion of the overview of Agile in Section 2.3, which outlines four (4) core values and twelve (12) guiding principles central to Agile methodologies. Section 2.4 duscussed agile values and principles in the construction industry. Section 2.5 examined fifty (50) construction project management practices, primarily drawn from the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b). Section 2.6 explored sixteen (16) key project performances associated with the application of Scrum as one of the very popular Agile methodologies (SCRUMstudy, 2017; Schwaber and Sutherland, 2020).

2.2 The Concept of Agility

When discussing Agile, it is necessary to clarify the concept of agility, which broadly refers to the ability to respond swiftly and effectively to change (Azanha et al., 2017). Originating from economic literature on flexibility, agility was formally introduced in the early 1990s through research at the Iacocca Institute, Lehigh University, which sought to identify practices critical to manufacturing competitiveness (Yusuf et al., 1999; Seethamraju, 2006). These studies emphasized continuous adaptation through speed, flexibility, responsiveness, and adaptable infrastructure, particularly the capability of manufacturing systems to rapidly switch between product models in response to changing market and customer demands (Youssef, 1994).

Early thinking on agile enterprise strategy was shaped by the Agility Forum (Dove, 2001) and seminal work by Goldman et al. (1995), who described agile organizations as those able to remain profitable amid constant and unpredictable market change. Dove (1999) further conceptualized agility as a balance among cost, time, quality, and scope, while Fliedner and Vokurka (1997) emphasized rapid, flexible delivery of customized, high-quality products. These foundational ideas were later extended by numerous scholars, including Goranson (1999), Yusuf et al. (1999), Menor et al. (2001), Sambamurthy et al. (2003), and Mathiyakalan et al. (2005).

Yusuf et al. (1999) defined agility as the effective pursuit of competitive advantages—such as speed, flexibility, innovation, proactivity, quality, and profitability—achieved through the integration of adaptable resources and best practices within a knowledge-rich environment. This approach enables the delivery of customer-focused products and services in rapidly changing markets. Building on this foundation, Dove (1999) introduced the idea that agility is grounded in two fundamental components: knowledge management and response ability, encapsulated in his formula: Agility = Response Ability + Knowledge Management. His definition aligns with Yusuf et al.'s, describing agility as an organization’s capacity to succeed in environments marked by continuous and often unpredictable change. Dove later refined this perspective, emphasizing that truly agile systems must be able to respond both efficiently and creatively to proactive and reactive demands—even when such demands are uncertain, volatile, or unforeseen (Dove, 2001). Similarly, Goranson (1999) highlighted that the greater an enterprise's agility, the more effectively it can respond to sudden and unexpected changes—with "unexpected" being the key element. Another widely recognized definition comes from Menor et al. (2001), who described agility as the organizational capability to deliver high-quality products or services cost-effectively while maintaining the flexibility to quickly adapt to both internal and external changes.

Mathiyakalan et al. (2005), after conducting an extensive review of agility-related literature from both industry and academia, proposed a broader definition of agility. They described it as an organization's ability to detect changes—whether opportunities, threats, or a combination of both—in its business environment, and to respond swiftly and purposefully to customer and stakeholder needs. This response is made possible through the reconfiguration of resources, processes, and strategies. This definition captures both the strategic and operational dimensions of agility, offering a comprehensive view of how organizations can enhance their agility by effectively managing capabilities, resources, and business processes (Mathiyakalan et al., 2005; Seethamraju, 2006).

Researchers such as Sambamurthy et al. (2003) emphasized the role of business processes in defining organizational agility. They described it as a firm's ability to rapidly redesign existing processes and develop new ones in a timely manner to capitalize on and thrive in unpredictable, fast-changing market conditions (Ashrafi et al., 2005). Several other definitions of agility have also gained wide recognition. For instance, Kumar and Motwani (1995) highlighted agility as the ability to accelerate activities along the critical path, contributing to time-based competitiveness. Cho et al. (1996) defined it as the capability to survive and thrive in competitive environments characterized by continuous and unpredictable changes, by responding quickly and effectively to shifting market demands—especially through customer-driven product and service designs. According to Gartner Research Group (as cited in Ashrafi et al., 2005), agility refers to an organization's ability to sense environmental change and respond both efficiently and effectively. Similarly, Raschke and David (2005) defined agility as the firm's capability to dynamically modify or reconfigure its individual business processes in response to both current and anticipated needs.

Qumer and Henderson-Sellers (2006a, b) describe agility as a persistent capability of a responsive entity that demonstrates flexibility in accommodating both expected and unexpected changes, utilizing economical and efficient tools, applying prior knowledge, and learning continuously from its internal and external environment. Building on this foundation, Conforto et al. (2014b) view agility as the ability to sense environmental changes, make rapid decisions, and reconfigure resources accordingly balancing the need for flexibility with the requirement for stability. In a more project-specific context, Conforto et al. (2016) define agility as the project team's ability to quickly adjust plans in response to evolving customer or stakeholder needs, market trends, or technological advancements, with the ultimate goal of improving project and product outcomes in innovative and dynamic settings. Similarly, the Project Management Institute (PMI, 2017a) frames agility as the ability to successfully deliver projects in fast-changing environments by embracing change, promoting collaboration, and enabling iterative progress. Collectively, these definitions underscore agility as a multifaceted capability rooted in responsiveness, adaptability, learning, and strategic alignment with evolving demands.

While Appendix B provides a comprehensive compilation of agility definitions and their embedded essential characteristics (Ganguly et al., 2009), Table 2.1 distils this information by summarising the recurring essential characteristics across definitions to support conceptual clarity. Adaptability refers to the capacity of an organization or team to adjust effectively to changes in project scope, market dynamics, or unforeseen challenges (Highsmith, 2009). Customer needs emphasize the prioritization of client requirements, ensuring that project outcomes align with or exceed stakeholder expectations (Conforto et al., 2016). Learning reflects the continuous process of improvement through feedback, reflection, and the systematic sharing of knowledge across individuals and teams (Serrador & Pinto, 2015). Quality denotes the commitment to delivering outputs that are reliable, sustainable, and aligned with established standards, rather than focusing solely on short-term deliverables (Rigby, Sutherland, & Takeuchi, 2016). Responsiveness highlights the ability to react promptly and effectively to stakeholder inputs, emerging risks, and evolving opportunities (Conforto et al., 2016). Speed captures the efficiency of delivering results within shorter cycles by breaking down work into smaller, manageable components to minimize delays (Highsmith, 2009). Finally, value underscores the focus on maximizing benefits to clients and stakeholders by directing efforts toward outcomes that deliver meaningful and measurable impact (Denning, 2018). In this thesis, agility is defined as the capability of construction project teams to adapt effectively to changing project conditions while continuously learning and responding to stakeholder needs, in order to deliver high-quality outcomes rapidly and efficiently, and to maximise value throughout the project lifecycle. This capability is characterised by responsiveness to change, speed in decision-making and delivery, a strong emphasis on customer requirements, ongoing learning and improvement, and a commitment to quality and value creation rather than rigid adherence to predefined plans (Conforto et al., 2016).

Table 2.1: The Essential Characteristics of Agility

References	Adaptability	Customer needs	Learning	Quality	Responsiveness	Speed	Value
Iacocca/Lehigh (1991)	X	X			X	X	
Goldman et al. (1995)	X	X			X	X	X
Kumar & Motwani (1995)		X			X	X	
Cho et al. (1996)		X			X	X	
Fliedner & Vokurka (1997)		X		X		X	X
Yusuf et al. (1999)	X	X	X	X	X	X	X
Dove (2001)	X	X		X	X	X	X
Menor et al. (2001)	X			X		X	X
Sambamurthy et al. (2003)	X	X	X		X	X	
Ashrafi et al. (2005)		X			X	X	
Raschke & David (2005)	X	X	X		X	X	
Mathiyakalan et al. (2005)		X	X		X	X	
Qumer & Henderson-Sellers (2006a, b)	X	X	X	X	X	X	X
Conforto et al. (2014b)	X		X			X	
Conforto et al. (2016)	X	X		X	X	X	X
PMI (2017a)	X	X			X		

2.3 The Agile Overview

Agile, born from the 2001 Agile Manifesto for software development, is a project management and product delivery philosophy that prioritises flexibility, customer collaboration, and iterative progress over rigid planning and contractual negotiation (Beck et al., 2001). It represents a fundamental shift from the traditional, sequential "Waterfall" methodology. At its core, Agile is not a single methodology but a set of principles based on valuing:

- Individuals and interactions over processes and tools.
- Working software over comprehensive documentation.
- Customer collaboration over contract negotiation.
- Responding to change over following a plan

In addition to these four values, the Agile Manifesto establishes 12 principles (SCRUMstudy, 2017; Beck et al., 2001) as follows:

1) Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2) Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3) Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale.
4) Business people and developers must work together daily throughout the project.
5) Build projects around motivated individuals, give them the environment and support they need and trust them to get the job done.

6) The most efficient and effective method of conveying information with and within a development team is face-to-face conversation.
7) Working software is the primary measure of progress.
8) Agile processes promote sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely.
9) Continuous attention to technical excellence and good design enhances agility.
10) Simplicity - the art of maximizing the amount of work not done - is essential.
11) The best architectures, requirements and designs emerge from self-organizing teams.
12) At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

The goal is to deliver value to the customer in small, frequent increments, known as "sprints" or "iterations," allowing for continuous feedback and adaptation to changing requirements. This approach mitigates risk by making uncertainty and learning an integral part of the process, rather than treating them as exceptions to be managed (Highsmith, 2009).

While Agile originated in software, its success has catalysed a "trend of practices" spreading across diverse sectors. This trend, often termed "Business Agility," sees organisations adopting Agile principles to enhance innovation, improve customer focus, and accelerate time-to-market. Inspired by Lean manufacturing principles, which share a symbiotic relationship with Agile, companies like Toyota and Tesla have integrated Agile mindsets. They use short feedback loops, cross-functional teams, and iterative design processes. For instance, rapid prototyping and concurrent engineering allow design and manufacturing teams to work in tandem, identifying and resolving issues early, drastically reducing development cycles (Conforto et al., 2016). In the fast-paced world of digital marketing, Agile has become a staple. Marketing teams organise in "squads" to run campaigns in short sprints, using tools like Kanban boards to visualise workflow. This allows them to A/B test (split test) advertisements, analyse real-time data on consumer engagement, and pivot strategies weekly or even daily, maximising return on investment in a dynamic market (Rigby, Sutherland, & Takeuchi, 2016). Even in highly regulated, engineering-intensive fields, Agile is making inroads. Companies like Bosch and SpaceX use Agile frameworks like Scaled Agile Framework (SAFe) to manage complex hardware-software integration. They break down large projects into smaller, manageable subsystems developed iteratively, facilitating faster innovation and problem-solving despite stringent compliance requirements (Leffingwell, 2018). The financial sector, once a bastion of hierarchy and long-term planning, has embraced Agile to drive digital transformation. Banks like ING and Barclays have completely restructured their organisations into Agile "tribes" and "chapters" to develop new financial products and digital services more responsively, improving customer experience and competing with fintech disruptors (Rigby et al., 2018). This cross-industry trend demonstrates that Agile is a versatile paradigm. Its practices are not about a one-size-fits-all prescription but about applying the underlying principles of empiricism, collaboration, and value-driven delivery to the specific context of an industry.

The construction industry, historically characterised by the linear Waterfall model (design-bid-build), high fragmentation, adversarial relationships, and cost/time overruns, presents a challenging yet fertile ground for Agile practices (Kortenko et al., 2020). The traditional model struggles with uncertainty, late change requests, and a lack of stakeholder integration, problems that Agile is inherently designed to solve. The articulation of Agile in construction is not about directly transplanting software sprints but adapting the principles to the physical, regulated, and long-lead-time nature of construction projects (Moreno et al., 2024).

Several established and emerging practices in construction already embody the Agile spirit. First, Lean Construction (LC) and the Last Planner System (LPS). This is arguably the most direct and mature parallel to Agile in construction. Originating from the Toyota Production System, Lean Construction focuses on maximising value and minimising waste. The Last Planner System, a key component, involves collaborative weekly work planning with frontline supervisors and trades. This creates short-term commitment cycles, promotes "should-can-will" commitments, and makes constraints visible, allowing the team to adapt plans based on real-time conditions—a direct manifestation of iterative planning and responding to change (Ballard, 2000). Second, Building Information Modelling (BIM): BIM acts as a powerful enabler of Agile practices. It provides a shared digital environment for all stakeholders (architects, engineers, contractors), facilitating the intense collaboration Agile requires. BIM allows for rapid prototyping and clash detection in a virtual space before physical work begins, akin to a software developer testing code. This iterative "test-before-build" approach reduces rework and allows for the exploration of design alternatives based on client feedback (Sacks, Eastman, & Lee, 2018). Third, Integrated Project Delivery (IPD): IPD is a project delivery method that contractually aligns the interests of the owner, designer, and builder. It fosters a collaborative, transparent environment from the project's inception, mirroring Agile's principle of "customer collaboration over contract negotiation." Multi-party agreements and shared risk/reward pools break down silos, creating a single, cross-functional team focused on the project's overall value, much like an Agile product team (American Institute of Architects, 2007). Fourth, Modular and Off-Site Construction: This approach physically decouples and parallelises work streams. While the foundation is prepared on-site, modules are manufactured simultaneously in a factory. This factory environment is highly conducive to Agile and Lean practices, with small, empowered teams iterating on the manufacturing process to improve quality and efficiency, dramatically compressing project schedules (Bertelsen, 2003).

2.4 Agile Values in the Construction Industry

Agile value emphasises face-to-face communication, empowered teams, and collaborative decision-making. This aligns closely with the principles of Integrated Project Delivery (IPD), collaborative contracting, and Lean Construction, which also promote trust, transparency, and team alignment (Ballard & Howell, 2003; Liphadzi et al., 2015). Construction studies consistently highlight communication breakdowns as a major source of project failure (Doloi, 2013), suggesting that Agile's collaborative orientation has high relevance for improving team performance.

Agile values early and continuous delivery of functional outputs. In construction, although contractual requirements necessitate extensive documentation, iterative prototyping through BIM modelling, mock-ups, and rapid simulation allows teams to evaluate "working versions" of a design before finalisation (Barbosa et al., 2017). Research shows that early iteration helps reduce rework and improves stakeholder clarity.

Traditional construction procurement separates designers, contractors, and clients, often leading to adversarial interactions (Oyewobi et al., 2016). Agile value emphasises on continuous client involvement aligns with IPD, alliancing, and relational contracting, where clients participate throughout the design and construction process. Studies demonstrate that increased collaboration fosters shared risk ownership, fewer disputes, and better performance outcomes (Sacks et al., 2010).

Construction projects are highly susceptible to late design changes, unforeseen site conditions, and coordination issues. Agile treats change as inevitable and manages it incrementally. Short planning cycles, rolling-wave scheduling, and frequent coordination meetings have been shown to improve flexibility and minimise delays (Dong et al., 2024). However, construction firms frequently operate under rigid contractual obligations that penalise changes, limiting the extent to which Agile adaptability can be operationalised (Nuottila et al., 2017).

2.5 Agile Principles in the Construction Industry

Agile's first principle emphasises delivering value to clients early and frequently. In construction, early delivery is often interpreted as front-loaded design outputs, rapid prototypes, and progressive design development through BIM (Karasu et al., 2023; Aziz & Zainon, 2023). While continuous delivery is limited by physical work sequencing, research shows that iterative design reviews and digital mock-ups enhance client satisfaction and reduce late-stage changes (Sacks et al., 2018). However, full adoption is constrained by traditional procurement methods where client involvement is front-loaded and not continuous (Asadi et al., 2023). Construction projects face constant changes such as design clashes, site uncertainties, and regulatory revisions. Agile's second principle promotes embracing change as part of value optimisation. Rolling-wave planning and short planning cycles have been adopted in some Lean-IPD projects, facilitating better change absorption (Dong et al., 2024). Nevertheless, in most construction environments, late changes generate variation orders, cost escalations, and contractual disputes. Thus, the literature recognises potential benefits but emphasises that rigid contracts severely limit adoption (Nuottila et al., 2017).

Agile's third principle refers to functional prototypes in software; but in construction, scholars interpret it as iterative design deliverables, BIM models, physical mock-ups, and phased handovers (Mujumdar & Maheswari, 2018). Iterative delivery has been shown to reduce design errors and improve coordination (Barbosa et al., 2017). Yet, frequent physical delivery during construction is unrealistic due to safety, sequencing, and engineering constraints. Adoption is therefore mainly confined to the design and pre-construction phases. Agile's fourth principle translates into collaboration between clients, consultants, contractors, and end users in construction. Integrated Project Delivery (IPD) operationalises this principle through shared risk/reward systems, joint decision-making, and co-location (Karasu et al., 2023). Literature shows significant performance improvements in IPD projects due to real-time communication and collective problem-solving (Sacks et al., 2010). However, most construction projects remain fragmented, with adversarial relationships limiting consistent collaboration (Dainty et al., 2001).

Agile's fifth principle emphasises empowering competent, motivated teams. Construction literature consistently highlights workforce motivation as a critical success factor (Liphadzi et al., 2015). Agile-related practices such as self-organising teams, decentralised decision-making, and empowered site coordination groups have shown positive effects on productivity and conflict reduction (Aziz & Zainon, 2023). Nonetheless, hierarchical structures and command-and-control management styles dominate the industry, preventing widespread adoption (Chia et al., 2022). Common agile practices – daily stand-up meetings, co-location, and visual planning boards have been applied effectively under Agile's sixth principle. These practices improve transparency and reduce delays caused by information bottlenecks (Sadikoglu & Ozorhon, 2022; Salama & Said, 2025). However, multi-organisational participation, spatial separation of participants, and subcontractor turnover make consistent implementation challenging.

Based on Agile's seventh principle, progress is measured by delivered functionality in software; but in construction, progress is typically measured through schedules, milestones, and earned-value metrics (Barbosa et al., 2017). Agile-inspired pilots have used completed design modules, clash-free BIM models, and completed trade packages as progress indicators (Askour & Al Quosi, 2025; Hemmatian & Elliott, 2025). While these enhance transparency, contractual progress claims still rely on linear completion metrics, limiting full Agile adoption. Agile's eighth principle promotes a steady, sustainable pace to avoid burnout and maintain productivity. Construction researchers agree that excessive overtime and unrealistic schedules are major causes of accidents, rework, and low morale (Lam, 2022). Agile practices like shorter planning cycles and realistic workload allocation can improve sustainability. Yet, commercial pressures, liquidated damages, and compressed timelines often force unsustainable pacing, making this principle difficult to uphold.

Agile's ninth principle emphasises quality via continuous refinement. In construction, technical excellence aligns with clash detection, iterative detailing, design standardisation, and early constructability reviews. BIM-enabled Agile workflows support continuous quality assurance (Sacks et al., 2018). However, rushed design phases and limited early contractor involvement often undermine technical excellence, a persistent challenge noted across many empirical studies (Asadi et al., 2023). Simplicity in Agile's tenth principle means eliminating unnecessary work. Lean construction advocates share this value through waste reduction, streamlined processes, and last planner techniques (Ballard & Howell, 2003). Studies show that integrating Agile and Lean can minimise design rework and reduce coordination waste (Aslam et al., 2024). Nevertheless, construction's heavy documentation and compliance requirements prevent significant reduction of administrative work.

Refer to Agile's eleventh principle, self-organising teams, which are common in Agile environments, thrive on autonomy and shared accountability. Partial adoption is evident in collaborative planning sessions and IPD environments where teams jointly manage workflows (Karasu et al., 2023). However, the fragmented and hierarchical nature of construction organisations makes widespread self-organisation unlikely (Winch, 2012). Subcontractors operate under strict supervision, while consultants and contractors have separate contractual responsibilities, restricting autonomy. Lastly, Agile's twelfth principle promotes continuous improvement through retrospectives. Construction equivalents include lessons-learned meetings, post-mortems, and continuous process reviews (Asadi et al., 2023). While some contractors conduct reviews, literature shows that lessons learned are rarely applied to future projects due to short-term teams and lack of institutional learning (Dainty et al., 2001). Therefore, this principle remains weakly adopted.

2.6 Practices in Construction Project Management

The integration of Agile methodologies into construction project management has gained increasing attention in recent years, prompting a re-evaluation of established practices within the industry. To explore this intersection, the literature identifies fifty (50) construction project management practices that offer insight into how traditional project approaches can be adapted to more flexible, iterative frameworks. These practices are primarily sourced from two foundational documents: the Construction Extension to the PMBOK Guide (PMI, 2016), which tailors general project management standards to the specific demands of the construction sector, and the Agile Practice Guide (PMI, 2017b), which provides practical guidance on applying Agile principles across various project environments.

Together, these references form the basis for examining how Agile techniques can complement and enhance conventional construction management practices. The PMBOK knowledge areas are adopted to organise construction project management practices identified from the literature. PMBOK provides a globally recognised and neutral taxonomy that is particularly suitable for organising a large and fragmented set of construction project management practices identified from the literature. Using this structure ensured systematic coverage across core project management domains such as schedule, cost, risk, quality, stakeholder, and communications management, thereby enhancing conceptual clarity and content validity (PMI, 2017a; PMI, 2021).

2.6.1 Schedule Management Practices

Effective planning and delivery in construction depend on decomposing projects into manageable stages supported by evolving baselines, staged reviews, and continuous feedback. Deliverables are progressively defined across design, procurement, and construction phases to maintain alignment with milestones and enable timely adjustments (Kalach et al., 2021).

Progressive planning across multiple stages facilitates ongoing review and refinement (Binci et al., 2023), while performance-based adjustments help minimise delays and improve schedule reliability (Lin et al., 2024). Plans must remain flexible to accommodate design changes or site conditions in order to sustain progress (Zhang and Yu, 2020).

Breaking work into smaller, manageable packages improves flexibility, reduces waste, and simplifies scheduling control (Sui Pheng and T'ng, 1998). Staged milestone reviews support early detection of deviations and timely corrective action, while continuous feedback during delivery improves outcomes and reduces rework (Okudan et al., 2021; Ford and Gosling, 2024).

2.6.2 Cost Management Practices

Construction supports cost control through staged allocation of financial and physical resources rather than fixed upfront commitments. Incremental resource deployment helps prevent shortages, waste, and cost overruns by aligning expenditure with actual progress (Tian et al., 2025).

Rough cost baselines established at project initiation are progressively refined and re-evaluated as more accurate information becomes available (Thiele et al., 2024; Alotaibi et al., 2025).

Lean practices further enhance cost efficiency by reducing waste and rework while supporting long-term economic and environmental sustainability (Victar and Waidyasekara, 2024).

2.6.3 Stakeholder Management Practices

Stakeholder collaboration is central to construction, ensuring transparency, shared accountability, and alignment of objectives. Active client involvement in design approvals, material selection, and key decisions strengthens trust and reduces downstream rework (Kissi et al., 2023).

Clearly defined roles and responsibilities reduce disputes and reinforce accountability (Oke and Ogunsemi, 2016), while systematic assessment of change impacts sustains stakeholder engagement throughout the project lifecycle (Tarode and Shrivastava, 2022).

Joint prioritisation of critical tasks with contractors and consultants helps mitigate conflicts and avoid delays (Stephen et al., 2025). A shared understanding of project vision and success criteria further aligns stakeholder expectations with delivery outcomes (Christenson and Walker, 2008; Kiani Mavi et al., 2024).

2.6.4 Risk Management Practices

Balancing timely delivery with proactive risk management is essential in construction. Projects must continuously identify and respond to risks such as cost escalation, safety hazards, and regulatory changes to avoid disruption (Javid, 2025).

Requirements are frequently reprioritised in response to environmental or stakeholder changes, ensuring that urgent risks are addressed without compromising overall project objectives (Kadenic and Tambo, 2023; Myeza et al., 2024).

Early validation mechanisms, such as site mock-ups, allow potential issues to be identified and mitigated before full-scale implementation, reducing the likelihood of costly failures (Staub-French et al., 2021).

2.6.5 Quality Management Practices

Quality assurance in construction is achieved through early and continuous verification rather than end-stage inspection. Inspections at critical milestones ensure compliance with design specifications and enable defects to be corrected promptly (Mohamed and Tran, 2023).

Systematic testing of materials and building systems prior to completion verifies safety, functionality, and performance requirements (Mwelu et al., 2020). Embedding verification activities within each delivery stage allows quality issues to be identified when corrective actions are least disruptive and most cost-effective (Mohamed and Tran, 2023).

This iterative inspection approach supports continuous improvement by providing real-time quality feedback that informs subsequent work packages and reinforces adherence to agreed standards (Mohamed and Tran, 2023).

2.6.6 Scope Management Practices

Construction requires workflows that are clearly defined yet adaptable to project-specific conditions. Processes are tailored to the skills and experience of team members to improve efficiency and reduce errors (Lee and Chen, 2020).

Project characteristics such as scope complexity, location, and regulatory constraints necessitate customised execution approaches (Mainga, 2017). Maintaining a logical task sequence—from foundation to finishing—prevents rework and supports safe progression (Makarfi Ibrahim et al., 2009).

Cycle times are reduced by streamlining repetitive activities or adopting techniques such as prefabrication, improving productivity and delivery speed (Pérez and Bastos Costa, 2021).

2.6.7 Resource Management Practices

Effective construction project delivery depends on the integrated management of human, material, and physical resources on site. While people remain central enablers of project success, the coordinated deployment of labour, materials, equipment, and temporary facilities is equally critical to maintaining productivity, quality, and adaptability.

Developing technical competence, interpersonal skills, and leadership capacity enhances workforce effectiveness, while clear ground rules for communication and conflict resolution strengthen teamwork and accountability (e Cunha et al., 2022). Training in collaboration and active listening reduces misunderstandings and improves stakeholder interaction (Rahimian et al., 2022), and targeted technical training improves proficiency in construction methods, tools, and standards, thereby minimising errors and rework (Li et al., 2023).

Beyond human capability, effective resource management requires timely material planning, proper storage, and coordinated equipment utilisation to prevent shortages, congestion, and waste on site. Aligning labour availability with material deliveries and equipment readiness supports smoother workflows and reduces idle time. Encouraging emergent leadership enables teams to respond proactively to resource-related constraints and unforeseen site challenges, strengthening resilience and problem-solving capacity (Tabassum et al., 2024). Additionally, understanding motivational factors allows managers to foster supportive environments that enhance performance, retention, and responsible use of project resources (Jarkas et al., 2014).

2.6.8 Communications Management Practices

Effective communication underpins learning and accountability in construction. Open information sharing, structured issue tracking, and regular coordination meetings enable early identification of problems and timely resolution (Soja and Paliwoda-Pękosz, 2009; Thunberg et al., 2017).

Digital collaboration tools, including BIM and project management platforms, improve transparency and coordination across teams (Oke et al., 2024). Documenting lessons learned and disseminating best practices through training prevents repeated mistakes and enhances decision-making (Senaratne et al., 2017).

Visible issue registers with assigned ownership and updated resolution status further strengthen accountability and transparency (Lingard et al., 2018). Post-project reflection supports continuous improvement by identifying root causes and informing future practice (Raviv et al., 2022).

2.7 Project Performance

In recent years, the adoption of Agile methodologies has been increasingly linked to improved project performance across various industries, including construction. A review of the literature highlights sixteen (16) key benefits of project performance that are closely associated with the implementation of Agile practices (SCRUMstudy, 2017; Schwaber and Sutherland, 2020; PMI, 2021). These performances encompass critical elements that are essential to achieving project success in dynamic and complex environments. By examining these performances through the lens of Agile practices, this review seeks to establish a clearer understanding of how Agile approaches contribute to enhanced outcomes in project execution and delivery.

Given the absence of a unified performance classification for Agile-oriented project delivery, particularly in construction. The PMBOK performance domains are adopted to organise the benefits of project performance identified from Scrum literature. Using the PMBOK performance domains enhances conceptual clarity and supports the consistent interpretation of Scrum-derived performance outcomes within the construction project management context (PMI, 2021; PMI, 2017a).

2.7.1 Delivery Performance Domain

Continuous delivery emphasises providing value throughout the project lifecycle rather than only at completion. Delivering visible outcomes early enables stakeholder feedback, supports timely adjustments, and reduces risks, ensuring ongoing alignment with project goals (Yadav et al., 2020).

Early delivery provides stakeholders with usable project outputs as soon as possible, improving cash flow, meeting urgent needs, and enabling early feedback. It reduces risks associated with late-stage changes and increases stakeholder value (Tampio et al., 2023).

Effective deliverables are outputs that meet stakeholder requirements, scope, and quality standards while being delivered on time and within budget. High-quality deliverables reduce rework, strengthen client confidence, and enhance project reliability (Amoah et al., 2020).

An efficient development process completes tasks cost-effectively and on time through strong planning, clear communication, and tools such as BIM or lean methods. This reduces waste, prevents delays, and improves stakeholder collaboration, ensuring faster and higher-value results (Tumpa & Naeni, 2025).

High velocity describes delivering tasks quickly and efficiently without compromising quality. It depends on clear priorities, effective processes, and rapid decision-making. High velocity helps stakeholders gain value earlier and enhances agility in meeting deadlines (Mainga, 2017).

2.7.2 Stakeholders Performance Domain

Collective ownership means all stakeholders share responsibility for project success. It promotes collaboration, joint decision-making, and accountability, reducing conflicts and improving communication. When ownership is shared, teams are more proactive, motivated, and productive (Nazir et al., 2024).

Continuous feedback involves regularly gathering and acting on stakeholder and team input. It helps detect issues early, improves communication, and ensures alignment with expectations. This process builds trust, reduces errors, and enhances quality and efficiency (Eaidgah et al., 2016).

A customer-centric approach places client and end-user needs at the centre of decisions through active engagement, clear communication, and responsiveness. This builds trust, aligns the project with client goals, and supports tailored, high-quality solutions (Haverila et al., 2024).

Transparency involves openly sharing project information, decisions, and progress. It builds trust, prevents misunderstandings, and supports early problem-solving, strengthening accountability and stakeholder confidence (Tran et al., 2017).

2.7.3 Team Performance Domain

Faster problem resolution refers to quickly identifying and addressing issues to prevent disruptions. It relies on communication, teamwork, and proactive risk management, supported by digital tools and experienced teams. Quick resolution prevents escalation and strengthens stakeholder trust (John & Kadadevaramath, 2020).

A high-trust environment is built on openness, respect, and transparency, allowing team members to express ideas or concerns without fear. Trust reduces conflict, improves accountability, and enhances teamwork, leading to smoother and more innovative project outcomes (Buvik & Tvedt, 2016).

Motivation reflects team members' enthusiasm and commitment, shaped by leadership, recognition, communication, and fair rewards. Motivated teams are more productive, collaborative, and resilient, leading to stronger project outcomes (Shurrab et al., 2018).

A sustainable pace manages workloads to prevent burnout while maintaining steady progress. With realistic deadlines and balanced tasks, teams achieve better long-term quality, reduced stress, and more consistent delivery (Lam, 2022).

2.7.4 Uncertainty Performance Domain

Adaptability refers to a project's ability to respond to changes and unexpected challenges through flexible design, processes, and resource use. It minimises delays and cost overruns by addressing risks early and enables teams to adjust and innovate, thereby strengthening project resilience and stakeholder confidence (Kwofie et al., 2024).

Continuous improvement is the ongoing effort to refine processes by identifying inefficiencies, learning from past work, and implementing systematic changes. It helps teams adapt, innovate, reduce waste, and achieve higher-quality outcomes across project phases (Omotayo et al., 2020).

An innovative environment promotes creativity and the use of new methods or technologies—such as BIM, modular construction, and sustainable materials—to improve quality, reduce costs, and enhance client value. It also motivates teams and strengthens a forward-thinking reputation (Idrees et al., 2024).

2.8 Identification of the Research Gap

The construction industry worldwide continues to struggle with persistent challenges such as delays, cost overruns, coordination failures, and productivity stagnation (Changali et al., 2015; Armstrong et al., 2023). Traditional project management approaches—especially the waterfall model—

provide structure but often lack flexibility in managing uncertainty, stakeholder dynamics, and iterative information flow (Wysocki, 2019; Kerzner, 2022). As projects become more complex and interdependent, scholars argue that construction requires more adaptive and collaborative methods (Atkinson, 2021; PMI, 2017a).

Agile originating in software development, has demonstrated positive outcomes in responding to uncertainty, enhancing team collaboration, and promoting incremental value delivery (Beck et al., 2001; Conforto et al., 2016). Attempts to apply Agile thinking to construction—such as Scrum adaptations, Lean–Agile integration, iterative design management, and the Last Planner System—have shown promise in improving workflow reliability and communication (Rokooei, 2015; Tzortzopoulos et al., 2020). However, current applications remain fragmented, vary widely in methodology, and often deviate from core Agile values and principles (Serrador & Pinto, 2015; Dikert et al., 2016).

Within Malaysia, construction performance continues to be hindered by issues such as rework, communication breakdowns, fragmented procurement practices, and limited innovation adoption (CIDB, 2023a; Shehu et al., 2014). Yet, there is limited evidence of how Agile-oriented practices are understood or implemented in the local context. While digitalisation efforts such as BIM and IBS adoption have increased (Zairul, 2021; CIDB, 2023b), empirical studies exploring Agile-oriented practices remain scarce.

Furthermore, organisational behaviour research suggests that individual characteristics—such as profession, experience, and managerial role—can influence openness to new practices and innovation adoption (Rogers, 2003; Sung & Choi, 2014). However, this relationship has not been examined in relation to Agile adoption within construction. The absence of such insights limits both theoretical understanding and practical guidance for capability-building in the industry.

Based on this synthesis, several key research gaps become evident. First, there is no validated set of Agile-oriented practices specifically tailored to the construction context, making it difficult to understand how Agile is operationalised within project environments (Chia et al., 2022). Second, prior studies have not examined how these practices align with the core Agile values and the twelve Agile principles, leaving the theoretical and behavioural foundations of Agile in construction insufficiently explored (Chia et al., 2022). Third, empirical evidence linking Agile-oriented practices to construction project performance is limited, resulting in a lack of clarity on whether such practices meaningfully influence project outcomes (Ozorhon et al., 2022). Fourth, no research has investigated how practitioner demographics—such as profession, experience, designation, company size, or project type—shape or differentiate Agile-oriented behaviours within the construction workforce (Tung et al., 2024). Finally, there is currently no integrated framework that combines Agile-oriented practices, Agile values and principles, project performance, and practitioner demographics to guide industry adoption (Ciric et al., 2018).

These gaps collectively demonstrate the need for a comprehensive empirical investigation to clarify how Agile-oriented practices are adopted within construction, how they relate to Agile philosophy, how they influence performance, and how practitioner attributes contribute to these patterns. Addressing these gaps will enable the development of an integrated, context-specific framework for Agile-oriented construction project management.

2.9 Conceptual Framework of the Study

The conceptual framework for this study is grounded in the recognition that Agile-oriented behaviours in construction emerge from an interaction between practitioners' operational practices, their alignment with Agile philosophy, and the contextual characteristics of the individuals and organisations involved. Existing research emphasises that Agile success in other industries is driven not only by tools or techniques but also by shared values, guiding principles, and consistent behavioural practices (Conforto et al., 2016). However, the construction industry lacks empirical evidence demonstrating how these elements manifest in practice, particularly within the Malaysian context. The proposed framework therefore consolidates these theoretical and practical components to address the identified research gaps.

At the core of the framework are Common Agile-Oriented Practices (CP), representing the observable behaviours and work patterns exhibited by construction practitioners (Chia et al., 2022). These practices extracted through Exploratory Factor Analysis in this study, capturing how Malaysian practitioners naturally operate in ways that may align with or diverge from Agile philosophy. Positioning CP as the central construct is justified because they serve as the practical embodiment of Agile behaviours in real projects—they are what practitioners actually do, rather than what Agile theory prescribes.

Surrounding these practices are the Agile Values (AV) and Agile Principles (AP). Agile values form the philosophical foundation of Agile thinking, emphasising collaboration, responsiveness, transparency, and stakeholder engagement. Agile principles extend these values into 12 practical guidelines for iterative planning, early delivery, continuous improvement, and adaptive project execution (Beck et al., 2001). In the construction context, where project environments are dynamic and stakeholder expectations frequently shift, the alignment of CP with AV and AP provides a meaningful measure of "Agile orientation". This alignment has not been empirically assessed in construction research, making its inclusion critical to advancing theoretical understanding.

The framework further incorporates Project Performance (PP) as an outcome variable to determine whether Agile-oriented practices meaningfully influence project success (Ozorhon et al., 2022). Testing the relationship between CP and PP allows this study to empirically evaluate whether Agile-oriented behaviours contribute to better outcomes in Malaysian construction projects, directly addressing the gap concerning Agile's practical impact on performance.

In addition, Practitioner Demographics (profession, years of experience, designation, project type, company size, and nature of business) are incorporated in the framework. Prior studies suggest that demographic factors can significantly shape attitudes, behaviours, and openness toward new project management approaches (Tung et al., 2024). Yet, demographic influence on Agile-oriented behaviours has rarely been examined in construction. By including demographics, the framework enables identification of differences in Agile orientation across practitioner groups, providing deeper insight into adoption patterns and supporting more targeted industry interventions (Ciric et al., 2018).

Together, these components form an integrated conceptual framework as shown in Figure 2.1 that reflects how Agile-oriented practices emerge, how they align with Agile philosophy, how they influence project outcomes, and how they vary across practitioner profiles. This holistic approach is necessary because no existing framework in the construction domain connects these elements. By empirically validating these relationships, the framework directly addresses the research gaps identified in the literature and supports the development of a context-specific framework for Agile-Oriented Construction Project Management in Malaysia.

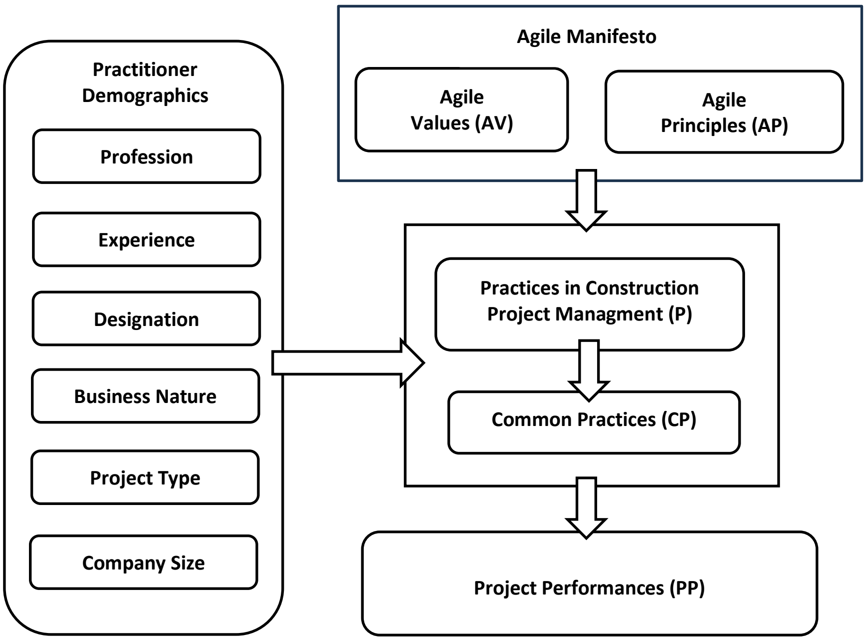


Figure 2.1: Conceptual Framework

2.10 Summary

This chapter examined the concept of agility and the evolution of Agile Project Management, beginning with the Agile Manifesto's four values and twelve principles and their theoretical foundations. The review analysed how these values and principles have been interpreted in non-software, project-based environments, with particular emphasis on the construction industry, where projects are characterised by physical constraints, sequential workflows, and contractual rigidity.

The chapter reviewed construction project management practices reported in the literature, including planning, coordination, communication, risk handling, quality control, and stakeholder engagement, and evaluated how these practices reflect or diverge from Agile values and principles. Agile-inspired and

Lean-based approaches applied in construction—such as collaborative planning, iterative design development, continuous review, and early stakeholder involvement—were critically examined to assess the extent to which agility is embedded in current construction practices rather than adopted through formal Agile methodologies.

Empirical studies linking Agile-oriented practices to project performance were reviewed, focusing on outcomes such as schedule reliability, cost control, quality, team effectiveness, stakeholder satisfaction, and learning-oriented improvement. The literature indicates that while Agile-aligned behaviours can enhance adaptability and coordination, evidence remains fragmented and context-dependent, particularly within developing construction markets.

A synthesis of the reviewed literature identified several critical gaps: the absence of a validated set of Agile-oriented common practices specific to construction; limited empirical examination of alignment between construction practices and Agile values and principles; insufficient evidence on how such practices influence project performance; minimal attention to practitioner demographic differences in Agile orientation; and the lack of an integrated framework linking these elements. These gaps justify the research objectives of this study and underpin the development of the proposed conceptual framework, which is empirically examined using a quantitative approach in the subsequent chapters.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

To carry out research effectively, it is crucial to establish a structured process or strategy. Using an inappropriate methodology can lead to poor-quality research. Therefore, it is important to determine the research method and the specific tests to be conducted before beginning the research process.

This chapter outlines the research philosophy and develops the conceptual framework. The research design includes a sequence of steps, starting with clarifying the research questions and progressing to the creation of research instruments. The sampling strategy is detailed, and hypotheses are formulated. The chapter concludes by addressing data preparation and analysis.

3.2 Research Philosophy

Research philosophies represent systems of beliefs and assumptions that guide the development of knowledge. They encompass fundamental assumptions about how researchers perceive the world, which in turn influence every aspect of a research project. To grasp the essence of a research philosophy, researchers must cultivate reflexivity—a skill that involves critically examining their own beliefs and assumptions, subjecting them to the same level of scrutiny as they would apply to the beliefs of others. In the realm of business and management research, there is no one-size-fits-all philosophy. Instead, each philosophy offers a distinct and valuable perspective for understanding the organizational world (Saunders, Lewis & Thornhill, 2019).

All research philosophies are grounded in three key types of assumptions: ontological, epistemological, and axiological. These assumptions help differentiate between various philosophies by highlighting their unique or shared perspectives on ontology (the nature of reality), epistemology (the nature of knowledge), and axiology (the role of values). By examining these assumptions, we can identify the distinctions and commonalities among different research philosophies (Saunders, Lewis & Thornhill, 2019).

Ontology refers to the assumptions researchers hold about the nature of the world and reality. These ontological assumptions shape what research objects and phenomena are prioritized, as well as how they are perceived and approached in the research process (Saunders, Lewis & Thornhill, 2019).

Epistemology deals with assumptions about knowledge—how we come to know what we claim to know, what qualifies as acceptable, valid, and legitimate knowledge, and how we share this knowledge with others. The epistemological assumptions you adopt determine the nature of the contribution your research can make to the broader body of knowledge (Saunders, Lewis & Thornhill, 2019).

Axiology pertains to the role of values and ethics in the research process. It involves considerations about how researchers manage their own values, as well as those of their participants, throughout the course of the study (Saunders, Lewis & Thornhill, 2019).

Research philosophies can be distinguished based on where their assumptions lie along the objectivism-subjectivism spectrum. Objectivism aligns with the assumptions of the natural sciences, embracing a realist ontology (the belief that social entities exist independently of social actors and are external to them), an epistemology centred on uncovering truth through observable and measurable facts, and a claim to a value-free, detached axiology (Saunders, Lewis & Thornhill, 2019).

Subjectivism draws on assumptions rooted in the arts and humanities. It involves a nominalist ontology (the view that social phenomena are constructed through the language, perceptions, and actions of social actors), an epistemology centred on the opinions, narratives, interpretations, and perceptions of social actors that shape these realities, and a value-bound, reflexive axiology (Saunders, Lewis & Thornhill, 2019).

Management and business research is guided by five primary philosophies: positivism, critical realism, interpretivism, postmodernism, and pragmatism (Saunders, Lewis & Thornhill, 2019).

Positivism aligns with the philosophical approach of natural scientists. It involves studying an observable social reality, with the goal of producing law-like generalizations akin to those found in the physical and natural sciences (Saunders, Lewis & Thornhill, 2019).

Critical realism emphasizes explaining observable phenomena by uncovering the underlying structures of reality that influence these events. Critical realists often conduct historical analyses of evolving or persistent societal and organizational structures, employing diverse methods to explore these dynamics (Saunders, Lewis & Thornhill, 2019).

Interpretivism is a subjectivist philosophy that highlights the distinction between humans and physical phenomena, emphasizing that humans create meaning. Interpretivists explore these meanings to develop deeper, more nuanced understandings of organizational realities. Empirically, they focus on individuals' lived experiences and cultural artifacts, integrating both their participants' interpretations and their own into the research process (Saunders, Lewis & Thornhill, 2019).

Postmodernism focuses on the role of language and power relations in shaping the world. Postmodernists challenge conventional ways of thinking and aim to amplify marginalized and silenced perspectives that have been overlooked by dominant narratives. They deconstruct data to reveal its inherent instabilities and gaps. The axiology of postmodernism is deeply reflexive, encouraging critical self-awareness throughout the research process (Saunders, Lewis & Thornhill, 2019).

Pragmatism centres its ontology, epistemology, and axiology on the goal of enhancing practice. Pragmatists employ a diverse array of research strategies, selecting them based on the specific requirements and nature of their research problems (Saunders, Lewis & Thornhill, 2019).

3.2.1 Research Philosophy of The Study

Given the nature of this research, a positivism philosophy was embraced. Ontologically, positivism aligns with objectivism, asserting that knowledge can only be attained through the unbiased utilization of the senses to collect objective, perceptible, and quantifiable data employing scientific methods. In this paradigm, the researcher's primary role is to systematically collect and organize data that already exists (Alvesson and Skoldberg, 2018). Positivists view social science as a source of factual evidence, and the relationships uncovered through such research can be established as scientific laws (Crossan, 2003). However, acknowledging the inherent imperfections in research data, researchers consistently emphasize that their role is not to prove a hypothesis conclusively but rather to indicate a failure to reject it (Creswell and Creswell, 2018).

In the pursuit of formulating law-like generalizations, researchers within the positivist paradigm engage with a social reality that is both observable and measurable, relying on data derived from processes that are themselves observable and quantifiable. Within this philosophical framework, the emphasis is placed on developing quantitative measures of observation, a crucial aspect for generating meaningful and authentic assertions. The significance of a positivist approach is evident in its ability to provide causal explanations through statistical analyses, enabling the forecasting of organizational behaviour and situations. In this context, a positivist researcher leverages existing theories to construct hypotheses that are systematically investigated and empirically validated (Saunders, Lewis, and Thornhill, 2019).

The positivist perspective asserts that all studies should adhere to a quantitative approach, as it is considered the sole method capable of establishing a robust foundation for meaningful generalizations and laws in research (Crossan, 2003). Positivism, being inherently reductionist, involves breaking down complex issues and ideas into their most basic components. In practical terms, this means that researchers following a positivist philosophy collect data based on measures completed by respondents or recorded observations (Creswell and Creswell, 2018). From an axiological standpoint, positivism advocates for researcher neutrality and detachment to prevent any undue influence on the research and its findings. In other words, positivist researchers strive to maintain objectivity and avoid personal biases. They position themselves as independent from the data-gathering process, asserting that little can be done to alter the substance of the data once it has been attained (Saunders, Lewis, and Thornhill, 2019). This commitment to detachment is intended to ensure the credibility and reliability of the research outcomes within the positivist framework. Table 3.1 summarizes the research philosophy for this study.

Table 3.1: Research Philosophy Applied in This Study

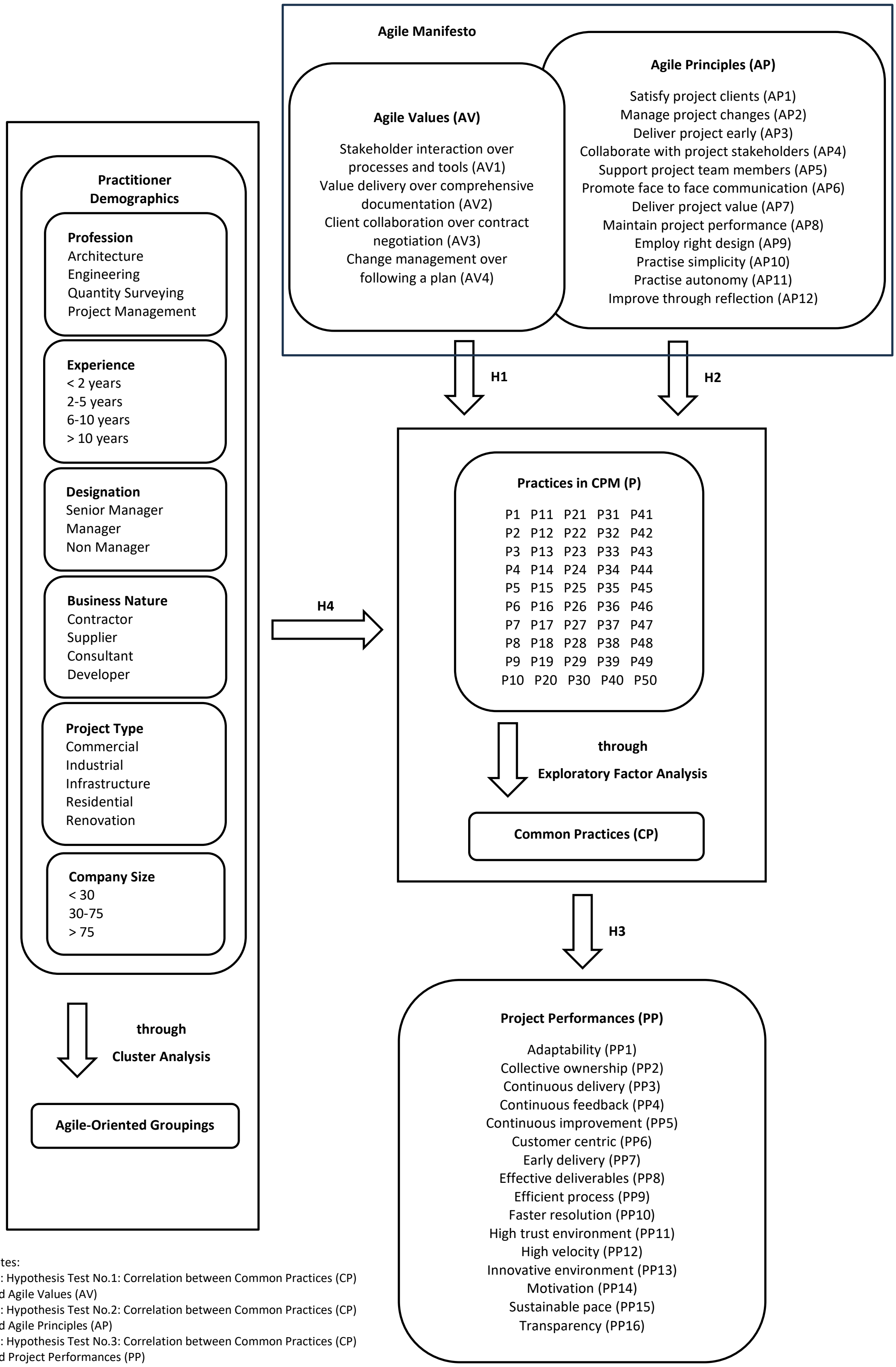
Research Philosophy	Application to Present Research
1) A positivist seeks to uphold objectivity and maintain a degree of separation from both the study and the data to prevent any potential impact on the research findings. (Saunders, Lewis and Thornhill, 2019).	Data was collected using a questionnaire to ensure an impartial utilization of senses, and the SPSS software was employed as a scientific method to analyse the data.
2) Rather than proving a hypothesis, the focus is on showing a lack of evidence to reject the hypothesis. (Creswell and Creswell, 2018).	In this research, several hypotheses were formulated for investigation.
3) Researchers engage with a social reality that is observable and measurable, utilizing statistics to derive law-like generalizations. (Alvesson and Skoldberg, 2018; Creswell and Creswell, 2018; Saunders, Lewis and Thornhill, 2019).	The concepts of agile values, agile principles, practices in construction project management, and project performances were considered as observable and measurable phenomena.
4) Recognition of contribution occurs when there is a causal explanation for the generated data and predictions about the behaviours and events within organizations. (Alvesson and Skoldberg, 2018; Creswell and Creswell, 2018; Saunders, Lewis and Thornhill, 2019).	This study aims to explore the connections between the foundational elements of agile and i) agile values, ii) agile principles, and iii) project performances.
5) A researcher following a positivist approach will formulate hypotheses and subsequently test and validate them using established theories. (Alvesson and Skoldberg, 2018; Creswell and Creswell, 2018; Saunders, Lewis and Thornhill, 2019).	Initially, the research was constructed on the foundation of existing theories, and subsequently, the questionnaire was devised.

6) Every study must adopt a quantitative approach because only quantitative research can establish a basis for meaningful generalizations and laws. (Crossan, 2003).	Data collection exclusively relied on the use of a questionnaire.
7) The positivist asserts independence from the data gathering process, contending that there is minimal room for altering the substance of the acquired data. (Saunders, Lewis and Thornhill, 2019).	The data were gathered through an online questionnaire, and the list of potential responses was crafted to ensure no influence on the answers provided by the respondents.

3.3 Selection of Research Method

3.3.1 Research Framework

There are several parts to the research framework as shown in Figure 3.1, the first being identifying the respondents' demographic information, followed by the investigation of agile values (AV), agile principles (AP), practices in construction project management (P) and project performances (PP) among Malaysian construction practitioners. Then, the common practices (CP) in construction project management were determined and extracted through exploratory factor analysis (EFA) of practices in construction project management. The correlations between the common practices (CP) in construction project management and i) agile values (AV), ii) agile principles (AP), and iii) project performances (PP) were ascertained. Subsequently, the influence of respondents' background characteristics on the common practices (CP) in construction project management were determined. Then, the distinct groups of construction practitioners based on their common practices were identified through cluster analysis (Conforto et al., 2014a).



Notes:
H1: Hypothesis Test No.1: Correlation between Common Practices (CP) and Agile Values (AV)
H2: Hypothesis Test No.2: Correlation between Common Practices (CP) and Agile Principles (AP)
H3: Hypothesis Test No.3: Correlation between Common Practices (CP) and Project Performances (PP)
H4: Hypothesis Test No.4: The Differences in Common Practices (CP) between Respondents with Different Demographic Characteristics

Figure 3.1: Research Framework

The respondents' demographic information was divided into six (6) background characteristics, which included profession, industry experience, designation, nature of business, type of project, and total employees. Agile values (AV) were determined by adopting Agile Manifesto by Beck et al. (2001), which has four (4) values. Agile principles (AP) were established by using Agile Manifesto as well, which included 12 principles. Practices in construction project management (P), which comprised 50 practices were ascertained by referring the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b). Lastly, project performances were instituted by referring A Guide to the Scrum Body of Knowledge (SBOK Guide) (SCRUMstudy, 2017) and The Scrum Guide (Schwaber and Sutherland, 2020), which included 16 project performances of using agile approaches.

i) Hypothesis Test No.1: Correlation between Common Practices (CP) and Agile Values (AV)

Null hypothesis (H1o): There is no significantly correlated between common practices, CPn and agile values, AVr

Alternative hypothesis (H1a): There is significantly correlated between common practices, CPn and agile values, AVr

n = To be determined using EFA

r = 1, 2, 3, 4

AV1 = Stakeholder interaction over processes and tools

AV2 = Value delivery over comprehensive documentation

AV3 = Client collaboration over contract negotiation

AV4 = Change management over following a plan

The first hypothesis test investigates whether common practices (CP) in Malaysian construction project management are significantly correlated with agile values (AV). This relationship is important because the Agile Manifesto (Beck et al., 2001) identifies four foundational values that underpin agile-oriented behaviours. If the common practices (CP) derived from exploratory factor analysis (EFA) of construction practices show significant correlations with these values, it would suggest that agile values are implicitly embedded within existing industry practices. The correlation test examines the strength and direction of association between CP and AV. A statistically significant correlation ($p < 0.05$) would support the alternative hypothesis (H1a), indicating that agile values are already embedded within certain common practices. Insignificant correlations would support the null hypothesis (H1o), suggesting limited alignment between CP and AV.

ii) Hypothesis Test No.2: Correlation between Common Practices (CP) and Agile Principles (AP)

Null hypothesis (H2o): There is no significantly correlated between common practices, CP_n and agile principles, AP_s

Alternative hypothesis (H2a): There is significantly correlated between common practices, CP_n and agile principles, AP_s

n = To be determined using EFA

s = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

AP1 = Satisfy project clients

AP2 = Manage project changes

AP3 = Deliver project early

AP4 = Collaborate with project stakeholders

AP5 = Support project team members

AP6 = Promote face to face communication

AP7 = Deliver project value

AP8 = Maintain project performance

AP9 = Employ right design

AP10 = Practise simplicity

AP11 = Practise autonomy

AP12 = Improve through reflection

The second hypothesis test examines whether common practices (CP) identified in Malaysian construction project management are significantly correlated with the agile principles (AP). The Agile Manifesto (Beck et al., 2001) outlines twelve guiding principles that operationalize the four agile values and provide actionable direction for project management. Correlating CP with these principles helps to determine the extent to which current construction practices embody agile-oriented behaviours. Correlation analysis will be applied to test associations between CP and AP. A statistically significant correlation ($p < 0.05$) will support the alternative hypothesis (H2a), indicating that construction practices are behaviourally aligned with agile principles. Non-significant results will support the null hypothesis (H2o), implying limited adoption of agile principles in current practice.

iii) Hypothesis Test No.3: Correlation between Common Practices (CP) and Project Performances (PP)

Null hypothesis (H3o): There is no significantly correlated between common practices, CPn and project performances, PPt

Alternative hypothesis (H3a): There is significantly correlated between common practices, CPn and project performances, PPt

n = To be determined using EFA

t = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

PP1 = Adaptability

PP2 = Collective ownership

PP3 = Continuous delivery of project value

PP4 = Continuous feedback

PP5 = Continuous improvement

PP6 = Customer centric

PP7 = Early delivery of project value

PP8 = Effective deliverables

PP9 = Efficient development process

PP10 = Faster problem resolution

PP11 = High trust environment

PP12 = High velocity

PP13 = Innovative environment

PP14 = Motivation

PP15 = Sustainable pace

PP16 = Transparency

The third hypothesis test evaluates whether common practices (CP) in Malaysian construction project management are significantly correlated with project performances (PP). Project performance in an agile context is not limited to time, cost, and quality outcomes; instead, it encompasses broader measures such as adaptability, value delivery, transparency, and motivation (SCRUMstudy, 2017; Schwaber and Sutherland, 2020). By examining CP–PP correlations, the study investigates whether the practices currently in use contribute directly to agile-oriented project outcomes. The correlation test will be employed to assess the degree of association between CP and PP. A significant correlation ($p < 0.05$) supports the alternative hypothesis (H3a), suggesting that CP positively influence project performance. Non-significant results would support the null hypothesis (H3o), indicating that the link between practices and project performance is weak or absent.

iv) Hypothesis Test No.4: The Differences in Common Practices between Respondents with Different Demographic Characteristics

Null hypothesis (H4o): There is no significant difference in common practices, CPn between respondents with different demographic characteristics, DCu

Alternative hypothesis (H4a): There is significant difference in common practices, CPn between respondents with different demographic characteristics, DCu

n = To be determined using EFA

u = 1, 2, 3, 4, 5, 6

DC1 = Profession

DC2 = Industry Experience

DC3 = Designation

DC4 = Nature of Business

DC5 = Type of Project

DC6 = Company Size

The fourth hypothesis test examines whether common practices (CP) identified in Malaysian construction project management differ significantly across respondents with varying demographic characteristics (DC). Unlike the earlier tests, which focus on correlations between practices and agile values, principles, or project performance, this test investigates whether demographic factors such as profession, industry experience, designation, business nature, project type and company size influence the adoption of agile-aligned practices (Conforto et al., 2014a). Non-parametric tests such as Kruskal–Wallis H (for comparisons across multiple groups) and post-hoc pairwise comparisons) are appropriate, given that the survey data are ordinal and not normally distributed. Significant test results ($p < 0.05$) will support the alternative hypothesis (H4a), indicating that demographic differences do affect the adoption of CPs. Insignificant results will support the null hypothesis (H4o), suggesting homogeneity across demographic subgroups.

3.3.2 Quantitative Research Approach

This study adopted a quantitative and exploratory research design, which was deemed most appropriate for systematically and objectively examining the relationships and differences among key variables across a large sample of construction practitioners in Malaysia. The exploratory nature of the research aligns with its aim to uncover underlying patterns of Agile-oriented practices and behaviours, rather than to test a pre-existing model. Quantitative analysis was chosen because the research objectives required measurement, statistical testing, and the identification of generalisable patterns that could inform the wider construction industry.

Grounded in the positivist paradigm, the study assumes that reality is objective, observable, and measurable. Positivism emphasises empirical evidence and systematic methods to discover consistent and generalisable truths. Accordingly, structured survey instruments and statistical techniques were employed to collect and analyse data in a rigorous and replicable manner.

This paradigm was particularly suitable as the study sought to identify measurable relationships, latent constructs, and naturally emerging practitioner groups in the adoption of Agile practices. Methods such as Exploratory Factor Analysis (EFA) were used to uncover the underlying structure of common practices, while cluster analysis further explored how practitioners could be grouped based on their Agile orientations and demographic characteristics.

These techniques provided empirical insights into behavioural patterns that might not be evident through descriptive or theoretical approaches alone.

Adopting a positivist and exploratory stance also ensured objectivity and minimised researcher bias, which was essential when investigating Agile adoption across diverse demographic and professional groups. The reliance on statistically derived evidence enhanced the validity, neutrality, and practical relevance of the findings, enabling the study to generate credible conclusions and actionable recommendations for advancing Agile-oriented project management in the Malaysian construction industry.

i) Research Objectives and Associated Analytical Methods

Research Objective 1 (RO1) – To identify common practices for construction project management in Malaysia – was supported Research Question, RQ1. This objective necessitates the use of exploratory factor analysis (EFA), which is inherently quantitative. EFA enables the identification of latent constructs (common practices) from a large set of observed variables. The structured survey responses allow the researcher to statistically reduce data and extract reliable factors that represent common practices.

For RO1, Exploratory Factor Analysis (EFA) was selected to identify common practices in construction project management. EFA is appropriate because the study aims to explore and uncover underlying structures rather than to validate a pre-established theoretical model. Although advanced methods such as Structural Equation Modelling (SEM) could be considered, it was not applied for several reasons. First, SEM is primarily confirmatory techniques used to test causal relationships within an already established framework, whereas this study is at the theory-building stage, seeking to derive new constructs (CP1–CP8) from construction practices. Second, the available sample size (N = 252) meets the requirements for EFA but falls below the recommended thresholds for complex SEM analysis, which often requires larger datasets for stable estimates. Finally, the research objective does not involve testing structural paths or predictive models but rather identifying clusters of practices. Therefore, EFA was the most suitable technique, with SEM reserved for potential future confirmatory studies.

Research Objective 2 (RO2) – To investigate the alignment of common practices with agile values and agile principles – was supported Research Questions, RQ2 and RQ3. Quantitative methods allow for testing correlations between extracted common practices (CP) and agile values (AV) as well as agile principles (AP). Using correlation techniques, the study can establish the strength and direction of associations. This is essential for validating whether the common practices identified are aligned with Agile theory.

Research Objective 3 (RO3) – To investigate the relationships between common practices and project performance – was supported Research Question, RQ4. To test whether adopting certain CP leads to better project performance, statistical analysis is necessary. Quantitative techniques allow for empirical testing of these relationships, producing generalisable evidence that links practice with performance.

For Research Objectives RO2, and RO3, Spearman's rank correlation coefficient (Spearman's rho) was employed to assess the strength and direction of the relationships between common practices, agile values, agile principles, and project performances. Unlike Pearson's correlation, which assumes linearity and normally distributed interval data, Spearman's rho is a non-parametric technique that is suitable when the data are ordinal, not normally distributed, or contain outliers (Corder & Foreman, 2014; Field, 2018). It operates by ranking the values of the variables and calculating the correlation based on these ranks, thereby reducing the influence of extreme values and relaxing normality assumptions. Given that the survey responses were measured on Likert scales, which generate ordinal data, Spearman's rho provides a more appropriate and robust measure of association. This method ensures that meaningful monotonic relationships can be identified even if the data do not meet parametric assumptions.

Research Objective 4 (RO4) – To examine differences in common practices across practitioner demographics – was addressed through Research Questions, RQ5 and RQ6. For RQ5, non-parametric group comparison methods such as Kruskal–Wallis, and Dunn–Bonferroni tests were applied to examine whether demographic factors such as profession, industry experience, designation, and type of project are associated with greater inclination towards common practices. These tests were appropriate because the data were ordinal (Likert scales) and did not meet the assumptions of parametric tests, ensuring robust identification of demographic influences. For RQ6, cluster analysis was employed to classify practitioners into distinct groups based on their adoption of the common practices extracted through Exploratory Factor Analysis (EFA). Cluster analysis was suitable because it uncovers natural groupings in the data without requiring predefined categories, thereby revealing meaningful practitioner segments.

Research Objective 5 (RO5) – To develop an agile-oriented construction project management framework integrating common practices, agile values, agile principles, project performance, and practitioner demographics – was supported Research Question, RQ7. Together, the results from RO4 were integrated with earlier findings from RO1 – EFA of common practices; and RO1-RO3 – correlations with agile values, agile principles, and project performances to construct the framework for agile-oriented construction project management.

ii) Data Collection Instrument: Questionnaire

The instrument used to collect data in this study was a questionnaire. A questionnaire is a preformulated written set of questions to which respondents record their answers, usually within rather closely defined alternatives. Questionnaires are generally designed to collect large numbers of quantitative data. Questionnaires are generally less expensive and time consuming than interviews and observation, but they also introduce a much larger chance of nonresponse and nonresponse error. Closed questions were created for this questionnaire. A closed question asks the respondents to make choices among a set of alternatives given in the questionnaire. All items in a questionnaire using a nominal, ordinal, or ratio scale are considered closed. Closed questions help the respondents to make quick decisions to choose among the several alternatives before them. They also help for coding the information easily for subsequent analysis. The questionnaire began with a brief and clear introduction to the research and the group of eligible respondents. The questionnaire was divided into sections. All sections needed to be answered by respondents, and there was no alternative section and skipping section were allowed.

iii) Mode of Questionnaire Distribution

Surveys are categorized into five main types: web surveys, mail surveys, phone surveys, in-person interviews, and direct observation (Doane and Seward, 2016). Given that the target respondents for this study were construction practitioners dispersed across Malaysia, web surveys were deemed suitable. Furthermore, as the study collected substantial personal information, ensuring respondent anonymity was ensured through the utilisation of a self-administered survey. However, due to the nature of this self-administered survey, potential errors such as misrepresentation of information, lack of knowledge, and incomplete participation may occur.

iv) Questionnaire Structure and Content

The questionnaire was designed with five sections as summarized in Table 3.2. It comprised administrative questions for participant identification, classification questions for demographic data collection, and study specific questions.

Table 3.2: Questions Constructed in The Questionnaire

Variables	Breakdown and Sources	Scale Type
Agile values (AV)	Agile values were developed by Beck et al. (2001) as stated in Agile Manifesto.	Ordinal
Agile principles (AP)	Agile principles were developed by Beck et al. (2001) as stated in Agile Manifesto.	Ordinal
Practices in Construction Project Management (P)	Practices in construction Project Management were determined by referring the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b)	Ordinal
Project Performances (PP)	Project performances were determined by referring A Guide to the Scrum Body of Knowledge (SBOK Guide) (SCRUMStudy, 2017) and The Scrum Guide (Schwaber and Sutherland, 2020)	Ordinal
Demographics	<u>Profession</u> Architecture Engineering Quantity Surveying Project Management Other <u>Industry Experience</u> Less than 2 years 2 – 5 years 6 – 10 years More than 10 years <u>Designation</u> Senior Manager & above Manager Executive <u>Nature of Business</u> Construction business Construction merchant Consultancy Property development Other <u>Type of Project</u> Commercial Industrial Infrastructure Residential Renovation Other <u>Company Size</u> Less than 30 30 – 75 More than 75	Nominal

No explicit criteria such as prior experiences in Agile practices, as the exploratory nature of this study seeks to capture agility tendencies across the wider construction practitioner population. Nonetheless, practitioner demographic data were collected, including profession, industry experience, designation, nature of business, project type, and company size. These variables were subsequently analysed to identify differences in agility alignment among practitioner groups, ensuring an inclusive sample while avoiding bias and enabling meaningful demographic-based interpretations.

Section A was the agile values (AV) developed by Beck et al. (2001) as stated in Agile Manifesto. It comprised four (4) values as shown in Table 3.3. A 1 to 10 rating scale was employed to assess the inclination of AV. Rating 1 represents highly incline towards processes and tools, and rating 10 represents highly incline towards project stakeholder interaction for first agile value. However, for second agile value, rating 1 represents highly incline towards comprehensive documentation, and rating 10 represents highly incline towards project value delivery. As for third agile value, rating 1 represents highly incline towards contract negotiation, and rating 10 represents highly incline towards project client collaboration. Lastly for fourth agile value, rating 1 indicates highly incline towards following a plan, and rating 10 indicates highly incline towards responding to change.

Table 3.3: Variables in Agile Values Scale

Code	Variables Measuring Agile Values (AV)
AV1	Stakeholder interaction over processes and tools
AV2	Value delivery over comprehensive documentation
AV3	Client collaboration over contract negotiation
AV4	Change management over following a plan

Section B was the agile principles (AP) developed by Beck et al. (2001) as stated in Agile Manifesto as well. It consisted of 12 principles as shown in Table 3.4. A five-point Likert scale from strongly agree to strongly disagree was used to assess the AP scale.

Table 3.4: Variables in Agile Principles Scale

Code	Variables Measuring Agile Principles (AP)
AP1	Satisfy project clients
AP2	Manage project changes
AP3	Deliver project early
AP4	Collaborate with project stakeholders
AP5	Support project team members
AP6	Promote face to face communication
AP7	Deliver project value
AP8	Maintain project performance
AP9	Employ right design
AP10	Practise simplicity
AP11	Practise autonomy
AP12	Improve through reflection

Section C was the practices in construction project management (P), which comprised 50 practices were ascertained by employing the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b). The 50 items were assessed using a five-point Likert scale ranging from strongly agree to strongly disagree and the variables were summarised in Table 3.5.

Table 3.5: Variables in Construction Project Management Practices Scale

Code	Variables Measuring CPM Practices (P)
P1	Define project deliverables progressively
P2	Refine project requirements based on client acceptance criteria
P3	Tailor processes based on team experience
P4	Tailor processes based on organisational characteristics
P5	Tailor processes based on project characteristics
P6	Follow the sequence of work
P7	Limit the cycle time
P8	Solicit client collaboration
P9	Prioritise project work through stakeholders' collaboration
P10	Work balance between project delivery and risk reduction
P11	Reprioritise requirements based on changes of project environment needs
P12	Reprioritise requirements based on changes of project stakeholder needs
P13	Conduct inspections
P14	Conduct testing
P15	Engage with project stakeholders
P16	Share information with project stakeholders
P17	Form agreement with project involvement
P18	Assess project changes to maintain stakeholder involvement
P19	Use collaborative decision making
P20	Use collaborative conflict resolution
P21	Understand project vision
P22	Understand project success criteria
P23	Develop ground rules with project members
P24	Develop project members' interpersonal skills
P25	Develop project members' technical skills
P26	Encourage emergent leadership
P27	Understand project members motivators and demotivators
P28	Encourage communication via collaboration tools
P29	Reduce distractions among project members
P30	Encourage project members to measure performance
P31	Plan progressively at multiple project stages
P32	Adjust planning based on project performance
P33	Adjust planning based on project changes
P34	Size project elements progressively
P35	Adjust project resources in stages
P36	Create rough baselines at the beginning of project
P37	Refine baselines as the project progresses
P38	Evaluate baselines based on project changes
P39	Perform project reviews in stages
P40	Seek feedback via progressive project delivery
P41	Seek feedback via site mock-up
P42	Create a project environment of continuous learning
P43	Reduce project wastes
P44	Disseminate project knowledge
P45	Retrospect project issues
P46	Open to reveal project problems
P47	Identify issues with project members
P48	Resolve issues with pertinent project members
P49	Maintain a visible list of project issues to track ownership
P50	Maintain a visible list of project issues to track resolution status

Section D was the project performances were established by referring A Guide to the Scrum Body of Knowledge (SBOK Guide) (SCRUMStudy, 2017) and The Scrum Guide (Schwaber and Sutherland, 2020), which included 16 benefits. The 16 items were analysed using a five-point Likert scale ranging from strongly agree to strongly disagree and the variables were outlined in Table 3.6.

Table 3.6: Variables in Project Performances Scale

Code	Variables Measuring Project Performances (PP)
PP1	Adaptability
PP2	Collective ownership
PP3	Continuous delivery of project value
PP4	Continuous feedback
PP5	Continuous improvement
PP6	Customer centric
PP7	Early delivery of project value
PP8	Effective deliverables
PP9	Efficient development process
PP10	Faster problem resolution
PP11	High trust environment
PP12	High velocity
PP13	Innovative environment
PP14	Motivation
PP15	Sustainable pace
PP16	Transparency

Section E was demographic information of respondents. This section was to collect nominal data on respondents' background characteristic such as gender, profession, industry experience, designation, business nature, project types and total employees in the company. The categories were established for each background characteristics were outlined in Table 3.2.

v) Pre-test

Pre-testing of the questionnaire is essential for identifying potential errors in questionnaire design. Pre-tests serve to evaluate the efficiency of data collection techniques and survey instruments under real-world conditions (Fowler, 2014). By conducting pretests, issues related to question content, language, sequencing, and overall survey quality can be detected and addressed, thus enhancing survey completion rates (Cooper and Schindler, 2014). It is recommended to use a minimum of five to ten respondents for pre-testing a research instrument (Burns and Veeck, 2020).

Consequently, five respondents were enlisted in this study to verify the precision and appropriateness of the questionnaire's wording, aligning it with the respondents' reading proficiency and knowledge level. The pre-test respondents included two internal lecturers, and three industry practitioners engaged in the construction industry. Comments and suggested changes gathered from their feedback were systematically organized and documented in Table 3.7.

Table 3.7: Comments Received and Changes Made After Pre-test

Variable	Comments	Changes Made
Demographic Information	To attract respondents' interest by first answering a questionnaire related to the research.	Moved the demographic information section to the end instead of placing it at the beginning.
Gender	Is this information required for analysis?	This question was removed from the questionnaire.
Age	Age is sensitive. Should this information require for analysis.	This question was removed from the questionnaire.
Education background	Based on the research title, educational background does not appear to be a crucial attribute for the analysis.	This question was removed from the questionnaire.
Profession	It is suggested to include the 'Other' option.	The 'Other' option was included.

Industry experience	There are too many answer categories.	A new category, 'more than 10 years' was introduced to replace the existing categories of '11–20 years' and 'more than 20 years'.
Nature of business	It is suggested to include the 'Other' option.	The 'Other' option was included.
Designation	There are too many answer categories.	A new category, 'senior manager and above' was introduced to replace the existing categories of 'general manager' and 'director'
Type of project	It is suggested to include the 'Other' option.	The 'Other' option was included.
Research topic	It would be helpful to include a brief introduction to agile project management for the respondents.	A brief paragraph was inserted to provide an introduction to agile project management.

vi) Pilot Study

The pilot group typically consists of 25 to 100 individuals selected from the target group, aimed at refining data collection methods and processes (Cooper and Schindler, 2014). This study conducted a pilot study to assess the effectiveness of planned recruitment methods and the suitability of the survey instrument. Initially, the questionnaire was distributed through email to Malaysian construction companies for a questionnaire survey, but no responses were received through this channel.

Subsequently, the LinkedIn platform was utilized, resulting in the successful acquisition of thirty (30) responses. The received data underwent proposed data analysis techniques to identify any potential issues, revealing no significant concerns. Generally, respondents completed the questionnaire satisfactorily, requiring no modifications. However, it was observed during the pilot study that reaching out to construction companies via email was challenging. Consequently, the main study primarily targeted respondents through the LinkedIn platform. Following preliminary data analysis, the research questions were revised, while the questionnaire remained unchanged. Therefore, the thirty (30) samples obtained from the pilot study were incorporated into the main study.

3.3.3 Sampling Design

This study adopted a cross-sectional survey sampling design to collect quantitative evidence on Agile-oriented construction project management practices in Malaysia. Because a complete and accessible list of all construction practitioners in Malaysia was not available, the study employed a non-probability, practitioner-based sampling approach focused on reaching respondents who were most able to provide informed judgements on project management practices and agility-related behaviours.

A purposive sampling strategy was used to ensure that participants met the study's relevance criteria specifically direct involvement in construction project activities and familiarity with project delivery practices. To broaden reach across different professional groups and organisations, the recruitment was complemented by a snowball approach, where initial respondents helped disseminate the survey to other eligible practitioners within their professional networks. This approach is appropriate for industry settings where access to respondents is network-driven and the population is fragmented across multiple firms and project types.

The target population comprised construction industry practitioners in Malaysia who are involved in planning, managing, or delivering construction projects specifically project managers, engineers, quantity surveyors, architects, and related roles.

i) Sample Size

In this study, the Cochran sample size formula was utilised. Various essential factors need to be taken into account to ascertain the optimal sample size, including the degree of precision and the level of confidence. The precision level denotes the permissible error between the estimated and population values, determining the closeness of an estimate to the actual characteristics of the population. This precision, also known as sampling error, varies based on the researcher's willingness to assume risk and is typically expressed as a percentage (Cochran, 1977; Stockemer, 2019). A larger sample size enables a more accurate estimation of the actual population mean with reduced sampling error (Evans and Basu, 2013).

While many researchers commonly utilise a 5% margin of error, Cochran (1977) suggests that this choice is somewhat arbitrary. The desired confidence level is another crucial factor to consider when determining the sample size. It indicates the likelihood of the interval containing the true population parameter. A higher confidence level indicates a greater certainty that the interval encompasses the true population parameter. Typically, confidence levels of 90%, 95%, and 99% are employed. For instance, with 100 samples, a 95% confidence level implies that 95 out of 100 samples will yield an estimate within the precision specified by the researcher. The z-value is utilised to establish the desired confidence level during sample size calculation. Researchers can adjust the sample size or confidence level if they opt for a more precise interval. When faced with budget and time constraints, researchers may reduce the confidence interval from 95% to 90% and increase the maximum error from 3% to 4% (Evans and Basu, 2013; Doane and Seward, 2016).

In this study, since the population size is unknown, there is no available information regarding the probable p-value. Consequently, the p-value was assumed to be 0.50, with a 5% margin of error (Cooper and Schindler, 2014). Using Cochran's (1977) sample size formula, the sample size was determined to be 385, calculated with a 95 percent confidence level, a p-value of 0.50, and a 5% margin of error.

$$n_0 = \frac{Z^2 pq}{e^2}$$

$$n_0 = \frac{1.96^2 \text{ x } 0.5 \text{ x } 0.5}{0.05^2} = 385$$

n = sample size

Z = confidence level, 95% confidence level for estimating the interval

p = the estimated proportion of the population, if an unknown population will use 0.50

$q = 1 - p$

pq = measure of sample dispersion

e = margin of error, used 5% of margin error

ii) Central Limit Theorem (CLT)

If the population adheres to a normal distribution, the sample mean for any given sample size will also exhibit a normal distribution. However, in cases where the population does not exhibit a normal distribution or the distribution is unknown, statisticians often turn to one of the fundamental principles in statistics—the Central Limit Theorem (CLT) (Evans and Basu, 2013; Doane and Seward, 2016).

In 1810, Laplace introduced the Central Limit Theorem (CLT), which suggests that assuming normality can provide accurate outcomes when analysing means. Essentially, this theorem implies that the normal curve can be utilised to make inferences based on means if there are a sufficient number of observations. The normal curve is centred around the value being estimated. Laplace initially experimented with a sample size of 20 observations, obtaining reasonable results with the CLT. However, he achieved even better outcomes when he increased the sample size to 30 observations (Wilcox, 2010).

According to the Central Limit Theorem (CLT), when sample sizes are sufficiently large (n = 30), the distribution of sample means approximates a normal distribution centred around the population mean (Cooper and Schindler, 2014; Field, 2018). For large enough sample sizes (N), the sampling distribution becomes approximately normal, with a mean equal to the population mean and a standard deviation equal to the population standard deviation divided by the square root of the sample size (Siegel, 1956). CLT is a robust result that allows for the approximation of the sampling distribution of the sample mean, even if the population is not normally distributed (Doane and Seward, 2016). While deviations from normality can have a significant impact on results in smaller samples with 50 or fewer observations, especially when the sample size is less than 30, the effects are less pronounced in larger sample sizes such as 200 (Pituch and Stevens, 2016; Field, 2018; Hair et al., 2017). CLT provides researchers with the confidence to use small samples, as they can effectively reflect population characteristics (Cramer and Howitt, 2004). Additionally, CLT enables researchers to generalize findings from a sample to the entire population (Neuman, 2014).

3.4 Description of Research Method

Before conducting the main statistical analyses, the collected data underwent a thorough preparation process to ensure accuracy and reliability. This involved examining missing data, identifying response patterns and outliers, and testing for common method bias to minimise potential measurement errors. Subsequently, validity and reliability analyses were carried out to confirm the consistency and credibility of the measurement instruments prior to further statistical testing.

3.4.1 Data Preparation

Survey responses are commonly coded numerically to facilitate analysis. It is essential to filter out multiple responses, extreme responses, inconsistent responses, and straight-lining responses. A tabulated summary of data preparation methods can be found in Table 3.8.

Table 3.8: Summary of Data Preparation

Assessment	Purpose	Analysis	Criteria	Reference
Missing data	To decide whether the missing value should be removed	Screen the data and identify user-defined missing values	Recode the data	Green and Salkind, (2014)
Response patterns	To identify and remove cases with the same option throughout the questionnaire	Standard deviation	Standard deviation = 0 will be removed	Hair *et al.*, (2017)
Outliers	To identify outliers	Boxplot	Extreme outliers were identified with more than 3 box lengths away from the quartiles	Evans and Basu, (2013); Cooper and Schindler, (2014)
Common method bias	To ensure that variance is not attributed to the measurement method	Harman’s single factor test	Threshold level less than 50%	Podsakoff, MacKenzie and Podsakoff, (2012); Steenkamp and Maydeu-Olivares, (2021)

i) Mising Data

When data is collected through a questionnaire, it is common to encounter missing data, typically when respondents do not answer specific questions. However, missing data is less of an issue now than in the past due to the use of electronic questionnaires, which reduce incomplete responses. With web-based systems, respondents are unable to proceed to the next question without providing a complete answer to the previous one, ensuring data completeness.

ii) Response Patterns

When analysing questionnaire responses, it is crucial to assess their consistency and the level of engagement from respondents. To ensure accuracy, the questionnaire includes questions to confirm the identity of the respondents. Consistency and commitment in answering questionnaire items are evaluated using a technique called straight-lining, where participants respond to sets of questions using the same response scale. If respondents consistently provide identical or nearly identical responses across all items using the same scale, it indicates a lack of differentiation, resulting in nondifferentiated responses (Lavrakas, 2008; Kim et al., 2019). This assessment involves excluding cases where there is no variation in responses across all questions.

iii) Outliers

An outlier refers to a response that deviates significantly from the norm and can have a notable impact on the results. Before proceeding with the analysis, it is essential to examine the data for outliers. The interquartile range (IQR) is commonly employed to identify outliers, while box plots are useful for detecting outliers within constructs. This study will focus on identifying extreme outliers that are more than three box lengths away from the quartiles (Evans and Basu, 2013; Cooper and Schindler, 2014).

When there is a valid reason for exceptionally high or low data points, outliers are usually retained as they may represent a specific subset of the population, particularly if they contain valuable information. It's important to assess their impact on the research findings carefully. While the temptation to discard an outlier may arise, they should be preserved if they offer meaningful insights. Sometimes, an unusual finding can convey an important message (Doane and Seward, 2016; Pituch and Stevens, 2016; Hair et al., 2017).

iv) Common Method Bias (CMB)

Common method bias (CMB) occurs when the relationship between two or more constructs is distorted due to using the same measurement method, potentially leading to misleading findings in empirical data. High variance in CMB can result in an inaccurate interpretation of the results (Podsakoff et al., 2003; Jordan and Troth, 2020). CMB is primarily caused by factors such as using a single-item setting, respondent characteristics, interpretation of assessments, and item characteristics. When respondents answer all survey items in one session, CMB can threaten the validity of the data (Tehseen, Ramayah, and Sajilan, 2017). It is crucial to assess CMB, especially when collecting data through self-reported questionnaires or surveys (Podsakoff et al., 2003).

CMB may arise from social desirability or respondents' tendency to provide answers that portray them in a favourable light. It can also occur when respondents consistently give either extremely positive or negative responses (Podsakoff et al., 2003; Podsakoff, MacKenzie, and Podsakoff, 2012; Tehseen, Ramayah, and Sajilan, 2017). Additionally, respondents' individual traits, such as agreeable behaviour, can contribute to CMB. When surveys contain complex or ambiguous items, bias can develop as respondents may struggle to accurately interpret unclear questions. Moreover, administering a survey in a single session where all variables, are collected using Likert scales, can lead to identical responses and potential CMB (Mishra, 2016; Jordan and Troth, 2020).

There are two main remedies that can be employed to mitigate CMB,

a) Procedural Remedies

Studies should be designed to enhance respondents' understanding and motivation while simplifying question complexity to enable more precise responses. Procedures should be implemented to facilitate respondents' ability to answer questions. One approach is to ensure that respondents are not required to engage in unfamiliar tasks. Additionally, the difficulty of providing accurate responses can be minimized by using concise and clear language, simple syntax, defining unclear or new concepts, and similar strategies (Podsakoff, MacKenzie and Podsakoff, 2012; Mishra, 2016; Tehseen, Ramayah and Sajilan, 2017).

b) Statistical Remedies

Several post-hoc strategies have been proposed to address CMB using statistical methods. One widely used and straightforward technique is Harman's single-factor test, frequently employed in international business research (Steenkamp and Maydeu-Olivares, 2021). To conduct this test, all study variables were subjected to exploratory factor analysis, which evaluates the set of criteria required in an unrotated solution (Hulland, Baumgartner, and Smith, 2018). CMB is considered negligible if a single factor in the unrotated solution explains less than 50% of the variance. In this study, Harman's single-factor test was applied, with all factors loaded and the common factor's variance standardized to one.

3.4.2 Validity and Reliability Analysis

Validity analysis was conducted using summated scales and highest mean variables to assess the constructs defined for AV, AP, P, and PP. The reliability of these scales was evaluated using Cronbach's Alpha.

i) Validity Analysis

To assess the construct validity of AV, AP, P, and PP, the study compared the summated scales with their respective highest mean variables to identify consistent patterns. This method offers a practical approach for evaluating the robustness of the scales.

ii) Reliability Analysis

Reliability analysis is employed to scrutinize the properties of measurement scales and the individual items comprising these scales. Apart from revealing correlations among specific scale items, reliability analysis offers various metrics commonly used to assess scale reliability. In this study, the Cronbach's Alpha Reliability test was utilised to evaluate internal consistency reliability across the AV, AP, P, PP, and CP scales. Introduced by Cronbach in 1951, this test evaluates the consistency of a test or scale, particularly when multiple questions are formulated using Likert scales, aiming to gauge the scale's reliability. The alpha coefficient, ranging from zero to one, indicates the scale's reliability, with a value exceeding 0.7 considered acceptable. In cases of internal inconsistency, researchers can pinpoint problematic items and decide whether to retain them (Hammond and Wellington, 2021).

3.5 Method of Analysis

The data underwent analysis and numerical coding in Microsoft Excel before being imported into Statistical Package for the Social Sciences (SPSS). The research utilised Microsoft Excel, and IBM SPSS Statistics 29. Both descriptive and inferential statistical methods were employed in the analysis, and a summary of the data analysis methods was presented in Table 3.9.

Table 3.9: Summary Data Analysis Methods

Assessment	Purpose	Analysis	Criteria	Reference
Reliability analysis	To measure internal consistency between items on a scale of AV, AP, P, PP, and CP.	Cronbach's Alpha	$\alpha > .70$ acceptable	George and Mallery, (2019)
Correlation Analysis	To check the relationship between CP and (i) AV, (ii) AP and (iii) PP	Spearman's rank correlation	$p < .05$ has significant relationship	Doane and Seward, (2016); Howitt and Cramer, (2017)
	To identify the influential common practices (CP) in CPM based on AV, AP and PP	Spearman's rank partial correlation		Field, (2018)
Inferential Statistics	To check how the respondents' demographic characteristics influence their inclination towards agile practices	1) Mann-Whitney U test 2) Kruskal Wallis test 3) Dunn-Bonferroni test	$p < .05$ has significant different	Siegel, (1956); Cooper and Schindler, (2014); Green and Salkind, (2014); Field, (2018)

Data reduction method	To identify the underlying structure (factors) in a set of observed variables	Exploratory factor analysis (EFA)	a) Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA) Test values > 0.50 for both the overall test and each individual variable. b) Bartlett's Test of Sphericity ($p < 0.05$) c) Retain variables with communalities > 0.50 d) Retain factors with eigenvalues > 1 e) Factor loading => 0.50 (practical significance)	Hair et al., 2019
Data reduction method	To group objects based on the characteristics they possess	Cluster Analysis	a) Hierarchical approach is used to select the number of clusters and profile cluster centres that serve as initial cluster seeds in the nonhierarchical procedure. b) Nonhierarchical method then clusters all observations using the seed points to provide more accurate cluster memberships. c) Silhouette analysis is employed to assess the validity and quality of the clustering solution	Hair et al., 2019

3.5.1 Inferential Analysis

Inferential statistics is a branch of statistics concerned with drawing conclusions about a population based on sample data. Researchers use inferential statistics to extrapolate implications beyond the observed data. In research, inferential statistics help researchers infer the population's characteristics from sample data and determine whether observed differences between groups are statistically significant or occurred by chance alone (Ho, 2018). Siegel (1956) suggests that nonparametric hypothesis testing methods are particularly suitable for behavioural science data. These tests are often termed "distribution-free" because they do not necessitate the scores being derived from a population with a specific distribution (Siegel, 1956; Green and Salkind, 2014). Nonparametric tests make fewer assumptions about the population and are especially useful when working with data likely to be skewed and with small sample sizes (Doane and Seward, 2016). Given that this study employed a nonprobability sampling method and had a relatively small and skewed sample size, nonparametric tests were used as inferential statistics.

Nonparametric tests, often referred to as "ranking tests," focus on the order of scores rather than their numerical values. These tests are valuable for scenarios involving one or more nominal or ordinal scale variables. Since the data in this study were collected using Likert scales, which yield non-numeric values, parametric methods were not appropriate (Siegel, 1956). When the dependent variable is measured on an ordinal scale, nonparametric tests are recommended (Green and Salkind, 2014). The summary of nonparametric tests used in this study were tabulated in Table 3.9.

i) Measures of Association

In management research, the examination of relationships between two or more variables is common, often aiming to determine whether one variable is accountable for the other (Cooper and Schindler, 2014). Spearman's Rank correlation and partial correlation were employed to assess the association. Developed by Charles E. Spearman (1863-1945) to evaluate human intellect, Spearman's rank correlation coefficient is particularly useful when an interval scale, as required by the Pearson correlation coefficient, is not applicable (Doane and Seward, 2016). An advantage of Spearman's rank is its simplicity in calculation, especially when dealing with small sample sizes and ordinal data scales (Cramer and Howitt, 2004; Howitt and Cramer, 2017). It utilises rankings to gauge the strength of the relationship between two variables, with outliers being less pronounced when the data is ranked. If the sample size (n) is sufficiently large (typically at least 30 observations according to CLT), Spearman's rho can be assumed to follow the normal distribution (Doane and Seward, 2016; Field, 2018). Partial correlation is a statistical technique used to measure the strength and direction of the relationship between two variables while controlling for the influence of one or more additional variables. Its primary purpose is to isolate the unique association between two variables by removing the effects of other variables that may confound or distort the relationship (Field, 2018).

In this study, Spearman's Rank Correlation was used to investigate the relationships between common practices and (i) agile values, (ii) agile principles and (iii) project performances. Subsequently, partial correlation was used to identify the influential common practices in construction project management. According to Cohen (1988), the relationship strength (also known as effect size) is small if the correlation coefficient, r value is between 0.1 and 0.3, medium if the r value is between 0.3 and 0.5, and large if the r value is between .5 and 1.0. Table 3.10 displays these interpretations of the relationship strength.

Table 3.10: Interpretation of Strength of Relationship

Relationship Strength (Effect Size)	Correlation Coefficient, r
Small	0.1 - 0.3
Medium	0.3 - 0.5
Large	0.5 - 1.0

Sources: Cohen (1988)

ii) Mann-Whitney (M-W) Test

The Mann-Whitney test, also referred to as the Wilcoxon rank sum test, is a nonparametric method used to compare two populations. It operates under the assumption that the distributions of the two populations are similar but does not require the assumption of normality (Doane and Seward, 2016). This test is particularly useful when outcomes are measured on ordinal scales. It is especially advantageous when the data is skewed or influenced by a small number of observations, as it evaluates whether two samples drawn from populations with equal medians exhibit a predicted effect (Conroy, 2012).

Mann-Whitney (M-W) test was used in this study to determine the influence of agile groups on agile values, agile principles, common practices and project performances.

iii) Kruskal-Wallis (K-W) Test

William H. Kruskal and W. Allen Wallis introduced a statistical test designed to compare more than two groups of independent samples. In this method, all scores are ranked from lowest to highest, irrespective of their group affiliation, and the average rank within each group is then analysed (Doane and

Seward, 2016; Field, 2018; Howitt and Cramer, 2017). To further investigate significant findings from the Kruskal-Wallis (K-W) test, the Dunn-Bonferroni test will be employed as a post-hoc analysis. The accuracy of the p-value derived from the chi-square approximation in the K-W test is considered reliable when the number of cases is 30 or greater (Green and Salkind, 2014).

In this study, Kruskal-Wallis (K-W) test and Dunn-Bonferroni test were used to determine the influence of the construction respondents with different demographic characteristics on the common practices in construction project management.

Since SPSS does not measure effect size, it can be calculated roughly from the z-score for the test statistic. The equation from Rosenthal (1991) for converting a z-score into an effect size estimate (Field, 2018), r, is as follows:

$$r = z/\sqrt{N}$$

Z = z-score that SPSS produces

N = number of total observations on which z is based

The effect size of the K-W result, as shown in Table 3.10, was divided into three categories using the Cohen (1988) standard inclusive small effect size, medium effect size, and large effect size.

3.5.2 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is an interdependence technique used to uncover the underlying structure among variables. In social sciences, direct measurement of abstract concepts is often impossible, so researchers rely on variables that reflect these concepts based on perceptions, prior knowledge, and experiences. From a broader perspective, EFA serves as a valuable tool for examining relationships between variables, revealing hidden patterns or structures based on their interconnections, (Hair et al., 2019).

(a) Stage 1: Objectives of Exploratory Factor Analysis

Hair et al. (2019) outlined seven key stages in the application of exploratory factor analysis (EFA). The first stage involves clarifying the objectives of EFA. The general purpose of exploratory factor analytic techniques is to find a way to condense the information contained in a number of original variables into a smaller set of new, composite dimensions or factors with a minimum loss of information that is to search for and define the fundamental constructs or dimensions assumed to underlie the original variables. .

(b) Stage 2: Design of Exploratory Factor Analysis

Three key decisions involved in the second stage to design the exploratory factor analysis (EFA) (Saeed et al., 2022; Hair et al., 2019). First, researchers must structure the study by selecting variables that are measurable and suitable for correlation analysis, noting that metric variables are preferred and that factors should not rely on single variables. Second, sample size must be determined based on dataset adequacy, the ratio of cases to variables, and the strength of communalities. General rules suggest at least 50–100 observations, five cases per variable, and larger samples (up to 400) when communalities are weak (<.40) (Fabrigar & Wegener, 2012). The communalities show the total amount of variance an original variable shares with all other variables included in the factor analysis. Finally, the correlation matrix must be examined to decide between R-type analysis, which groups variables, and Q-type analysis, which groups respondents.

(c) Stage 3: Assumptions in Exploratory Factor Analysis

The third stage addresses the assumptions of exploratory factor analysis (EFA), focusing more on conceptual than purely statistical considerations. While statistical requirements are important, Hair et al. (2019) stress that the key concern is the relevance and characteristics of the variables. EFA assumes that variables must be both conceptually meaningful and statistically appropriate, with an underlying structure among them. Meeting statistical criteria alone does not guarantee conceptual validity, so researchers must ensure that identified patterns make sense beyond correlations. Attention should also be given to sample homogeneity (Saeed et al., 2022; Hair et al., 2019). Once conceptual requirements are met, the next step is to test statistical assumptions to ensure variables are sufficiently correlated with underlying factors. Three key checks are required (Saeed et al., 2022; Hair et al., 2019). First, correlations among variables must be adequate; if few exceed .30, EFA may not be suitable. Partial correlations, shown in the anti-image matrix, should be low when common factors exist, while values above 0.70 suggest problems. Second, Bartlett's Test of Sphericity must show that the correlation matrix differs significantly from an identity matrix ($p < 0.05$), confirming meaningful correlations. Third, the Measure of Sampling Adequacy (MSA) should exceed 0.50 overall and for individual variables. Low-MSA variables should be removed step by step until all meet the threshold. Only then can factor analysis proceed.

(d) Stage 4: Factor Extraction Method

The fourth stage of exploratory factor analysis (EFA) focuses on data reduction, extracting the fewest factors while retaining maximum variance. This involves two steps: choosing an extraction method and deciding how many factors to keep. Principal component analysis (PCA) and common factor analysis are the most common methods (Saeed et al., 2022; Hair et al., 2019). PCA captures total variance (common, unique, and error) and is suited for summarizing information, while common factor analysis isolates shared variance to reveal latent constructs (Costello and Osborne, 2005). The number of factors was then determined using established criteria such as the a priori rule, variance explained, scree test, and especially the latent root criterion, which retains only factors with eigenvalues greater than one (Saeed et al., 2022; Hair et al., 2019).

(e) Stage 5: Factor Rotation Method

The fifth stage of exploratory factor analysis (EFA) focuses on interpreting factors through three steps: (1) estimating the initial (unrotated) factor matrix, which shows the correlations (loadings) between variables and extracted factors; (2) assessing whether this unrotated solution is meaningful;

and (3) applying rotation to achieve a clearer structure (Saeed et al., 2022; Hair et al., 2019). Unrotated solutions often concentrate variance on the first factor, making interpretation difficult. Rotation redistributes variance to produce a simpler and more theoretically sound factor pattern. Two rotation types are common: orthogonal, which assumes uncorrelated factors, and oblique, which allows correlations (Worthington & Whittaker, 2006; Hair et al., 2019). Orthogonal rotation is widely used since it simplifies interpretation, avoids multicollinearity, and is supported by most software. Oblique rotation is more suitable when factors are expected to correlate but is less applied due to its complexity. Overall, rotation aims to simplify the factor matrix so that columns (factors) and rows (variables) are easier to interpret. Among orthogonal methods, varimax simplifies factors, quartimax simplifies variables, and equimax balances both (Hair et al., 2019). When interpreting factors, loadings indicate the correlation between a variable and a factor, while squared loadings show the proportion of variance explained. For example, 0.30 explains about 10% of variance, 0.50 explains 25%, and 0.70 explains 50% (Hair et al., 2019). In practice, loadings below ±0.10 are negligible, ±0.30–0.40 mark the minimum threshold, ±0.50 indicate practical significance, and ±0.70 reflect a well-defined factor structure. These benchmarks are most applicable with samples above 100, where practical significance is emphasised over purely statistical measures (Hair et al., 2019).

The concept of simple structure, introduced by Thurstone (1947), aims to make factor solutions easier to interpret by ensuring that (i) each variable loads highly on only one factor and (ii) each factor has strong loadings from only a subset of variables. Although rarely achieved perfectly, it remains the goal in factor analysis. To support this, Hair et al. (2019) outline five key steps. First, examine the factor loading matrix, usually from the rotated solution, where variables (rows) load onto factors (columns). Second, identify the highest loading for each variable and mark it if it meets practical significance, while also checking for cross-loadings—cases where a variable loads significantly on multiple factors, complicating interpretation. Cross-loadings can be addressed by testing alternative rotations or removing problematic variables. Third, review communalities to ensure each variable is adequately explained by the solution, with 0.50 often used as a minimum threshold. Fourth, re-specify the model if issues arise (e.g., no significant loadings, low communalities, or persistent cross-loadings) by removing variables, adjusting rotation, or altering the number of factors. Finally, assign labels to factors based on the meaning of the variables with the strongest loadings, ensuring that the names reflect the underlying dimension.

(f) Stage 6: Validation of Exploratory Factor Analysis

Stage six of the exploratory factor analysis (EFA) process focuses on validating the results, particularly when defining the underlying structure among variables. The main goal is to test the generalisability of the factor solution and ensure that it reflects the broader population rather than being shaped by sample responses (Saeed et al., 2022; Hair et al., 2019). Since EFA is an interdependence-based technique, generalisability is a key concern. Ideally, validation should be carried out through confirmatory factor analysis (CFA), such as structural equation modelling. However, this type of follow-up is often not feasible, an alternative is split-sample validation, where the dataset is divided into two subsets to examine the stability of the factor structure (Hair et al., 2019).

(g) Stage 7: Additional Uses for Exploratory Factor Analysis Results

In the final stage, researchers must decide whether to end with factor interpretation or proceed to data reduction. If the aim is to explain how variables group together, interpretation alone is sufficient. If representative variables are needed for further analysis, data reduction is preferred (Hair et al., 2019). One option is to select the highest-loading variable as a surrogate, though this risks measurement error and bias (Saeed et al., 2022). A stronger approach is to create summated scales, which combine several items into a single score. This method reduces error, captures a fuller view of the construct, and maintains parsimony (Saeed et al., 2022; Hair et al., 2019).

3.5.3 Cluster Analysis

Cluster analysis is a multivariate quantitative technique employed to classify objects or individuals into homogeneous groups based on shared characteristics (Hair et al., 2019). In this study, it serves to identify naturally occurring clusters among Malaysian construction practitioners according to their adoption of common practices derived from Exploratory Factor Analysis (EFA). The objective is to determine whether distinct practitioner groups can be discerned that reflect varying degrees of agile orientation without any prior assumption of group membership.

(a) Hierarchical Cluster Analysis

The choice of clustering algorithm, which involves two complementary techniques to ensure robust classification. Firstly, Hierarchical Cluster Analysis (HCA) is applied to explore the underlying data structure and to provide an empirical indication of the potential number of clusters. The agglomerative method with Ward's linkage and squared Euclidean distance is used to minimise within-cluster variance.

(b) K-Means Cluster Analysis

Subsequently, K-Means Cluster Analysis was performed as a non-hierarchical refinement technique to partition respondents into k clusters, using the cluster centroids derived from the Hierarchical Cluster Analysis (HCA) as initial seeds. This iterative procedure reassigns each case to the nearest centroid, thereby minimising within-cluster variance and maximising cluster homogeneity (Kaufman and Rousseeuw, 2009; Hair et al., 2019).

(c) Silhouette Analysis

The following is cluster validity assessment, which evaluates the stability and robustness of the clustering solution. Silhouette analysis was employed to assess the validity and quality of the clustering solution. The technique evaluates both cluster cohesion (how closely cases within the same cluster resemble each other) and cluster separation (how distinctly each cluster differs from others). It provides a numerical measure, the silhouette coefficient that quantifies how appropriately each observation has been assigned to its cluster (Kaufman and Rousseeuw, 2009; Hair et al., 2019).

The coefficient ranges from –1 to +1, where values close to +1 indicate well-clustered cases, values near 0 suggest overlapping boundaries, and negative values denote possible misclassification. The average silhouette value across all cases represents the overall strength and interpretability of the clustering solution, guiding the evaluation of its internal validity. According to Kaufman and Rousseeuw (2009), average values above 0.50 indicate a reasonable structure, while values below 0.25 imply no meaningful pattern. Hence, silhouette analysis serves as a diagnostic tool to confirm the robustness and practical meaningfulness of the identified clusters in this study.

(d) Cluster Interpretation

Finally involves cluster interpretation, whereby the identified practitioner groups are examined to understand their distinctive characteristics in relation to Agile Values, Agile Principles, common practices, and project performance. This interpretation is operationalised through non-parametric comparative analysis to determine whether the clusters represent statistically meaningful differences in agile orientation. The cluster interpretation process enables the differentiation of practitioners with higher and lower levels of agile alignment, thereby directly addressing Research Question 6 (RQ6) and supporting Research Objective 4 (RO4) by explaining how varying degrees of agile orientation manifest in values, principles, practices, and project performance within the Malaysian construction context.

3.6 Summary

This research adopted a positivism approach. The literature review helped define the study's aims and objectives, leading to the formulation of research questions and hypotheses. A web-based questionnaire served as the research instrument, which was pretested and refined based on feedback. Since no significant revisions were needed, the pilot study results were included in the main analysis. The target group comprised all construction practitioners working in the construction industry, with sampling methods including judgement, convenience, and snowball techniques. The Central Limit Theorem (CLT) was applied, requiring at least 30 respondents per group. Data analysis was conducted using Excel and SPSS Statistics 29. Prior to analysis, the data was screened for missing values, response patterns, outliers, and common method bias. The data analysis incorporated both descriptive and inferential statistical techniques, complemented by exploratory factor analysis (EFA) and cluster analysis to uncover underlying patterns and group differences.

CHAPTER 4

RESEARCH ANALYSIS AND FINDINGS

4.1 Introduction

The survey targeted all construction practitioners working in the Malaysian construction industry. The questionnaire was distributed, and the collected data was analysed using IBM SPSS Statistics 29 to ensure methodological rigor, reliability, and clarity in interpreting the findings. The chapter begins with data preparation and testing, followed by an overview of the demographic profile. Thereafter, the chapter progresses through the main analytical components of the study: exploratory factor analysis (EFA) to identify underlying common practices, hypothesis testing to evaluate relationships between constructs, and cluster analysis to segment practitioners based on their Agile orientation. Together, these analyses provide a comprehensive foundation for addressing the research objectives and answering the proposed research questions.

4.2 Data Preparation and Testing

260 responses were collected and screened for missing values and response patterns. The data were then investigated for outliers.

In this research, a web-based online questionnaire was used because web-based systems can be designed and set to prevent respondents from skipping to the next question or section if they do not answer the question. None of the downloaded responses in this research contained any missing data.

Six responses were disqualified because they did not work in the Malaysian construction industry as they were not the target respondents for this research. As result, the number of qualified responses fell from 260 to 254.

Furthermore, response patterns from the questionnaire were analysed for a phenomenon known as nondifference or straight-lining. It was detected that 2 cases had “straight-lining” responses. Lack of distinction weaken data quality with regard to reliability and validity for some extend. Therefore, straight-lining cases were removed from the dataset for further analysis. The number of qualified samples was reduced further from 254 to 252.

4.2.1 Outliers

A univariate outlier on the agile values (AV), agile principles (AP), practices in construction project management (P) and project performances (PP) was investigated using a boxplot respectively. The difference between the means and the 5 percent trimmed means were insignificant for AV, AP, P and PP as shown in Table 4.1, therefore the outliers were not recommended to remove from the overall dataset. Subsequently, the outliers had remained in this research for further analysis as the outliers may furnish an important information.

Table 4.1: Summary of Extreme Outlier (N=252)

Variables	Extreme Outlier	Mean	5% Trimmed Mean	Difference
Agile Values (AV)	-	7.01	7.09	0.08
Agile Principles (AP)	37, 105, 203	3.77	3.79	0.02
Practices in CPM (P)	37, 93, 105, 203, 204	3.83	3.87	0.04
Project Performance (PP)	93	3.96	3.98	0.02

4.2.2 Common Method Bias

This study collected all variables using Likert scales through a self-report questionnaire, raising concerns about common method bias (CMB). To address this, several procedural and statistical remedies were applied. The following procedural remedies were implemented during the questionnaire design to minimize common method bias (CMB):

i) Respondents were informed at the beginning of the questionnaire that there were no right or wrong answers, aiming to reduce socially desirable responding.

ii) Participants' motivation was enhanced by clarifying that the information provided would be used exclusively for research purposes, analysed in aggregate form, and that their identities would remain anonymous.

iii) The questionnaire items were organised into separate sections to minimise the impact of item similarity.

iv) The questionnaire incorporated diverse response formats, including Likert-scale items and single-response questions.

v) Cover stories and question explanations were provided to respondents to enhance the accuracy of their responses.

vi) A pretest and pilot study were carried out to clarify ambiguous content and include explanations for unfamiliar terms.

Harman's one-factor test was employed as a post-hoc remedy for common method bias (CMB). All variables were entered into an unrotated exploratory factor analysis, and the first factor accounted for 40.625% of the variance—below the 50% threshold—suggesting that CMB was not a significant concern.

4.2.3 Demographic Information of Respondents

The descriptive statistics of personal demographic information for the 252 respondents, encompassing diverse attributes including profession, industry experience, designation, nature of business, type of project, and total number of employees in the company, are presented in Table 4.2. For the purpose of this research, four categories of professional background were selected, namely architecture (22.62%), engineering (21.83%), quantity surveying (35.71%), and project management (19.84%).

Table 4.2: Summary of Construction Related Respondents' Demographic Information (N=252)

Parameter	Category	Frequency (n)	Percentage (%)
Profession	Architecture	57	22.62
	Engineering	55	21.83
	Quantity Surveying	90	35.71
	Project Management	50	19.84
Industry Experience	Less than 2 years	53	21.03
	2 – 5 years	53	21.03
	6 – 10 years	55	21.83
	More than 10 years	91	36.11
Designation	Senior Manager & above	69	27.38
	Manager	65	25.79
	Executive	118	46.83

Nature of Business	Contractor	111	44.05
	Supplier	34	13.49
	Consultant	56	22.22
	Developer	51	20.24
Type of Project	Commercial	67	26.59
	Industrial	31	12.30
	Infrastructure	48	19.05
	Residential	73	28.97
	Renovation	33	13.10
Total Employees	Less than 30	72	28.57
	30 to 75	66	26.19
	More than 75	114	45.24

In terms of industry experience, most respondents had more than 10 years of experience (36.11%), followed by 6 to 10 years (21.83%), 2 to 5 years (21.03%), and less than 2 years (21.03%). While 53 out of 252 respondents (21.03%) had less than two years of experience, this does not deflate the reliability of the dataset. The overall sample size (n = 252) is statistically robust and exceeds the requirements for exploratory quantitative analysis. In line with the Central Limit Theorem (CLT), a minimum of 30 observations per respondent category is generally sufficient to support reliable statistical inference, a condition that is satisfied in this study. Furthermore, within the Malaysian construction context, executive-level practitioners are actively involved in site-level coordination, reporting, and day-to-day project delivery, making their perspectives particularly relevant to understanding construction project management practices. Their inclusion therefore enhances the practical validity of the findings by capturing both operational and managerial viewpoints. As this research adopts an exploratory approach, representing the full spectrum of construction practitioners—including early-career professionals who will shape future Agile adoption—strengthens, rather than weakens, the overall reliability and relevance of the study.

In terms of designation, the majority of respondents held positions of senior manager and above (27.38%) and manager (25.79%). Nevertheless, executive and non-managerial positions also represented a substantial proportion of the sample (46.83%). Four major categories of business nature within the Malaysian construction industry were identified for this research. Most respondents were affiliated with contractor organisations (44.05%), followed by consultants (22.22%), developers (20.24%), and suppliers (13.49%). Regarding project type, respondents' organisations were mainly involved in residential projects (28.97%), followed by commercial (26.59%), infrastructure (19.05%), renovation (13.10%), and industrial projects (12.30%). In terms of organisational size, the majority of respondents worked in organisations with more than 75 employees (45.24%), followed by organisations with fewer than 30 employees (28.57%) and those with 30 to 75 employees (26.19%).

Table 4.3 presents the demographic distribution of respondents by professional discipline. Quantity Surveyors form the largest group (35.71%), followed by Architects (22.62%), Engineers (21.83%), and Project Managers (19.84%). Architects and Project Managers exhibit a higher proportion of senior and experienced practitioners, whereas Quantity Surveyors are predominantly younger and non-managerial, reflecting typical industry career progression patterns. Engineers demonstrate a relatively balanced distribution across organisational types and project categories. Residential projects dominate across all professional groups, with notable involvement in infrastructure projects among Engineers and Quantity Surveyors. The distribution of organisation size indicates representation from small, medium, and large firms, providing a diverse empirical base for analysis. Overall, the sample reflects a realistic industry composition and establishes a robust foundation for subsequent profession-based comparisons of agile-oriented practices.

Table 4.3: Summary of Respondents' Demographic Distribution by Profession (N=252)

Category	Architecture n=57 (22.62%)		Engineering n=55 (21.83%)		Quantity Surveying n=90 (35.71%)		Project Management n=50 (19.84%)	
	Freq. n	Pct. %	Freq. n	Pct. %	Freq. n	Pct. %	Freq. n	Pct. %
Industry Experience								
Less than 2 years	4	1.59	8	3.17	32	12.70	9	3.57
2 - 5 years	7	2.78	14	5.56	28	11.11	4	1.59
6 - 10 years	14	5.56	10	3.97	19	7.54	12	4.76
More than 10 years	32	12.70	23	9.13	11	4.37	25	9.92
Designation								
Senior Manager & above	29	11.51	12	4.76	9	3.57	19	7.54
Manager	15	5.95	18	7.14	11	4.37	21	8.33
Non-Manager	13	5.16	25	9.92	70	27.78	10	3.97
Nature of Business								
Contractor	10	3.97	18	7.14	56	22.2	27	10.7
Supplier	10	3.97	18	7.14	3	1.19	3	1.19
Consultancy	15	5.95	13	5.16	24	9.52	4	1.59
Developer	22	8.73	6	2.38	7	2.78	16	6.35
Type of Project								
Commercial	12	4.76	15	5.95	18	7.14	22	8.73
Industrial	5	1.98	16	6.35	7	2.78	3	1.19
Infrastructure	1	0.40	13	5.16	27	10.71	7	2.78
Residential	13	5.16	10	3.97	38	15.08	12	4.76
Renovation	26	10.32	1	0.4	0	0	6	2.38
Total Employees								
Less than 30	23	9.13	11	4.37	29	11.51	9	3.57
30 to 75	17	6.75	16	6.35	24	9.52	9	3.57
More than 75	17	6.75	28	11.11	37	14.68	32	12.70

4.2.4 Reliability and Validity Analysis

The alpha coefficient for the four items of agile values is 0.748, the 12 items of agile principles is 0.881, the 50 items of practices in construction project management is 0.978, and the 16 items of project performances is 0.937, suggesting that all the items have satisfied the internal consistency as indicated in the Table 4.4.

Table 4.4: Internal Consistency Reliability (N=252)

Constructs	Cronbach's Alpha	N of Items
Agile Values (AV)	0.748	4
Agile Principles (AP)	0.881	12
Practices in CPM (P)	0.978	50
Project Performances (PP)	0.937	16

A Mann-Whitney test was conducted by comparing the results of the respective summated scales and highest mean variables to assess the validity of AV, AP, P, and PP. The results consistently show the same patterns between the two agile groups, demonstrating validity between these two measures, as shown in Table 4.5.

Table 4.5: Comparing M-W Test Result between Summated Scales and Highest Mean Variables (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
Summated Scales				
AV	133.84	85.17	<.001	-3.798
AP	142.98	33.70	<.001	-8.529
P	145.40	20.08	<.001	-9.772
PP	138.14	60.92	<.001	-6.039
Highest Mean Variables				
AV4	133.76	85.62	<.001	-3.818
AP8	139.08	55.66	<.001	-7.344
P17	135.10	78.09	<.001	-5.097
PP5	134.46	81.70	<.001	-4.524

4.3 Exploratory Factor Analysis

4.3.1 Stage 1: Clarifying the Objectives of Exploratory Factor Analysis

The first stage of Exploratory Factor Analysis (EFA) involves clarifying its purpose in relation to the study objectives. In this research, the EFA was conducted to identify and summarise the underlying structure among a large set of observed project management practices reported by Malaysian construction practitioners. The primary aim was to reduce a wide range of individual practice variables into a smaller, conceptually coherent set of latent dimensions, known in this study as common practices.

EFA serves as data summarization with interpretation and data reduction, designed to condense information while maintaining the maximum possible variance from the original dataset (Hair et al., 2019; Field, 2018). By doing so, it reveals the fundamental constructs that represent shared characteristics of practitioners in managing construction projects with agility-oriented tendencies. This process is particularly important for this research, as it enables the identification of naturally emerging clusters of practices that align with Agile philosophies without imposing any predefined theoretical model.

4.3.2 Stage 2: Designing an Exploratory Factor Analysis

In this study, the variables selected for EFA comprised fifty (50) observed items representing practices in construction project management adopted by Malaysian construction practitioners. The selection was conceptually driven and guided by the theoretical foundations of the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b).

Understanding the structure of the observed variables requires R-type factor analysis and a correlation matrix between variables, not respondents. All the variables are metric and constitute a homogeneous set of perceptions appropriate for exploratory factor analysis.

Hair et al. (2019) recommends the sample size should be 100 observations the preferred minimum, with at least a 5:1 ratio of cases to variables. Fabrigar and Wegener (2012) propose that the sample size should be at least 200 if the communalities fall to the range of 0.40 to 0.70. In this study, the communalities values for all variables are above 0.50 as shown in Table 4.6, and a total of 252 valid responses were obtained from Malaysian construction practitioners, satisfying these criteria for exploratory factor analysis.

Table 4.6: Communalities (N=252)

Practices in Construction Project Management (P)	Extraction
P1 – Define project deliverables progressively	0.564
P2 – Refine project requirements based on client acceptance criteria	0.612
P3 – Tailor processes based on team experience	0.721
P4 – Tailor processes based on organisational characteristics	0.683
P5 – Tailor processes based on project characteristics	0.752
P6 – Follow the sequence of work	0.658
P7 – Limit the cycle time	0.636
P8 – Solicit client collaboration	0.692
P9 – Prioritise project work through stakeholders' collaboration	0.745
P10 – Work balance between project delivery and risk reduction	0.716
P11 – Reprioritise requirements based on changes of project environment needs	0.641
P12 – Reprioritise requirements based on changes of project stakeholder needs	0.723
P13 – Conduct inspections	0.772
P14 – Conduct testing	0.765
P15 – Engage with project stakeholders	0.639
P16 – Share information with project stakeholders	0.680
P17 – Form agreement with project stakeholders	0.651

P18 – Assess project changes to maintain stakeholder involvement	0.665
P19 – Use collaborative decision making	0.663
P20 – Use collaborative conflict resolution	0.627
P21 – Understand project vision	0.666
P22 – Understand project success criteria	0.651
P23 – Develop ground rules with project members	0.754
P24 – Develop project members' interpersonal skills	0.736
P25 – Develop project members' technical skills	0.734
P26 – Encourage emergent leadership	0.705
P27 – Understand project members motivators and demotivators	0.702
P28 – Encourage communication via collaboration tools	0.739
P29 – Reduce distractions among project members	0.770
P30 – Encourage project members to measure performance	0.607
P31 – Plan progressively at multiple project stages	0.624
P32 – Adjust planning based on project performance	0.717
P33 – Adjust planning based on project changes	0.745
P34 – Size project elements progressively	0.697
P35 – Adjust project resources in stages	0.648
P36 – Create rough baselines at the beginning of project	0.667
P37 – Refine baselines as the project progresses	0.781
P38 – Evaluate baselines based on project changes	0.725
P39 – Perform project reviews in stages	0.768
P40 – Seek feedback via progressive project delivery	0.653
P41 – Seek feedback via site mock-up	0.610
P42 – Create a project environment of continuous learning	0.697
P43 – Reduce project wastes	0.645
P44 – Disseminate project knowledge	0.758
P45 – Retrospect project issues	0.749
P46 – Open to reveal project problems	0.715
P47 – Identify issues with project members	0.666
P48 – Resolve issues with pertinent project members	0.733
P49 – Maintain a visible list of project issues to track ownership	0.717
P50 – Maintain a visible list of project issues to track resolution status	0.749

4.3.3 Stage 3: Testing Assumptions of Exploratory Factor Analysis

In this study, the observed variables representing practices in construction project management were first screened to ensure conceptual homogeneity and theoretical alignment with the constructs drawn from the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017b). This conceptual verification ensured that the dataset contained interrelated practices likely to share a common underlying structure, representing agile-oriented common practices.

Once conceptual suitability was confirmed, statistical assumptions were tested following the procedures recommended by Saeed et al. (2022) and Hair et al. (2019). A visual inspection of the correlation matrix (Appendix C) indicates a substantial number of correlations exceeding the threshold value of 0.30 among the variables. Specifically, 1,194 out of 1,225 correlations (97.5%) are significant at the 0.01 level, suggesting a sufficient degree of intercorrelation. This provides an adequate empirical basis for proceeding with the assessment of sampling adequacy for factor analysis, both overall and at the individual variable level.

The Bartlett's test of sphericity ($X^2 = 10558.753$; df = 1225) as indicated in Table 4.7, was significant at $p < 0.05$, indicating that the correlations were sufficiently large for exploratory factor analysis (Hooper, 2012). The overall KMO (Measure of Sampling Adequacy) value is 0.954 as indicated in Table 4.7. MSA values of individual variables were also examined through an anti-image correlation matrix (Appendix D). MSA values of all individual variables are observed above 0.5, and therefore, there is no omission of any variable at this stage and indicating that all sets of variables are appropriate for exploratory factor analysis (Fields, 2000).

Table 4.7: KMO and Bartlett's Test (N=252)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.954
Bartlett's Test of Sphericity	
Approx. Chi-Square	10558.753
Df	1225
Sig.	0.000

4.3.4 Stage 4: Deriving Factors and Assessing Overall Fit

In this study, principal component analysis (PCA) was performed to extract initially unrotated factors analysis to obtain the potential of data reduction and the initial number of factors to be extracted. Hence, the initial eight factors were extracted based on eigenvalues greater than 1 as shown in Table 4.8. and the unrotated principal component analysis factor matrix as shown in Table 4.9.

Table 4.8: Unrotated Total Variance Explained (N=252)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.506	49.011	49.011	24.506	49.011	49.011
2	2.399	4.797	53.809	2.399	4.797	53.809
3	1.752	3.504	57.312	1.752	3.504	57.312
4	1.444	2.889	60.201	1.444	2.889	60.201
5	1.374	2.747	62.948	1.374	2.747	62.948
6	1.192	2.385	65.333	1.192	2.385	65.333
7	1.043	2.085	67.418	1.043	2.085	67.418
8	1.024	2.047	69.466	1.024	2.047	69.466
9	.918	1.836	71.301			
10	.881	1.761	73.063			
11	.789	1.578	74.641			
12	.716	1.433	76.074			
13	.679	1.358	77.432			
14	.627	1.254	78.685			
15	.611	1.223	79.908			
16	.584	1.168	81.076			
17	.567	1.135	82.210			
18	.553	1.106	83.316			
19	.507	1.013	84.330			
20	.497	.994	85.324			
21	.468	.937	86.260			
22	.437	.875	87.135			
23	.424	.849	87.984			
24	.399	.799	88.783			
25	.385	.770	89.553			
26	.366	.732	90.285			
27	.360	.720	91.005			
28	.321	.642	91.648			
29	.312	.624	92.272			
30	.294	.588	92.860			
31	.283	.566	93.426			
32	.269	.538	93.964			
33	.261	.522	94.486			
34	.259	.518	95.003			
35	.243	.486	95.490			
36	.226	.452	95.942			
37	.203	.407	96.348			
38	.198	.396	96.744			
39	.187	.375	97.119			
40	.177	.354	97.473			

41	.167	.335	97.808
42	.157	.314	98.122
43	.148	.295	98.417
44	.141	.282	98.699
45	.136	.272	98.971
46	.123	.247	99.218
47	.109	.218	99.436
48	.105	.211	99.646
49	.091	.183	99.829
50	.086	.171	100.000

The unrotated principal component analysis factor matrix is shown in Table 4.9. The results for the eight extracted factors indicate the factor loadings of each variable on each factor.

Table 4.9: Unrotated Component Analysis Factor Matrix (N=252)

Variables	Component							
	1	2	3	4	5	6	7	8
P1	0.658	0.248	-0.143	-0.121	-0.069	0.048	0.148	0.075
P2	0.566	0.350	0.236	0.084	0.302	-0.072	0.053	0.086
P3	0.555	0.231	0.512	-0.034	0.072	0.290	-0.009	-0.082
P4	0.678	0.133	0.174	-0.021	-0.211	0.325	-0.135	-0.084
P5	0.553	0.399	0.496	0.011	0.075	0.130	0.045	-0.131
P6	0.641	0.238	-0.118	-0.095	-0.344	-0.052	-0.139	0.164
P7	0.598	0.379	-0.045	0.157	-0.323	-0.009	-0.060	-0.011
P8	0.724	0.295	-0.032	0.038	-0.240	-0.110	-0.080	-0.049
P9	0.566	0.405	0.180	0.024	0.143	-0.348	-0.143	0.257
P10	0.718	0.270	0.193	-0.192	-0.036	-0.034	-0.052	0.221
P11	0.742	0.188	0.075	-0.023	-0.210	-0.012	-0.055	0.048
P12	0.710	0.405	0.136	-0.116	0.027	-0.083	-0.105	0.064
P13	0.646	0.261	-0.255	0.155	-0.072	0.173	0.129	-0.383
P14	0.615	0.325	-0.275	0.030	-0.092	0.151	0.138	-0.393
P15	0.704	0.040	-0.057	0.263	-0.135	-0.179	-0.027	0.137
P16	0.518	0.163	-0.079	0.394	-0.022	-0.157	0.376	0.240
P17	0.578	0.025	-0.235	0.283	0.197	0.056	0.369	-0.054
P18	0.731	0.019	-0.126	0.244	-0.021	-0.223	0.044	0.048
P19	0.729	0.116	-0.232	-0.154	-0.052	0.047	0.112	0.152
P20	0.724	-0.104	-0.209	-0.133	0.007	0.152	0.055	0.064
P21	0.734	-0.185	0.011	0.212	-0.126	0.078	-0.024	0.159
P22	0.647	-0.229	0.169	0.147	-0.233	0.039	0.248	0.112
P23	0.771	-0.228	0.075	-0.050	-0.157	0.092	0.139	0.215
P24	0.724	-0.328	0.164	-0.162	-0.165	0.048	0.148	-0.010
P25	0.757	-0.304	0.057	-0.129	-0.141	0.023	0.136	0.095
P26	0.756	-0.290	0.187	0.000	-0.099	-0.041	0.043	0.030
P27	0.729	-0.356	0.028	-0.036	-0.011	-0.133	0.140	-0.059
P28	0.748	-0.221	0.017	0.293	0.021	-0.042	-0.195	-0.060
P29	0.697	-0.261	0.296	-0.064	0.182	-0.188	0.143	-0.188
P30	0.723	-0.175	0.093	0.098	-0.108	0.093	0.122	-0.018
P31	0.670	-0.097	0.037	0.230	0.021	0.307	-0.127	0.026
P32	0.717	-0.094	0.026	0.271	0.140	0.154	-0.278	-0.001
P33	0.716	-0.115	-0.041	0.178	0.187	0.309	-0.206	0.113
P34	0.746	-0.204	0.220	0.141	-0.007	0.150	-0.083	-0.035
P35	0.604	0.053	-0.325	0.059	0.293	0.221	-0.138	0.135
P36	0.672	0.068	-0.389	0.010	0.186	0.063	-0.061	0.131
P37	0.732	0.036	0.030	-0.287	0.327	0.089	0.174	0.124
P38	0.736	-0.054	0.034	-0.323	0.154	0.131	0.137	0.123

P39	0.746	0.165	-0.122	-0.070	0.379	-0.057	0.132	-0.023
P40	0.677	0.207	-0.190	-0.266	-0.105	-0.046	0.049	-0.172
P41	0.707	-0.013	0.179	0.002	0.106	-0.166	-0.005	-0.198
P42	0.759	0.028	-0.100	-0.248	-0.167	-0.110	-0.058	-0.075
P43	0.746	-0.102	-0.051	-0.054	-0.093	-0.118	-0.075	-0.209
P44	0.816	-0.149	-0.089	-0.217	0.066	0.023	-0.040	-0.088
P45	0.746	-0.160	-0.215	-0.279	0.084	0.066	-0.171	0.038
P46	0.742	-0.235	-0.088	-0.187	-0.049	-0.148	-0.206	0.004
P47	0.734	-0.124	-0.005	0.029	0.150	-0.205	-0.189	-0.104
P48	0.775	-0.149	-0.132	0.138	0.120	-0.185	-0.151	-0.056
P49	0.793	-0.169	-0.082	0.001	-0.079	-0.169	-0.088	-0.100
P50	0.761	-0.029	0.138	0.058	0.197	-0.241	0.016	-0.224

4.3.5 Stage 5: Rotating and Interpreting the Factors

Unrotated solutions often concentrate variance on the first factor, making interpretation difficult. In this study, orthogonal rotation method was employed because this method is the most widely use rotational method and the preferred method when the research goal is data reduction to either a smaller number of variables or a set of uncorrelated measures for subsequent use in other multivariate techniques.

PCA with equimax rotation revealed the presence of eight factors or common practices in this study with eigenvalues greater than 1 as shown in Table 4.10. These common practices accounted for 69.466 per cent of the data set. Common Practice 1 (CP1) with an eigenvalue of 4.739 explains 9.477 per cent of the variance in the identified construction project management practices. Common Practice 2 (CP2) with an eigenvalue of 4.626 explains 9.251 per cent, while Common Practices 3, 4, 5, 6, 7 and 8 have eigenvalues 4.483, 4.364, 4.314, 4.262. 4.075 and 3.870, respectively, that explain 8.966, 8.727, 8.628, 8.525, 8.151 and 7.740 per cent of the variance, respectively.

Table 4.10: Rotated Total Variance Explained (N=252)

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.506	49.011	49.011	4.739	9.477	9.477
2	2.399	4.797	53.809	4.626	9.251	18.728
3	1.752	3.504	57.312	4.483	8.966	27.695
4	1.444	2.889	60.201	4.364	8.727	36.422
5	1.374	2.747	62.948	4.314	8.628	45.050
6	1.192	2.385	65.333	4.262	8.525	53.575
7	1.043	2.085	67.418	4.075	8.151	61.726
8	1.024	2.047	69.466	3.870	7.740	69.466
9	.918	1.836	71.301			
10	.881	1.761	73.063			
11	.789	1.578	74.641			
12	.716	1.433	76.074			
13	.679	1.358	77.432			
14	.627	1.254	78.685			
15	.611	1.223	79.908			
16	.584	1.168	81.076			
17	.567	1.135	82.210			
18	.553	1.106	83.316			
19	.507	1.013	84.330			
20	.497	.994	85.324			
21	.468	.937	86.260			
22	.437	.875	87.135			
23	.424	.849	87.984			
24	.399	.799	88.783			
25	.385	.770	89.553			
26	.366	.732	90.285			
27	.360	.720	91.005			
28	.321	.642	91.648			
29	.312	.624	92.272			
30	.294	.588	92.860			
31	.283	.566	93.426			
32	.269	.538	93.964			
33	.261	.522	94.486			
34	.259	.518	95.003			
35	.243	.486	95.490			
36	.226	.452	95.942			
37	.203	.407	96.348			
38	.198	.396	96.744			
39	.187	.375	97.119			
40	.177	.354	97.473			
41	.167	.335	97.808			
42	.157	.314	98.122			
43	.148	.295	98.417			
44	.141	.282	98.699			
45	.136	.272	98.971			
46	.123	.247	99.218			
47	.109	.218	99.436			
48	.105	.211	99.646			
49	.091	.183	99.829			
50	.086	.171	100.000			

The extracted common practices listed in Table 4.11 show that items correlations were more than 0.50 (15 items were deleted and dropped for further interpretation and analysis due to the factor loadings failed to achieve practical significance, 0.50), suggesting a strong inter-item correlation (Hon et al., 2012). In addition, there was no incidence of cross-loading, indicating a unidimensionality of items as reliable measures of extracted components (Durdyev and Mbachu, 2017).

Table 4.11: Rotated Component Analysis Factor Matrix (N=252)

	Common Practices								
Variables	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	
P24	0.670								
P25	0.622								
P22	0.622								
P23	0.611								
P26	0.558								
P27	0.514								
P50		0.602							
P29		0.595							
P47		0.577							
P48		0.534							
P49		0.507							
P41		0.507							
P37			0.650						
P38			0.596						
P45			0.573						
P39			0.532						
P36			0.521						
P35			0.511						
P33				0.677					
P32				0.659					
P31				0.598					
P28				0.551					
P5					0.792				
P3					0.748				
P2					0.589				
P12					0.522				
P6						0.668			
P8						0.550			
P7						0.544			
P14							0.776		
P13							0.755		
P40							0.502		
P16								0.758	
P17								0.590	
P18								0.516	
									Total
Eigenvalues	4.739	4.626	4.483	4.364	4.314	4.262	4.075	3.870	34.733
% of variance explained	9.477	9.251	8.966	8.727	8.628	8.525	8.151	7.740	69.466

As shown in Table 4.11, six variables each loaded on Common Practices 1, 2 and 3, and they are labelled as “Resilient Team”, “Transparent

Environment" and "Progressive Assessment", respectively. Four variables each loaded on Common Practices 4 and 5, and they are labelled as "Adaptive Development" and "Bespoke Processes", respectively. Three variables each loaded on Common Practices 6, 7 and 8, and they are labelled as "Pragmatic Delivery", "Continuous Refinement" and "Engaging Stakeholders". These eight components constitute the principal factors that are common practices (CP) of construction project management in the Malaysian construction industry.

Resilient Team (CP1) consists of six variables and their respective factor loading in descending order were P24 - develop project members' interpersonal skills ($\lambda = 0.670$), P25 - develop project members' technical skills ($\lambda = 0.622$), P22 - understand project success criteria ($\lambda = 0.622$), P23 - develop ground rules with project members ($\lambda = 0.611$), P26 - encourage emergent leadership ($\lambda = 0.558$), and P27 - understand project members motivators and demotivators ($\lambda = 0.514$) as shown in Table 4.11.

Transparent Environment (CP2) comprises six variables and their respective factor loading in descending order were P50 - maintain a visible list of project issues to track resolution status ($\lambda = 0.602$), P29 - reduce distractions among project members ($\lambda = 0.595$), P47 - identify issues with project members ($\lambda = 0.577$), P48 - resolve issues with pertinent project members ($\lambda = 0.534$), P49 - maintain a visible list of project issues to track ownership ($\lambda = 0.507$), and P41 - seek feedback via site mock-up ($\lambda = 0.507$) as shown in Table 4.11.

In Progressive Assessment (CP3), six variables were contained. These variables were P37 - refine baselines as the project progresses ($\lambda = 0.650$), P38 - evaluate baselines based on project changes ($\lambda = 0.596$), P45 - retrospect project issues ($\lambda = 0.573$), P39 - perform project reviews in stages ($\lambda = 0.532$), P36 - create rough baselines at the beginning of project ($\lambda = 0.521$), and P35 - adjust project resources in stages ($\lambda = 0.511$) as shown in Table 4.11.

In Adaptive Development (CP4), four variables were contained as shown in Table 4.11. These variables were P33 - adjust planning based on project changes ($\lambda = 0.677$), P32 - adjust planning based on project performance ($\lambda = 0.659$), P31 - plan progressively at multiple project stages ($\lambda = 0.598$), and P28 - encourage communication via collaboration tools ($\lambda = 0.551$).

In Bespoke Processes (CP5), four variables were contained as shown in Table 4.11. These variables were P5 - tailor processes based on project characteristics ($\lambda = 0.792$), P3 - tailor processes based on team experience ($\lambda = 0.748$), P2 - refine project requirements based on client acceptance criteria ($\lambda = 0.589$), and P12 - reprioritise requirements based on changes of project stakeholder needs ($\lambda = 0.522$).

Pragmatic Delivery (CP6) includes three variables and their respective factor loading in descending order were P6 - follow the sequence of work ($\lambda = 0.668$), P8 - solicit client feedback ($\lambda = 0.550$), and P7 - limit the cycle time ($\lambda = 0.544$) as shown in Table 4.11.

Continuous Refinement (CP7) contains three variables and their respective factor loading in descending order were P14 - conduct testing (λ = 0.776), P13 - conduct inspections (λ = 0.755), and P40 - seek feedback via progressive project delivery (λ = 0.502) as shown in Table 4.11.

Engaging Stakeholders (CP8) was the eighth and final component containing three variables and their respective factor loading in descending order were P16 - share information with project stakeholders (λ = 0.758), P17 - form agreement with project stakeholders (λ = 0.590), and P18 - assess project changes to maintain stakeholder involvement (λ = 0.516) as shown in Table 4.11.

4.3.6 Stage 6: Validating Exploratory Factor Analysis Solutions

As discussed in Section 3.5.2 and consistent with the recommendation of Hair et al. (2019), a split-sample analysis was conducted to achieve the objective of Stage 6. The total dataset was evenly divided into two subsamples of 126 respondents each to validate the results of the exploratory factor analysis. Table 4.12 shows that eight factors were extracted based on eigenvalues greater than 1, accounting for 59.839 per cent of the dataset. Factor loadings between the extracted factors and the listed variables were all above 0.50.

Table 4.12: Validation of EFA Result by 1st Split Sample (N=126)

Varaibles	Common Practices								
	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	
P24	0.912								
P25	0.888								
P22	0.868								
P23	0.861								
P26	0.855								
P27	0.778								
P50		0.871							
P29		0.855							
P47		0.848							
P48		0.846							
P49		0.838							
P41		0.819							
P37			0.895						
P38			0.883						
P45			0.879						
P39			0.858						
P36			0.785						
P35			0.764						
P33				0.886					
P32				0.883					
P31				0.872					
P28				0.798					
P5					0.834				
P3					0.803				
P2					0.785				
P12					0.774				
P6						0.916			
P8						0.911			
P7						0.803			
P14							0.888		
P13							0.858		
P40							0.820		
P16								0.849	
P17								0.824	
P18								0.798	
									Total
Eigenvalues	5.054	4.900	4.891	3.565	3.157	2.916	2.800	2.639	29.920
% of variance explained	10.107	9.799	9.781	7.129	6.313	5.831	5.599	5.277	59.839

Similarly, Table 4.13 indicates that eight factors were extracted using the same group of variables, also based on eigenvalues greater than 1. These factors accounted for 57.503 per cent of the dataset, with factor loadings consistently exceeding 0.50. Moreover, no cross-loading was observed, confirming the unidimensionality of the items. Taken together, the findings in Tables 4.12 and 4.13 suggest that the factor structure remains stable across both subsamples.

Table 4.13: Validation of EFA Result by 2nd Split Sample (N=126)

Variables	Common Practices								
	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	
P24	0.853								
P25	0.830								
P22	0.818								
P23	0.812								
P26	0.772								
P27	0.729								
P50		0.872							
P29		0.810							
P47		0.795							
P48		0.793							
P49		0.768							
P41		0.737							
P37			0.832						
P38			0.780						
P45			0.776						
P39			0.752						
P36			0.735						
P35			0.719						
P33				0.838					
P32				0.828					
P31				0.826					
P28				0.805					
P5					0.869				
P3					0.850				
P2					0.766				
P12					0.743				
P6						0.903			
P8						0.890			
P7						0.796			
P14							0.862		
P13							0.827		
P40							0.821		
P16								0.817	
P17								0.803	
P18								0.756	
									Total
Eigenvalues	4.622	4.560	4.274	3.466	3.363	2.990	2.848	2.631	28.752
% of variance explained	9.243	9.119	8.547	6.931	6.725	5.979	5.695	5.261	57.503

4.3.7 Stage 7: Applying Exploratory Factor Analysis Results for Subsequent Analyses

The objective at this stage was to identify representative variables for use in subsequent statistical analyses. To achieve this, a data reduction technique, as recommended by Hair et al. (2019), was employed. Specifically, this study adopted the summated scale approach, whereby multiple variables exhibiting high loadings on a common factor were aggregated to form a composite measure.

Exploratory factor analysis assists in the construction of the summated scale by identifying the dimensionality of the variables (defining the factors), which then form the basis for the composite values as they met the conceptual definitions driven and guided by the Construction Extension to the PMBOK Guide (PMI, 2016) and the Agile Practice Guide (PMI, 2017).

In this study, the eight-factor solution suggests that eight summated scales should be constructed. The eight factors, discussed earlier, correspond to dimensions that can be named and related to concepts with adequate content validity reviewed by industry professionals. The dimensionality of each scale is supported by the clean interpretation of each factor, with high factor loadings of each variable on only one factor.

The reliability of the summated scales was measured by Cronbach's alpha, which in this case is 0.915 for scale 1, 0.904 for scale 2, 0.890 for scale 3, 0.862 for scale 4, 0.817 for scale 5, 0.802 for scale 6, 0.819 for scale 7, and 0.736 for scale 8. Moreover, Mann-Whitney tests were conducted by comparing the results of the respective summated scales and surrogate variables to assess the validity of the summated scales. The results consistently show similar patterns of differences between the two groups of agile practitioners, demonstrating a level of convergent validity of these two measures, as shown in Table 4.14.

Table 4.14: Comparing M-W Test Result between Summated Scales and Surrogate Variables (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
Summated Scales				
CP1	141.51	41.99	<.001	-7.833
CP2	142.39	37.03	<.001	-8.281
CP3	143.08	33.11	<.001	-8.662
CP4	141.53	41.87	<.001	-7.978
CP5	142.21	38.03	<.001	-8.232
CP6	143.57	30.37	<.001	-9.127
CP7	141.86	40.03	<.001	-8.139
CP8	140.87	45.55	<.001	-7.750
Surrogate Variables				
P24	139.11	55.49	<.001	-7.115
P50	140.22	49.21	<.001	-7.752
P37	139.00	56.13	<.001	-7.185
P33	138.50	58.95	<.001	-7.069
P5	138.95	56.41	<.001	-6.926
P6	139.54	53.09	<.001	-7.615
P14	138.67	57.95	<.001	-6.868
P16	139.71	52.08	<.001	-7.863

4.4 Hypothesis Testing

4.4.1 Hypothesis Test No.1: Correlation between Common Practices and Agile Values

Null hypothesis (H1o): There is no significantly correlated between common practices, CPn and agile values, AVr

Alternative hypothesis (H1a): There is significantly correlated between common practices, CPn and agile values, AVr

A Spearman's rank-order correlation was run for hypothesis test no.1 to determine the relationship between 8 CPs in CPM and 4 AVs as shown in Figure 4.1.

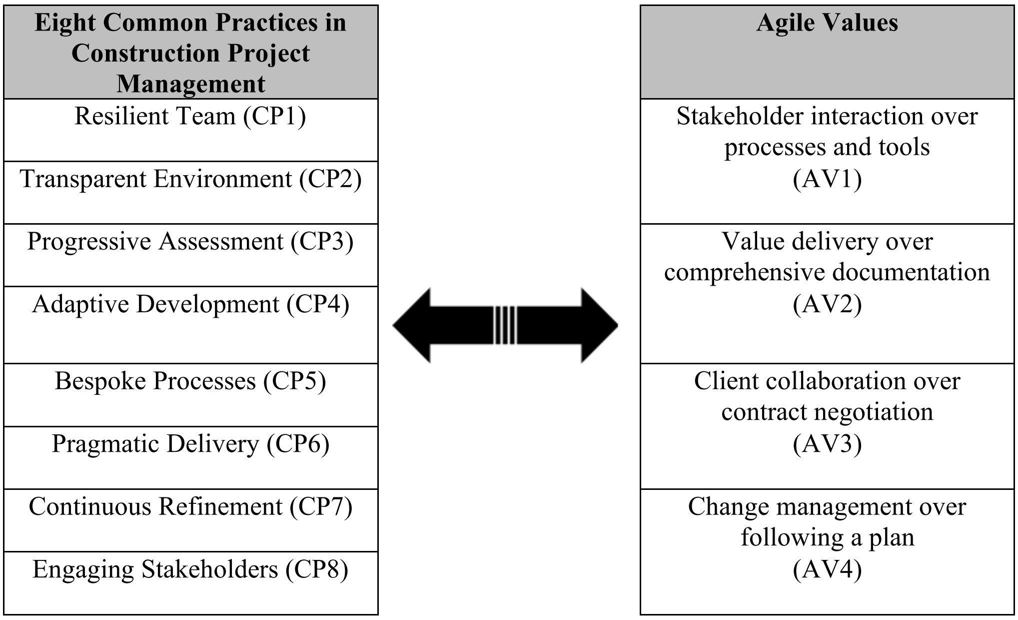


Figure 4.1: Correlation between Common Practices and Agile Values

The results indicated that there was a statistically significant correlation between CPs and AVs as shown in Table 4.15. Therefore, the null hypothesis was rejected. The results indicated that there is a weak but statistically significant positive correlation (r = .165, Sig. = .009) between having a resilient team (CP1) and prioritizing stakeholder interaction over processes and tools (AV1), suggesting that resilient teams tend to value stakeholder interaction more than rigid processes and tools. However, the correlation between a resilient team and value delivery over comprehensive documentation (AV2) is weak and not statistically significant (r = .112, Sig. = .075). Similarly, the correlation with client collaboration over contract negotiation (AV3) is also weak and not statistically significant (r = .106, Sig. = .093). On the other hand, there is a weak but statistically significant positive correlation (r = .132, Sig. = .036) between a resilient team and change management over following a plan (AV4), indicating that resilient teams are more likely to prioritize managing change over strictly following a plan. Overall, while a resilient team shows some alignment with Agile values, particularly in stakeholder interaction and change management, its influence on value delivery and client collaboration is less pronounced.

Table 4.15: Correlation between Common Practices and Agile Values (N=252)

Agile values		Common practices in construction project management								
		CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP
AV1	*r*	.165**	.147*	.264**	.188**	.237**	.144*	.181**	.116	.199**
	Sig.	.009	.020	.000	.003	.000	.022	.004	.067	.001
AV2	*r*	.112	.112	.188**	.223**	.209**	.305**	.245**	.195**	.196**
	Sig.	.075	.076	.003	.000	.001	.000	.000	.002	.002
AV3	*r*	.106	.152*	.190**	.142*	.240**	.216**	.201**	.072	.190**
	Sig.	.093	.016	.002	.024	.000	.001	.001	.256	.002
AV4	*r*	.132*	.210**	.294**	.293**	.237**	.221**	.232**	.176**	.265**
	Sig.	.036	.001	.000	.000	.000	.000	.000	.005	.000
AV	*r*	.105	.134*	.232**	.227**	.272**	.238**	.223**	.141*	.211**
	Sig.	.098	.033	.000	.000	.000	.000	.000	.026	.001

Note: *r* = coefficient of correlation

The results indicated that there is a weak but statistically significant positive correlation (r = .147, Sig. = .020) between a transparent environment (CP2) and prioritizing stakeholder interaction over processes and tools (AV1), indicating that transparency fosters a greater emphasis on stakeholder interaction over rigid processes and tools. However, the correlation with value delivery over comprehensive documentation (AV2) is weak and not statistically significant (r = .112, Sig. = .076). In contrast, there is a weak but statistically significant positive correlation (r = .152, Sig. = .016) between a transparent environment and client collaboration over contract negotiation (AV3), showing that transparency supports prioritizing collaboration with clients over formal contract negotiations. Most notably, there is a moderate and statistically significant positive correlation (r = .210, Sig. = .001) between a transparent environment and change management over following a plan (AV4), indicating that transparency strongly encourages managing change effectively rather than adhering strictly to a predefined plan. Overall, a transparent environment aligns well with Agile values, particularly in promoting stakeholder interaction, client collaboration, and adaptability to change.

There is a moderate and statistically significant positive correlation (r = .264, Sig. = .000) between progressive assessment (CP3) and prioritizing stakeholder interaction over processes and tools (AV1), indicating that teams that engage in progressive assessment are more likely to value stakeholder interaction over rigid processes and tools. Additionally, there is a weak but statistically significant positive correlation (r = .188, Sig. = .003) between progressive assessment and value delivery over comprehensive documentation (AV2), suggesting that progressive assessment supports a focus on delivering value rather than extensive documentation. Similarly, there is a weak but statistically significant positive correlation (r = .190, Sig. = .002) between progressive assessment and Client collaboration over contract negotiation (AV3), showing that this practice encourages collaboration with clients over formal contract negotiations. Most notably, there is a moderate and statistically significant positive correlation (r = .294, Sig. = .000) between progressive assessment and Change management over following a plan (AV4), highlighting that progressive assessment strongly promotes adaptability and managing change effectively over strictly following a predefined plan. Overall, progressive assessment is closely tied to Agile values, particularly in fostering stakeholder interaction, value delivery, client collaboration, and adaptability to change.

There is a weak but statistically significant positive correlation (r = .188, Sig. = .003) between adaptive development (CP4) and prioritizing Stakeholder interaction over processes and tools (AV1), indicating that adaptive development encourages teams to focus more on stakeholder interaction than on rigid processes and tools. Additionally, there is a weak to moderate and statistically significant positive correlation (r = .223, Sig. = .000) between adaptive development and Value delivery over comprehensive documentation (AV2), suggesting that this practice supports delivering value over extensive documentation. Furthermore, there is a weak but statistically significant positive correlation (r = .142, Sig. = .024) between adaptive development and Client collaboration over contract negotiation (AV3), showing that adaptive development fosters collaboration with clients rather than relying heavily on formal contract negotiations. Most notably, there is a moderate and statistically significant positive correlation (r = .293, Sig. = .000) between adaptive development and Change management over following a plan (AV4), highlighting that adaptive development strongly aligns with managing change effectively over adhering strictly to a predefined plan. Overall, adaptive development is closely associated with Agile values, particularly in promoting stakeholder interaction, value delivery, client collaboration, and adaptability to change.

There is a weak to moderate and statistically significant positive correlation (r = .237, Sig. = .000) between a bespoke processes (CP5) and prioritizing Stakeholder interaction over processes and tools (AV1), indicating that customizing processes encourages teams to focus more on stakeholder interaction than on rigid processes and tools. Additionally, there is a weak but statistically significant positive correlation ($r = .209$, Sig. = .001) between a bespoke processes and Value delivery over comprehensive documentation (AV2), suggesting that tailored processes support delivering value over extensive documentation. Furthermore, there is a weak to moderate and statistically significant positive correlation ($r = .240$, Sig. = .000) between a bespoke processes and Client collaboration over contract negotiation (AV3), showing that custom processes foster collaboration with clients rather than relying heavily on formal contract negotiations. Similarly, there is a weak to moderate and statistically significant positive correlation ($r = .237$, Sig. = .000) between a bespoke processes and Change management over following a plan (AV4), indicating that bespoke processes strongly align with managing change effectively over strictly adhering to a predefined plan. Overall, a bespoke process is closely tied to Agile values, particularly in promoting stakeholder interaction, value delivery, client collaboration, and adaptability to change.

There is a weak but statistically significant positive correlation ($r = .144$, Sig. = .022) between pragmatic delivery (CP6) and prioritizing Stakeholder interaction over processes and tools (AV1), indicating that a focus on practical delivery encourages teams to value stakeholder interaction over rigid processes and tools. More notably, there is a moderate and statistically significant positive correlation ($r = .305$, Sig. = .000) between pragmatic delivery and Value delivery over comprehensive documentation (AV2), highlighting that this practice strongly supports delivering value over extensive documentation. Additionally, there is a weak but statistically significant positive correlation ($r = .216$, Sig.

= .001) between pragmatic delivery and Client collaboration over contract negotiation (AV3), suggesting that pragmatic delivery fosters collaboration with clients rather than relying heavily on formal contract negotiations. Similarly, there is a weak but statistically significant positive correlation (r = .221, Sig. = .000) between pragmatic delivery and Change management over following a plan (AV4), indicating that this approach aligns with managing change effectively over strictly adhering to a predefined plan. Overall, pragmatic delivery is closely associated with Agile values, particularly in emphasizing value delivery, stakeholder interaction, client collaboration, and adaptability to change.

There is a weak but statistically significant positive correlation (r = .181, Sig. = .004) between continuous refinement (CP7) and prioritizing Stakeholder interaction over processes and tools (AV1), indicating that teams that engage in continuous refinement are more likely to value stakeholder interaction over rigid processes and tools. Additionally, there is a weak to moderate and statistically significant positive correlation (r = .245, Sig. = .000) between continuous refinement and Value delivery over comprehensive documentation (AV2), suggesting that this practice supports delivering value over extensive documentation. Furthermore, there is a weak but statistically significant positive correlation (r = .201, Sig. = .001) between continuous refinement and Client collaboration over contract negotiation (AV3), showing that continuous refinement fosters collaboration with clients rather than relying heavily on formal contract negotiations. Similarly, there is a weak but statistically significant positive correlation (r = .232, Sig. = .000) between continuous refinement and Change management over following a plan (AV4), indicating that this practice aligns with managing change effectively over strictly adhering to a predefined plan. Overall, continuous refinement is closely tied to Agile values, particularly in promoting stakeholder interaction, value delivery, client collaboration, and adaptability to change.

The correlation between engaging stakeholders (CP8) and prioritizing Stakeholder interaction over processes and tools (AV1) is weak and not statistically significant (r = .116, Sig. = .067), However, there is a weak but statistically significant positive correlation (r = .195, Sig. = .002) between engaging stakeholders and Value delivery over comprehensive documentation (AV2), indicating that this practice supports delivering value over extensive documentation. On the other hand, the correlation with Client collaboration over contract negotiation (AV3) is weak and not statistically significant (r = .072, Sig. = .256). Finally, there is a weak but statistically significant positive correlation (r = .176, Sig. = .005) between engaging stakeholders and Change management over following a plan (AV4), suggesting that this practice aligns with managing change effectively over strictly adhering to a predefined plan. Overall, while engaging stakeholders shows some alignment with Agile values, particularly in value delivery and change management, its influence on stakeholder interaction and client collaboration is less pronounced.

The control variable "Resilient Team (CP1)" significantly influences the relationship between agile values and common practices as shown in table 4.16. Specifically, for AV1, which emphasizes stakeholder interaction over processes and tools, the correlation becomes non-significant when controlling for CP1, and the variance explained drops notably by 2.677%. For the other agile values, the partial correlations remain statistically significant, but the variance explained undergoes slight changes. For AV2, which prioritizes value delivery over comprehensive documentation, the variance explained decreases by 0.630%, while for AV3, which focuses on client collaboration over contract negotiation, it decreases by 0.455%. In contrast, for AV4, which emphasizes change management over following a plan, the variance explained increases slightly by 0.255%. These findings highlight the role of resilient teams in controlling the relationship between agile values and their practical implementation, with AV1 being the most affected.

Table 4.16: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Resilient Team (CP1)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.114	0.072	0.013	2.677
AV2	0.196	0.002	0.039	0.180	0.004	0.032	0.630
AV3	0.190	0.002	0.036	0.178	0.005	0.032	0.455
AV4	0.265	0.000	0.070	0.269	0.000	0.073	-0.255

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Transparent Environment (CP2) has a substantial impact on the relationship between agile values and common practices as shown in Table 4.17. For AV3, which emphasizes client collaboration over contract negotiation, the correlations become non-significant when controlling for CP2, and the variance explained drops significantly by 2.259%. However, for the other agile values, the partial correlations remain statistically significant, though the variance explained is notably reduced. Specifically, for AV1, which prioritizes stakeholder interaction over processes and tools, the variance explained decreases by 1.983%. For AV2, which focuses on value delivery over comprehensive documentation, it drops by 2.259%, and for AV4, which emphasizes change management over following a plan, the reduction is even more pronounced at 4.242%. These results underscore the significant role of a transparent environment in shaping the relationship between agile values and their practical application, with AV4 being the most affected.

Table 4.17: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Transparent environment (CP2)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.141	0.025	0.020	1.983
AV2	0.196	0.002	0.039	0.188	0.003	0.035	0.330
AV3	0.190	0.002	0.036	0.116	0.066	0.014	2.259
AV4	0.265	0.000	0.070	0.166	0.008	0.028	4.242

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Progressive Assessment (CP3) has a substantial impact on the relationship between agile values and common practices as indicated in Table 4.18. For all agile values, AV1 to AV4, the correlations become non-significant when controlling for CP3, and the variance explained drops significantly. The most substantial impact is observed on AV4, which emphasizes change management over following a plan, where the difference in variance explained is 6.710%. Similarly, for AV1, which prioritizes stakeholder interaction over processes and tools, the variance explained decreases by 3.944%. For AV2, which focuses on value delivery over comprehensive documentation, the reduction is 3.230%, and for AV3, which highlights client collaboration over contract negotiation, the variance explained drops by 3.178%. These findings highlight the considerable influence of progressive assessment in controlling the relationship between agile values and their practical implementation, with AV4 being the most affected.

Table 4.18: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Progressive Assessment (CP3)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	-0.017	0.786	0.000	3.944
AV2	0.196	0.002	0.039	0.079	0.212	0.006	3.230
AV3	0.190	0.002	0.036	0.066	0.298	0.004	3.178
AV4	0.265	0.000	0.070	0.054	0.398	0.003	6.710

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable "Adaptive Development (CP4)" has a significant impact on the relationship between agile values and common practices as indicated in Table 4.19. For AV1, which emphasizes stakeholder interaction over processes and tools, AV3, which focuses on client collaboration over contract negotiation, and AV4, which prioritizes change management over following a plan, the correlations become non-significant when controlling for CP4. Additionally, the variance explained drops notably by 3.194%, 1.986%, and 6.553% for AV1, AV3, and AV4, respectively. However, for AV2, which highlights value delivery over comprehensive documentation, the partial correlation remains statistically significant, though the variance explained is still reduced significantly by 3.679%. These results demonstrate the substantial influence of adaptive development in shaping the relationship between agile values and their practical application, with AV4 being the most affected.

Table 4.19: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Adaptive Development (CP4)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.088	0.163	0.008	3.194
AV2	0.196	0.002	0.039	0.042	0.508	0.002	3.679
AV3	0.190	0.002	0.036	0.128	0.043	0.016	1.986
AV4	0.265	0.000	0.070	0.067	0.293	0.004	6.553

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Bespoke Processes (CP5) has a substantial impact on the relationship between agile values and common practices as shown in Table 4.20. For AV1, which emphasizes stakeholder interaction over processes and tools, AV2, which focuses on value delivery over comprehensive documentation, and AV3, which prioritizes client collaboration over contract negotiation, the correlations become non-significant when controlling for CP5. Additionally, the variance explained drops significantly by 3.905%, 3.542%, and 3.608% for AV1, AV2, and AV3, respectively. However, for AV4, which highlights change management over following a plan, the partial correlation remains statistically significant, though the variance explained is still reduced significantly by 5.246%. These findings underscore the considerable influence of bespoke processes in controlling the relationship between agile values and their practical implementation, with AV4 experiencing the most pronounced reduction in variance explained.

Table 4.20: Bivariate and Partial Correlation between Common Practices and Agile Values Control [Variables: Bespoke Processes (CP5)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.026	0.678	0.001	3.905
AV2	0.196	0.002	0.039	0.056	0.377	0.003	3.542
AV3	0.190	0.002	0.036	0.007	0.909	0.000	3.608
AV4	0.265	0.000	0.070	0.132	0.036	0.018	5.246

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Pragmatic Delivery (CP6) has a substantial impact on the relationship between agile values and common practices as shown in Table 4.21. For AV2, which emphasizes value delivery over comprehensive documentation, and AV3, which focuses on client collaboration over contract negotiation, the correlations become non-significant when controlling for CP6, and the variance explained drops significantly by 3.781% and 3.311%, respectively. However, for AV1, which prioritizes stakeholder interaction over processes and tools, and AV4, which highlights change management over following a plan, the partial correlations remain statistically significant, though the variance explained is still reduced significantly by 2.038% and 4.516%, respectively. These results highlight the considerable influence of pragmatic delivery in shaping the relationship between agile values and their practical application, with AV4 experiencing the most notable reduction in variance explained.

Table 4.21: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Pragmatic Delivery (CP6)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.139	0.028	0.019	2.038
AV2	0.196	0.002	0.039	-0.027	0.669	0.001	3.781
AV3	0.190	0.002	0.036	0.055	0.386	0.003	3.311
AV4	0.265	0.000	0.070	0.158	0.012	0.025	4.516

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Continuous Refinement (CP7) has a substantial impact on the relationship between agile values and common practices as indicated in Table 4.22. For AV1, which emphasizes stakeholder interaction over processes and tools, AV2, which focuses on value delivery over comprehensive documentation, and AV3, which prioritizes client collaboration over contract negotiation, the correlations become non-significant when controlling for CP7, and the variance explained drops significantly by 2.911%, 3.726%, and 3.117%, respectively. However, for AV4, which highlights change management over following a plan, the partial correlation remains statistically significant, though the variance explained is still reduced significantly by 4.842%. These findings demonstrate the considerable influence of continuous refinement in controlling the relationship between agile values and their practical implementation, with AV4 experiencing the most pronounced reduction in variance explained.

Table 4.22: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Continuous Refinement (CP7)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.103	0.103	0.011	2.911
AV2	0.196	0.002	0.039	0.036	0.571	0.001	3.726
AV3	0.190	0.002	0.036	0.070	0.266	0.005	3.117
AV4	0.265	0.000	0.070	0.147	0.020	0.022	4.842

Note: r = coefficient of correlation, r^2 = coefficient of determination

The control variable - Stakeholder Engagement (CP8) has a substantial impact on the relationship between agile values and common practices as shown in Table 4.23. For AV2, which emphasizes value delivery over comprehensive documentation, the correlation becomes non-significant when controlling for CP8, and the variance explained drops significantly by 3.073%. For the other agile values, the partial correlations remain statistically significant, but the variance explained undergoes notable changes. Specifically, for AV1, which prioritizes stakeholder interaction over processes and tools, the variance explained decreases by 1.224%, and for AV4, which focuses on change management over following a plan, it drops by 2.986%. In contrast, for AV3, which highlights client collaboration over contract negotiation, the variance explained increases slightly by 0.119%. These results underscore the significant role of stakeholder engagement in shaping the relationship between agile values and their practical implementation, with AV2 being the most affected.

Table 4.23: Bivariate and Partial Correlation between Common Practices and Agile Values [Control Variables: Engaging Stakeholders (CP8)] (N=252)

Agile values	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AV1	0.199	0.001	0.040	0.166	0.008	0.027	1.224
AV2	0.196	0.002	0.039	0.088	0.162	0.008	3.073
AV3	0.190	0.002	0.036	0.193	0.002	0.037	-0.119
AV4	0.265	0.000	0.070	0.200	0.001	0.040	2.986

Note: r = coefficient of correlation, r^2 = coefficient of determination

4.4.2 Hypothesis Test No.2: Correlation between Common Practices and Agile Principles

Null hypothesis (H2o): There is no significantly correlated between common practices, CPn and agile principles, APs

Alternative hypothesis (H2a): There is significantly correlated between common practices, CPn and agile principles, APs

A Spearman's rank-order correlation was run for hypothesis test no.2 to determine the relationship between 8 CPs in CPM and 12 APs as shown in Figure 4.2.

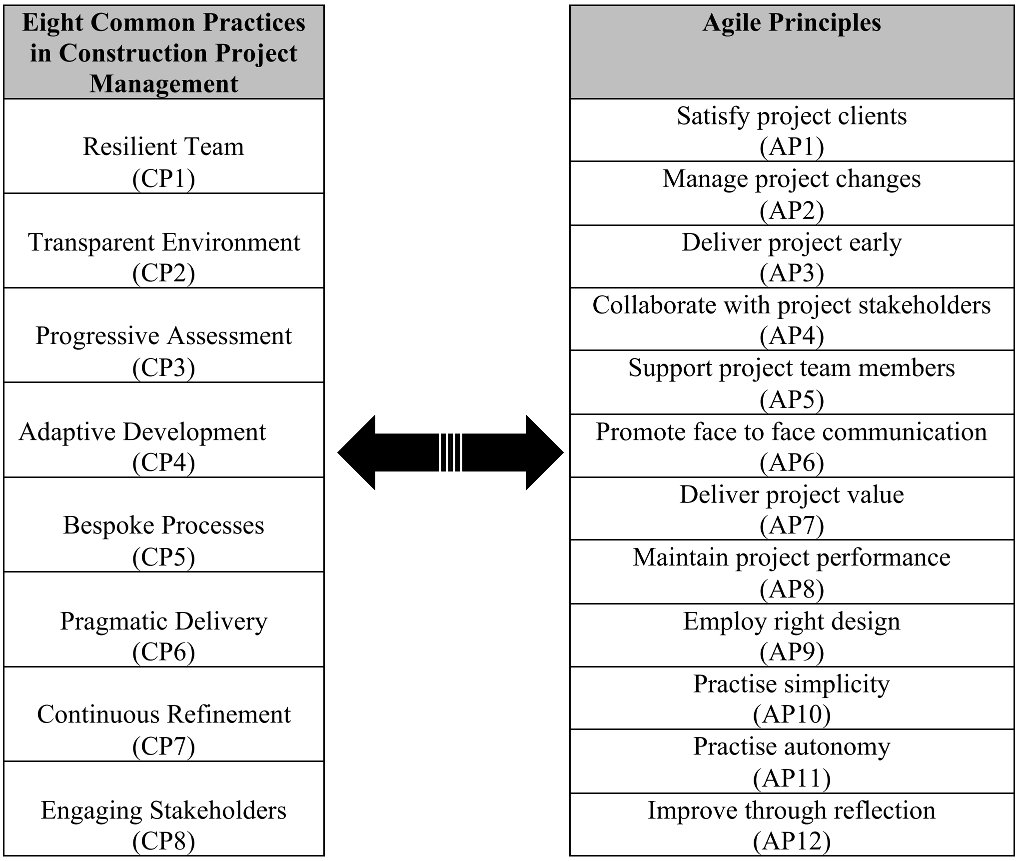


Figure 4.2: Correlation between Common Practices and Agile Principles

The results indicated that there was a statistically significant correlation between CPs and APs presented in Table 4.24. Therefore, the null hypothesis was rejected. A resilient team (CP1) shows strong positive correlations with several Agile Principles, particularly with satisfying project clients (AP1) (r = 0.496, Sig. = .000), delivering projects early (AP3) (r = 0.476, Sig. = .000), and practicing simplicity (AP10) (r = 0.434, Sig. = .000). These strong correlations suggest that a resilient team is crucial for achieving client satisfaction, ensuring timely project delivery, and maintaining streamlined, simple processes. On the other hand, the weakest correlation is observed with promoting face-to-face communication (AP6) (r = 0.253, Sig. = .000), indicating that resilience in teams is more about their ability to handle challenges and deliver results rather than the specific mode of communication they use.

Table 4.24: Correlation between Common Practices and Agile Principles (N=252)

Agile principles		Common practices in construction project management								
		CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP
AP1	*r*	.496**	.494**	.408**	.449**	.498**	.510**	.428**	.403**	.578**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP2	*r*	.263**	.307**	.385**	.318**	.307**	.334**	.235**	.316**	.379**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP3	*r*	.476**	.531**	.458**	.505**	.380**	.479**	.366**	.412**	.544**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP4	*r*	.336**	.386**	.339**	.380**	.299**	.342**	.369**	.217**	.400**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.001	.000
AP5	*r*	.423**	.363**	.427**	.379**	.423**	.407**	.359**	.388**	.504**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP6	*r*	.253**	.253**	.372**	.262**	.387**	.362**	.423**	.356**	.387**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP7	*r*	.387**	.395**	.434**	.387**	.433**	.547**	.396**	.281**	.491**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP8	*r*	.427**	.472**	.532**	.445**	.442**	.529**	.468**	.327**	.558**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP9	*r*	.280**	.348**	.350**	.371**	.302**	.413**	.354**	.308**	.400**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP10	*r*	.434**	.407**	.524**	.333**	.399**	.411**	.403**	.364**	.505**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP11	*r*	.365**	.334**	.421**	.236**	.410**	.342**	.309**	.314**	.444**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP12	*r*	.422**	.352**	.386**	.378**	.478**	.366**	.429**	.302**	.495**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
AP	*r*	.568**	.583**	.637**	.550**	.616**	.647**	.582**	.498**	.743**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000

Note: r = coefficient of correlation

A transparent environment (CP2) demonstrates strong positive correlations with several Agile Principles, particularly with delivering projects early (AP3) (r = 0.531, Sig. = .000), satisfying project clients (AP1) (r = 0.494, Sig. = .000), and maintaining project performance (AP8) (r = 0.472, Sig. = .000). These strong correlations highlight the critical role of transparency in fostering efficiency, client satisfaction, and consistent performance in construction projects. On the other hand, the weakest correlation is observed with promoting face-to-face communication (AP6) (r = 0.253, Sig. = .000), suggesting that transparency can be effectively maintained through various communication channels, not necessarily limited to face-to-face interactions.

Progressive assessment (CP3), which involves continuous evaluation and iterative improvement of project processes, shows strong positive correlations with key Agile Principles, particularly with maintaining project performance (AP8) (r = 0.532, Sig. = .000), practicing simplicity (AP10) (r = 0.524, Sig. = .000), and delivering projects early (AP3) (r = 0.458, Sig. = .000). These strong correlations suggest that regular and iterative assessment is essential for ensuring consistent performance, streamlining processes, and achieving timely project delivery. On the other hand, the weakest correlation, though still positive, is observed with collaborating with project stakeholders (AP4) (r = 0.339, Sig. = .000). This indicates that progressive assessment is more focused on internal team dynamics and workflows, with stakeholder collaboration playing a relatively smaller role in the iterative improvement process.

Adaptive development (CP4) shows strong positive correlations with key Agile Principles, particularly with delivering projects early (AP3) (r = 0.505, Sig. = .000), satisfying project clients (AP1) (r = 0.449, Sig. = .000), and maintaining project performance (AP8) (r = 0.445, Sig. = .000). These strong correlations highlight the importance of flexibility and adaptability in construction project management, as they enable teams to respond effectively to changing requirements, meet client expectations, and ensure consistent performance. In contrast, the weakest correlation is observed with practicing autonomy (AP11) (r = 0.236, Sig. = .000), suggesting that while adaptive development is highly effective in achieving project goals, it may require more collaborative decision-making and structured oversight rather than relying heavily on individual autonomy.

A bespoke process (CP5), which involves tailoring project management practices to suit specific project needs, shows strong positive correlations with several Agile Principles, particularly with satisfying project clients (AP1) (r = 0.498, Sig. = .000), improving through reflection (AP12) (r = 0.478, Sig. = .000), and maintaining project performance (AP8) (r = 0.442, Sig. = .000). These strong correlations suggest that customizing processes to fit the unique requirements of a project enhances client satisfaction, fosters continuous improvement, and contributes to consistent performance. On the other hand, the weakest correlation is observed with collaborating with project stakeholders (AP4) (r = 0.299), indicating that while bespoke processes are highly effective in achieving internal project goals, they may not be as strongly tied to external stakeholder engagement.

Pragmatic delivery (CP6), which emphasizes practical and results-oriented project execution, demonstrates strong positive correlations with key Agile Principles, particularly with delivering project value (AP7) (r = 0.547, Sig. = .000), maintaining project performance (AP8) (r = 0.529, Sig. = .000), and satisfying project clients (AP1) (r = 0.510, Sig. = .000). These strong correlations highlight the importance of focusing on tangible outcomes, efficiency, client satisfaction in construction project management, and sustain high performance throughout their lifecycle. On the other hand, the weakest correlation, though still positive, is observed with managing project changes (AP2) (r = 0.334, Sig. = .000). This suggests that while pragmatic delivery is highly effective in achieving project objectives, it may prioritize practical execution and results over extensive management of changes.

Continuous refinement (CP7), which involves ongoing improvement and adjustment of project processes, shows strong positive correlations with several Agile Principles, particularly with maintaining project performance (AP8) (r = 0.468, Sig. = .000), improving through reflection (AP12) (r = 0.429, Sig. = .000), and satisfying project clients (AP1) (r = 0.428, Sig. = .000). These strong correlations suggest that iterative refinement is essential for ensuring consistent performance, fostering a culture of continuous improvement, and enhancing client satisfaction. On the other hand, the weakest correlation is observed with managing project changes (AP2) (r = 0.235, Sig. = .000), indicating that while continuous refinement is highly effective in improving internal processes and team dynamics, it may not be as strongly tied to the management of project changes.

Engaging stakeholders (CP8) shows moderate positive correlations with several Agile Principles, particularly with delivering projects early (AP3) (r = 0.412, Sig. = .000), satisfying project clients (AP1) (r = 0.403, Sig. = .000), and supporting project team members (AP5) (r = 0.388, Sig. = .000). These correlations suggest that stakeholder engagement contributes to timely project delivery, client satisfaction, and team support, highlighting its role in fostering collaboration and alignment within projects. However, the overall strength of these correlations is relatively lower compared to other Common Practices, indicating that stakeholder engagement may not be as strongly aligned with Agile Principles as other practices. Notably, the weakest correlation is with collaborating with project stakeholders (AP4) (r = 0.217, Sig. = .001), which is somewhat counterintuitive given that both concepts involve stakeholder interaction. This suggests that while engaging stakeholders is important, it may not always translate into deep collaboration or direct alignment with Agile goals.

The analysis reveals the varying influence of Resilient Teams (CP1) on different Agile Principles (APs) as shown in Table 4.25. For AP1 (Satisfy project clients), there is a substantial reduction in variance explained, with a decrease of 21.4%. This indicates that resilient teams play a critical role in controlling the relationship between client satisfaction and common practices, as their ability to adapt and recover from challenges ensures that client needs are consistently met. Similarly, for AP3 (Deliver project early), the reduction of 20.1% highlights the significant impact of resilient teams on accelerating project timelines. Their capacity to streamline workflows and overcome obstacles enables faster delivery. For AP10 (Practise simplicity), the reduction of 17.1% demonstrates that resilient teams simplify processes, reducing reliance on external factors and fostering efficiency.

Table 4.25: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Resilient Team (CP1)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	*r*²	*r*	Sig.	*r*²	
AP1	0.578	0.000	0.335	0.348	0.000	0.121	21.356
AP3	0.544	0.000	0.296	0.308	0.000	0.095	20.095
AP10	0.505	0.000	0.255	0.290	0.000	0.084	17.065
AP5	0.504	0.000	0.254	0.303	0.000	0.092	16.201
AP12	0.495	0.000	0.245	0.288	0.000	0.083	16.180
AP8	0.558	0.000	0.312	0.400	0.000	0.160	15.190
AP7	0.491	0.000	0.241	0.328	0.000	0.108	13.362
AP11	0.444	0.000	0.197	0.272	0.000	0.074	12.327
AP4	0.400	0.000	0.160	0.232	0.000	0.054	10.621
AP9	0.400	0.000	0.160	0.306	0.000	0.094	6.627
AP2	0.379	0.000	0.143	0.292	0.000	0.085	5.843
AP6	0.387	0.000	0.150	0.319	0.000	0.102	4.768

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the varying influence of Transparent Environment (CP2) on different Agile Principles (APs) as shown in Table 4.26. For AP3 (Deliver project early), there is a substantial reduction in variance explained, with a decrease of 24.9%. This significant reduction indicates that a transparent environment plays a crucial role in enabling early project delivery, likely by reducing ambiguities, aligning expectations, and facilitating timely decision-making. Similarly, for AP1 (Satisfy project clients), the reduction of 21.4% underscores the importance of transparency in fostering client satisfaction. A transparent environment enhances trust and clarity, ensuring that client needs are met effectively. For AP8 (Maintain project performance), the reduction of 19.7% demonstrates that transparency helps sustain performance by enabling real-time issue resolution and accountability.

Table 4.26: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Transparent Environment (CP2)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP3	0.544	0.000	0.296	0.216	0.001	0.046	24.906
AP1	0.578	0.000	0.335	0.347	0.000	0.120	21.408
AP8	0.558	0.000	0.312	0.339	0.000	0.115	19.686
AP10	0.505	0.000	0.255	0.328	0.000	0.108	14.698
AP7	0.491	0.000	0.241	0.319	0.000	0.102	13.951
AP4	0.400	0.000	0.160	0.154	0.015	0.024	13.635
AP9	0.400	0.000	0.160	0.212	0.001	0.045	11.498
AP5	0.504	0.000	0.254	0.391	0.000	0.153	10.071
AP11	0.444	0.000	0.197	0.319	0.000	0.102	9.595
AP12	0.495	0.000	0.245	0.389	0.000	0.152	9.298
AP2	0.379	0.000	0.143	0.234	0.000	0.055	8.861
AP6	0.387	0.000	0.150	0.329	0.000	0.108	4.142

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis reveals the significant influence of Progressive Assessment (CP3) on various Agile Principles (APs) as exhibited in Table 4.27. For AP8 (Maintain project performance), there is a substantial reduction in variance explained, with a decrease of 24.2%. This indicates that progressive assessments play a critical role in sustaining project performance by enabling continuous monitoring, timely adjustments, and proactive risk management. Similarly, for AP10 (Practise simplicity), the reduction of 22.6% highlights how progressive assessments simplify processes by identifying inefficiencies and eliminating redundancies, thereby reducing reliance on external factors. For AP3 (Deliver project early), the reduction of 18.4% demonstrates that iterative assessments streamline workflows and accelerate timelines, ensuring projects are delivered ahead of schedule.

Table 4.27: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Progressive Assessment (CP3)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP8	0.558	0.000	0.312	0.264	0.000	0.070	24.226
AP10	0.505	0.000	0.255	0.171	0.007	0.029	22.551
AP3	0.544	0.000	0.296	0.334	0.000	0.111	18.428
AP7	0.491	0.000	0.241	0.268	0.000	0.072	16.942
AP5	0.504	0.000	0.254	0.300	0.000	0.090	16.360
AP11	0.444	0.000	0.197	0.200	0.001	0.040	15.734
AP12	0.495	0.000	0.245	0.335	0.000	0.112	13.222
AP2	0.379	0.000	0.143	0.130	0.039	0.017	12.646
AP1	0.578	0.000	0.335	0.459	0.000	0.210	12.433
AP6	0.387	0.000	0.150	0.162	0.010	0.026	12.343
AP9	0.400	0.000	0.160	0.214	0.001	0.046	11.425
AP4	0.400	0.000	0.160	0.229	0.000	0.052	10.763

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the varying influence of Adaptive Development (CP4) on different Agile Principles (APs) as exhibited in Table 4.28. For AP3 (Deliver project early), there is a substantial reduction in variance explained, with a decrease of 21.4%. This significant reduction indicates that adaptive development strongly drives early project delivery, likely through iterative cycles, rapid adjustments, and the ability to respond swiftly to changing requirements or challenges. Similarly, for AP8 (Maintain project performance), the reduction of 16.9% demonstrates that adaptive methods help sustain performance by enabling continuous improvements and proactive risk management. For AP1 (Satisfy project clients), the reduction of 16.7% underscores the importance of adaptive development in aligning deliverables with evolving client needs, thereby enhancing satisfaction through flexibility and responsiveness.

Table 4.28: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Adaptive Development (CP4)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP3	0.544	0.000	0.296	0.285	0.000	0.081	21.423
AP8	0.558	0.000	0.312	0.378	0.000	0.143	16.911
AP1	0.578	0.000	0.335	0.409	0.000	0.167	16.740
AP7	0.491	0.000	0.241	0.329	0.000	0.108	13.316
AP4	0.400	0.000	0.160	0.185	0.003	0.034	12.574
AP12	0.495	0.000	0.245	0.345	0.000	0.119	12.559
AP5	0.504	0.000	0.254	0.359	0.000	0.129	12.493
AP9	0.400	0.000	0.160	0.195	0.002	0.038	12.186
AP2	0.379	0.000	0.143	0.222	0.000	0.049	9.400
AP10	0.505	0.000	0.255	0.411	0.000	0.169	8.632
AP6	0.387	0.000	0.150	0.300	0.000	0.090	5.991
AP11	0.444	0.000	0.197	0.420	0.000	0.176	2.128

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis reveals the significant influence of Bespoke Processes (CP5) on various Agile Principles (APs) as presented in Table 4.29. For AP1 (Satisfy project clients), there is a substantial reduction in variance explained, with a decrease of 21.1%. This indicates that bespoke processes play a critical role in enhancing client satisfaction by tailoring workflows to meet specific client needs and expectations, ensuring deliverables align closely with their requirements. Similarly, for AP12 (Improve through reflection), the reduction of 19.5% highlights how customized processes facilitate reflective practices, enabling teams to learn from past experiences and continuously improve their workflows. For AP8 (Maintain project performance), the reduction of 16.7% demonstrates that bespoke processes help sustain performance by aligning methods with project-specific challenges and goals, ensuring consistent progress and stability.

Table 4.29: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Bespoke Processes (CP5)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	*r*²	*r*	Sig.	*r*²	
AP1	0.578	0.000	0.335	0.352	0.000	0.124	21.083
AP12	0.495	0.000	0.245	0.224	0.000	0.050	19.462
AP8	0.558	0.000	0.312	0.380	0.000	0.145	16.722
AP7	0.491	0.000	0.241	0.273	0.000	0.074	16.685
AP5	0.504	0.000	0.254	0.307	0.000	0.094	15.939
AP11	0.444	0.000	0.197	0.220	0.000	0.048	14.903
AP10	0.505	0.000	0.255	0.338	0.000	0.114	14.053
AP6	0.387	0.000	0.150	0.149	0.018	0.022	12.739
AP3	0.544	0.000	0.296	0.426	0.000	0.182	11.386
AP2	0.379	0.000	0.143	0.234	0.000	0.055	8.850
AP9	0.400	0.000	0.160	0.275	0.000	0.076	8.431
AP4	0.400	0.000	0.160	0.279	0.000	0.078	8.238

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the significant influence of Pragmatic Delivery (CP6) on various Agile Principles (APs) as presented in Table 4.30. For AP8 (Maintain project performance), there is a substantial reduction in variance explained, with a decrease of 21.6%. This indicates that pragmatic delivery plays a crucial role in sustaining project performance by focusing on actionable results, minimizing inefficiencies, and ensuring that practical outcomes are prioritized over theoretical ideals. Similarly, for AP7 (Deliver project value), the reduction of 20.9% underscores the importance of pragmatic methods in aligning deliverables with tangible benefits, ensuring that the value provided meets stakeholder expectations. For AP1 (Satisfy project clients), the reduction of 20.5% demonstrates that pragmatic delivery enhances client satisfaction by setting realistic timelines and delivering results that meet practical client needs.

Table 4.30: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Pragmatic Delivery (CP6)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP8	0.558	0.000	0.312	0.309	0.000	0.096	21.631
AP7	0.491	0.000	0.241	0.179	0.004	0.032	20.911
AP1	0.578	0.000	0.335	0.359	0.000	0.129	20.547
AP3	0.544	0.000	0.296	0.332	0.000	0.110	18.551
AP10	0.505	0.000	0.255	0.333	0.000	0.111	14.395
AP5	0.504	0.000	0.254	0.335	0.000	0.112	14.124
AP9	0.400	0.000	0.160	0.169	0.007	0.028	13.143
AP12	0.495	0.000	0.245	0.359	0.000	0.129	11.583
AP6	0.387	0.000	0.150	0.199	0.002	0.040	10.989
AP11	0.444	0.000	0.197	0.306	0.000	0.093	10.412
AP4	0.400	0.000	0.160	0.239	0.000	0.057	10.306
AP2	0.379	0.000	0.143	0.214	0.001	0.046	9.754

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis reveals the significant influence of Continuous Refinement (CP7) on various Agile Principles (APs) as displayed in Table 4.31. For AP8 (Maintain project performance), there is a substantial reduction in variance explained, with a decrease of 17.8%. This indicates that continuous refinement plays a critical role in sustaining project performance by enabling iterative adjustments, proactive risk mitigation, and ongoing optimization of workflows. Similarly, for AP12 (Improve through reflection), the reduction of 15.4% highlights how continuous improvement cycles enhance reflective practices, allowing teams to learn from past experiences and embed those lessons into future processes. For AP1 (Satisfy project clients), the reduction of 14.8% demonstrates that continuous refinement aligns deliverables with evolving client needs, fostering satisfaction through adaptability and responsiveness.

Table 4.31: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Continuous Refinement (CP7)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP8	0.558	0.000	0.312	0.366	0.000	0.134	17.783
AP12	0.495	0.000	0.245	0.302	0.000	0.091	15.367
AP1	0.578	0.000	0.335	0.432	0.000	0.187	14.777
AP10	0.505	0.000	0.255	0.341	0.000	0.116	13.865
AP7	0.491	0.000	0.241	0.327	0.000	0.107	13.458
AP6	0.387	0.000	0.150	0.141	0.026	0.020	12.983
AP4	0.400	0.000	0.160	0.214	0.001	0.046	11.434
AP5	0.504	0.000	0.254	0.379	0.000	0.143	11.018
AP3	0.544	0.000	0.296	0.432	0.000	0.187	10.864
AP9	0.400	0.000	0.160	0.228	0.000	0.052	10.816
AP11	0.444	0.000	0.197	0.336	0.000	0.113	8.458
AP2	0.379	0.000	0.143	0.309	0.000	0.095	4.798

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the influence of Engaging Stakeholders (CP8) on various Agile Principles (APs) as displayed in Table 4.32. For AP3 (Deliver project early), there is a notable reduction in variance explained, with a decrease of 14.0%. This suggests that engaging stakeholders plays a significant role in enabling early project delivery, likely by identifying risks early, aligning expectations, and facilitating timely decision-making. Similarly, for AP1 (Satisfy project clients), the reduction of 12.9% underscores the importance of stakeholder engagement in enhancing client satisfaction. By involving stakeholders, teams can better understand and meet client needs, fostering trust and alignment. For AP5 (Support project team members), the reduction of 12.8% indicates that engaging stakeholders also contributes to supporting team members, possibly by clarifying roles, providing resources, and ensuring alignment with project goals.

Table 4.32: Bivariate and Partial Correlation between Common Practices and Agile Principles [Control Variables: Engaging Stakeholders (CP8)] (N=252)

Agile principles	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
AP3	0.544	0.000	0.296	0.394	0.000	0.155	14.032
AP1	0.578	0.000	0.335	0.453	0.000	0.205	12.910
AP5	0.504	0.000	0.254	0.354	0.000	0.126	12.797
AP10	0.505	0.000	0.255	0.377	0.000	0.142	11.295
AP6	0.387	0.000	0.150	0.211	0.001	0.044	10.517
AP2	0.379	0.000	0.143	0.235	0.000	0.055	8.803
AP11	0.444	0.000	0.197	0.331	0.000	0.110	8.777
AP9	0.400	0.000	0.160	0.273	0.000	0.075	8.527
AP8	0.558	0.000	0.312	0.485	0.000	0.235	7.657
AP12	0.495	0.000	0.245	0.414	0.000	0.171	7.337
AP7	0.491	0.000	0.241	0.427	0.000	0.182	5.923
AP4	0.400	0.000	0.160	0.353	0.000	0.125	3.543

Note: r = coefficient of correlation, r^2 = coefficient of determination

4.4.3 Hypothesis Test No.3: Correlation between Common Practices and Project Performances

Null hypothesis (H3o): There is no significantly correlated between common practices, CPn and project performances, PPt

Alternative hypothesis (H3a): There is significantly correlated between common practices, CPn and project performances, PPt

A Spearman's rank-order correlation was run for hypothesis test no.3 to determine the relationship between 8 CPs in CPM and 16 PPs as shown in Figure 4.3.

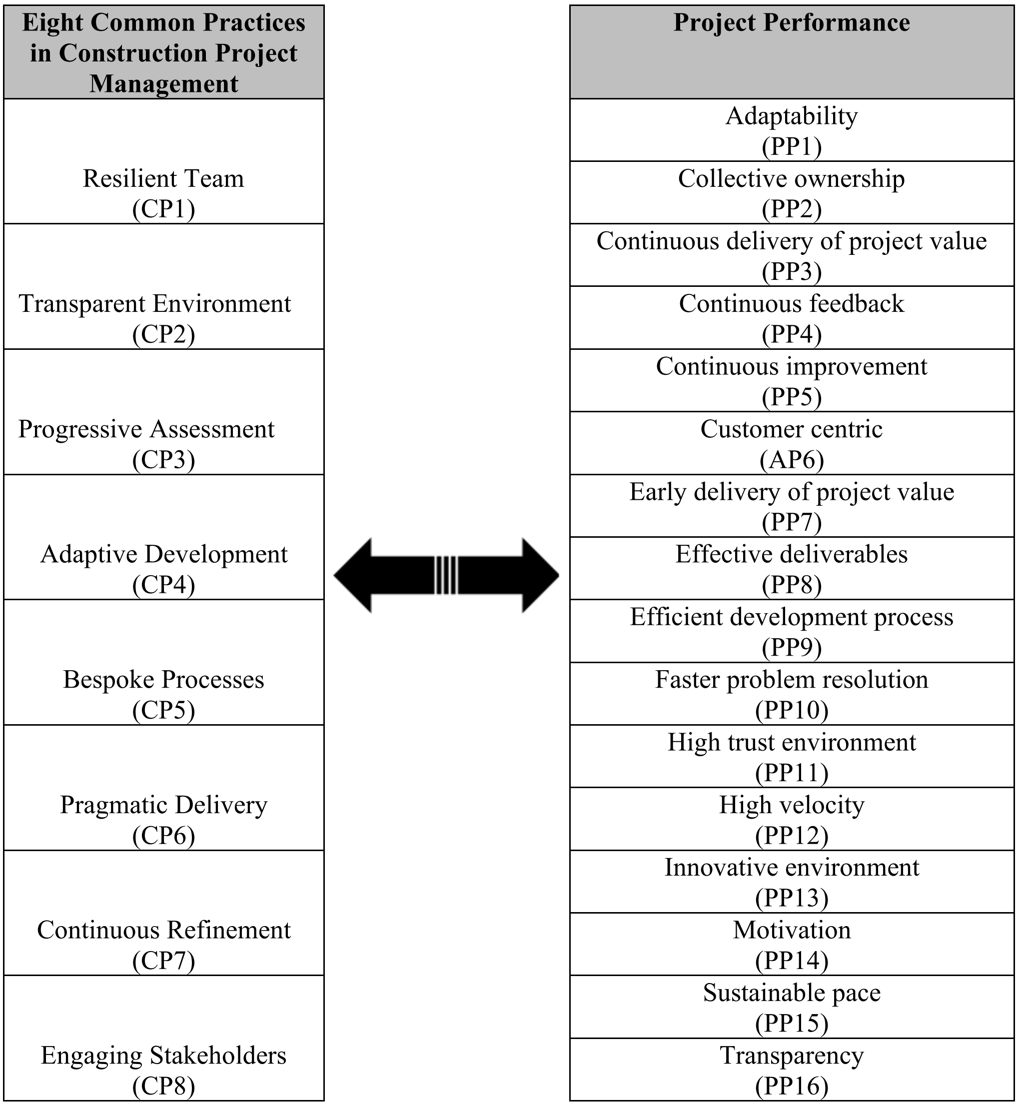


Figure 4.3: Correlation between Common Practices and Project Performances

The results indicated that there was a statistically significant correlation between CPs and PPs as displayed in Table 4.33. Therefore, the null hypothesis was rejected. A resilient team (CP1) has the strongest correlations with High trust environment (PP11) (r = .502, Sig. = .000), Motivation (PP14) (r = .491, Sig. = .000) and Sustainable pace (PP15) (r = .464, Sig. = .000). This indicates that resilience within a team significantly contributes to fostering a high-trust environment, maintaining motivation among team members, and ensuring a sustainable pace of work. A resilient team is better equipped to handle challenges, which builds trust and keeps members motivated, while also enabling them to maintain productivity over the long term.

Table 4.33: Correlation between Common Practices and Project Performance (N=252)

Project Performance		Common practices in construction project management								
		CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP
PP1	*r*	.384**	.444**	.370**	.411**	.297**	.365**	.350**	.303**	.448**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP2	*r*	.367**	.359**	.295**	.217**	.217**	.298**	.247**	.289**	.325**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP3	*r*	.384**	.464**	.380**	.384**	.267**	.273**	.282**	.360**	.432**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP4	*r*	.367**	.449**	.363**	.390**	.312**	.316**	.259**	.358**	.432**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.001	.000
PP5	*r*	.392**	.436**	.329**	.421**	.222**	.251**	.228**	.352**	.414**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP6	*r*	.309**	.393**	.290**	.346**	.251**	.345**	.326**	.325**	.388**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP7	*r*	.353**	.382**	.324**	.347**	.272**	.303**	.285**	.410**	.419**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP8	*r*	.375**	.458**	.415**	.365**	.265**	.236**	.319**	.431**	.442**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP9	*r*	.355**	.411**	.495**	.386**	.236**	.253**	.372**	.436**	.440**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP10	*r*	.336**	.452**	.362**	.381**	.302**	.318**	.288**	.313**	.426**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP11	*r*	.502**	.536**	.471**	.427**	.329**	.348**	.340**	.382**	.509**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP12	*r*	.361**	.327**	.250**	.430**	.200**	.273**	.183**	.288**	.368**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP13	*r*	.441**	.415**	.376**	.476**	.290**	.277**	.302**	.276**	.431**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP14	*r*	.491**	.480**	.368**	.496**	.334**	.306**	.282**	.330**	.485**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP15	*r*	.464**	.512**	.395**	.407**	.309**	.416**	.334**	.350**	.494**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP16	*r*	.428**	.508**	.531**	.429**	.274**	.340**	.353**	.402**	.490**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	*r*	.534**	.579**	.483**	.534**	.351**	.406**	.362**	.463**	.577**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000

Note: r = coefficient of correlation

A transparent environment (CP2) demonstrates the strongest correlations with High trust environment (PP11) (r = .536, Sig. = .000), Sustainable pace

(PP15) (r = .512, Sig. = .000), and Transparency (PP16) (r = .508, Sig. = .000). This highlights that transparency within a project significantly fosters a high-trust environment, ensures a sustainable pace of work, and reinforces overall transparency in processes and communication. When team members have access to clear and open information, it builds trust, reduces misunderstandings, and helps maintain a steady and manageable workflow.

Progressive assessment (CP3) demonstrates the strongest correlations with Transparency (PP16) (r = .531, Sig. = .000), Efficient development process (PP9) (r = .495, Sig. = .000), and High trust environment (PP11) (r = .471, Sig. = .000). This indicates that continuous and progressive assessment of project processes significantly enhances the efficiency of development, fosters transparency, and builds a high-trust environment. By regularly evaluating and refining processes, teams can identify and address inefficiencies, which leads to smoother workflows and clearer communication. This transparency, in turn, strengthens trust among team members, as everyone is kept informed and aligned with project goals.

Adaptive development (CP4) shows the strongest correlations with Motivation (PP14) (r = .496, Sig. = .000), Innovative environment (PP13) (r = .476, Sig. = .000), and High velocity (PP12) (r = .430, Sig. = .000). This suggests that adaptive development practices significantly contribute to maintaining team motivation, fostering an innovative environment, and achieving high velocity in project delivery. By being flexible and responsive to changes, teams can adapt to new challenges and opportunities, which keeps members motivated and encourages creative problem-solving. Additionally, adaptive development enables teams to work at a faster pace, ensuring that projects progress swiftly without compromising quality.

Bespoke processes (CP5) exhibit the strongest correlations with PP14 Motivation (PP14) ($r = .334$, Sig. = .000), High trust environment (PP11) ($r = .329$, Sig. = .000), and Continuous feedback (PP4) ($r = .312$, Sig. = .000). This indicates that customizing processes to fit the specific needs of a project can positively impact team motivation, foster a high-trust environment, and encourage continuous feedback. When processes are tailored to the unique requirements of a project, team members feel more engaged and valued, which boosts their motivation. Additionally, bespoke processes help build trust, as they demonstrate a commitment to addressing the team's specific challenges and goals. The emphasis on customization also promotes continuous feedback, as teams are more likely to provide input and refine processes when they feel their needs are being prioritized.

Pragmatic delivery (CP6) demonstrates the strongest correlations with Sustainable pace (PP15) ($r = .416$, Sig. = .000), Adaptability (PP1) ($r = .365$, Sig. = .000), and High trust environment (PP11) ($r = .348$, Sig. = .000). This indicates that a practical, results-oriented approach to project delivery is crucial for maintaining a sustainable pace, ensuring adaptability, and fostering a high-trust environment. By focusing on delivering tangible outcomes efficiently, pragmatic delivery helps teams avoid burnout and maintain a steady workflow, which supports long-term productivity. Additionally, this approach enhances adaptability, as teams are better equipped to respond to changes and challenges without compromising progress. Pragmatic delivery also builds trust, as consistent and reliable results reinforce confidence among team members and stakeholders.

Continuous refinement (CP7) shows the strongest correlations with Efficient development process (PP9) (r = .372, Sig. = .000), Transparency (PP16) (r = .353, Sig. = .000), and Adaptability (PP1) (r = .350, Sig. = .000). This suggests that regularly refining and improving processes is essential for enhancing the efficiency of development, maintaining transparency, and fostering adaptability within a project. By continuously evaluating and optimizing workflows, teams can identify and eliminate inefficiencies, leading to smoother and more effective operations. Transparency is also strengthened, as ongoing refinement encourages open communication and clear documentation of changes. Additionally, continuous refinement supports adaptability, enabling teams to respond quickly to new challenges or shifting project requirements.

Engaging stakeholders (CP8) demonstrates the strongest correlations with Efficient development process (PP9) (r = .436, Sig. = .000), Effective deliverables (PP8) (r = .431, Sig. = .000), and Early delivery of project value (PP7) (r = .410, Sig. = .000). This indicates that involving stakeholders throughout the project lifecycle significantly enhances the efficiency of development processes, ensures the delivery of effective and high-quality outcomes, and facilitates the early delivery of project value. By actively engaging stakeholders, teams can align their efforts with stakeholder expectations, gather valuable feedback, and make informed decisions, which streamlines development and improves the quality of deliverables. Early delivery of value is also supported, as stakeholder input helps prioritize tasks and focus on high-impact activities.

The analysis reveals that the control variable Resilient Team (CP1) has a substantial impact on several key project performance (PP) as shown in Table 4.34. Specifically, PP11 (High trust environment) shows the highest difference in variance explained at 21.757%, indicating that a resilient team significantly contributes to fostering a high-trust environment. Trust is a critical component of team cohesion and collaboration, and the strong influence of CP1 suggests that resilience within the team enhances trust levels, which in turn can lead to better communication, reduced conflicts, and improved overall project outcomes. Similarly, PP14 (Motivation) demonstrates a significant difference in variance explained at 20.480%, highlighting that a resilient team strongly influences motivation within the team. Motivation is essential for maintaining high levels of engagement and productivity, and the data suggests that resilience helps sustain team morale, even in challenging situations. Additionally, PP15 (Sustainable pace) shows a difference in variance explained of 19.187%, indicating that CP1 plays a crucial role in maintaining a sustainable pace in the project. A sustainable pace ensures that team members can work efficiently without burnout, which is vital for long-term project success. The resilient team's ability to manage stress, adapt to changes, and maintain balance contributes significantly to achieving this sustainable pace.

Table 4.34: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Resilient Team (CP1)] (N=252)

Project Performances	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP11	0.509	0.000	0.259	0.203	0.001	0.041	21.757
PP14	0.485	0.000	0.235	0.173	0.006	0.030	20.480
PP15	0.494	0.000	0.244	0.228	0.000	0.052	19.187
PP16	0.490	0.000	0.240	0.271	0.000	0.074	16.648
PP13	0.431	0.000	0.186	0.143	0.023	0.021	16.533
PP5	0.414	0.000	0.171	0.180	0.004	0.032	13.907
PP1	0.448	0.000	0.201	0.255	0.000	0.065	13.629
PP3	0.432	0.000	0.187	0.225	0.000	0.051	13.606
PP8	0.442	0.000	0.195	0.254	0.000	0.065	13.061
PP4	0.432	0.000	0.187	0.248	0.000	0.061	12.543
PP7	0.419	0.000	0.176	0.244	0.000	0.059	11.633
PP9	0.440	0.000	0.193	0.278	0.000	0.077	11.603
PP12	0.368	0.000	0.135	0.138	0.028	0.019	11.596
PP10	0.426	0.000	0.181	0.278	0.000	0.077	10.405
PP2	0.325	0.000	0.105	0.053	0.405	0.003	10.253
PP6	0.388	0.000	0.150	0.246	0.000	0.061	8.987

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the significant influence of the control variable Transparent Environment (CP2) on several critical project performance (PP) as shown in Table 4.35. PP11 (High trust environment) exhibits the highest difference in variance explained at 24.131%, indicating that a transparent environment plays a crucial role in fostering a high-trust environment. Trust is foundational for effective teamwork, collaboration, and communication, and the strong influence of CP2 suggests that transparency helps build and maintain trust among team members. Similarly, PP15 (Sustainable pace) shows a substantial difference in variance explained at 22.408%, suggesting that a transparent environment strongly contributes to maintaining a sustainable pace in the project. A sustainable pace is essential for ensuring that team members can work efficiently without experiencing burnout, which is particularly important in agile project management where continuous delivery and adaptability are required. Transparency helps teams manage workloads effectively, set realistic expectations, and avoid overcommitment, all of which contribute to a sustainable and healthy work rhythm. Additionally, PP16 (Transparency) demonstrates a notable difference in variance explained at 22.093%, reinforcing that CP2 has a significant impact on transparency within the team. Transparency ensures that all team members have access to the same information, which promotes alignment, reduces misunderstandings, and fosters a culture of openness.

Table 4.35: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Transparent Environment (CP2)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP11	0.509	0.000	0.259	0.133	0.036	0.018	24.131
PP15	0.494	0.000	0.244	0.141	0.025	0.020	22.408
PP16	0.490	0.000	0.240	0.138	0.029	0.019	22.093
PP14	0.485	0.000	0.235	0.173	0.006	0.030	20.469
PP8	0.442	0.000	0.195	0.121	0.055	0.015	18.061
PP3	0.432	0.000	0.187	0.092	0.144	0.009	17.826
PP1	0.448	0.000	0.201	0.158	0.012	0.025	17.611
PP4	0.432	0.000	0.187	0.117	0.065	0.014	17.321
PP10	0.426	0.000	0.181	0.098	0.120	0.010	17.176
PP5	0.414	0.000	0.171	0.101	0.110	0.010	16.122
PP13	0.431	0.000	0.186	0.169	0.007	0.029	15.728
PP9	0.440	0.000	0.193	0.193	0.002	0.037	15.609
PP7	0.419	0.000	0.176	0.198	0.002	0.039	13.656
PP6	0.388	0.000	0.150	0.118	0.062	0.014	13.653
PP2	0.325	0.000	0.105	0.048	0.452	0.002	10.305
PP12	0.368	0.000	0.135	0.181	0.004	0.033	10.232

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis underscores the significant influence of the control variable Progressive Assessment (CP3) on several key project performance (PP) as indicated in Table 4.36. PP16 (Transparency) exhibits the highest difference in variance explained at 22.244%, indicating that progressive assessment has a substantial impact on fostering transparency within the team. Transparency is critical for ensuring that all team members have access to the same information, which promotes alignment, reduces misunderstandings, and supports informed decision-making. Progressive assessment, which involves continuous evaluation and feedback, helps maintain openness and clarity throughout the project lifecycle, ensuring that everyone is on the same page and working toward common goals. Similarly, PP11 (High trust environment) shows a significant difference in variance explained at 19.545%, suggesting that progressive assessment strongly contributes to creating a high-trust environment. Trust is a cornerstone of effective teamwork, and the data indicates that regular assessments and feedback mechanisms help build and sustain trust among team members. Additionally, PP9 (Efficient development process) demonstrates a notable difference in variance explained at 18.569%, highlighting that progressive assessment has a significant impact on the efficiency of the development process. Efficiency is crucial for delivering projects on time and within budget, and the data suggests that continuous assessment helps identify bottlenecks, streamline workflows, and optimize resource allocation.

Table 4.36: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Progressive Assessment (CP3)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP16	0.490	0.000	0.240	0.133	0.036	0.018	22.244
PP11	0.509	0.000	0.259	0.252	0.000	0.063	19.545
PP9	0.440	0.000	0.193	0.088	0.164	0.008	18.569
PP8	0.442	0.000	0.195	0.203	0.001	0.041	15.404
PP15	0.494	0.000	0.244	0.323	0.000	0.105	13.955
PP3	0.432	0.000	0.187	0.233	0.000	0.054	13.269
PP13	0.431	0.000	0.186	0.235	0.000	0.055	13.072
PP1	0.448	0.000	0.201	0.274	0.000	0.075	12.576
PP4	0.432	0.000	0.187	0.254	0.000	0.064	12.229
PP10	0.426	0.000	0.181	0.245	0.000	0.060	12.158
PP14	0.485	0.000	0.235	0.340	0.000	0.116	11.904
PP5	0.414	0.000	0.171	0.266	0.000	0.071	10.089
PP7	0.419	0.000	0.176	0.282	0.000	0.079	9.635
PP2	0.325	0.000	0.105	0.155	0.014	0.024	8.117
PP6	0.388	0.000	0.150	0.271	0.000	0.074	7.696
PP12	0.368	0.000	0.135	0.287	0.000	0.082	5.267

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the significant influence of the control variable Adaptive Development (CP4) on several critical project performance (PP) as indicated in Table 4.37. PP14 (Motivation) exhibits the highest difference in variance explained at 19.845%, indicating that adaptive development has a substantial impact on fostering motivation within the team. Motivation is essential for maintaining high levels of engagement, productivity, and commitment among team members, and the data suggests that adaptive development practices, which emphasize flexibility and responsiveness to change, play a key role in keeping teams motivated. Similarly, PP13 (Innovative environment) shows a significant difference in variance explained at 17.129%, suggesting that adaptive development strongly contributes to creating an innovative environment. Innovation is crucial for staying competitive and delivering value in agile projects, and the data indicates that adaptive development practices encourage creativity and experimentation. Additionally, PP16 (Transparency) demonstrates a notable difference in variance explained at 16.224%, highlighting that adaptive development has a significant impact on transparency within the team. Transparency is vital for ensuring that all team members have access to the same information, which promotes alignment, reduces misunderstandings, and supports informed decision-making. Adaptive development practices, which often involve regular communication and iterative feedback, help maintain openness and clarity throughout the project lifecycle, ensuring that everyone is on the same page and working toward common goals.

Table 4.37: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Adaptive Development (CP4)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP14	0.485	0.000	0.235	0.191	0.002	0.036	19.845
PP13	0.431	0.000	0.186	0.121	0.056	0.015	17.129
PP16	0.490	0.000	0.240	0.279	0.000	0.078	16.224
PP11	0.509	0.000	0.259	0.314	0.000	0.099	16.037
PP1	0.448	0.000	0.201	0.230	0.000	0.053	14.816
PP15	0.494	0.000	0.244	0.311	0.000	0.097	14.709
PP5	0.414	0.000	0.171	0.160	0.011	0.026	14.584
PP4	0.432	0.000	0.187	0.227	0.000	0.052	13.514
PP9	0.440	0.000	0.193	0.245	0.000	0.060	13.363
PP3	0.432	0.000	0.187	0.234	0.000	0.055	13.222
PP12	0.368	0.000	0.135	0.069	0.277	0.005	13.040
PP10	0.426	0.000	0.181	0.226	0.000	0.051	13.018
PP8	0.442	0.000	0.195	0.271	0.000	0.074	12.159
PP7	0.419	0.000	0.176	0.255	0.000	0.065	11.081
PP6	0.388	0.000	0.150	0.205	0.001	0.042	10.852
PP2	0.325	0.000	0.105	0.251	0.000	0.063	4.225

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis reveals that the control variable Bespoke Processes (CP5) has a moderate influence on several key project performance (PP) as presented in Table 4.38. PP14 (Motivation) shows a difference in variance explained of 9.131%, suggesting that bespoke processes moderately influence motivation within the team. Motivation is crucial for maintaining team engagement and productivity, and the data indicates that tailored processes, which are designed to fit the specific needs of the team, can help create a more supportive and empowering work environment. Similarly, PP4 (Continuous feedback) demonstrates a difference in variance explained of 8.650%, indicating that bespoke processes moderately affect continuous feedback. Continuous feedback is essential for agile project management, as it allows teams to make timely adjustments and improvements. The data suggests that bespoke processes, which are customized to the team's workflow, facilitate more effective and regular feedback loops. Additionally, PP10 (Faster problem resolution) shows a difference in variance explained of 7.966%, suggesting that bespoke processes moderately influence problem resolution speed. Faster problem resolution is critical for maintaining project momentum and minimizing disruptions. The data indicates that bespoke processes, which are tailored to the team's specific challenges and strengths, enable quicker identification and resolution of issues.

Table 4.38: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Bespoke Processes (CP5)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP14	0.485	0.000	0.235	0.379	0.000	0.143	9.131
PP4	0.432	0.000	0.187	0.317	0.000	0.100	8.650
PP10	0.426	0.000	0.181	0.319	0.000	0.102	7.966
PP11	0.509	0.000	0.259	0.425	0.000	0.181	7.820
PP1	0.448	0.000	0.201	0.361	0.000	0.130	7.070
PP13	0.431	0.000	0.186	0.341	0.000	0.117	6.937
PP15	0.494	0.000	0.244	0.423	0.000	0.179	6.491
PP7	0.419	0.000	0.176	0.342	0.000	0.117	5.872
PP6	0.388	0.000	0.150	0.316	0.000	0.100	5.063
PP3	0.432	0.000	0.187	0.369	0.000	0.136	5.053
PP8	0.442	0.000	0.195	0.388	0.000	0.150	4.478
PP2	0.325	0.000	0.105	0.253	0.000	0.064	4.138
PP16	0.490	0.000	0.240	0.456	0.000	0.208	3.173
PP9	0.440	0.000	0.193	0.418	0.000	0.174	1.905
PP5	0.414	0.000	0.171	0.393	0.000	0.154	1.726
PP12	0.368	0.000	0.135	0.344	0.000	0.118	1.704

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the significant influence of the control variable Pragmatic Delivery (CP6) on several critical project performance (PP) as presented in Table 4.39. PP15 (Sustainable pace) exhibits the highest difference in variance explained at 14.674%, indicating that pragmatic delivery has a substantial impact on maintaining a sustainable pace in the project. A sustainable pace is essential for ensuring that team members can work efficiently without experiencing burnout, which is particularly important in agile project management where continuous delivery and adaptability are required. Pragmatic delivery, which focuses on practical and realistic approaches to project execution, helps teams manage workloads effectively, set achievable goals, and avoid overcommitment. Similarly, PP1 (Adaptability) shows a significant difference in variance explained at 11.740%, suggesting that pragmatic delivery strongly influences adaptability. Adaptability is crucial for agile teams, as it allows them to respond quickly to changes and uncertainties. The data indicates that pragmatic delivery practices, which emphasize flexibility and practical problem-solving, enable teams to adjust their strategies and workflows as needed. Additionally, PP6 (Customer centric) demonstrates a moderate difference in variance explained at 10.301%, indicating that pragmatic delivery has a notable impact on customer-centric practices. Being customer-centric is vital for ensuring that the project delivers value to its stakeholders and meets their needs. The data suggests that pragmatic delivery, with its focus on practical and results-oriented approaches, helps teams stay aligned with customer requirements and expectations.

Table 4.39: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Pragmatic Delivery (CP6)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP15	0.494	0.000	0.244	0.312	0.000	0.097	14.674
PP1	0.448	0.000	0.201	0.289	0.000	0.084	11.740
PP6	0.388	0.000	0.150	0.218	0.001	0.047	10.301
PP11	0.509	0.000	0.259	0.396	0.000	0.157	10.196
PP16	0.490	0.000	0.240	0.375	0.000	0.141	9.936
PP10	0.426	0.000	0.181	0.300	0.000	0.090	9.153
PP4	0.432	0.000	0.187	0.312	0.000	0.097	8.966
PP7	0.419	0.000	0.176	0.305	0.000	0.093	8.289
PP2	0.325	0.000	0.105	0.170	0.007	0.029	7.657
PP14	0.485	0.000	0.235	0.398	0.000	0.158	7.638
PP12	0.368	0.000	0.135	0.257	0.000	0.066	6.916
PP13	0.431	0.000	0.186	0.346	0.000	0.120	6.602
PP3	0.432	0.000	0.187	0.351	0.000	0.123	6.338
PP5	0.414	0.000	0.171	0.346	0.000	0.119	5.202
PP9	0.440	0.000	0.193	0.380	0.000	0.145	4.881
PP8	0.442	0.000	0.195	0.399	0.000	0.159	3.608

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis underscores the significant influence of the control variable Continuous Refinement (CP7) on several key project performance (PP) as exhibited in Table 4.40. PP9 (Efficient development process) exhibits the highest difference in variance explained at 12.037%, indicating that continuous refinement has a substantial impact on the efficiency of the development process. Efficiency is critical for delivering projects on time and within budget, and the data suggests that continuous refinement practices, which involve regular evaluation and improvement of processes, help streamline workflows, eliminate bottlenecks, and optimize resource allocation. Similarly, PP1 (Adaptability) shows a significant difference in variance explained at 10.838%, suggesting that continuous refinement strongly influences adaptability. Adaptability is essential for agile teams, as it allows them to respond quickly to changes and uncertainties. The data indicates that continuous refinement practices, which emphasize iterative improvements and flexibility, enable teams to adjust their strategies and workflows as needed. Additionally, PP16 (Transparency) demonstrates a notable difference in variance explained at 10.795%, highlighting that continuous refinement has a significant impact on transparency within the team. Transparency is vital for ensuring that all team members have access to the same information, which promotes alignment, reduces misunderstandings, and supports informed decision-making. Continuous refinement practices, which often involve regular communication and iterative feedback, help maintain openness and clarity throughout the project lifecycle.

Table 4.40: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Continuous Refinement (CP7)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP9	0.440	0.000	0.193	0.270	0.000	0.073	12.037
PP1	0.448	0.000	0.201	0.304	0.000	0.093	10.838
PP16	0.490	0.000	0.240	0.363	0.000	0.132	10.795
PP11	0.509	0.000	0.259	0.403	0.000	0.163	9.615
PP6	0.388	0.000	0.150	0.236	0.000	0.056	9.466
PP15	0.494	0.000	0.244	0.387	0.000	0.150	9.456
PP8	0.442	0.000	0.195	0.323	0.000	0.104	9.124
PP13	0.431	0.000	0.186	0.322	0.000	0.104	8.195
PP10	0.426	0.000	0.181	0.328	0.000	0.108	7.359
PP7	0.419	0.000	0.176	0.321	0.000	0.103	7.298
PP3	0.432	0.000	0.187	0.342	0.000	0.117	6.957
PP14	0.485	0.000	0.235	0.419	0.000	0.175	5.931
PP2	0.325	0.000	0.105	0.219	0.000	0.048	5.737
PP4	0.432	0.000	0.187	0.364	0.000	0.132	5.431
PP5	0.414	0.000	0.171	0.365	0.000	0.134	3.790
PP12	0.368	0.000	0.135	0.341	0.000	0.116	1.894

Note: r = coefficient of correlation, r^2 = coefficient of determination

The analysis highlights the significant influence of the control variable Engaging Stakeholders (CP8) on several critical project performance (PP) as displayed in Table 4.41. PP9 (Efficient development process) exhibits the highest difference in variance explained at 14.641%, indicating that engaging stakeholders has a substantial impact on the efficiency of the development process. Efficiency is crucial for delivering projects on time and within budget, and the data suggests that involving stakeholders in the development process helps streamline workflows, align priorities, and optimize resource allocation. Similarly, PP8 (Effective deliverables) shows a significant difference in variance explained at 14.488%, suggesting that engaging stakeholders strongly influences the effectiveness of deliverables. Effective deliverables are those that meet or exceed stakeholder expectations and provide real value to the project.

The data indicates that stakeholder engagement ensures that deliverables are aligned with stakeholder needs and requirements, reducing the risk of misalignment or rework. Additionally, PP16 (Transparency) demonstrates a notable difference in variance explained at 13.613%, highlighting that engaging stakeholder has a significant impact on transparency within the team. Transparency is essential for ensuring that all team members and stakeholders have access to the same information, which promotes alignment, reduces misunderstandings, and supports informed decision-making. Engaging stakeholders fosters open communication and collaboration, ensuring that everyone is on the same page and working toward common goals.

Table 4.41: Bivariate and Partial Correlation between Common Practices and Project Performance [Control Variables: Engaging Stakeholders (CP8)] (N=252)

Project Performance	Common practices in construction project management						Diff (%)
	Spearman's correlations			Partial correlations			
	r	Sig.	r^2	*r*	Sig.	r^2	
PP9	0.440	0.000	0.193	0.217	0.001	0.047	14.641
PP8	0.442	0.000	0.195	0.224	0.000	0.050	14.488
PP16	0.490	0.000	0.240	0.322	0.000	0.104	13.613
PP7	0.419	0.000	0.176	0.210	0.001	0.044	13.186
PP11	0.509	0.000	0.259	0.368	0.000	0.135	12.353
PP3	0.432	0.000	0.187	0.274	0.000	0.075	11.177
PP4	0.432	0.000	0.187	0.276	0.000	0.076	11.056
PP5	0.414	0.000	0.171	0.254	0.000	0.065	10.670
PP15	0.494	0.000	0.244	0.373	0.000	0.139	10.525
PP14	0.485	0.000	0.235	0.376	0.000	0.141	9.341
PP6	0.388	0.000	0.150	0.241	0.000	0.058	9.245
PP10	0.426	0.000	0.181	0.306	0.000	0.094	8.755
PP1	0.448	0.000	0.201	0.347	0.000	0.120	8.067
PP12	0.368	0.000	0.135	0.245	0.000	0.060	7.526
PP2	0.325	0.000	0.105	0.182	0.004	0.033	7.223
PP13	0.431	0.000	0.186	0.345	0.000	0.119	6.666

Note: r = coefficient of correlation, r^2 = coefficient of determination

4.4.4 Hypothesis Test No.4: The Differences in Common Practices between Respondents with Different Demographic Characteristics

Null hypothesis (H4o): There is no significant difference in common practices, CPn between respondents with different demographic characteristics, DCu

Alternative hypothesis (H4a): There is significant difference in common practices, CPn between respondents with different demographic characteristics, DCu

Kruskal-Wallis test and Dunn-Bonferroni test (Pairwise Comparison) were run for hypothesis test no.4 to determine the influence of the respondents' demographic characteristics on the application of common practices. There are numbers of significant differences among the demographic characteristics of construction practitioners for common practices inclination to Agile project management in Malaysia. Therefore, the null hypothesis was rejected.

The Kruskal-Wallis (KW) test was conducted to assess whether different professions significantly influence common practices in construction project management (CPM). The pairwise comparisons further explore differences between professions where significance was found. Below is an analysis of the significant results for each common practice based on the result as shown in Table 4.42.

Table 4.42: Inferential Statistics on Common Practices Grouped by Profession (N=252)

Profession								
	Mean Rank				Pairwise Comparison			
Common Practices	Architecture (N=57)	Engineering (N=55)	Quantity Surveying (N=90)	Project Management (N=50)	Adj. Sig,	Z Value	Effect Size	KW Asymp. Sig.
CP1	103.70	-	140.93	-	0.012	-3.097	-0.255	0.013
CP2	112.79	110.90	141.03	121.97	-	-	-	0.040
CP3	-	103.59	140.92	-	0.016	-3.002	-0.249	0.022
CP6	130.21	110.10	117.08	146.05	-	-	-	0.038
CP8	-	96.39	140.56	-	0.001	-3.664	-0.304	0.004

The analysis of Resilient Team (CP1) revealed a significant difference among professions, indicating that the approach to building resilient teams varies across disciplines. The Kruskal-Wallis test (Sig. = 0.013) confirmed that this difference is statistically significant, suggesting that profession plays a role in shaping perceptions of team resilience. The pairwise comparison showed that professionals in Quantity Surveying (MR = 140.93) placed significantly higher importance on resilience within teams compared to those in Architecture (MR = 103.70). Additionally, the effect size (d = -0.255) indicates a small to moderate impact, meaning that while the difference is present, it is not overwhelmingly large but still meaningful in a construction project management context.

The analysis of Transparent Environment (CP2) revealed differences in how professions prioritize transparency in construction project management. Quantity Surveying (MR = 141.03) ranked the highest, indicating a stronger emphasis on maintaining a transparent environment compared to Project Management (MR = 121.97), Architecture (MR = 112.79), and Engineering (MR = 110.90). The Kruskal-Wallis test (Sig. = 0.040) confirmed that this difference is statistically significant, suggesting that the level of transparency in professional practices is influenced by one's field of expertise.

The analysis of Progressive Assessment (CP3) indicates that different professions place varying levels of importance on systematic and continuous evaluation in construction project management. The Kruskal-Wallis test (Sig. = 0.022) confirmed that this difference is statistically significant, suggesting that the profession influences how progressive assessment is prioritized. The pairwise comparison revealed that Quantity Surveying (MR = 140.92) ranked significantly higher than Engineering (MR = 103.59) in valuing progressive assessment. Additionally, the effect size (d = -0.249) indicates a small to moderate impact, meaning that while the difference is notable, it is not overwhelmingly large but still relevant in shaping professional practices.

The analysis of CP6 (Pragmatic Delivery) highlights variations in how different professions approach practical and efficient execution in construction project management. Project Management (MR = 146.05) ranked the highest, suggesting that professionals in this field place the greatest emphasis on pragmatic delivery. Architecture (MR = 130.21) followed, while Quantity Surveying (MR = 117.08) and Engineering (MR = 110.10) ranked lower in comparison. The Kruskal-Wallis test (Sig. = 0.038) confirmed that these differences are statistically significant, indicating that the profession plays a role in shaping attitudes toward pragmatic and results-oriented project execution.

The analysis of CP8 (Engaging Stakeholders) indicates significant differences in how professions prioritize stakeholder involvement in construction project management. The Kruskal-Wallis test (Sig. = 0.004) confirmed that this difference is highly statistically significant, suggesting that professional background strongly influences the perception of stakeholder engagement. The pairwise comparison revealed that Quantity Surveying (MR = 140.56) placed significantly greater emphasis on engaging stakeholders compared to Engineering (MR = 96.39). Additionally, the effect size (d = -0.304) indicates a moderate impact, meaning that the variation between professions is meaningful and could influence project outcomes. The Quantity Surveying profession demonstrates higher mean ranks across most statistically significant differences in common practices. As shown in Table 4.3, Quantity Surveying practitioners are predominantly younger and non-managerial, with notable involvement in residential and infrastructure projects, and are largely contractor-based and employed within small- and medium-sized organisations.

Based on the results of the Kruskal-Wallis Test and Pairwise Comparison as shown in Table 4.43, the influence of industry experience on common practices in construction project management can be analysed as follows.

Table 4.43: Inferential Statistics on Common Practices Grouped by Industry Experience (N=252)

Industry Experience								
	Mean Rank				Pairwise Comparison			KW
Common Practices	<2 yrs (N=53)	2-5 yrs (N=53)	6-10 yrs (N=55)	>10 yrs (N=91)	Adj. Sig,	Z Value	Effect Size	Asymp. Sig.
CP1	149.61	-	-	104.03	0.002	3.655	0.305	0.001
CP1	-	137.77	-	104.33	0.041	2.706	0.226	0.001
CP2	149.33	-	-	106.29	0.003	3.446	0.287	0.004
CP3	153.24	-	-	103.97	0.000	3.953	0.329	<0.001
CP3	-	146.08	-	103.97	0.004	3.379	0.282	<0.001

For Resilient Team (CP1), significant differences were observed based on industry experience. Practitioners with less than 2 years of experience had a mean rank of 149.61, which was significantly higher than those with more than

10 years of experience (MR = 104.03). Similarly, individuals with 2-5 years of experience had a mean rank of 137.77, also notably higher than those with more than 10 years (MR = 104.33). These findings suggest that less experienced practitioners tend to place a greater emphasis on building resilient teams compared to their more seasoned practitioners, and it indicates a small to moderate impact as the effect size are 0.226 and 0.305 respectively.

For Transparent Environment (CP2), significant differences were observed between practitioners with varying industry experience. Those with less than 2 years of experience had a mean rank of 149.33, which was significantly higher than the mean rank of 106.29 recorded for practitioners with more than 10 years of experience. This suggests that newer practitioners place a stronger emphasis on transparency compared to their more experienced practitioners, and it indicates a small to moderate impact as the effect size is 0.287.

For Progressive Assessment (CP3), significant differences were found based on industry experience. Practitioners with less than 2 years of experience had a mean rank of 153.24, which was significantly higher than the mean rank of 103.97 recorded for those with more than 10 years of experience. Similarly, practitioners with 2-5 years of experience had a mean rank of 146.08, also notably higher than the mean rank of 103.97 observed for the most experienced practitioners. These findings indicate that less experienced practitioners place a greater emphasis on progressive assessment compared to their more seasoned practitioners, and it indicates a moderate impact as the effect size are 0.282 and 0.329 respectively.

The Kruskal-Wallis test and pairwise comparisons were conducted to examine how designation namely Senior Manager and above, Manager, and Executive influences common practices in construction project management. Below is an analysis based on the provided test results as shown in Table 4.44.

Table 4.44: Inferential Statistics on Common Practices Grouped by Designation (N=252)

Designation							
	Mean Rank			Pairwise Comparison			
Common Practices	Senior Manager & Above (N=69)	Manager (N=65)	Executive (N=118)	Adj. Sig,	Z Value	Effect Size	KW Asymp. Sig.
CP1	114.23	-	145.54	0.013	-2.862	-0.209	<0.001
CP1	-	104.96	145.54	0.001	-3.640	-0.269	<0.001
CP2	112.80	-	146.86	0.006	-3.109	-0.227	<0.001
CP2	-	104.08	146.86	0.000	-3.831	-0.283	<0.001
CP3	110.96	-	148,93	0.002	-3.474	-0.254	<0.001
CP3	-	102.28	148.93	0.000	-4.187	-0.310	<0.001
CP4	-	103.78	140.92	0.002	-3.389	-0.251	0.003
CP5	119.46	112.58	138.28	-	-	-	0.044
CP7	-	107.65	135.86	0.031	-2.569	-0.190	0.036
CP8	-	109.75	137.86	0.028	-2.604	-0.192	0.030

The analysis of Resilient Team (CP1) revealed significant differences across designations ($p < 0.001$), indicating that job role influences perceptions of team resilience. Non-Managers rated CP1 significantly higher (MR = 145.54) compared to Senior Managers and above (MR = 114.23) and Managers (MR = 104.96). The effect sizes, ranging from -0.209 to -0.269, suggest a small to moderate impact of designation on this practice. This implies that Non-Managers perceive team resilience as more integral to their work compared to those in higher positions.

The analysis of Transparent Environment (CP2) indicated significant differences across designations ($p < 0.001$), demonstrating that job role influences perceptions of transparency in construction project management. Non-Managers rated CP2 the highest (MR = 146.86), followed by Senior Managers and above (MR = 112.80) and Managers (MR = 104.08). The small to moderate effect size (d = -0.227 to -0.283) suggests that designation plays a meaningful role in shaping these perceptions. This finding implies that transparency may be more valued at lower levels.

The analysis of Progressive Assessment (CP3) revealed significant differences across designations ($p < 0.001$), indicating that perceptions of ongoing evaluations vary by job role. Non-Managers rated CP3 the highest (MR = 148.93), followed by Senior Managers and above (MR = 110.96) and Managers (MR = 102.28). The effect sizes (d = -0.254 to -0.310) suggest a moderate influence of designation on this practice. This finding implies that those in lower positions consider progressive assessments more critical to their roles compared to those in management.

The analysis of Adaptive Development (CP4) showed significant differences across designations ($p = 0.003$), highlighting variations in how different roles perceive adaptability in construction project management. Non-Managers rated CP4 significantly higher (MR = 140.92) compared to Managers

(Mr = 103.78), with a moderate effect size (d = -0.251) indicating a meaningful impact of designation. This suggests that adaptive development is considered more important at operational levels compare to managerial roles.

The analysis of Continuous Refinement (CP7) revealed significant differences across designations (p = 0.036), indicating that perceptions of ongoing improvements vary by job role. Non-Managers rated CP7 higher (MR = 135.86) compared to Managers (MR = 107.65), with a small effect size (d = -0.190) suggesting a relatively weaker impact of designation compared to CP1-CP4. This finding implies that those at lower levels view continuous refinement as a necessary process, likely due to their hands-on involvement in project execution.

The analysis of Engaging Stakeholders (CP8) showed significant differences across designations (p = 0.030), indicating that perceptions of stakeholder involvement vary based on job role. Non-Managers rated CP8 higher (MR = 137.86) compared to Managers (MR = 109.75), with a small effect size (d = -0.192) suggesting a modest impact of designation. This implies that stakeholder engagement is more of a day-to-day concern for operational staff, who frequently interact with clients, suppliers, and other project participants.

Based on the results of the Kruskal-Wallis Test and Pairwise Comparison as shown in Table 4.45, the influence of business nature on common practices in construction project management can be analysed as follows.

Table 4.45: Inferential Statistics on Common Practices Grouped by Nature of Business (N=252)

Nature of Business								
	Mean Rank				Pairwise Comparison			KW
Common Practices	Contractor (N=111)	Supplier (N=34)	Consultant (N=56)	Developer (N=51)	Adj. Sig,	Z Value	Effect Size	Asymp. Sig.
CP1	138.37	85.70	-	-	0.002	3.605	0.299	0.003
CP2	132.28	86.70	-	-	0.011	3.113	0.259	0.017
CP2	-	86.70	-	130.61	0.044	2.682	-0.289	0.017
CP3	153.45	87.52	-	-	0.006	3.282	0.273	0.009
CP7	-	-	105.69	144.21	0.027	-2.846	-0.275	0.017

Contractors demonstrated a significantly higher adherence to the Resilient Team (CP1) practice, with a mean rank of 138.37, compared to Suppliers, who had a considerably lower mean rank of 85.70. This suggests that contractors prioritize building and maintaining resilient teams more than suppliers do. The statistical analysis further supports this difference, as the Kruskal-Wallis test confirmed a significant variation across business types ($p = 0.003$). Additionally, the effect size of 0.299 indicates a practical significance, reinforcing the impact of business nature on the adoption of this practice.

The Transparent Environment (CP2) practice was more commonly adopted by Contractors (MR = 132.28) and Developers (MR = 130.61) compared to Suppliers (MR = 86.70). This indicates that both contractors and developers place a greater emphasis on maintaining openness and clarity in their project environments, whereas suppliers exhibit significantly lower adoption of this practice. The pairwise comparisons confirmed statistically significant differences between Contractors & Suppliers ($p = 0.011$), and Developers & Suppliers ($p = 0.044$), with effect sizes of 0.259 and -0.289, respectively. These findings suggest that the nature of business plays a crucial role in shaping transparency within construction project management.

The Progressive Assessment (CP3) practice was significantly more prevalent among Contractors (MR = 153.45) compared to Suppliers (MR = 87.52). This suggests that contractors place a stronger emphasis on continuous evaluation and improvement throughout the project lifecycle, whereas suppliers adopt this approach to a much lesser extent. The statistical significance (p = 0.006) confirms that this difference is unlikely to be due to chance, and the effect size of 0.273 indicates a practical impact. These findings highlight the varying degrees of commitment to ongoing assessment based on the nature of business in construction project management.

The Continuous Refinement (CP7) practice showed a significant difference in adoption between Consultants (MR = 105.69) and Developers (MR = 144.21). This suggests that developers place a greater emphasis on continuously improving and optimizing processes compared to consultants. The statistical analysis confirmed this difference, with a p-value of 0.027, indicating a significant variation between these two business types. Additionally, the effect size of -0.275 reflects a practical impact, emphasizing the role of business nature in shaping the approach to ongoing refinement in construction project management.

The results of the Kruskal-Wallis test indicate that the type of project has a significant influence on the emphasis placed on building a resilient team (CP1), with a p-value of 0.014 as shown in Table 4.46. Among the different project types, Infrastructure projects ranked the highest (MR = 145.86), followed by Residential (MR = 129.95), Commercial (MR = 129.54), and Industrial (MR =

105.11), while Renovation projects had the lowest mean rank of 95.16. This suggests that infrastructure projects prioritize resilience in teams more than other project types, whereas renovation projects place the least emphasis on this practice.

Table 4.46: Inferential Statistics on Common Practices Grouped by Type of Project (N=252)

Type of Project									
	Mean Rank					Pairwise Comparison			
Common Practices	Commer-cial (N=67)	Indus-trial (N=31)	Infra-structure (N=48)	Resi-dential (N=73)	Reno-vation (N=33)	Adj. Sig,	Z Value	Effect Size	KW Asymp. Sig.
CP1	129.54	105.11	145.86	129.95	95.16	-	-	-	0.014

The Kruskal-Wallis (KW) test was conducted to compare different employee size groups for less than 30, between 30-75, more than 75 across various common practices, CP1 to CP8. Among all the common practices, Transparent Environment (CP2) was the only one that showed a statistically significant difference, with a p-value of 0.038 as shown in Table 4.47.

Table 4.47: Inferential Statistics on Common Practices Grouped by Total Employees (N=252)

Total Employees							
	Mean Rank			Pairwise Comparison			KW
Common Practices	<30 (N=72)	30 – 75 (N=66)	>75 (N=114)	Adj. Sig,	Z Value	Effect Size	Asymp. Sig.
CP2	144.90	118.27	119.64	-	-	-	0.038

For CP2, companies with fewer than 30 employees had the highest mean rank of 144.90, suggesting a stronger emphasis on transparency. In contrast, companies with 30-75 employees had a lower mean rank of 118.27, while those with more than 75 employees had a similar mean rank of 119.64 to mid-sized companies. This indicates that smaller companies tend to have a more transparent environment compared to medium and large companies. As company size increases, transparency might decline, potentially due to the presence of hierarchical structures and bureaucratic processes that can limit open communication and decision-making.

4.5 Cluster Analysis

A cluster analysis was performed to classify Malaysian construction practitioners based on their adoption of agile-oriented common practices (CP1–CP8) derived from Exploratory Factor Analysis (EFA). Following the recommendation of Hair et al. (2019), hierarchical cluster analysis was first conducted to explore the data structure and determine the optimal number of clusters (k) by inspecting the agglomeration coefficients. Subsequently, K-Means cluster analysis was performed using the identified k value to refine the cluster memberships through iterative centroid optimization. This two-stage approach enhances the stability and interpretability of the final cluster solution.

4.5.1 Hierarchical Clustering for Initial Cluster Identification

In the first step, a hierarchical cluster analysis using Ward's linkage method was conducted to explore the underlying structure of the data. Ward's method minimizes within-cluster variance, thereby producing compact and homogeneous clusters. The Agglomeration Schedule with Ward Linkage (Appendix E) was examined to determine the optimal number of clusters. A distinct increase in the agglomeration coefficient was observed between Stages 250 and 251 (from 1256.89 to 2008.00), signifying that merging beyond this point would combine highly dissimilar groups. The stage prior to this jump therefore indicated a two-cluster solution.

4.5.2 K-Means Clustering for Final Cluster Allocation

In the second step, the K-Means cluster analysis was conducted using the standardized (Z-score) values of eight common practices (CP1–CP8) and k = 2 as suggested by the hierarchical results to refine the membership of each case. K-Means re-allocates cases iteratively to minimize within-group variance and maximize between-group separation. Table 4.48 presents the Initial Cluster Centres, showing the preliminary mean standardized scores for each variable before iteration. Cluster 1 displayed high positive Z-scores (1.33 to 1.89) across all eight common practices, whereas Cluster 2 showed strong negative Z-scores (–3.00 to –4.43). This early polarity suggested the formation of two clearly contrasting groups: Cluster 1 - respondents demonstrating higher adoption of agile-oriented common practice, and Cluster 2 - respondents with relatively low adoption.

Table 4.48: Initial Cluster Centres (N=252)

Common Practices	Z-score	
	Cluster 1	Cluster 2
CP1	1.45391	-3.86609
CP2	1.33845	-3.57013
CP3	1.79640	-4.11948
CP4	1.69052	-4.43364
CP5	1.89625	-3.00842
CP6	1.71270	-3.48730
CP7	1.57600	-3.20896
CP8	1.80830	-4.07504

The Iteration History (Table 4.49) records the magnitude of change in cluster centres across successive iterations. Convergence was achieved after six iterations, where the maximum coordinate change became 0.000, confirming stability of the two-cluster solution. The minimum distance between initial centres (15.281) indicates strong separation between the two groups. This iterative refinement ensures that each respondent is assigned to the most representative cluster.

Table 4.49: Iteration History (N=252)

Iteration	Change in Cluster Centres	
	Cluster 1	Cluster 2
1	4.199	5.383
2	.074	.506
3	.071	.406
4	.053	.290
5	.014	.077
6	.000	.000

The Cluster Membership Table (Appendix F) lists each respondent's assigned cluster and their distance from the respective cluster centre. Distances ranged mostly between 0.5 and 3.0, indicating strong within-cluster cohesion and no evident outliers. Each case was allocated based on proximity to the nearest centroid using Euclidean distance, ensuring internal homogeneity within clusters.

Table 4.50 shows the Final Cluster Centres, representing the stabilized Z-score means after convergence. Cluster 1 retained slightly positive Z-scores (0.23 to 0.28) across all eight variables, reflecting consistently above-average engagement with agile-oriented common practices. Cluster 2 remained negative (–1.31 to –1.58) across all dimensions, indicating below-average performance in similar practices. The consistent directional pattern confirms that the two groups are conceptually distinct, reinforcing the labels More Agile (Cluster 1) and Less Agile (Cluster 2) (Conforto et al., 2014a).

Table 4.50: Final Cluster Centres (N=252)

Common Practices	Z-score	
	Cluster 1	Cluster 2
CP1	.24443	-1.37652
CP2	.27460	-1.54642
CP3	.26275	-1.47967
CP4	.25070	-1.41185
CP5	.23298	-1.31207
CP6	.28126	-1.58395
CP7	.25454	-1.43349
CP8	.25374	-1.42894

The Euclidean distance between the two final centres was 4.826, as shown in Table 4.51. This relatively large value indicates a high degree of separation between the clusters. According to Hair et al. (2019), distances greater than 3.0 denote well-differentiated clusters. Hence, the result supports the discriminant validity of the two-cluster solution and confirms minimal overlap between groups.

Table 4.51: Distances between Final Cluster Centres (N=252)

Cluster	1	2
1		4.826
2	4.826	

The ANOVA results (Table 4.52) confirm that all eight common practices significantly contribute to distinguishing the two clusters. Each factor recorded a high F-value (110.703–202.310) with $p < .001$, verifying that every dimension of practice is influential in defining cluster membership. The highest discriminating variable was Pragmatic Delivery (CP6) ($F = 202.310$), followed by Transparent Environment (CP2) and Progressive Appraisal (CP3). Although SPSS cautions that these F-tests are descriptive, their magnitude affirms that the two-cluster structure meaningfully differentiates practitioners along all eight agile-oriented dimensions.

Table 4.52: ANOVA Results (N=252)

Common Practices	Cluster (df = 1) Mean Square	Error (df = 250) Mean Square	F	Sig.
CP1	84.789	.665	127.531	<.001
CP2	107.010	.576	185.793	<.001
CP3	97.972	.612	160.054	<.001
CP4	89.196	.647	137.815	<.001
CP5	77.034	.696	110.703	<.001
CP6	112.268	.555	202.310	<.001
CP7	91.952	.636	144.534	<.001
CP8	91.369	.639	143.095	<.001

As displayed in Table 4.53, Cluster 1 comprised 214 respondents (84.9%), and Cluster 2 included 38 respondents (15.1%). The majority of practitioners were thus classified into the *More Agile* group, suggesting that most Malaysian construction professionals in the sample demonstrate moderate-to-high adoption of agile-aligned practices. The smaller *Less Agile* group represents practitioners still adhering to more traditional, plan-driven project management styles.

Table 4.53: Number of Cases in each Cluster (N=252)

Cluster	Size
Cluster 1	214.000
Cluster 2	38.000

4.5.3 Cluster Validation Using Silhouette Analysis

Table 4.54 presents the Silhouette Coefficients, which evaluate cluster quality and cohesion. The overall mean silhouette value (0.614) indicates a good clustering structure, with values above 0.5 considered satisfactory (Kaufman & Rousseeuw, 2009). Cluster 1 (Mean = 0.651) showed strong cohesion, confirming that members of Cluster 1 are highly similar in their practice adoption patterns. Cluster 2 (Mean = 0.455) reflected moderate cohesion, typical for smaller clusters with higher variability. No negative silhouette values were observed (range 0.001–0.768), indicating that all cases were appropriately classified. This confirms that the two-cluster solution is both statistically robust and conceptually meaningful.

Table 4.54: Silhouette Statistics (N=252)

Cluster	Case Count	Mean	Minimum	Maximum
1	214.000	.651	.001	.768
2	38.000	.455	.109	.620
Total	252.000	.614	.001	.768

4.5.4 Interpretation of Practitioner Clusters

Mann–Whitney U tests were performed to compare the two identified practitioner groups across the four Agile Values. Results revealed statistically significant differences ($p < .01$) in all cases, with the More Agile Group consistently achieving higher mean ranks as shown in Table 4.55. This pattern demonstrates that practitioners with greater adoption of agile-oriented common practices also exhibit stronger alignment with the foundational Agile Values — particularly in valuing change management (AV4) and value delivery (AV2). These findings provide convergent evidence that the cluster solution meaningfully represents distinct levels of agile orientation among Malaysian construction practitioners.

Table 4.55: Inferential Statistics on Agile Values Grouped by Agile Groups (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
AV1	132.44	93.04	.002	-3.120
AV2	133.47	87.25	<.001	-3.648
AV3	132.39	93.34	.002	-3.070
AV4	133.76	85.62	<.001	-3.818

The Mann–Whitney U tests were conducted to compare the two practitioner groups on the 12 Agile Principles. All comparisons yielded statistically significant results ($p < .001$), with the More Agile Group consistently achieving higher mean ranks as shown in Table 4.56. The largest difference was found for maintaining project performance (AP8), followed by delivering project value (AP7) and satisfying project clients (AP1). These findings confirm that practitioners who exhibit higher levels of agile-oriented practices also embody the core agile mindset reflected in both the values and principles of the Agile Manifesto. This provides strong convergent validity for the two-cluster solution.

Table 4.56: Inferential Statistics on Agile Principles Grouped by Agile Groups (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
AP1	139.17	55.13	<.001	-6.816
AP2	133.35	87.92	<.001	-3.843
AP3	138.22	60.50	<.001	-6.853
AP4	136.29	71.36	<.001	-5.670
AP5	137.60	63.97	<.001	-6.505
AP6	137.01	67.32	<.001	-5.894
AP7	138.29	60.08	<.001	-6.984
AP8	139.08	55.66	<.001	-7.344
AP9	136.21	71.84	<.001	-5.768
AP10	137.22	66.12	<.001	-5.908
AP11	134.47	81.61	<.001	-4.400
AP12	135.55	75.54	<.001	-5.145

Mann–Whitney U tests were performed to examine differences in the eight Common Practices between the two clusters. Results indicate statistically significant differences ($p < .001$) across all practices, with the More Agile Group achieving substantially higher mean ranks as shown in Table 4.57. The strongest discriminating dimensions were Pragmatic Delivery (CP6) and Progressive Assessment (CP3), confirming that agile-oriented practitioners emphasize value-focused delivery and continuous evaluation. These results reinforce the validity of the cluster segmentation and illustrate how agile orientation translates into tangible project management behaviors.

Table 4.57: Inferential Statistics on Common Practices Grouped by Agile Groups (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
CP1	141.51	41.99	<.001	-7.833
CP2	142.39	37.03	<.001	-8.281
CP3	143.08	33.11	<.001	-8.662
CP4	141.53	41.87	<.001	-7.978
CP5	142.21	38.03	<.001	-8.232
CP6	143.57	30.37	<.001	-9.127
CP7	141.86	40.03	<.001	-8.139
CP8	140.87	45.55	<.001	-7.750

The Mann–Whitney U test results (Table 4.58) indicate statistically significant differences ($p < .001$) in all sixteen performances between the More Agile and Less Agile groups. Respondents in the More Agile Group demonstrated superior performance in adaptability (PP1), continuous feedback (PP4), problem resolution (PP10), and sustainable pace (PP15). These findings provide strong empirical evidence that the adoption of agile-oriented practices contributes directly to enhanced project outcomes.

Table 4.58: Inferential Statistics on Project Performances Grouped by Agile Groups (N=252)

Measure	Mean Rank		Mann-Whitney U	
	More Agile Group (N=214)	Less Agile Group (N=38)	Adj. Sig.	Z Value
PP1	136.01	72.95	<.001	-5.450
PP2	134.49	81.53	<.001	-4.572
PP3	134.09	83.74	<.001	-4.443
PP4	135.85	73.87	<.001	-5.369
PP5	134.46	81.70	<.001	-4.524
PP6	134.90	79.20	<.001	-4.714
PP7	135.30	76.95	<.001	-4.949
PP8	135.08	78.18	<.001	-4.978
PP9	134.58	80.99	<.001	-4.702
PP10	135.49	75.87	<.001	-5.102
PP11	135.61	75.20	<.001	-5.093
PP12	134.59	80.96	<.001	-4.655
PP13	134.52	81.32	<.001	-4.609
PP14	134.99	78.67	<.001	-4.785
PP15	135.96	73.22	<.001	-5.437
PP16	135.03	78.49	<.001	-5.006

The Mann–Whitney U test results confirm that the two practitioner clusters represent statistically distinct levels of agile orientation. Across Agile Values, Agile Principles, Common Practices, and project performance outcomes, the More Agile Group consistently demonstrated significantly higher mean ranks. These findings validate the cluster solution and demonstrate that stronger agile orientation is associated with superior behavioural alignment and enhanced construction project performance.

Taken together, the findings from the inferential analysis and cluster analysis indicate that agile orientation among Malaysian construction practitioners is systematically differentiated by demographic and organisational characteristics. The More Agile Group is predominantly characterised by Quantity Surveyors, less experienced and non-managerial practitioners, contractors, those involved in infrastructure projects, and individuals working within smaller organisations. In contrast, the Less Agile Group is largely composed of architects, engineers, and project managers with greater experience and managerial responsibilities, practitioners from consultancy, supplier, and developer organisations, those engaged in commercial, industrial, residential, and renovation projects, and individuals employed in larger organisational structures. These contrasting demographic profiles correspond closely with higher or lower adoption of Agile-oriented common practices (CP1–CP8), thereby confirming that agile orientation in the construction industry is not uniform, but is instead highly contextual, role-dependent, and shaped by organisational and project-level structures.

4.6 Summary

In summary, this chapter analyses the data collected from the questionnaire survey. Prior to further analysis, the data underwent screening. Descriptive statistics were used to examine demographic information. Reliability analyses for the AV, AP, P, and PP constructs confirmed that the data were both acceptable and highly reliable, making them suitable for subsequent analysis. Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) for extraction and Equamax for rotation identified eight common practices in construction project management, each with eigenvalues greater than 1. These practices – Resilient Team, Transparent Environment, Progressive Assessment, Adaptive Development, Bespoke Processes, Pragmatic Delivery, Continuous Refinement, and Engaging Stakeholders – accounted for 69.466 percent of the dataset. Mean scores were calculated to derive composite values for each common practice, enabling further multiple analyses. Reliability and validity analyses confirmed that the data for these common practices were acceptable, valid, and highly reliable, making them suitable for subsequent analysis.

The primary findings supported the hypotheses, confirming that the eight common practices are statistically significantly correlated with agile values, agile principles, and project performances. The results revealed statistically significant differences in the inclination toward Agile project management practices based on the demographic characteristics of construction practitioners. The cluster analysis identified two distinct groups of construction practitioners based on their alignment with agile-oriented practices. Cluster 1, More Agile represents practitioners with higher agile tendencies, while Cluster 2, Less Agile reflects lower agile alignment. These clusters were validated using both Hierarchical and K-Means methods, showing consistent overall structure.

CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter interprets the study's findings in relation to existing literature to address the research objectives (RO1–RO5) and research questions (RQ1–RQ7). It discusses how the eight common practices identified through exploratory factor analysis reflect current construction project management practices in Malaysia, how they align with Agile values and principles, how they relate to project performance, and how they differ across practitioner demographic groups. The discussion situates these findings within broader theoretical and industry contexts, highlighting areas of consistency and divergence with established research. It also integrates the empirical insights to support the development of an Agile-oriented construction project management framework that reflects the behavioural, methodological, and contextual dynamics observed in the Malaysian industry. Overall, this chapter provides the basis for the study's theoretical contributions and practical implications.

5.2 Identification of Eight Agility-Oriented Construction Project Management Practices in Malaysia

The exploratory factor analysis revealed eight distinct dimensions that characterise contemporary construction project management practices in

Malaysia: Resilient Team, Transparent Environment, Progressive Assessment, Adaptive Development, Bespoke Processes, Pragmatic Delivery, Continuous Refinement, and Engaging Stakeholders. These eight common practices collectively capture how Malaysian practitioners manage complexity, coordinate multidisciplinary teams, respond to uncertainties, and sustain decision-making throughout project lifecycles.

From a higher-level perspective, the factor structure indicates that Malaysian construction practice is neither purely traditional nor fully agile, but reflects a hybrid orientation (Ozorhon et al., 2022). For example, Resilient Team and Transparent Environment highlight the importance of interpersonal dynamics, collaboration, and candour—elements that align with relationship-oriented perspectives in construction literature (Laan et al., 2011; Meng, 2012). Progressive Assessment and Continuous Refinement demonstrate iterative thinking and feedback-driven improvement, which parallel Agile and Lean Construction principles (Tzortzopoulos et al., 2020; Schimanski et al., 2020).

Meanwhile, Adaptive Development, Bespoke Processes and Pragmatic Delivery reflect the industry's tendency to customise methods based on project context, consistent with findings in studies emphasising the adaptive yet procedural nature of construction management. This customization reflects a pragmatic approach to balancing client expectations, regulatory requirements, and resource constraints (Lindgren & Packendorff, 2009; Kärnä et al., 2013). Furthermore, Engaging Stakeholders underscores the importance of collaboration beyond the project team, echoing literature that positions stakeholder involvement as a determinant of project success (Yang et al., 2011).

Overall, the eight-factor structure expands current understanding of Malaysian construction practice by showing that agility-oriented behaviours already exist in embedded forms, even without explicit adoption of Agile frameworks. This finding provides the foundation for exploring how these practices interact with Agile values, principles, and project performance.

5.3 Empirical Evidence of Strong Alignment Between Construction Practices and Agile Values and Principles

The findings reveal a statistically significant correlation between the eight common practices and both agile values and principles, indicating that Malaysian construction project management is not only adopting adaptive practices but is conceptually aligned with the philosophy of agility. This alignment is noteworthy because it suggests that the industry is moving beyond superficial adoption of agile techniques toward embracing its underlying mindset.

Several practices demonstrate clear parallels with agile values. For example, Engaging Stakeholders reflects the agile value of customer collaboration over contract negotiation, emphasizing active involvement of clients and partners throughout the project lifecycle. Similarly, Transparent Environment resonates with the value of individuals and interactions over processes and tools, highlighting the importance of open communication and trust within project teams (Liao & Teo, 2019; Howell & Koskela, 2000).

The alignment extends to agile principles as well. Continuous Refinement and Adaptive Development embody the principle of continuous improvement and responsiveness to change, which is critical in managing uncertainty and complexity in construction projects. Likewise, Progressive Assessment supports the principle of frequent delivery of valuable outcomes, ensuring that progress is monitored iteratively rather than relying solely on end-stage evaluations (Highsmith, 2009; Denning, 2018).

This convergence between common practices and agile philosophy suggests that Malaysian construction firms are developing hybrid approaches that integrate traditional project management structures with agile-oriented behaviours. Such integration is consistent with global trends reported in literature, where industries with high complexity and variability—such as construction—adopt agility to enhance flexibility and stakeholder satisfaction (Ozorhon et al., 2022). However, the adaptation appears contextualized; rather than fully replacing conventional methods, agile principles are selectively incorporated to address local challenges such as regulatory compliance and resource constraints.

In summary, the strong alignment between common practices and agile values and principles underscores the relevance of agility in the Malaysian construction sector. It provides empirical support for the argument that agility is not confined to software development but can be effectively translated into project-based industries, offering a foundation for frameworks that promote adaptability, collaboration, and continuous improvement (Beck et al., 2001).

5.4 Agility-Oriented Practices as Significant Predictors of Improved Project Performance

The analysis revealed a statistically significant positive relationship between the eight common practices and project performance, indicating that these practices are not merely conceptual ideals but have tangible benefits in real-world construction projects. Projects that exhibit higher adoption of practices such as Resilient Team, Transparent Environment, and Continuous Refinement tend to achieve better outcomes in terms of cost efficiency, timely delivery, and quality standards (Chan & Chan, 2004; Doloi et al., 2012).

This finding reinforces the argument that agility-oriented practices enhance project success by improving adaptability and responsiveness. For instance, Adaptive Development allows teams to adjust plans in response to unforeseen challenges, reducing delays and mitigating risks (Jørgensen & Emmitt, 2009; Koskela et al., 2020). Similarly, Engaging Stakeholders ensures that client expectations are continuously addressed, minimizing costly rework and fostering trust (Yang et al., 2011). These mechanisms align with prior studies in agile and lean construction literature, which consistently link collaborative and iterative approaches to improved project performance (Tzortzopoulos et al., 2020).

The implications of this relationship are significant for both theory and practice. From a theoretical perspective, it validates the integration of agile principles into construction project management as a viable strategy for performance improvement. From a practical standpoint, it suggests that organizations seeking to enhance project outcomes should prioritise the adoption of these common practices, particularly those related to team resilience, transparency, and stakeholder engagement (Beck et al., 2001).

In summary, the strong association between common practices and project performance underscores their strategic importance. By fostering adaptability, collaboration, and continuous improvement, these practices contribute to achieving superior project results, positioning agility as a critical success factor in the Malaysian construction industry.

5.5 Practitioner Demographics Significantly Influence the Adoption of Agility-Oriented Practices

The analysis reveals meaningful differences in how common practices are demonstrated across different practitioner demographic groups. These differences highlight that agility-oriented behaviours are not evenly distributed across the industry, but shaped by professional identity, experience, hierarchical position, business model, project exposure, and organisational structure.

Quantity surveyors demonstrated higher engagement with Resilient Team compared to architects, and with Progressive Assessment and Engaging

Stakeholders compared to engineers. This pattern suggests that quantity surveyors, who often manage cost and client relationships, prioritise adaptability and proactive communication. In contrast, architects and engineers may lean toward standardised processes and technical rigor, which literature associates with lower flexibility in dynamic environments (Ashworth & Perera, 2018).

Practitioners with less experience (5 years and below) showed significantly greater adoption of Resilient Team, Transparent Environment, and Progressive Assessment compared to highly experienced practitioners (more than10 years). This finding aligns with research indicating that younger practitioners are more receptive to collaborative and adaptive practices because they frequently operate in dynamic team environments, rely heavily on collaborative learning, and often possess greater flexibility, digital fluency, and openness to new methods (Dainty & Loosemore, 2013), while seasoned practitioners tend to favour traditional hierarchical structures (Sydow et al., 2009). The generational shift toward agility reflects evolving expectations for transparency and responsiveness in project delivery.

Non-managers reported higher adoption of multiple practices—including Adaptive development, Continuous refinement and Engaging stakeholders compared to managers and Resilient team, Transparent environment and Progressive assessment compared to managers and senior managers. This suggests that operational-level practitioners—who deal with real-time issues on site—tend to adopt more adaptive and collaborative behaviours, and operate in fast-feedback environments requiring real-time adaptability (Bredin, 2008), while managerial roles may be constrained by procedural responsibilities and influenced by governance, reporting requirements, and contractual constraints, tend to adopt more formalised processes (Kerzner, 2022). This discrepancy may stem from decision-making authority and accountability pressures at higher levels, which often reinforce conventional control mechanisms. Literature on agile transformation emphasizes leadership buy-in as a critical enabler for cultural change, suggesting that targeted interventions at managerial levels are essential (Ribeiro & Fernandes, 2010).

Contractors exhibited stronger engagement with Resilient Team, Transparent Environment, and Progressive Assessment compared to suppliers, while developers differed from suppliers on Transparent Environment and from consultants on Continuous Refinement. These differences likely reflect the operational realities of each role: contractors and developers are more directly involved in project execution and client interaction, face higher environmental volatility and thus require adaptive problem-solving and transparency (Bresnen & Marshall, 2000), whereas suppliers and consultants operate within narrower scopes, often emphasizing compliance and technical precision (Hobday, 2000).

These demographic differences underscore that agility adoption is not uniform across the industry. Professional specialization, experience, organizational role, and business nature all shape the extent to which common practices are embraced. For successful industry-wide transformation, strategies must be tailored to address these demographic-specific barriers.

5.6 Distinct “More Agile” and “Less Agile” Practitioner Demographics Identified Through Cluster Analysis

The cluster analysis revealed two clearly differentiated practitioner groups—classified as the More Agile Group and Less Agile Group—reflecting systematic differences in agile orientation within Malaysian construction project management. Subsequent Mann–Whitney U tests confirmed that these clusters are not merely demographic groupings but represent statistically significant and meaningful differences across Agile Values, Agile Principles, agile-oriented Common Practices, and project performance. Collectively, the results demonstrate that agile orientation manifests as an integrated construct encompassing mindset, behavioural practices, and performance effectiveness.

Practitioners within the More Agile Group were predominantly quantity surveyors, with lower levels of industry experience, occupying non-managerial roles. They were commonly associated with contractor organisations, infrastructure projects, and small- to medium-sized enterprises (SMEs) with 75 employees or fewer. Importantly, this group exhibited significantly stronger alignment with Agile Values, particularly value delivery and responsiveness to change, alongside consistently higher adherence to Agile Principles, notably maintaining project performance, delivering project value, and satisfying project clients. These orientations were operationalised through significantly higher adoption of agile-oriented Common Practices, especially Pragmatic Delivery and Progressive Assessment, which emphasise value-focused execution and continuous evaluation. Correspondingly, the More Agile Group achieved superior project performance, including adaptability, continuous feedback, faster problem resolution, and sustainable work pace. This pattern suggests that agility can thrive even in technically complex environments such as infrastructure projects when organisational structures are lean, decision-making is decentralised, and practitioners are closely engaged with operational project realities. Smaller firms and early-career professionals may exhibit greater openness to adaptive practices due to fewer bureaucratic constraints and a stronger need for flexibility in competitive markets (Rigby et al., 2020; Denning, 2018).

In contrast, the Less Agile Group primarily comprised practitioners from engineering, project management, and architectural disciplines, with longer industry experience and holding managerial or senior managerial positions. These practitioners were frequently employed by suppliers, developers, and consultancy organisations, involved in commercial, residential, renovation, or industrial projects, and operating within larger firms exceeding 75 employees. This group demonstrated significantly lower alignment with Agile Values and Principles, weaker adoption of agile-oriented Common Practices, and comparatively poorer performance across all measured dimensions. From a structural perspective, these findings align with organisational theory suggesting that larger organisations and senior management roles tend to prioritise control, standardisation, and risk minimisation, often reinforcing traditional, plan-driven management approaches. In addition, project environments characterised by fixed scopes, contractual rigidity, and segmented responsibilities—such as commercial and residential developments—may further limit opportunities for adaptive and iterative practices. (Burns & Stalker, 1994; Turner & Keegan, 2001).

Overall, the demographic segmentation provides compelling empirical evidence that agile orientation in construction is unevenly distributed and strongly shaped by professional role, organisational context, and project environment. The convergence of demographic patterns with differences in values, principles, practices, and performance strengthens the validity of the cluster solution and deepens understanding of where and why agility thrives or is constrained within the construction ecosystem. These insights have important implications for industry stakeholders, suggesting that efforts to enhance agility should be context-sensitive and targeted, particularly toward larger organisations, senior management roles, and project environments where structural and contractual constraints pose significant barriers to agile adoption.

5.7 Synthesis of Findings into an Agile-Oriented Construction Project Management Framework

The integration of all findings supports the development of an Agile-oriented construction project management framework. The eight common practices form the behavioural foundation of the framework, representing the current operational reality of construction projects in Malaysia. Their significant alignment with Agile values and principles shows that the industry already demonstrates conditions favourable for Agile thinking. The demonstrated relationship with project performance confirms that these practices are not only theoretically relevant but practically beneficial.

Furthermore, demographic insights highlight that agility is shaped by practitioner profiles and organisational contexts. Different groups exhibit varying levels of agility-oriented behaviour, implying that any proposed framework must be adaptive to practitioner differences rather than assuming uniform capability or inclination.

The resulting framework therefore integrates as presented in Figure 5.1:

- Common Practices
- Agile Values
- Agile Principles
- Project Performance
- Agility Segmentation and Practitioner Demographics

Together, these components provide a holistic framework that captures the behavioural, methodological, and contextual dimensions of Agile-oriented construction management. The framework extends existing literature by demonstrating how Agile conceptual elements, performance logic, and practitioner diversity interact within the construction environment.

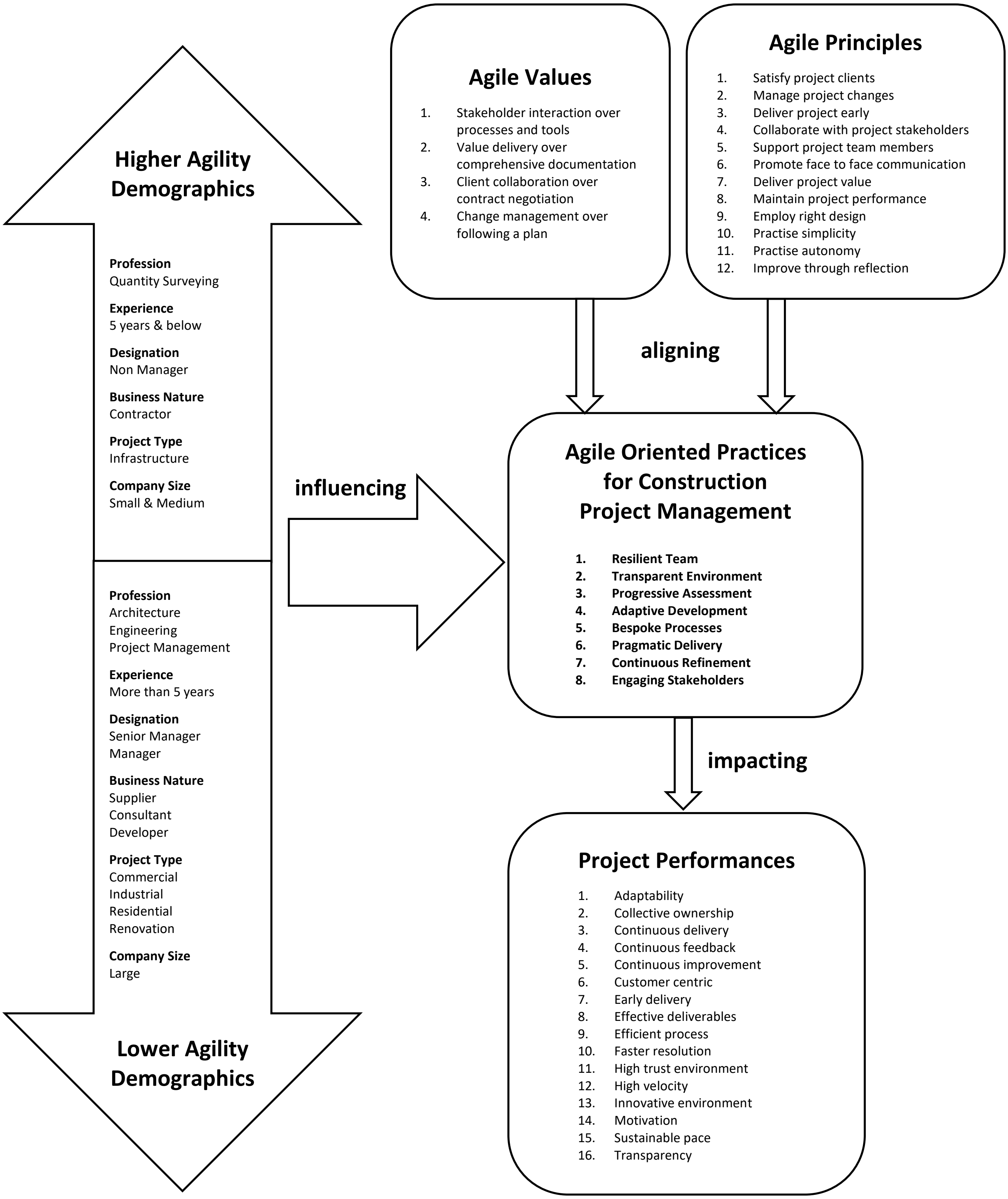


Figure 5.1: Agile-Oriented Construction Project Management Framework

5.8 Summary

This chapter interpreted the study's findings in relation to existing literature and the research objectives. The eight common practices identified in RO1/RQ1 showed that Malaysian construction project management follows a hybrid model, combining traditional processes with agility-oriented behaviours such as collaboration, transparency, and iterative improvement.

Analyses for RO2/RQ2–RQ3 demonstrated strong alignment between these practices and Agile values and principles, suggesting that the industry already reflects Agile thinking even without formal frameworks. The relationship with project performance (RO3/RQ4) further indicated that higher adoption of these practices contributes to better cost, time, and quality outcomes.

Demographic analyses (RO4/RQ5–RQ6) revealed that agility is uneven across practitioner groups. Younger, non-managerial practitioners, quantity surveyors, and those in contractor organisations showed higher agility, while senior, highly experienced, and managerial practitioners—often in larger firms—exhibited more traditional patterns.

Integrating these insights (RO5/RQ7), the chapter supports an Agile-oriented construction project management framework that links common practices, Agile constructs, performance outcomes, and demographic influences. This framework captures the behavioural and contextual dynamics needed to promote agility within the Malaysian construction sector.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the overall conclusions of the study and highlights its theoretical, practical, and policy-related contributions. It synthesises the key findings in relation to the research aim, objectives, and questions, and reflects on how the results advance understanding of Agile-oriented practices within the Malaysian construction industry. The chapter also outlines the limitations of the research, offers recommendations for future study, and concludes with a final reflection on the significance of the study. Together, these sections provide a cohesive summary of the research and its implications for both academia and industry.

6.2 Summary of the Study

This study set out to examine how Agile-oriented practices can be understood, interpreted, and applied within the Malaysian construction industry. The findings demonstrate that, despite the sector's traditionally structured and sequential nature, Agile behaviours are already embedded within many aspects of project delivery. The eight identified common practices reflect a blend of collaboration, transparency, adaptability, iterative decision-making, and stakeholder engagement—elements that closely mirror Agile values and principles. This suggests that agility in construction is not a foreign concept but is instead manifested through context-specific behaviours shaped by industry norms, team dynamics, and project environments.

The results further show that these practices have tangible relevance for improving project performance. Strong positive associations between adaptive, transparent, and team-centred practices and key performance indicate that agility contributes meaningfully to better communication, coordination, stakeholder satisfaction, and project delivery effectiveness. This highlights the potential value of fostering Agile-oriented capabilities within construction teams, even in settings where formal Agile methodologies may not be directly applicable.

The study also concludes that agility is not uniformly distributed across the practitioner population. Differences across profession, experience level, designation, business nature, project type, and company size reveal that agility is influenced by demographic and organisational contexts. These variations underline the importance of recognising human, professional, and structural factors when assessing or promoting agility in construction projects.

Overall, the research concludes that Agile-oriented practices form a viable, relevant, and performance-enhancing dimension of contemporary construction project management in Malaysia. By integrating behavioural tendencies, methodological alignment, project peroformance, and demographic demographics into a cohesive framework, the study provides a structured foundation for understanding how agility operates in construction and how it can be further strengthened to meet the evolving demands of the industry.

6.3 Implications of the Study

6.3.1 Theoretical Contribution

This study makes several contributions to the theoretical discourse on Agile project management and construction management. First, this study extends Agile theory beyond its traditional software-based origins by empirically validating eight common practices as indicators of agility. The findings confirm that many Agile practices and requirements—previously overlooked in earlier research—are shared across construction and software contexts and are embedded within construction management practice. By demonstrating how Agile-oriented behaviours manifest in a non-software, project-based environment (Kineber et al., 2024), the study contributes to the emerging conceptualisation of construction agility as a distinct yet theoretically aligned extension of Agile practice (Moreno et al., 2024).

Second, this study advances theoretical conceptualisations of agility by empirically linking Agile Values and Principles to observable construction behaviours. By establishing clear alignment patterns between the eight validated practices and the Agile Manifesto's values and principles, the research bridges the gap between Agile philosophy and construction practice, demonstrating how Agile-oriented thinking translates into real-world project behaviours (Askour & Al Quosi, 2025). In doing so, the study reframes agility as a value-driven and behavioural orientation rather than a prescriptive project management method, reinforcing emerging perspectives that position agility as a contextual capability applicable within hybrid and traditional project environments (Kumar, 2025).

Third, this study contributes to behavioural and socio-technical theories of project management and Agile adoption by demonstrating systematic variation in agility across practitioner demographics and project contexts. The findings extend Agile theory beyond purely organisational or methodological explanations by showing that agility in construction projects is shaped by professional roles, experience levels, designation levels and contextual conditions such as business nature, project type, and company size. In doing so, the study conceptualises agility as a context-dependent capability rather than a uniform practice (Francis, 2025), reinforcing contingency-based perspectives of project management which emphasise the alignment of management approaches with situational and organisational factors (Shiva Jayanth et al., 2025).

Finally, this study contributes to project management theory and Agile-oriented construction theory by developing an integrated Agile-oriented construction project management framework that synthesises common practices, Agile Values and Principles, project performance outcomes, and practitioner demographics into a coherent theoretical system. By integrating behavioural tendencies, methodological alignment, and performance considerations within a single framework, the study addresses a longstanding gap in the literature where these elements have typically been examined in isolation. The framework offers a new conceptual lens for examining agility in construction and provides a foundation for future theoretical development and empirical validation across diverse construction contexts (Yang & Wang, 2025)

6.3.2 Practical Implications to the Industry

The findings of this study offer several practical implications for construction organisations, project teams, and industry stakeholders seeking to enhance adaptability and performance. First, the eight agile-oriented practices can be applied within existing construction workflows without requiring organisations to fully adopt formal Agile methodologies, thereby lowering organisational resistance and perceived implementation risk while enabling incremental adoption of agile-oriented working practices. These practices—such as resilient teams, transparent environments, adaptive development, and continuous refinement—function as operational enablers that can be embedded into routine project activities through mechanisms including regular coordination meetings, iterative progress reviews, open information sharing, and collaborative problem-solving (Francis, 2025). By integrating these practices into day-to-day project operations, construction teams can progressively incorporate Agile principles in a manner that aligns with established management processes and industry norms.

Second, alignment between agile-oriented practices and Agile Values and Principles supports the gradual normalisation of collaborative, adaptive, and feedback-driven project management practices, thereby making Agile adoption more acceptable and sustainable within construction contexts. This alignment enables construction organisations to strengthen adaptive and collaborative project cultures through routine practices such as transparent communication and frequent stakeholder interaction, which help reduce approval bottlenecks, as well as pragmatic delivery and continuous refinement, which support learning-oriented execution and timely adjustment to emerging risks or design changes (Han et al., 2024). Collectively, these embedded practices contribute to improved coordination, schedule reliability, and client satisfaction at the project level.

Finally, differences in agility across practitioner demographics enable organisations to deploy teams and allocate responsibilities in ways that leverage existing strengths, thereby accelerating Agile adoption through practical, role-appropriate application rather than uniform mandates. These differences have direct implications for internal people management and team deployment strategies, as organisations can capitalise on the higher agility orientation often observed among early-career and non-managerial practitioners by positioning them in coordination-intensive roles, pilot initiatives, or cross-functional teams. Conversely, more experienced or senior practitioners may benefit from structured facilitation tools or reflective practices that support adaptation within established leadership roles (Moreno et al., 2024). Such internally driven approaches enable firms to enhance agility while accommodating professional diversity and existing organisational hierarchies.

6.3.3 Implications to the Governing Body

The findings offer important implications for policymakers, regulatory agencies, and professional bodies responsible for shaping the long-term capability of the Malaysian construction sector. First, the validated set of eight agile-oriented practices provides an evidence-based reference for updating national competency frameworks, professional standards, and accreditation criteria, thereby embedding Agile capabilities within existing institutional structures and supporting wider, sustained adoption (p. 212, paragraph 1). By incorporating adaptive and collaborative capabilities alongside traditional technical competencies, these frameworks can formally recognise and legitimise agile-oriented project management practices across the construction workforce (Shiva Jayanth et al., 2025). Such institutional alignment strengthens the long-term integration of Agile principles within professional development and certification pathways.

Second, recognition of variation in agility across practitioner groups supports more targeted organisational and policy initiatives, facilitating Agile adoption by aligning agile-oriented practices with organisational capacity and practitioner readiness rather than imposing a single project management approach (p. 212, paragraph 2). This differentiated perspective enables policymakers and industry bodies to design inclusive sector-wide initiatives that address structural capability gaps—such as tailored support for SMEs, cross-disciplinary collaboration platforms, and national knowledge-sharing programmes—while preserving methodological flexibility (Lendínez, 2025;

SMEScale, 2024). By accommodating organisational and contextual diversity, such initiatives promote broader and more sustainable diffusion of agile-oriented practices across the construction industry.

Finally, the Agile-oriented construction project management framework developed in this study offers a practical guide for modernising project delivery by translating empirical findings into actionable project management practices, thereby enabling progressive Agile adoption without displacing established construction management methods (p. 212, paragraph 3). By conceptualising agility as a context-dependent capability rather than a rigid methodology, the framework also provides policymakers with a strategic lens to support modernised project delivery governance, including flexible procurement models, integrated project teams, and performance evaluation systems that reward collaboration, learning, and adaptability (Nahod, 2025). Such an approach aligns Malaysian construction practice with global shifts toward adaptive and value-driven project delivery while preserving regulatory stability.

6.4 Limitation of the Study

This study has several limitations. First, although Cochran's formula indicated a target sample size of 385 to maximise generalisability and statistical precision, this number was not achieved. Cochran's formula is commonly used for determining minimum sample size based on confidence level, margin of error, and population variability. Despite extensive recruitment efforts, the final sample was smaller than the ideal threshold.

However, the sample remained adequate for the analyses conducted. The study met the minimum requirements of the Central Limit Theorem (CLT), which holds that when sample sizes reach approximately 30 observations per group, the sampling distribution of the mean tends toward normality regardless of the population distribution. As each demographic group in this study exceeded this threshold, the assumptions underpinning parametric tests were reasonably satisfied, supporting the robustness and interpretability of the results.

Additionally, the study adhered to established guidelines for Exploratory Factor Analysis (EFA), which generally require at least five observations per variable to ensure stability of the factor solution. With 252 usable responses for 50 variables—a 5:1 ratio—the dataset met this criterion. This allowed EFA to be performed meaningfully and ensured that the latent constructs identified were statistically defensible.

While the final sample fell short of the optimum size suggested by Cochran's formula, compliance with CLT assumptions and EFA minimum requirements supports the reliability of the study's findings. As such, the results remain valuable and analytically sound despite the smaller-than-planned sample size.

Second, although the survey instrument did not incorporate a dedicated or formalised framework for evaluating construction project performance, this limitation was addressed through reference to established Agile literature. Specifically, the study used the 16 project benefits documented in the SBOK

Guide as interpretive criteria to explain project performance. These benefits provided a theoretically grounded lens for linking Agile-oriented practices with improvements in performance. This compensatory approach offered conceptual coherence, even in the absence of a bespoke performance framework tailored to construction project contexts within the questionnaire design.

6.5 Recommendation for Future Research

Building on the insights and limitations of this study, several opportunities for future research are identified. First, future research could incorporate qualitative or mixed-method approaches—such as interviews, focus groups, ethnographic observations, or case studies—to complement the survey findings. Such methods would capture richer contextual details, uncover underlying motivations for Agile-oriented behaviours, and validate the practices and framework through real-world project scenarios.

Second, confirmatory studies using Structural Equation Modelling (SEM) or Confirmatory Factor Analysis (CFA) would strengthen theoretical validity by testing the stability of the eight-factor structure and verifying the causal pathways between common practices, Agile constructs, and project performance. This would enhance the robustness and generalisability of the proposed framework.

Third, comparative research across different countries, regions, or construction subsectors could explore how cultural, regulatory, or organisational environments influence the adoption of Agile-oriented practices. Cross-country comparisons, in particular, would help determine whether the Malaysian-derived framework is universally applicable or requires contextual adaptation.

Fourth, future studies could examine the moderating effect of profession on the relationship between agile-oriented practices and project performance. Such analysis would provide deeper insight into how contextual factors shape the effectiveness of agile adoption across different professional roles within construction.

Finally, future studies may investigate additional influencing variables such as organisational culture, leadership style, digital maturity, or contractual strategies. Understanding how these factors interact with practitioner demographics to shape agility could lead to more comprehensive models of Agile-oriented construction project management.

6.6 Concluding Remarks

This study set out to explore how Agile-oriented practices can be understood and applied within the Malaysian construction industry, and the findings offer clear evidence that agility is both relevant and increasingly embedded within contemporary project management behaviours. By identifying eight common practices, establishing their alignment with Agile values and principles, demonstrating their positive influence on project performance, and revealing meaningful demographic variations, the study provides a comprehensive understanding of how agility manifests in a traditionally structured and sequential sector. The Agile-oriented framework developed through this research offers a cohesive foundation for guiding future practice, policy development, and academic inquiry. Ultimately, the study contributes to ongoing efforts to enhance adaptability, collaboration, and performance in construction project management, supporting the industry’s progression toward more responsive and resilient project delivery approaches.

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APPENDICES

Appendix A: Questionnaire

Exploring Agile Project Management in the Malaysian Construction Industry

Dear Sir/Madam,

Sincere greetings and best regards to you.

I am a PhD research student from the Lee Kong Chian Faculty of Engineering and Science at Universiti Tunku Abdul Rahman (UTAR). My research title is 'Exploring Agile Project Management in the Malaysian Construction Industry.' The main objective of this research is to examine the significant differences in the inclination towards agile practices among construction practitioners in Malaysia, based on their demographic characteristics. To gather information to achieve the stated objective, I would be grateful if all the questions are completed to facilitate data analysis.

You can be assured that any information you provide in this questionnaire survey will be kept strictly private and confidential. It will be used solely for academic purposes. Your participation is highly appreciated and will significantly contribute to the success of this research. For further inquiries or clarification, please do not hesitate to contact me at yewhou.tung@gmail.com.

I look forward to hearing your favourable reply to the questionnaire survey. Thank you again for taking the time to fill it out.

Sincerely
Tung Yew Hou
PhD Research Student
Lee Kong Chian Faculty of Engineering & Science
Universiti Tunku Abdul (UTAR)

Note:
Agile project management *is an iterative and flexible approach to delivering projects, focusing on collaboration, customer feedback, and incremental progress. Unlike traditional methods, Agile breaks projects into small, manageable phases (called sprints), allowing teams to adapt quickly to changes and deliver value continuously. It emphasizes teamwork, regular communication (e.g., daily stand-ups), and frequent reassessment of plans to ensure alignment with customer needs. Frameworks like Scrum and Kanban are commonly used in Agile, promoting transparency, adaptability, and efficiency in complex or evolving projects. The goal is to deliver high-quality results faster while remaining responsive to stakeholder feedback.*

PERSONAL DATA PROTECTION NOTICE

Please be informed that in accordance with Personal Data Protection Act 2010 (“PDPA”) which came into force on 15 November 2013, Universiti Tunku Abdul Rahman (“UTAR”) is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

1. Personal data refers to any information which may directly or indirectly identify a person which could include sensitive personal data and expression of opinion. Among others it includes:

a) Name
b) Identity card
c) Place of Birth
d) Address
e) Education History
f) Employment History
g) Medical History
h) Blood type
i) Race
j) Religion
k) Photo
l) Personal Information and Associated Research Data

2. The purposes for which your personal data may be used are inclusive but not limited to:

a) For assessment of any application to UTAR
b) For processing any benefits and services
c) For communication purposes
d) For advertorial and news
e) For general administration and record purposes
f) For enhancing the value of education
g) For educational and related purposes consequential to UTAR
h) For replying any responds to complaints and enquiries
i) For the purpose of our corporate governance
j) For the purposes of conducting research/ collaboration

3. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

4. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

5. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

<u>Consent:</u>

6. By submitting or providing your personal data to UTAR, you had consented and agreed for your personal data to be used in accordance to the terms and conditions in the Notice and our relevant policy.

7. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfill our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

8. You may access and update your personal data by writing to us at………

<u>Acknowledgment of Notice</u>

[ ] I have been notified and that I hereby understood, consented and agreed per UTAR above notice.

[ ] I disagree, my personal data will not be processed.

…………………………
Name:
Date:

Section A:

Please indicate your level of inclination towards project management based on the following pairs.
(Please select the answer option based on the projects that have been completed recently or are currently ongoing.)

Mark only one oval

1) Stakeholder interaction over processes and tools

	1	2	3	4	5	6	7	8	9	10	
Towards processes and tools	○	○	○	○	○	○	○	○	○	○	Towards stakeholder interactions

2) Value delivery over comprehensive documentation

	1	2	3	4	5	6	7	8	9	10	
Towards comprehensive documentation	○	○	○	○	○	○	○	○	○	○	Towards value delivery

3) Client collaboration over contract negotiation

	1	2	3	4	5	6	7	8	9	10	
Towards contract negotiation	○	○	○	○	○	○	○	○	○	○	Towards client collaboration

4) Change management over following a plan

	1	2	3	4	5	6	7	8	9	10	
Following a plan	○	○	○	○	○	○	○	○	○	○	Responding to change

Section B:

To what extent do you agree with the following principles?
(Please select the answer option based on the projects that have been completed recently or are currently ongoing.)

Mark only one oval

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
We satisfy project clients	○	○	○	○	○
We manage project changes	○	○	○	○	○
We deliver project early	○	○	○	○	○
We collaborate with project stakeholders	○	○	○	○	○
We support project team members	○	○	○	○	○
We promote face to face communication	○	○	○	○	○
We deliver project value	○	○	○	○	○
We maintain project performance	○	○	○	○	○
We employ right design	○	○	○	○	○
We practise simplicity	○	○	○	○	○
We practise autonomy	○	○	○	○	○
We improve through reflection	○	○	○	○	○

Section C:

To what extent do you agree with the following practices?
(Please select the answer option based on the projects that have been completed recently or are currently ongoing.)

Mark only one oval

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
We define project deliverables progressively	○	○	○	○	○
We refine project requirements based on client acceptance criteria	○	○	○	○	○
We tailor processes based on team experience	○	○	○	○	○
We tailor processes based on organisational characteristics	○	○	○	○	○
We tailor processes based on project characteristics	○	○	○	○	○
We follow the sequence of work	○	○	○	○	○
We limit the cycle time	○	○	○	○	○
We solicit client collaboration	○	○	○	○	○
We prioritise project work through stakeholders' collaboration	○	○	○	○	○
We work balance between project delivery and risk reduction	○	○	○	○	○
We reprioritise requirements based on changes of project environment needs	○	○	○	○	○
We reprioritise requirements based on changes of project stakeholder needs	○	○	○	○	○
We conduct inspections	○	○	○	○	○

We conduct testing	○	○	○	○	○
We engage with project stakeholders	○	○	○	○	○
We share information with project stakeholders	○	○	○	○	○
We form agreement with project involvement	○	○	○	○	○
We assess project changes to maintain stakeholder involvement	○	○	○	○	○
We use collaborative decision making	○	○	○	○	○
We use collaborative conflict resolution	○	○	○	○	○
We understand project vision	○	○	○	○	○
We understand project success criteria	○	○	○	○	○
We develop ground rules with project members	○	○	○	○	○
We develop project members' interpersonal skills	○	○	○	○	○
We develop project members' technical skills	○	○	○	○	○
We encourage emergent leadership	○	○	○	○	○
We understand project members motivators and demotivators	○	○	○	○	○
We encourage communication via collaboration tools	○	○	○	○	○
We reduce distractions among project members	○	○	○	○	○
We encourage project members to measure performance	○	○	○	○	○
We plan progressively at multiple project stages	○	○	○	○	○
We adjust planning based on project performance	○	○	○	○	○
We adjust planning based on project changes	○	○	○	○	○
We size project elements progressively	○	○	○	○	○

We adjust project resources in stages	○	○	○	○	○
We create rough baselines at the beginning of project	○	○	○	○	○
We refine baselines as the project progresses	○	○	○	○	○
We evaluate baselines based on project changes	○	○	○	○	○
We perform project reviews in stages	○	○	○	○	○
We seek feedback via progressive project delivery	○	○	○	○	○
We seek feedback via site mock-up	○	○	○	○	○
We create a project environment of continuous learning	○	○	○	○	○
We reduce project wastes	○	○	○	○	○
We disseminate project knowledge	○	○	○	○	○
We retrospect project issues	○	○	○	○	○
We open to reveal project problems	○	○	○	○	○
We identify issues with project members	○	○	○	○	○
We resolve issues with pertinent project members	○	○	○	○	○
We maintain a visible list of project issues to track ownership	○	○	○	○	○
We maintain a visible list of project issues to track resolution status	○	○	○	○	○

Section D:

To what extent do you agree with the following project performances based on the practices outlined in Section C?
(Please select the answer option based on the projects that have been completed recently or are currently ongoing.)

Mark only one oval

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Adaptability	○	○	○	○	○
Collective ownership	○	○	○	○	○
Continuous delivery of project value	○	○	○	○	○
Continuous feedback	○	○	○	○	○
Continuous improvement	○	○	○	○	○
Customer centric	○	○	○	○	○
Early delivery of project value	○	○	○	○	○
Effective deliverables	○	○	○	○	○
Efficient development process	○	○	○	○	○
Faster problem resolution	○	○	○	○	○
High trust environment	○	○	○	○	○
High velocity	○	○	○	○	○
Innovative environment	○	○	○	○	○
Motivation	○	○	○	○	○
Sustainable pace	○	○	○	○	○
Transparency	○	○	○	○	○

Section E:

Demographic Information
(Please select the answer option that best describes your situation.)

Mark only one oval

1) Which of the following best describes your profession?

- ○ Architecture
- ○ Engineering
- ○ Quantity Surveying
- ○ Project Management
- ○ Other: ________________________________

2) How long have you been working in the construction industry?

- ○ Less than 2 years
- ○ 2 – 5 years
- ○ 6 – 10 years
- ○ More than 10 years

3) Which of the following best describes your designation in the company?

- ○ Senior Manager & above
- ○ Manager
- ○ Executive

4) Which of the following best describes your company's business nature?

- ○ Construction business
- ○ Construction material, plant & equipment merchant
- ○ Consultancy
- ○ Property development
- ○ Other: ________________________________

5) Which of the following types of projects is your company mostly involved in?

- ○ Commercial
- ○ Industrial
- ○ Infrastructure
- ○ Residential
- ○ Renovation
- ○ Other: ________________________________

6) Approximately how many employees are currently employed at your company?

- ○ Less than 30
- ○ 30 - 75
- ○ More than 75

.

Appendix B: Definitions of Agility

Appendix B1

Definition	Adaptability	Customer needs	Learning	Quality	Responsiveness	Speed	Value
A system that shifts quickly among product models/lines, ideally in real time in order to respond to customer needs (Iacocca/Lehigh, 1991)	X	X			X	X	
Capability of an organization to operate profitably in a competitive environment comprised of continually changing customer habits (Goldman et al., 1995)	X	X			X		
Ability to accelerate the activities on critical path and time-based competitiveness (Kumar & Motwani, 1995)		X			X	X	
Capability to survive and prosper in a competitive environment or continuous and unpredictable changes by reacting quickly and effectively to changing markets, designed by customer designed products and services (Cho et al., 1996)		X			X	X	
Ability to market successfully low-cost, high- quality products with short lead times and in varying volumes that provide enhanced value to customers through customization (Fliedner & Vokurka, 1997)		X		X		X	X
A successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and knowledge management to provide customer driven products and services in a fast-changing market environment (Yusuf et al., 1999)	X	X	X	X	X	X	X

Source: Modified from Ganguly et al. (2009).

Appendix B2

Definition	Adaptability	Customer needs	Learning	Quality	Responsiveness	Speed	Value
Ability of an organization to respond efficiently and effectively to both proactive and reactive needs and opportunities on the face of an unpredictable and uncertain environment (Dove, 2001)	X	X		X	X	X	X
The ability of a firm to excel simultaneously on operations capabilities of quality, delivery, flexibility and cost in a coordinated fashion (Menor et al., 2001)	X			X		X	X
Ability of a firm to redesign their existing processes rapidly and create new processes in a timely fashion in order to be able to take advantage and thrive of the unpredictable and highly dynamic market conditions (Sambamurthy et al., 2003)	X	X	X		X	X	
An organization's ability to sense environmental changes and respond effectively and efficiently to that change (Ashrafi et al., 2005)		X			X	X	
Ability of a firm to dynamically modify and/ or reconfigure individual business processes to accommodate required and potential needs of the firm (Raschke & David, 2005)	X	X	X		X	X	

Source: Modified from Ganguly et al. (2009).

Appendix B3

Definition	Adaptability	Customer needs	Learning	Quality	Responsiveness	Speed	Value
Ability of an organization to detect changes (which can be opportunities or threats or a combination of both) in its business environment and hence providing focused and rapid responses to its customers and stakeholders by reconfiguring its resources, processes and strategies (Mathiyakalan et al., 2005)		X	X		X	X	
A persistent behaviour or ability of a sensitive entity that exhibits flexibility to accommodate expected or unexpected changes rapidly, follows the shortest time span, uses economical, simple and quality instruments in a dynamic environment and applies updated prior knowledge and experience to learn from the internal and external environment (Qumer & Henderson-Sellers, 2006a, b)	X	X	X	X	X	X	X
The capability to sense changes in the environment, make rapid decisions, and reconfigure resources to adapt project direction while balancing flexibility and stability (Conforto et al., 2014b)	X		X			X	
The project team's ability to quickly change the project plan as a response to customer or stakeholders needs, market or technology demands in order to achieve better project and product performance in an innovative and dynamic project environment (Conforto et al., 2016)	X	X		X	X	X	X
The ability to deliver projects successfully in dynamic environments by embracing change, fostering collaboration, and enabling iterative progress (PMI, 2017a)	X	X			X		

Source: Modified from Ganguly et al. (2009).

Appendix C: Correlation Matrix(N=252)

Appendix C1

Variables	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
P1	1.000									
P2	0.482	1.000								
P3	0.359	0.507	1.000							
P4	0.523	0.348	0.559	1.000						
P5	0.385	0.490	0.635	0.545	1.000					
P6	0.517	0.380	0.281	0.506	0.299	1.000				
P7	0.426	0.428	0.369	0.414	0.424	0.545	1.000			
P8	0.573	0.417	0.392	0.577	0.453	0.547	0.631	1.000		
P9	0.374	0.523	0.388	0.304	0.466	0.443	0.414	0.484	1.000	
P10	0.457	0.491	0.519	0.525	0.551	0.559	0.470	0.592	0.595	1.000
P11	0.469	0.456	0.431	0.544	0.480	0.537	0.552	0.605	0.497	0.579
P12	0.484	0.472	0.475	0.511	0.586	0.527	0.501	0.626	0.612	0.677
P13	0.402	0.344	0.338	0.433	0.382	0.442	0.554	0.493	0.326	0.388
P14	0.510	0.336	0.331	0.431	0.394	0.447	0.467	0.524	0.298	0.429
P15	0.459	0.321	0.316	0.418	0.324	0.498	0.506	0.519	0.467	0.486
P16	0.420	0.331	0.248	0.323	0.340	0.349	0.352	0.423	0.404	0.340
P17	0.448	0.367	0.253	0.310	0.253	0.292	0.312	0.424	0.258	0.332
P18	0.448	0.419	0.314	0.453	0.353	0.378	0.484	0.576	0.437	0.496
P19	0.499	0.427	0.335	0.439	0.326	0.583	0.492	0.496	0.406	0.590
P20	0.429	0.369	0.374	0.435	0.249	0.452	0.404	0.440	0.343	0.489
P21	0.440	0.325	0.330	0.516	0.301	0.451	0.360	0.517	0.335	0.478
P22	0.315	0.279	0.366	0.408	0.324	0.374	0.390	0.409	0.299	0.447
P23	0.512	0.365	0.462	0.475	0.313	0.493	0.408	0.484	0.343	0.538
P24	0.389	0.293	0.419	0.521	0.334	0.398	0.359	0.451	0.270	0.508
P25	0.499	0.323	0.358	0.477	0.336	0.427	0.347	0.467	0.316	0.512
P26	0.433	0.417	0.372	0.504	0.435	0.437	0.355	0.467	0.333	0.510
P27	0.399	0.333	0.290	0.438	0.310	0.369	0.301	0.425	0.268	0.447
P28	0.372	0.398	0.354	0.493	0.290	0.423	0.394	0.520	0.372	0.443
P29	0.305	0.439	0.462	0.374	0.382	0.328	0.277	0.350	0.399	0.447
P30	0.394	0.294	0.392	0.477	0.390	0.481	0.416	0.478	0.273	0.455
P31	0.397	0.361	0.417	0.510	0.353	0.352	0.390	0.455	0.275	0.401
P32	0.397	0.413	0.420	0.525	0.396	0.422	0.421	0.446	0.399	0.423
P33	0.395	0.394	0.385	0.517	0.368	0.413	0.359	0.433	0.348	0.486
P34	0.450	0.377	0.480	0.534	0.434	0.397	0.383	0.482	0.374	0.459
P35	0.374	0.345	0.277	0.339	0.267	0.370	0.342	0.347	0.325	0.419
P36	0.508	0.359	0.228	0.438	0.226	0.421	0.370	0.464	0.369	0.429
P37	0.482	0.425	0.426	0.447	0.462	0.377	0.334	0.454	0.431	0.583
P38	0.525	0.377	0.395	0.476	0.403	0.423	0.337	0.470	0.366	0.524
P39	0.552	0.540	0.380	0.406	0.419	0.381	0.425	0.531	0.478	0.518
P40	0.538	0.341	0.323	0.503	0.361	0.508	0.376	0.563	0.398	0.503
P41	0.425	0.415	0.415	0.447	0.471	0.386	0.335	0.508	0.417	0.530
P42	0.572	0.356	0.395	0.507	0.354	0.574	0.492	0.581	0.421	0.546
P43	0.470	0.319	0.391	0.502	0.361	0.443	0.440	0.549	0.395	0.473
P44	0.509	0.361	0.395	0.553	0.384	0.497	0.379	0.556	0.366	0.557
P45	0.507	0.332	0.332	0.481	0.273	0.457	0.377	0.495	0.348	0.527
P46	0.460	0.284	0.343	0.413	0.270	0.475	0.377	0.506	0.382	0.478
P47	0.383	0.432	0.390	0.400	0.358	0.433	0.331	0.513	0.424	0.493
P48	0.444	0.387	0.320	0.449	0.331	0.419	0.383	0.525	0.436	0.464
P49	0.510	0.346	0.279	0.522	0.351	0.498	0.483	0.573	0.351	0.485
P50	0.445	0.522	0.412	0.449	0.444	0.446	0.408	0.522	0.459	0.486

Appendix C2

Variables	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
P11	1.000									
P12	0.651	1.000								
P13	0.504	0.464	1.000							
P14	0.487	0.489	0.786	1.000						
P15	0.517	0.569	0.470	0.447	1.000					
P16	0.379	0.330	0.356	0.330	0.487	1.000				
P17	0.364	0.324	0.446	0.407	0.387	0.481	1.000			
P18	0.555	0.474	0.477	0.444	0.614	0.492	0.475	1.000		
P19	0.546	0.513	0.523	0.487	0.476	0.358	0.448	0.542	1.000	
P20	0.520	0.434	0.520	0.478	0.460	0.293	0.428	0.527	0.639	1.000
P21	0.523	0.467	0.457	0.388	0.580	0.393	0.359	0.564	0.523	0.468
P22	0.453	0.368	0.409	0.313	0.461	0.354	0.367	0.509	0.469	0.509
P23	0.561	0.460	0.413	0.359	0.544	0.401	0.425	0.503	0.567	0.607
P24	0.508	0.403	0.346	0.340	0.426	0.325	0.384	0.478	0.482	0.562
P25	0.593	0.432	0.384	0.380	0.494	0.356	0.417	0.523	0.496	0.584
P26	0.549	0.422	0.361	0.376	0.526	0.349	0.352	0.533	0.476	0.576
P27	0.496	0.398	0.346	0.335	0.471	0.369	0.446	0.562	0.540	0.534
P28	0.502	0.455	0.445	0.386	0.566	0.389	0.439	0.556	0.471	0.473
P29	0.425	0.415	0.382	0.344	0.478	0.266	0.352	0.449	0.452	0.508
P30	0.515	0.446	0.450	0.374	0.544	0.378	0.456	0.498	0.483	0.499
P31	0.481	0.401	0.427	0.355	0.503	0.344	0.388	0.426	0.426	0.463
P32	0.494	0.465	0.458	0.352	0.503	0.299	0.481	0.526	0.505	0.478
P33	0.480	0.466	0.459	0.391	0.454	0.355	0.447	0.475	0.496	0.558
P34	0.556	0.445	0.404	0.378	0.520	0.295	0.422	0.514	0.405	0.497
P35	0.384	0.394	0.420	0.440	0.415	0.361	0.410	0.458	0.470	0.563
P36	0.436	0.492	0.455	0.484	0.476	0.343	0.441	0.560	0.581	0.550
P37	0.455	0.596	0.440	0.405	0.463	0.334	0.395	0.454	0.549	0.532
P38	0.530	0.558	0.418	0.410	0.436	0.329	0.329	0.433	0.577	0.523
P39	0.524	0.592	0.529	0.474	0.460	0.398	0.558	0.560	0.583	0.505
P40	0.577	0.567	0.504	0.510	0.406	0.308	0.400	0.458	0.562	0.502
P41	0.482	0.542	0.399	0.416	0.463	0.325	0.360	0.532	0.447	0.439
P42	0.564	0.543	0.466	0.471	0.458	0.306	0.364	0.560	0.636	0.566
P43	0.501	0.492	0.452	0.437	0.464	0.356	0.427	0.542	0.552	0.522
P44	0.565	0.518	0.513	0.466	0.520	0.334	0.468	0.523	0.574	0.594
P45	0.476	0.443	0.413	0.429	0.474	0.251	0.393	0.459	0.567	0.622
P46	0.531	0.427	0.391	0.385	0.505	0.271	0.323	0.562	0.495	0.570
P47	0.522	0.483	0.439	0.387	0.487	0.314	0.420	0.564	0.447	0.511
P48	0.526	0.475	0.473	0.442	0.524	0.437	0.451	0.664	0.500	0.561
P49	0.534	0.467	0.491	0.450	0.647	0.418	0.388	0.557	0.517	0.541
P50	0.488	0.556	0.494	0.443	0.561	0.377	0.440	0.526	0.455	0.464

Appendix C3

Variables	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30
P21	1.000									
P22	0.629	1.000								
P23	0.661	0.616	1.000							
P24	0.534	0.536	0.687	1.000						
P25	0.572	0.578	0.728	0.762	1.000					
P26	0.602	0.577	0.656	0.682	0.641	1.000				
P27	0.543	0.548	0.544	0.687	0.670	0.694	1.000			
P28	0.657	0.493	0.534	0.587	0.549	0.615	0.626	1.000		
P29	0.500	0.510	0.554	0.623	0.572	0.634	0.650	0.556	1.000	
P30	0.586	0.580	0.611	0.490	0.566	0.599	0.539	0.566	0.564	1.000
P31	0.599	0.462	0.556	0.473	0.481	0.469	0.447	0.611	0.409	0.512
P32	0.548	0.441	0.526	0.446	0.510	0.507	0.525	0.670	0.479	0.512
P33	0.576	0.432	0.514	0.512	0.483	0.581	0.502	0.629	0.439	0.537
P34	0.583	0.540	0.630	0.588	0.644	0.646	0.553	0.587	0.580	0.635
P35	0.408	0.251	0.403	0.347	0.427	0.361	0.370	0.419	0.308	0.338
P36	0.522	0.356	0.468	0.360	0.437	0.413	0.452	0.476	0.353	0.450
P37	0.504	0.435	0.579	0.521	0.526	0.510	0.506	0.440	0.557	0.521
P38	0.506	0.449	0.597	0.582	0.589	0.552	0.520	0.463	0.547	0.559
P39	0.480	0.359	0.473	0.423	0.477	0.445	0.493	0.522	0.519	0.477
P40	0.420	0.346	0.447	0.474	0.459	0.412	0.442	0.404	0.379	0.435
P41	0.528	0.462	0.490	0.529	0.508	0.490	0.490	0.562	0.609	0.554
P42	0.501	0.445	0.559	0.561	0.558	0.559	0.583	0.506	0.505	0.508
P43	0.500	0.427	0.562	0.638	0.566	0.546	0.646	0.624	0.538	0.491
P44	0.543	0.482	0.622	0.589	0.650	0.611	0.667	0.578	0.576	0.618
P45	0.490	0.408	0.577	0.567	0.612	0.539	0.558	0.538	0.465	0.512
P46	0.517	0.455	0.607	0.542	0.655	0.607	0.551	0.527	0.545	0.537
P47	0.540	0.464	0.536	0.486	0.541	0.541	0.571	0.598	0.556	0.502
P48	0.591	0.437	0.589	0.534	0.583	0.623	0.577	0.670	0.538	0.488
P49	0.556	0.501	0.631	0.576	0.607	0.665	0.595	0.637	0.558	0.574
P50	0.498	0.474	0.537	0.493	0.506	0.593	0.566	0.559	0.716	0.556

Appendix C4

Variables	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40
P31	1.000									
P32	0.541	1.000								
P33	0.569	0.671	1.000							
P34	0.581	0.642	0.610	1.000						
P35	0.463	0.493	0.562	0.435	1.000					
P36	0.438	0.490	0.540	0.403	0.547	1.000				
P37	0.446	0.464	0.543	0.460	0.473	0.551	1.000			
P38	0.499	0.454	0.519	0.551	0.440	0.487	0.777	1.000		
P39	0.463	0.501	0.512	0.512	0.504	0.573	0.725	0.646	1.000	
P40	0.458	0.330	0.348	0.384	0.411	0.512	0.490	0.498	0.540	1.000
P41	0.475	0.459	0.437	0.526	0.403	0.427	0.508	0.491	0.520	0.499
P42	0.416	0.511	0.448	0.522	0.423	0.475	0.532	0.549	0.556	0.619
P43	0.459	0.510	0.520	0.558	0.409	0.484	0.446	0.461	0.506	0.592
P44	0.516	0.577	0.579	0.556	0.511	0.516	0.684	0.669	0.601	0.561
P45	0.473	0.512	0.571	0.507	0.523	0.584	0.600	0.594	0.572	0.518
P46	0.436	0.512	0.511	0.583	0.433	0.478	0.493	0.586	0.505	0.461
P47	0.537	0.523	0.496	0.511	0.412	0.506	0.477	0.484	0.572	0.470
P48	0.500	0.597	0.578	0.577	0.518	0.577	0.501	0.514	0.580	0.493
P49	0.499	0.598	0.528	0.566	0.442	0.454	0.566	0.572	0.557	0.513
P50	0.450	0.576	0.502	0.613	0.387	0.465	0.591	0.531	0.610	0.486

Variables	P41	P42	P43	P44	P45	P46	P47	P48	P49	P50
P41	1.000									
P42	0.497	1.000								
P43	0.572	0.647	1.000							
P44	0.563	0.666	0.622	1.000						
P45	0.462	0.567	0.580	0.762	1.000					
P46	0.497	0.625	0.577	0.673	0.706	1.000				
P47	0.554	0.535	0.548	0.637	0.603	0.655	1.000			
P48	0.556	0.577	0.635	0.631	0.572	0.623	0.683	1.000		
P49	0.568	0.623	0.585	0.716	0.660	0.688	0.595	0.678	1.000	
P50	0.628	0.536	0.553	0.624	0.513	0.554	0.608	0.618	0.713	1.000

Appendix D: Anti-Image Correlation Matrix (N=252)

Appendix D1

Variables	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
P1	.942[a]									
P2	-0.254	.930[a]								
P3	-0.015	-0.260	.907[a]							
P4	-0.145	0.121	-0.322	.944[a]						
P5	-0.045	-0.037	-0.303	-0.193	.913[a]					
P6	-0.127	-0.104	0.211	-0.261	0.141	.942[a]				
P7	-0.013	-0.163	-0.036	0.142	-0.140	-0.212	.916[a]			
P8	-0.095	0.060	0.022	-0.144	0.044	0.017	-0.351	.968[a]		
P9	0.008	-0.180	0.074	0.140	-0.106	-0.091	0.033	-0.079	.937[a]	
P10	0.097	-0.029	-0.125	-0.054	-0.085	-0.140	0.003	-0.110	-0.245	.973[a]
P11	0.134	-0.067	-0.001	-0.084	0.005	-0.007	-0.200	0.010	-0.103	0.029
P12	0.079	0.014	0.018	-0.022	-0.236	-0.040	-0.002	-0.145	-0.131	-0.168
P13	0.153	0.033	0.038	-0.056	-0.056	0.024	-0.282	0.118	-0.036	0.113
P14	-0.205	0.048	-0.061	0.074	-0.070	-0.067	0.123	-0.131	0.144	-0.071
P15	-0.132	0.215	-0.116	0.121	0.148	-0.112	-0.120	0.113	-0.144	0.011
P16	-0.086	0.020	-0.055	-0.007	-0.158	-0.092	0.079	-0.065	-0.260	0.083
P17	-0.163	-0.054	0.088	0.066	0.038	0.097	0.073	-0.121	0.103	-0.026
P18	0.055	-0.163	0.134	-0.152	0.005	0.259	-0.064	-0.121	0.024	-0.074
P19	0.087	-0.071	0.034	0.085	-0.072	-0.220	-0.029	0.049	0.055	-0.205
P20	-0.001	-0.023	-0.094	-0.042	0.204	0.021	0.044	-0.030	-0.037	0.057
P21	-0.068	0.010	0.118	-0.128	0.075	0.015	0.147	-0.139	0.059	0.002
P22	0.087	0.105	-0.094	0.031	0.011	-0.002	-0.158	0.075	-0.080	-0.032
P23	-0.146	-0.002	-0.235	0.166	0.200	-0.074	0.037	0.032	0.059	-0.063
P24	0.186	0.121	-0.103	-0.122	0.065	-0.054	-0.177	0.024	0.057	-0.037
P25	-0.182	-0.055	0.173	0.013	-0.087	0.055	0.108	0.006	0.048	-0.071
P26	-0.011	-0.194	0.180	-0.012	-0.305	-0.001	0.087	-0.004	0.044	-0.045
P27	-0.052	0.009	0.106	0.049	0.004	0.045	0.047	0.052	0.169	-0.020
P28	0.102	-0.120	-0.069	-6.800E-05	0.223	-0.033	0.066	-0.098	-0.039	0.011
P29	0.147	-0.110	-0.133	-0.010	0.022	0.072	0.032	0.112	-0.174	0.053
P30	0.143	0.139	-0.057	0.045	-0.096	-0.185	-0.125	0.019	0.180	0.025
P31	0.034	-0.058	0.003	-0.123	-0.057	0.141	-0.147	0.001	0.083	0.036
P32	0.031	0.020	-0.091	-0.102	-0.114	-0.047	-0.030	0.083	-0.133	0.141
P33	-0.033	-0.055	0.034	-0.032	0.033	-0.013	0.093	0.036	0.045	-0.097
P34	-0.036	0.067	-0.059	-0.066	-0.059	0.016	0.068	-0.054	-0.108	0.017
P35	0.148	-0.030	-0.032	0.106	-0.019	-0.085	-0.102	0.139	0.048	-0.062
P36	-0.103	-0.004	0.136	-0.195	0.153	0.082	-0.084	0.041	-0.042	0.080
P37	0.060	0.051	-0.046	0.064	-0.171	0.035	0.047	0.028	-0.068	-0.106
P38	-0.191	-0.004	0.062	-0.011	0.065	0.048	0.073	-0.020	0.048	0.065
P39	-0.119	-0.114	0.008	0.057	0.044	0.105	-0.050	0.013	-0.013	0.029
P40	-0.112	0.017	0.009	-0.048	0.004	-0.097	0.251	-0.084	-0.062	0.003
P41	-0.121	-0.023	0.038	0.088	-0.153	0.012	0.134	-0.030	0.008	-0.088
P42	-0.218	0.128	-0.110	0.053	0.116	-0.116	-0.102	-0.001	-0.051	0.003
P43	-0.034	0.117	-0.030	-0.031	-0.049	0.072	-0.132	-0.021	-0.085	0.097
P44	0.041	0.017	-0.019	-0.114	0.039	-0.034	0.134	-0.102	0.015	-0.021
P45	-0.082	-0.019	0.013	-0.046	0.036	0.082	-0.073	0.026	-0.060	-0.081
P46	3.469E-05	0.188	-0.171	0.151	0.073	-0.127	-0.003	-0.036	-0.078	0.031
P47	0.116	-0.090	-0.086	0.144	-0.110	-0.162	0.194	-0.093	-0.003	-0.038
P48	0.053	0.101	-0.006	0.049	0.006	0.005	-0.019	0.043	-0.077	0.038
P49	-0.036	0.011	0.299	-0.192	-0.048	0.122	-0.140	-0.051	0.138	-0.019
P50	0.048	-0.196	-0.004	0.042	0.060	-0.085	0.036	-0.064	0.040	0.049

Appendix D2

Variables	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
P11	.971[a]									
P12	-0.229	.950[a]								
P13	0.020	0.077	.923[a]							
P14	-0.079	-0.070	-0.666	.926[a]						
P15	0.045	-0.340	-0.011	-0.035	.936[a]					
P16	-0.050	0.154	-0.024	0.019	-0.146	.920[a]				
P17	0.037	0.047	-0.024	-0.065	-0.034	-0.253	.938[a]			
P18	-0.077	0.144	-0.009	-0.001	-0.334	-0.122	0.006	.950[a]		
P19	-0.043	0.106	-0.047	-0.002	-0.041	0.026	-0.083	-0.067	.959[a]	
P20	-0.056	-0.049	-0.163	0.015	0.018	0.083	-0.021	-0.049	-0.217	.968[a]
P21	-0.050	-0.011	-0.129	0.056	-0.131	-0.017	0.169	-0.009	-0.104	0.206
P22	0.098	-0.005	-0.060	0.037	0.115	-0.055	-0.100	-0.146	-0.039	-0.151
P23	-0.079	-0.077	-0.033	0.107	0.047	-0.100	-0.056	0.043	-0.127	-0.068
P24	0.069	0.040	0.038	0.008	0.070	-0.031	-0.154	-0.086	0.091	-0.040
P25	-0.200	0.008	-0.024	0.003	-0.040	-0.012	0.039	0.065	0.058	-0.040
P26	-0.081	0.119	0.127	-0.084	-0.104	0.085	0.060	0.035	0.078	-0.167
P27	-0.061	-0.056	0.097	0.022	0.037	-0.144	-0.014	-0.109	-0.144	0.002
P28	0.009	-0.052	-0.027	-0.034	-0.071	-0.029	0.013	0.043	0.048	0.098
P29	0.069	0.139	0.012	-0.079	-0.153	0.108	0.016	0.142	-0.050	-0.102
P30	0.006	0.033	-0.023	0.092	-0.054	-0.100	-0.183	-0.056	0.060	-0.039
P31	0.008	0.138	0.025	0.026	-0.185	-0.033	0.012	0.149	0.019	-0.047
P32	-0.006	-0.048	-0.073	0.128	0.047	0.210	-0.230	-0.084	-0.129	0.052
P33	-0.051	-0.100	-0.113	0.066	0.100	-0.090	-0.034	0.062	-0.026	-0.092
P34	-0.102	0.134	0.050	-0.045	-0.108	0.214	-0.030	0.001	0.177	0.031
P35	0.103	0.023	0.096	-0.133	-0.020	-0.167	-0.047	-0.055	0.059	-0.250
P36	0.066	-0.072	0.092	-0.151	-0.036	0.009	0.009	-0.092	-0.138	-0.043
P37	0.146	-0.049	0.007	0.034	-0.040	0.069	0.020	-0.017	0.117	-0.067
P38	-0.071	-0.172	-0.004	-0.017	0.105	-0.102	0.211	0.074	-0.241	0.084
P39	-0.057	-0.127	-0.139	0.101	0.137	-0.024	-0.266	-0.102	-0.126	0.051
P40	-0.226	-0.111	-0.151	0.046	0.073	0.097	-0.087	0.005	-0.077	-0.010
P41	-0.008	-0.109	0.080	-0.052	0.112	0.059	0.064	-0.137	-0.017	-0.002
P42	0.034	-0.111	0.048	-0.036	0.186	0.042	0.110	-0.127	-0.180	-0.028
P43	0.116	-0.048	-0.010	0.002	0.034	-0.020	0.008	0.020	-0.110	0.033
P44	-0.098	0.056	-0.168	0.072	-0.031	0.081	-0.126	0.046	0.059	0.072
P45	0.082	0.075	0.136	-0.089	-0.029	0.106	0.059	0.144	-0.093	-0.128
P46	-0.030	0.039	0.023	0.019	0.073	0.069	0.029	-0.227	0.061	-0.019
P47	-0.062	0.001	-0.078	0.065	-0.007	0.101	-0.057	-0.054	0.165	-0.015
P48	0.043	-0.014	0.014	-0.020	0.150	-0.106	-0.017	-0.244	0.053	-0.064
P49	-0.001	0.170	0.011	-0.018	-0.319	-0.121	0.161	0.163	0.009	-0.012
P50	0.086	-0.164	-0.093	0.021	0.008	-0.066	-0.038	0.005	0.073	0.105

Appendix D3

Variables	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30
P21	.964[a]									
P22	-0.285	.960[a]								
P23	-0.214	-0.085	.955[a]							
P24	0.012	0.087	-0.200	.936[a]						
P25	0.028	-0.150	-0.185	-0.410	.959[a]					
P26	-0.074	-0.089	-0.146	-0.185	0.137	.957[a]				
P27	-0.005	-0.114	0.227	-0.152	-0.142	-0.219	.961[a]			
P28	-0.156	-0.002	0.163	-0.130	0.005	-0.110	-0.095	.964[a]		
P29	-0.055	0.008	0.009	-0.166	-0.014	-0.065	-0.212	-0.030	.955[a]	
P30	-0.046	-0.047	-0.103	0.281	-0.089	-0.103	0.016	-0.129	-0.137	.955[a]
P31	-0.121	-0.023	-0.154	0.040	0.041	0.095	-0.019	-0.211	0.072	0.039
P32	-0.015	0.047	-0.060	0.130	-0.071	0.135	-0.087	-0.263	0.018	0.075
P33	-0.083	0.008	0.160	-0.155	0.160	-0.147	0.081	-0.077	0.084	-0.109
P34	-0.015	-0.089	-0.092	-0.028	-0.126	-0.094	-0.012	0.080	0.017	-0.209
P35	-0.079	0.173	0.048	0.104	-0.114	0.047	0.019	0.052	0.060	0.174
P36	-0.054	0.016	-0.049	0.101	0.001	-0.004	-0.054	0.019	0.061	-0.100
P37	-0.084	-0.014	-0.163	-0.040	0.000	0.040	-0.030	0.074	-0.043	-0.002
P38	0.097	-0.051	0.054	-0.220	0.056	-0.012	0.061	0.027	-0.074	-0.150
P39	-0.029	0.125	0.124	0.103	0.002	0.065	0.011	-0.114	-0.085	0.046
P40	0.036	-0.022	0.121	-0.145	0.056	0.013	0.045	0.095	0.051	-0.101
P41	-0.085	-0.071	0.090	-0.166	0.042	0.159	0.142	-0.099	-0.191	-0.195
P42	-0.027	0.017	0.076	-0.079	0.052	-0.068	-0.044	0.037	-0.046	-0.042
P43	0.067	0.079	-0.138	-0.135	0.070	0.091	-0.225	-0.174	-0.009	0.046
P44	0.072	0.025	-0.034	0.137	-0.067	-0.010	-0.216	0.062	0.002	-0.107
P45	0.010	0.012	0.032	-0.139	-0.026	0.068	0.021	-0.051	0.109	-0.057
P46	-0.027	0.079	-0.002	0.174	-0.227	-0.119	0.073	0.068	-0.108	0.042
P47	-0.030	-0.068	-0.019	0.007	0.029	0.067	-0.119	-0.014	-0.023	0.016
P48	-0.084	0.146	-0.085	0.103	-0.092	-0.157	0.090	-0.159	-0.026	0.151
P49	0.126	-0.072	-0.157	-0.021	0.056	-0.106	0.023	-0.128	0.099	0.012
P50	0.073	-0.037	0.024	0.064	0.066	-0.030	-0.024	0.128	-0.361	0.032

Appendix D4

Variables	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40
P31	.958[a]									
P32	-0.023	.956[a]								
P33	-0.133	-0.229	.963[a]							
P34	-0.141	-0.174	-0.134	.959[a]						
P35	-0.099	-0.089	-0.168	-0.117	.950[a]					
P36	0.024	-0.072	-0.085	0.082	-0.127	.961[a]				
P37	0.027	0.023	-0.138	0.199	-0.006	-0.176	.950[a]			
P38	-0.135	0.005	0.057	-0.148	-0.050	0.038	-0.418	.951[a]		
P39	0.008	0.113	0.049	-0.183	-0.048	-0.012	-0.361	-0.089	.962[a]	
P40	-0.246	0.161	0.196	0.099	-0.097	-0.113	-0.008	0.033	-0.023	.953[a]
P41	-0.087	0.047	0.090	0.004	-0.121	-0.022	0.023	0.066	0.014	-0.004
P42	0.017	-0.089	0.101	-0.068	-0.028	0.069	-0.051	0.091	-0.046	-0.145
P43	0.078	0.081	-0.113	-0.104	0.031	-0.010	0.090	0.110	0.010	-0.218
P44	-0.016	-0.029	-0.018	0.123	-0.107	0.127	-0.197	-0.117	0.100	0.031
P45	0.038	0.018	-0.063	-0.003	-0.063	-0.158	-0.038	0.052	-0.096	-0.045
P46	0.033	0.025	-0.092	-0.048	0.028	-0.023	0.123	-0.199	0.019	0.028
P47	-0.213	0.026	0.038	0.130	0.064	-0.114	0.142	0.010	-0.134	0.054
P48	0.047	-0.029	-0.047	-0.052	-0.045	-0.133	0.066	-0.066	-0.019	-0.044
P49	0.082	-0.181	0.034	0.115	-0.017	0.208	-0.057	0.009	-0.086	-0.096
P50	0.030	-0.082	0.004	-0.219	0.060	-0.075	-0.109	0.080	-0.005	-0.070

Variables	P41	P42	P43	P44	P45	P46	P47	P48	P49	P50
P41	.965[a]									
P42	0.082	.970[a]								
P43	-0.133	-0.112	.970[a]							
P44	-0.081	-0.175	-0.065	.969[a]						
P45	0.087	0.134	-0.052	-0.343	.965[a]					
P46	-0.007	-0.104	-0.077	0.001	-0.266	.958[a]				
P47	-0.029	-0.036	0.017	-0.060	-0.129	-0.195	.965[a]			
P48	-0.020	-0.009	-0.128	-0.064	0.052	0.052	-0.230	.972[a]		
P49	-0.123	-0.105	0.067	-0.082	-0.115	-0.220	-0.007	-0.161	.947[a]	
P50	-0.108	0.053	-0.027	-0.023	0.024	0.023	-0.071	-0.043	-0.326	.964[a]

Appendix E: Agglomeration Schedule with Ward Linkage (N=252)

Appendix E1:

Stage	Cluster Combined		Coefficients	Stage	Cluster Combined		Coefficients
	Cluster 1	Cluster 2			Cluster 1	Cluster 2	
1	231	232	0.000	51	138	146	1.117
2	228	231	0.000	52	17	135	1.285
3	226	228	0.000	53	229	244	1.455
4	222	226	0.000	54	141	178	1.626
5	212	222	0.000	55	107	142	1.808
6	215	216	0.000	56	167	168	1.993
7	204	215	0.000	57	97	187	2.180
8	201	212	0.000	58	217	251	2.368
9	205	211	0.000	59	68	98	2.570
10	110	205	0.000	60	5	81	2.780
11	203	204	0.000	61	230	240	2.995
12	198	201	0.000	62	79	80	3.225
13	191	198	0.000	63	21	115	3.461
14	182	197	0.000	64	42	195	3.707
15	186	191	0.000	65	247	252	3.953
16	175	186	0.000	66	11	15	4.223
17	163	175	0.000	67	23	99	4.497
18	156	163	0.000	68	5	127	4.773
19	125	156	0.000	69	203	223	5.055
20	153	155	0.000	70	138	236	5.338
21	132	133	0.000	71	229	250	5.642
22	123	125	0.000	72	52	87	5.951
23	112	123	0.000	73	166	246	6.271
24	114	117	0.000	74	65	193	6.606
25	111	112	0.000	75	192	202	6.943
26	94	111	0.000	76	6	97	7.281
27	103	104	0.000	77	1	189	7.621
28	102	103	0.000	78	18	165	7.966
29	100	102	0.000	79	47	241	8.343
30	86	94	0.000	80	120	234	8.723
31	91	92	0.000	81	9	16	9.107
32	83	86	0.000	82	151	157	9.513
33	67	83	0.000	83	57	136	9.923
34	54	67	0.000	84	78	237	10.335
35	26	54	0.000	85	72	126	10.751
36	32	41	0.000	86	56	84	11.170
37	3	38	0.000	87	71	145	11.590
38	11	36	0.000	88	2	55	12.034
39	13	32	0.000	89	119	199	12.481
40	5	26	0.000	90	64	141	12.936
41	217	239	0.027	91	31	35	13.398
42	12	58	0.054	92	217	249	13.868
43	27	85	0.115	93	106	170	14.342
44	5	62	0.178	94	69	101	14.841
45	7	30	0.266	95	39	181	15.355
46	161	185	0.373	96	27	65	15.870
47	240	245	0.488	97	7	173	16.394
48	166	171	0.631	98	25	192	16.918
49	27	53	0.785	99	21	137	17.444
50	110	209	0.949	100	3	34	17.977

Appendix E2:

Stage	Cluster Combined		Coefficients	Stage	Cluster Combined		Coefficients
	Cluster 1	Cluster 2			Cluster 1	Cluster 2	
101	208	224	18.513	151	120	208	63.055
102	74	207	19.050	152	45	132	64.487
103	95	116	19.589	153	73	106	65.955
104	22	31	20.137	154	11	134	67.425
105	68	109	20.695	155	68	177	68.896
106	20	76	21.271	156	19	159	70.385
107	17	107	21.848	157	166	242	71.897
108	132	174	22.443	158	89	128	73.476
109	28	29	23.046	159	24	40	75.074
110	159	248	23.651	160	6	176	76.686
111	230	247	24.265	161	5	91	78.304
112	4	14	24.891	162	50	188	79.939
113	139	140	25.527	163	2	44	81.662
114	75	148	26.167	164	59	71	83.480
115	79	88	26.815	165	8	139	85.328
116	82	179	27.486	166	42	72	87.269
117	56	213	28.179	167	153	238	89.252
118	91	235	28.885	168	17	23	91.308
119	73	138	29.620	169	147	169	93.378
120	12	150	30.359	170	214	243	95.452
121	11	90	31.108	171	143	200	97.552
122	44	70	31.883	172	19	49	99.725
123	144	210	32.663	173	162	184	102.000
124	49	217	33.473	174	52	161	104.314
125	169	233	34.300	175	25	46	106.639
126	60	121	35.144	176	167	220	108.980
127	149	152	35.996	177	221	225	111.343
128	11	113	36.882	178	9	130	113.749
129	166	230	37.783	179	8	78	116.184
130	43	182	38.711	180	68	73	118.647
131	64	77	39.654	181	3	108	121.151
132	5	194	40.616	182	42	120	123.657
133	221	227	41.597	183	20	64	126.266
134	151	160	42.583	184	39	149	129.038
135	46	66	43.631	185	89	164	131.823
136	69	122	44.690	186	196	206	134.618
137	164	183	45.762	187	4	5	137.428
138	79	219	46.855	188	50	61	140.310
139	1	154	47.961	189	51	143	143.202
140	159	218	49.072	190	9	63	146.239
141	72	82	50.196	191	20	56	149.286
142	7	27	51.369	192	93	105	152.374
143	23	57	52.553	193	131	162	155.584
144	12	74	53.747	194	68	158	158.850
145	17	21	54.976	195	22	42	162.150
146	18	28	56.265	196	39	151	165.450
147	56	95	57.581	197	17	25	168.795
148	144	172	58.921	198	110	129	172.167
149	79	229	60.281	199	12	119	175.619
150	4	47	61.653	200	144	166	179.189

Appendix E3:

Stage	Cluster Combined		Coefficients
	Cluster 1	Cluster 2	
201	147	221	182.923
202	43	89	186.791
203	7	75	190.747
204	10	153	194.791
205	20	79	198.985
206	20	60	203.204
207	37	203	207.647
208	180	196	212.103
209	13	114	216.742
210	1	45	221.501
211	51	110	226.277
212	24	131	231.281
213	33	147	236.617
214	19	214	242.068
215	18	69	247.609
216	51	124	253.463
217	6	52	259.346
218	9	68	265.257
219	118	190	271.255
220	2	7	277.409
221	11	22	283.901
222	4	17	290.561
223	19	144	297.981
224	20	59	305.532
225	24	50	313.443
226	1	39	322.445
227	12	48	332.111
228	2	4	341.891
229	8	11	352.191
230	37	93	363.940
231	9	18	376.301
232	33	51	388.942
233	1	167	401.656
234	118	180	414.469
235	24	43	429.129
236	6	12	445.222
237	33	96	461.729
238	19	20	478.606
239	1	8	497.003
240	3	19	517.742
241	2	9	540.109
242	24	118	562.965
243	2	10	590.222
244	2	100	619.343
245	1	6	651.222
246	13	24	688.833
247	13	33	742.590
248	2	3	798.045
249	13	37	1021.576
250	1	2	1256.894
251	1	13	2008.000

Appendix F: Cluster Membership (N=252)

Appendix F1

Case Number	Cluster	Distance	Case Number	Cluster	Distance
1	1	2.371	51	2	2.549
2	1	1.955	52	1	3.044
3	1	2.820	53	1	.742
4	1	1.138	54	1	.326
5	1	.326	55	1	1.770
6	1	3.794	56	1	1.650
7	1	1.528	57	1	1.144
8	1	2.428	58	1	2.701
9	1	1.861	59	1	2.177
10	1	3.355	60	1	2.305
11	1	1.880	61	2	3.055
12	1	2.626	62	1	.421
13	1	4.128	63	1	2.936
14	1	1.282	64	1	1.286
15	1	2.216	65	1	.672
16	1	2.039	66	1	1.888
17	1	.956	67	1	.326
18	1	2.231	68	1	1.146
19	1	2.461	69	1	1.755
20	1	1.988	70	1	1.701
21	1	.938	71	1	2.093
22	1	2.321	72	1	.894
23	1	1.258	73	1	1.190
24	1	3.251	74	1	2.997
25	1	1.262	75	1	1.278
26	1	.326	76	1	2.257
27	1	.214	77	1	1.710
28	1	2.880	78	1	2.630
29	1	2.033	79	1	1.773
30	1	1.156	80	1	1.201
31	1	1.405	81	1	.650
32	1	4.128	82	1	1.264
33	2	3.287	83	1	.326
34	1	2.071	84	1	1.113
35	1	2.001	85	1	.480
36	1	1.880	86	1	.326
37	2	4.281	87	1	3.557
38	1	2.820	88	1	1.695
39	1	2.873	89	2	3.110
40	1	3.262	90	1	1.961
41	1	4.128	91	1	.859
42	1	1.448	92	1	.859
43	2	2.831	93	2	5.984
44	1	1.513	94	1	.326
45	1	2.247	95	1	2.376
46	1	1.621	96	2	4.359
47	1	1.277	97	1	3.838
48	1	4.029	98	1	.834
49	1	1.650	99	1	.770
50	2	2.771	100	1	2.672

Appendix F2

Case Number	Cluster	Distance	Case Number	Cluster	Distance
101	1	2.041	151	1	2.412
102	1	2.672	152	1	1.934
103	1	2.672	153	1	2.645
104	1	2.672	154	1	3.115
105	2	6.561	155	1	2.645
106	1	1.180	156	1	.326
107	1	.717	157	1	2.260
108	1	2.989	158	1	2.182
109	1	1.559	159	1	1.982
110	2	.784	160	1	2.780
111	1	.326	161	1	3.417
112	1	.326	162	2	2.727
113	1	1.791	163	1	.326
114	1	3.448	164	1	2.817
115	1	1.179	165	1	2.354
116	1	2.155	166	1	1.770
117	1	3.448	167	1	2.537
118	2	3.761	168	1	2.320
119	1	3.884	169	2	1.581
120	1	1.364	170	1	1.414
121	1	1.622	171	1	1.505
122	1	2.518	172	1	2.100
123	1	.326	173	1	1.011
124	2	2.562	174	1	2.140
125	1	.326	175	1	.326
126	1	1.046	176	1	3.794
127	1	.582	177	1	2.047
128	1	2.911	178	1	1.736
129	2	1.901	179	1	1.478
130	1	2.035	180	2	2.552
131	1	3.288	181	1	2.278
132	1	2.047	182	2	2.236
133	1	2.047	183	1	2.765
134	1	1.932	184	2	3.054
135	1	1.103	185	1	3.532
136	1	.962	186	1	.326
137	1	1.253	187	1	4.000
138	1	.668	188	1	2.689
139	1	1.803	189	1	2.575
140	1	2.760	190	2	4.556
141	1	1.641	191	1	.326
142	1	.563	192	1	1.547
143	2	1.943	193	1	1.022
144	1	2.127	194	1	1.149
145	1	2.187	195	1	1.584
146	1	.723	196	2	2.226
147	2	2.474	197	2	2.236
148	1	1.896	198	1	.326
149	1	1.884	199	1	3.644
150	1	2.765	200	2	2.470

Appendix F3

Case Number	Cluster	Distance	Case Number	Cluster	Distance
201	1	.326	251	1	1.742
202	1	1.329	252	1	1.485
203	2	3.540			
204	2	3.540			
205	2	.784			
206	2	2.764			
207	1	2.382			
208	1	1.397			
209	2	.734			
210	1	1.960			
211	2	.784			
212	1	.326			
213	1	1.981			
214	1	3.405			
215	2	3.540			
216	2	3.540			
217	1	1.749			
218	1	2.054			
219	1	2.151			
220	1	2.617			
221	2	1.490			
222	1	.326			
223	2	3.240			
224	1	1.650			
225	2	1.882			
226	1	.326			
227	2	2.436			
228	1	.326			
229	1	1.428			
230	1	.912			
231	1	.326			
232	1	.326			
233	2	2.280			
234	1	1.480			
235	1	1.237			
236	1	1.174			
237	1	2.472			
238	1	2.867			
239	1	1.545			
240	1	.984			
241	1	.897			
242	1	1.603			
243	1	3.139			
244	1	1.684			
245	1	.674			
246	1	1.595			
247	1	1.463			
248	1	1.906			
249	1	1.698			
250	1	2.032			