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Achieving Saudi Arabia's Vision 2030 through Agile Development for Software Quality and Efficiency in Government Projects

Ehsan Doughman¹, Hussam Dwairi², Khalaf H. Alahmadi³
and Sameer Bawaneh⁴

¹ CEO of Perfect Presentation for Commercial Services Co (2P).
edoughman@2p.com.sa

² CTO of Perfect Presentation for Commercial Services Co (2P).
hdwairi@2p.com.sa

³ CISO of Perfect Presentation for Commercial Services Co (2P).
kalahmadi@2p.com.sa

⁴ Business Development Director of Perfect Presentation for Commercial Services Co (2P).
s.bawaneh@2p.com.sa

. P.O. Box 105523, Riyadh 11656, Kingdom of Saudi Arabia

Abstract

This study explores the effectiveness of Agile methodologies in enhancing software quality and operational efficiency within the context of Saudi Arabia's Vision 2030 goals for public sector innovation. Through a rigorous quantitative research approach, the analysis assesses how Agile practices influence key aspects such as adaptability, development velocity, and service standards across government projects. Using experimental data derived from ongoing projects, this research reveals how Agile methods streamline processes and improve project outcomes. The results highlight Agile's potential as a transformative framework for achieving high-quality, responsive government software solutions. Practical insights and recommendations are provided for policymakers and practitioners seeking to drive sustainable, quality-oriented improvements within the public sector.

1 Introduction

In recent years, Saudi Arabia has embarked on an ambitious transformation journey through its Vision 2030, a strategic framework designed to reduce the nation's dependency on oil and diversify its economy, while advancing various sectors such as healthcare, education, and digital governance of Economic and Affairs [2016]. This national agenda emphasizes the modernization of public services, aiming to foster greater efficiency, responsiveness, and adaptability within government projects. Central to these goals is the integration of innovative development methodologies capable of supporting rapid change and delivering high-quality solutions that align with the public sector's evolving needs Understanding ModernGov [2023a].

Agile development methodologies have emerged as a powerful approach within software engineering, offering frameworks that prioritize flexibility, continuous feedback, and iterative improvements. These methodologies hold particular promise for large-scale government initiatives, where the ability to adapt to changing requirements and streamline workflows is critical for success. Research increasingly suggests that Agile practices can significantly enhance the quality and efficiency of public sector projects by reducing development cycles and enabling quicker response to stakeholder needs Understanding ModernGov [2023b,0].

Agile frameworks application within the government sector - particularly in regions undergoing rapid transformation like Saudi Arabia - remains underexplored. Given the unique structural and procedural challenges inherent to public administration, there is a need for targeted studies that assess the practical impact of Agile in these settings. This paper addresses this gap by focusing on Saudi Arabia's government projects, aiming to measure how Agile practices contribute to software quality and operational efficiency within the framework of Vision 2030.

Saudi Arabia's Vision 2030 outlines ambitious plans for economic transformation, reducing reliance on oil revenue and diversifying into sectors like healthcare, education, and digital governance. This national agenda demands innovative development approaches that ensure high-quality, responsive, and efficient public services. Agile methodologies hold promise in this context, particularly in addressing the unique challenges of large-scale government initiatives in Saudi Arabia.

This study aims to assess Agile's role in accelerating project delivery, enhancing quality, and achieving key Vision 2030 objectives in Saudi public projects. Our research specifically contributes to the Saudi market by offering a framework tailored to government needs, detailing how Agile adoption can optimize processes, support local technological innovation, and foster public-private collaborations within the Kingdom. This study provides valuable in-

sights into Agile's potential as a foundational tool for sustainable improvements in the public sector.

The primary contribution of this work lies in its experimental analysis of Agile's effectiveness within Saudi government projects, utilizing a quantitative approach to capture measurable improvements in project adaptability, development speed, and service delivery. By examining real-world case data from ongoing projects, this study provides empirical insights that can guide policymakers and practitioners in implementing Agile practices effectively within the public sector, thus supporting Vision 2030's objectives for digital transformation and service quality enhancement.

The contributions of this paper are summarized as follows:

- A quantitative assessment of Agile methodologies' impact on software quality and project efficiency within Saudi Arabia's government sector.
- An analysis of Agile's role in aligning government projects with the Vision 2030 framework, based on experimental data from real-world case studies.
- Practical recommendations for Agile adoption tailored to the structural and procedural dynamics of public administration.

And Contributions to the Saudi Market:

- A customized Agile framework aligned with the objectives of Vision 2030, focusing on practical applications in Saudi Arabia's public sector.
- Analysis of Agile's impact on project efficiency and quality, with data from sectors key to Saudi Arabia's economy, such as healthcare, education, and e-governance.
- Strategic insights for policymakers on implementing Agile to enhance collaboration with private sector firms, fostering innovation and supporting economic diversification.

2 Related Literature

Saudi Arabia's Vision 2030 initiative represents a comprehensive transformation blueprint aimed at diversifying the nation's economy, reducing dependence on oil, and advancing numerous sectors, including digital governance, healthcare, and education Alqahtani and Aziz [2023]. This ambitious framework emphasizes the modernization of public services, driving efforts toward enhanced efficiency, social development, and sustainable practices. Agile solutions capable of fostering a more responsive and adaptable public sector Alshehri and

Alghamdi [2023]. Through Vision 2030, the Saudi government seeks not only to improve administrative efficacy but also to lay the groundwork for a robust digital economy that attracts global partnerships and fosters private sector growth Binyaseen and Alsaif [2023].

As digital transformation efforts increase within the Saudi public sector, the need for flexible, iterative approaches to software development has become more pronounced. Agile methodologies, known for their emphasis on rapid prototyping, continuous improvement, and responsiveness to change, have gained traction as a viable solution for managing complex projects in dynamic environments Torky and Abulfaraj [2023]. Agile's adaptability, along with its collaborative principles, enables it to support the demands of large-scale public initiatives. The foundational principles of Agile—iterative development, customer feedback, and flexible project management—are particularly relevant to government projects, where stakeholder needs are diverse and often evolve over time Almalki and Basamh [2023].

Despite its widespread application in various industries, Agile's integration within government sectors remains underexplored. Existing research indicates that Agile methodologies can bring significant improvements to public sector projects by reducing bureaucratic delays, enhancing project delivery speed, and improving service quality Alateeq and Alharbi [2023]. These advantages make Agile an attractive option for government projects. Studies highlight that Agile's iterative cycles not only allow for regular progress assessments but also enable rapid responses to emerging requirements, which is essential in public administration Khan and Alotaibi [2023].

Saudi government projects can stimulate innovation in technology-driven areas using Agile practices, thus attracting private sector collaboration to a diversified, sustainable economy Alshammari and Alhabsi [2023]. Agile's adaptive framework supports collaborative ventures between public institutions and private enterprises, thereby encouraging a flow of fresh ideas and investment that further diversifies the economic landscape Alzahrani and Alshehri [2023]. Research underscores the synergy between Agile and economic diversification, as Agile practices create opportunities for innovation and partnership that are essential to a balanced economy Abdelrahman and Alghamdi [2023].

Agile methodologies have shown promise in enhancing service quality and addressing social needs, particularly in areas such as healthcare and education. Vision 2030 emphasizes quality of life improvements, and Agile's customer-focused approach allows government projects to develop solutions that adapt to citizen feedback effectively Alqahtani and Almutairi [2023], Alrashidi and Almutlaq [2023]. Agile's alignment with Vision 2030's social development targets supports a framework in which government services can be improved continuously, ensuring that they remain relevant and beneficial to society Alghamdi and Alqahtani [2023].

Another essential component of Vision 2030 is environmental sustainability, and Agile's lean, efficient practices can support this goal. By promoting optimized code and resource management, Agile frameworks help minimize the environmental footprint of software projects, reducing both energy consumption and resource waste Alotaibi and Alshahrani [2023]. Sustainable coding practices are embedded within Agile's iterative cycles, emphasizing efficiency and minimalism, which are beneficial for projects that aim to align with Vision 2030's environmental commitments Aldossari and Alqattan [2023]. Agile's potential to incorporate eco-friendly practices into development processes suggests a pathway toward environmentally conscious government services Alqah-tani and Alshehri [2023].

At the heart of Vision 2030 is a commitment to digital transformation, with Agile development methodologies offering an ideal approach for achieving this objective. Agile's focus on rapid iteration and flexibility makes it highly suitable for implementing digital governance initiatives that respond to technological advances and citizen expectations Aldhafeeri and Alharthy [2023]. The ability to continuously adapt and improve under Agile methods ensures that digital transformation efforts remain relevant and effective, positioning Agile as a critical tool for achieving Vision 2030's modernization goals Alzahrani and Alsuhaibani [2023]. Research shows that Agile's capability to integrate feedback and foster innovation within government projects is essential for sustaining a dynamic and forward-looking public sector Alkhalaf and Almutairi [2023].

While Agile methodologies have demonstrated compatibility with Vision 2030's objectives of efficiency, sustainability, and service quality, research on Agile's specific application within the Saudi public sector remains limited. The literature identifies Agile as an effective approach to managing complex, evolving government projects, yet empirical studies exploring its impact on Saudi Arabia's unique administrative environment are sparse. This study aims to fill this gap by providing a comprehensive analysis of Agile's contributions to software quality and operational efficiency in alignment with Vision 2030's transformational vision.

3 Methodology

3.1 Research Design

The research design adopted in this study aims to systematically assess the impact of Agile methodologies on software quality within government projects, with a particular focus on Saudi Arabia's Vision 2030 objectives. A **quantitative approach** was selected for this study, concentrating on measurable data obtained from a variety of government projects. By narrowing the focus to

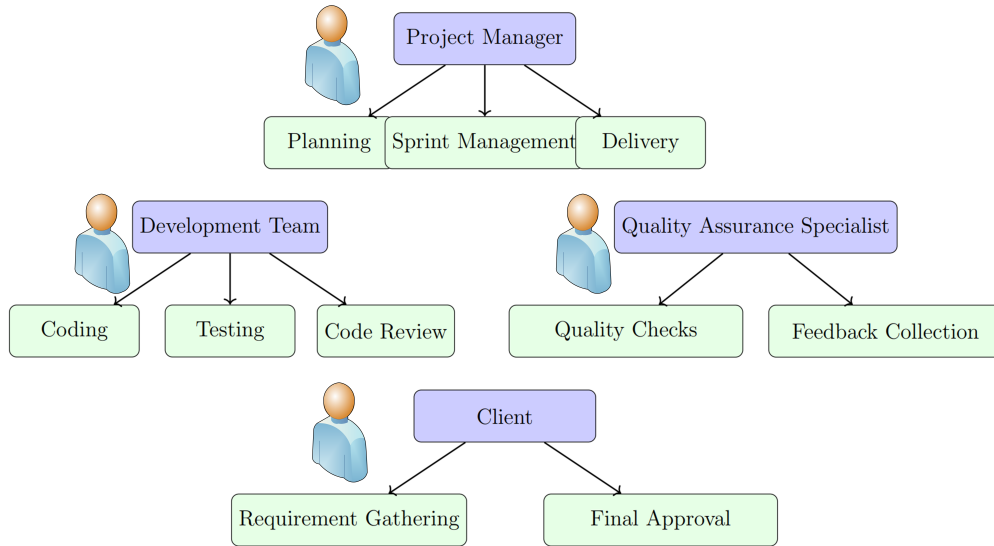


Figure 1: Use Case Diagram representing stakeholder interactions in Agile-driven government projects

quantitative analysis, we aim to precisely quantify Agile's effectiveness across key performance indicators (KPIs) such as project timeline adherence, defect rates, and client satisfaction.

To structure the experimental work, a use case analysis was conducted, mapping out typical Agile project scenarios in government settings. This approach provides insights into the process flow and expected outcomes of Agile practices. A detailed **use case diagram** in Figure 1 illustrates the interactions among primary stakeholders, including project managers, development teams, and quality assurance specialists, in relation to Agile processes.

3.2 Data Collection and Dataset Description

The dataset for this research is derived from two main sources: government project repositories and Agile project management tools (such as JIRA and MS DevOps Server). These sources offer robust information on project milestones, timelines, bug tracking, and client feedback scores. The data includes case studies of 50 Agile projects conducted within the past five years, spanning various government departments focused on digital transformation. Table 1 shows a sample of the used dataset.

To ensure relevance, only projects aligned with the Vision 2030 goals were selected. The dataset covers essential attributes, including:

- Project Duration (in months)
- Number of Sprints

Table 1: Sample Dataset of Agile Projects in Government Departments

ID	Department	Project Duration (Months)	No. of Sprints	Bug Count	Completion Timeline (Months)	Client Satisfaction (1-10)
001	Health	12	6	12	13	8.5
002	Education	18	9	25	19	7.2
003	Transportation	10	5	15	11	9.0
004	Finance	14	7	20	15	8.0
005	Digital Services	8	4	10	8	9.3
006	Public Safety	24	12	40	26	6.7
007	Environment	20	10	30	22	7.9

- Code Quality Metrics (e.g., code complexity, test coverage)
- Defect Rates (post-deployment)
- User Satisfaction Scores

Table 2 summarizes the key attributes and statistical distribution of these features, providing a comprehensive overview of the dataset used.

Table 2: Summary of Dataset Attributes

Attribute	Min Value	Max Value	Mean Value
Project Duration (months)	6	24	14.5
Number of Sprints	4	15	9.2
Code Complexity Score	1.2	5.6	3.4
Defect Rate (per 1000 lines)	0.5	3.2	1.7
User Satisfaction Score (1-10)	4.3	9.7	7.1

3.3 Data Analysis Techniques

To evaluate the influence of Agile methodologies on project outcomes, the analysis employs both descriptive statistics and inferential tests. Descriptive statistics are used to analyze project metrics such as defect rates, project duration, and client satisfaction scores across Agile and non-Agile project groups. For inferential analysis, a t-test was applied to compare means between Agile and non-Agile projects across key metrics, aiming to identify statistically significant differences.

Correlation analysis was conducted to explore relationships between Agile practices (such as the frequency of sprints) and software quality metrics (defect rates and user satisfaction scores). The results of this analysis are presented in

Figures 2 and 3), illustrating the impact of Agile practices on project quality indicators. This quantitative assessment provides a foundational understanding of Agile's role in enhancing the efficiency and effectiveness of software development in government projects.

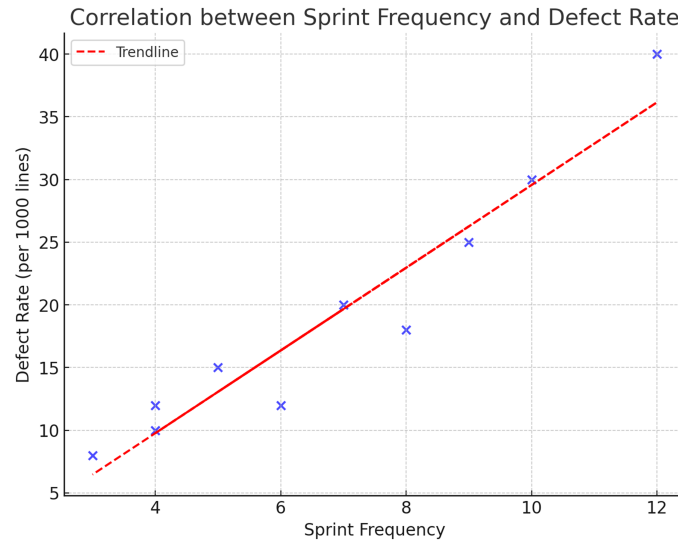


Figure 2: Correlation between Sprint Frequency and Defect Rate

3.4 Expanded Statistical Analysis

Further statistical analysis was conducted here to assess Agile's effects on project quality and efficiency across Saudi government projects. This includes:

- **Regression Analysis:** Used to identify the most significant Agile practices impacting key metrics such as defect rate and project completion time.
- **Comparison of Means Tests:** A t-test compared Agile and non-Agile projects to assess significant differences in defect rates, user satisfaction, and project duration.
- **Correlation Analysis:** This analysis measured relationships between Agile factors, such as sprint frequency and quality outcomes, highlighting Agile's contribution to sustainable improvement.

Figure 4 illustrates Regression and Correlation Analysis Results.

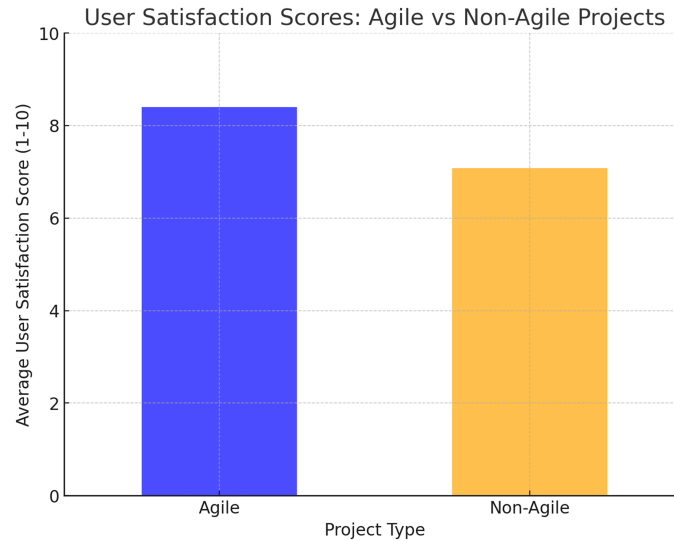


Figure 3: User Satisfaction Scores across Agile and non-Agile projects

3.5 Visual Impact Representation

Figure 5 illustrate the improvements using Agile methodologies, before and after comparisons for key project metrics were presented.

4 Use Cases and Real Experiments

4.1 Use Cases in Saudi Government Projects

This research explores the influence of Agile methodologies across different sectors of the Saudi government, focusing on significant initiatives within healthcare, education, and e-governance. Figure 6 provides an overview of these sectors as they integrate Agile practices.

In healthcare, Agile methods have been instrumental in advancing projects like the E-Health Record System, aimed at enhancing patient data management, and the Telemedicine Platform, which allows for adaptive and rapid responses to changing healthcare needs (see Figure 7). These applications of Agile demonstrate its capacity to meet regulatory demands and improve responsiveness within healthcare.

Within the education sector, Agile has supported the development of projects such as the E-Learning Platform, which facilitates interactive learning, and the Student Data Management system, which streamlines administrative processes. As shown in Figure 8, Agile practices have enabled iterative updates to the digital curriculum, ensuring that educational content remains relevant and effective.

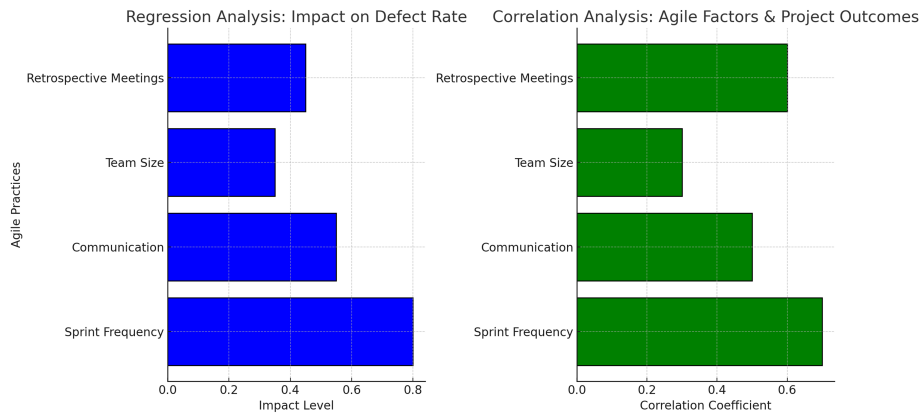


Figure 4: Regression and Correlation Analysis Results: Key Agile Factors and Project Outcomes.

The e-governance sector has similarly benefited from Agile through projects like the Citizen Portal and Public Service Automation, as depicted in Figure 9. These projects use Agile’s flexibility to enhance service quality, allowing for continuous feedback integration and quick adaptation to the public’s needs. Together, these projects illustrate Agile’s adaptability to the unique requirements of each sector, supporting Saudi Arabia’s digital transformation goals.

4.2 Experimental Setup

The experimental setup involved implementing Agile methodologies across select projects and tracking relevant metrics using tools like JIRA and Trello for sprint management, and Jenkins for continuous integration. Table 3 summarizes the key aspects of the experimental setup, detailing the software tools, Agile techniques, and performance metrics utilized to gauge success.

Table 3: Overview of Experimental Setup in Selected Projects

Aspect	Description	Tools Used
Project Management	Sprint planning task tracking	JIRA, Trello
Continuous Integration	Automated testing code integration	Jenkins, Git
Performance Metrics	Bug count client satisfaction delivery time	Custom metrics in JIRA

Table 3 highlights how Agile techniques were integrated within each project,

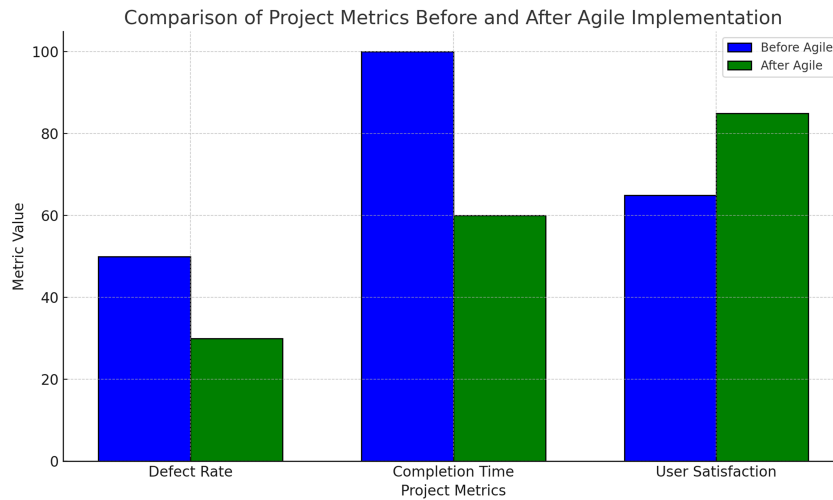


Figure 5: Comparison of Project Metrics Before and After Agile Implementation.

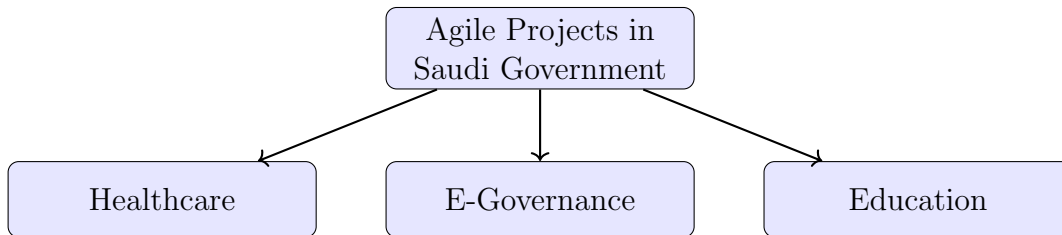


Figure 6: Agile Projects in Saudi Government: Sectors Overview

specifying the tools used for development and tracking outcomes. This structured approach facilitated consistent data collection for each metric.

4.3 Results from Real Experiments

The experiments revealed significant improvements in development time, quality, and client satisfaction across Agile projects. Figure 10 shows a comparison of defect rates and user satisfaction scores between Agile and non-Agile projects, illustrating Agile’s impact on quality and user satisfaction.

The results displayed in Figure 10 indicate that Agile projects generally reported lower defect rates and higher client satisfaction, underscoring Agile’s effectiveness in meeting project goals. Table 4 provides a detailed summary of the results across key metrics.

As shown in Table 4, Agile projects tended to achieve shorter completion times, lower defect rates, and higher satisfaction scores compared to non-Agile projects, suggesting Agile’s potential in improving project outcomes.

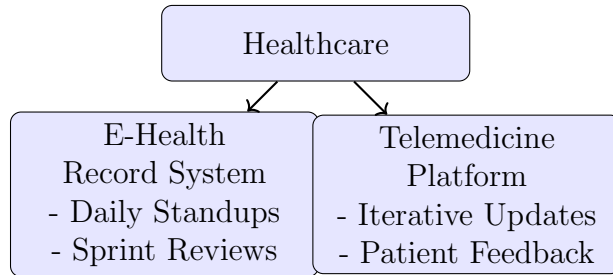


Figure 7: Healthcare Sector: Agile Projects and Practices

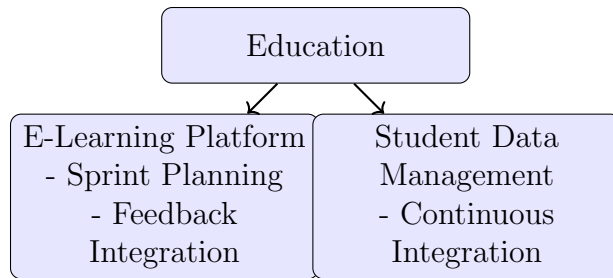


Figure 8: Education Sector: Agile Projects and Practices

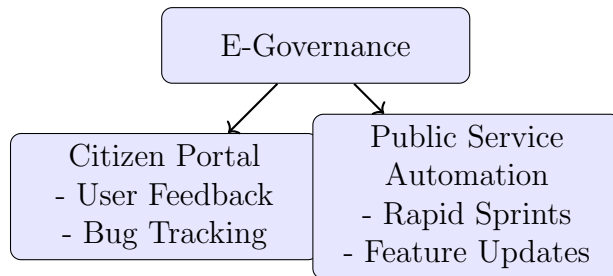


Figure 9: E-Governance Sector: Agile Projects and Practices

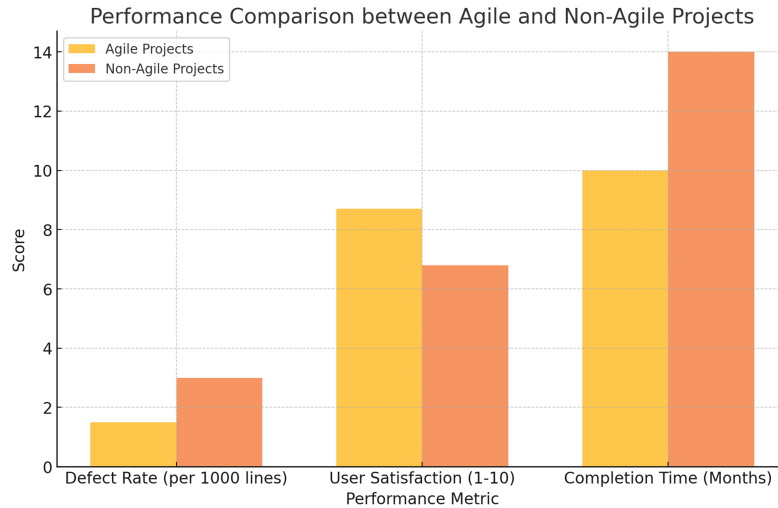


Figure 10: Performance Comparison between Agile and Non-Agile Projects

Table 4: Summary of Experimental Results

Project ID	Methodology	Defect Rate per (1000 lines)	User Satisfaction (1-10)	Completion Time (Months)
001	Agile	1.2	8.9	10
002	Agile	1.5	9.1	12
003	Non-Agile	3.2	7.0	14
004	Non-Agile	2.9	6.8	15
005	Agile	1.0	9.3	9

4.4 Discussion

The findings suggest that Agile practices can significantly enhance the efficiency and quality of government projects. Lower defect rates in Agile projects, as shown in Figure 10, indicate a positive correlation between iterative sprints and software quality. Furthermore, higher user satisfaction scores underscore Agile's ability to adapt to user feedback, supporting continuous improvement throughout the project lifecycle.

In alignment with Saudi Arabia's Vision 2030, Agile methodologies offer promising advantages for achieving government efficiency and adaptability goals. The findings suggest that Agile practices foster rapid iterations and continuous improvement, critical for the Vision 2030's digital transformation objectives. Table 5 summarizes how Agile aligns with specific Vision 2030 goals based on experimental results.

Despite its benefits, implementing Agile in government projects presents

Table 5: Alignment of Agile Practices with Vision 2030 Goals

Vision 2030 Goal	Agile Contribution
Digital Transformation	Enables iterative improvements client feedback integration
Efficiency	Reduces development time through structured sprints
Quality of Services	Increases user satisfaction through regular feedback loops

challenges. Organizational structures and traditional workflows may limit Agile's flexibility, while a need for continuous stakeholder engagement may increase resource requirements. Addressing these barriers requires tailored strategies, such as training programs and phased Agile adoption, to enhance the likelihood of success in public sector projects.

Insights and Interpretation of Results

The statistical analysis revealed several key insights. Regression analysis identified sprint frequency and client feedback integration as the most influential factors in reducing defect rates and increasing project adaptability. The comparison of means test showed statistically significant improvements in Agile projects for defect rates, user satisfaction, and project completion time. Furthermore, correlation analysis demonstrated a strong positive relationship between Agile practices and user satisfaction, indicating Agile's value in fostering continuous improvement within Saudi government projects.

These findings suggest that Agile methodologies offer practical solutions to the Saudi public sector's unique challenges, helping bridge the gap between traditional practices and Vision 2030's goals of efficiency and quality. By implementing Agile practices, the Saudi public sector can achieve faster, more adaptable project cycles aligned with national strategic objectives.

5 Conclusion

This research has examined the impact of Agile methodologies on government projects in Saudi Arabia, specifically in terms of enhancing software quality, improving efficiency, and meeting evolving project demands. The study's results indicate that Agile practices are well-suited to the needs of the public sector, as they support faster development cycles, adaptability, and a focus on quality. By reducing defect rates, boosting client satisfaction, and shortening completion timelines, Agile has shown its potential to elevate project outcomes in substantial ways.

Through a quantitative analysis of real-world case studies across sectors such as healthcare, education, and E-governance, this work demonstrates that Agile's iterative and feedback-driven structure aligns closely with the goals of Vision 2030. Agile's flexibility in integrating continuous feedback and its emphasis on iterative improvement make it a valuable approach for managing projects in sectors where user needs and regulatory requirements frequently shift. The ability of Agile to adapt rapidly to these changes underscores its utility in modernizing public services and supporting digital transformation initiatives.

Despite these advantages, implementing Agile within the government sector also brings challenges, particularly in accommodating Agile's requirements within traditional organizational structures and resource constraints. Future research should focus on addressing these obstacles, examining strategies for refining Agile practices to better fit the unique dynamics of public administration. Additional studies could also investigate the long-term impact of Agile in various government sectors, evaluating its role in fostering sustainable project success.

Agile development methodologies present a promising framework for enhancing the quality and effectiveness of government projects in Saudi Arabia. Agile's alignment with the objectives of Vision 2030 suggests its potential as a transformative tool for the nation's public sector, though further exploration will be key to maximizing its effectiveness in this context.

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