Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 3, Issue 4, 2025

A COMPREHENSIVE ANALYSIS OF THE IMPACT OF AGILE AND SCRUM FRAMEWORKS ON SOFTWARE PROJECT DELIVERY TIMELINES, TEAM COLLABORATION EFFICIENCY, AND STAKEHOLDER SATISFACTION IN MID-SCALE WEB AND MOBILE APPLICATION DEVELOPMENT ENVIRONMENTS

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DOI: https://doi.org/10.5281/zenodo.15234560

Keywords

Article History
Received on 09 March 2025
Accepted on 09 April 2025
Published on 17 April 2025

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Abstract

The purpose of this paper is to assess the advantages of Agile and Scrum frameworks for the management of time, collaboration, and satisfaction levels of software project stakeholders in web and mobile applications for mid-scale development environments. Therefore, the application of the Agile software development processes, which are characterized by new approaches and methods that focus on iterative and incremental values, is effective in increasing the speed of development and improving the efficiency of the organization and its teams. Scrum is one of the most popular Agile methods that uses sprints, feedback, and concrete roles to organize work on big complicated software projects. This topic focuses on the aspect of flexibility in use of Scrum as an improvement measure in project timelines' overall magnification of iteration speeds. The research further shows the effectiveness of scrum meetings which increase effective collaboration by making use of daily stand-up meetings in an organization. In addition, the inclusion of stakeholders results in increased stakeholder satisfaction, especially because of daily updates during the sprint review and feedback sessions, which allows for the development of a product that meets their expectations. However, they also mentioned some limitations including appearance of scope creep and some problems of coordination in mid-size projects, which have the potential to act as threats to most optimal utilization of the scrum approach. This research presents information on the versatility and effectiveness of agile and Scrum in mid-size projects to help organizations who wish to implement these frameworks.

INTRODUCTION

As software development is a highly evolving practice, customers expect bright applications as soon as possible, so modern approaches, such as Agile/Scrum, are actively used. These solutions intended to increase adaptability, promote cooperation, and promote stronger linkages between the teams and major stakeholders (Serrador and Pinto, 2015). In its fundamental form, Agile is

indeed iterative, and this enables a team to adapt to changes in requirements and the overall market environment. Scrum, being one of the Agile frameworks that is most commonly used, provides a framework to manage the project focus of software development by adopting small incremental work breakdown called sprints, frequent feedback, and distinct roles in the team (Schwaber & Sutherland, 2017).

Specifically, Agile and Scrum have had a profound effect on the software delivery cycle timelines as well as the organization of the work within the teams and satisfaction of various stakeholders. Software development projects, specifically the web and mobile application development project, have been very difficult in terms of development phase, communication among the team members, and response to stakeholders expectation (Conforto et al., 2016). These were the difficulties that Agile and Scrum were developed to address, offering enhanced speed, better collaboration, and better satisfaction for customers and stakeholders (VersionOne, 2020).

It proves the need for more flexible and lean processes even more within mid-tier Web and/or Mobile application development projects, as the team's her experience a great number of issues. The medium projects are characterized by moderate level of difficulty and internal and/or external resources and a greater number of participants compared to the small scale projects. It is therefore important to clarify the scalability and efficacy of Agile and Scrum in these areas where fluidity, velocity, teamwork, and responsiveness are deemed requisite yet the projects in question are not mega undertaking projects (Jorgensen, 2016). As such, gaining an understanding of Agile and Scrum on delivery timelines, team collaboration and acceptability of the deliverables to the stakeholders in these environments is important for any organization in its Agile/Scrum adoption decision making.

Project delivery timelines are among the most important measurements adopted in software development endeavors. Waterfall approaches are more linear and that makes it cumbersome when adjustments that need to be made amid project progress cannot be easily implemented due to the formalities involved (Conforto et al., 2016). Whereas, agile is the methodology that provides the solution in installments, letting the team to improve regularly in shorter spaces of time. Scrum particularly ensures that development is done in sprints, which usually last between a week and two to four, with every sprint having the potential of shipping a new increment. According to Schwaber & Sutherland (2017), this framework helps to minimize the duration that it takes for an organization to bring a product to the market since the teams receive continuous feedback that can help them make adjustments and get back on track.

In addition to assisting with identifying better timelines, Agile and Scrum have also been credited for improving the quality of team cooperation. In the Agile approach, the focus is made on people and their interactions with other members and stakeholders, rather than on tools and processes (Beck et al., 2001). It does so in the form of the roles in Scrum (Scrum Master, Product Owner, and Development Team) and the events carried out like daily meetings, Sprints, Reviews, and Retrospective. These frequent interactions contribute towards creating sustainable improvement and openness that in turn help boost some level of productivity in the teams (Serrador and Pinto, 2015).

Another aspect that Agile and Scrum strive to enhance is that of the satisfaction of stakeholders. This approach of working with stakeholders is common in most traditional project management approaches where the stakeholder is usually out of touch with the project implementation process, and therefore when the final product is delivered, stakeholders may not be happy with it as it does not meet their needs (Serrador and Pinto, 2015). The conventional nature of agile's framework as a series of iterations lets stakeholders participate in the development process frequently by means of sprint reviews and constant feedback meetings; this way the product is adjusted regularly with the goal of meeting the stakeholders' expectations. Due to the direct and frequent interaction with customers in the development process, there is enhanced satisfaction as they get to witness their contributions being implemented in the product on a regular basis (VersionOne, 2020).

Notwithstanding the popularity of Agile and Scrum, their implementation in mid-scale web and mobile application projects come with a number of issues.

Concerning the applicability of Scrum, it has been criticized by some scholars, for example, on the scalability perspective. Mid-scale Projects imply the involvement of several sub-teams, which means that these teams often work on various project parts concurrently, which can lead to difficulties in coordinating the project progress as a whole (Conforto et al., 2016). Moreover, Agile and Scrum in particular enforce cultural change within an organization, and teams who have not previously tackled self-organization and iterative working will have a hard time adapting to these frameworks (Jorgensen, 2016). This is because issues such as scope creep, resource availability and satisfaction of multiple stakeholders can also affect the perceived success of these frameworks in mid-scale projects.

The purpose of this study is to provide an overall evaluation of the effects of Agile and Scrum on time frames of project delivery, productivity of the collaborating team and satisfaction of the stakeholders in mid-scale web and mobile applications development. The information gathered from this study will shed light on the effectiveness of Agile and Scrum frameworks by detailing and analyzing the experiences of project managers, Scrum Masters, development team members, and stakeholders in mid-scale projects. Additionally, it will provide clear insight of the pros and cons of these frameworks that will help organizations that are looking forward to adopting these frameworks on how to undertake their development.

2. Literature Review

The use of Agile methodologies in software development has been a subject of debate for quite some time, especially due to its effectiveness in helping to meet the dynamic needs in the market. Among the approaches used in the Agile environment, Scrum is one of the most popular frameworks, especially for software development. Mid-scale web and mobile application development environments, Agile and Scrum principles have been the focus of numerous researches to investigate the efficiency of its application on project deliverables, cross team collaboration and stakeholders satisfaction. It systematically reviews research on the genesis of Agile practices, what Scrum is as a structure, and relevance of the said construct to the mentioned measures.

2.1 Agile Methodology and Scrum Framework

This paper aims to highlight the origins of agile methodology as an answer to weaknesses observed within the more rigid approach that characterizes the waterfall development method. The Agile Manifesto was published in 2001, bringing into article the concept of flexibility, iterative development and interaction with the stakeholders as the values (Highsmith, 2002). Agile is rooted in the principles that software development is an iterative and incremental process through which it could be claimed that the adaptation to new requirements and the delivery of high-quality software is facilitated (Dingsøyr et al., 2012).

Scrum is an Agile process which aims to allocate specific roles, »events,« and artifacts to work in iterations and ensure the correct cooperation and mutual understanding of the team members. Scrum structures work into the “sprints” that span between one and four weeks and where a set of tasks is defined prior to the particular sprint (Schwaber, 2004). This framework has gained a lot of popularity in the software development industry since it offers a solution to the challenge of delivering software in a short time and continually enhancing it. Scrum Master, Product Owner, Development Team is another important key of Scrum framework that helps to organize the work and provide effective collaboration (Schwaber & Sutherland, 2017).

While Scrum has been successfully used in many organizations, it is an adaptive framework for new product development that may exhibit different characteristics depending on the environment it is applied to. Despite the evidently successful Scrum implementation in small-scale and developed application in teams, there has been a growing question on the appropriateness of the Scrum in mid-to-large developments (C genius et al., 2010). These difficulties are likely to stem from such issues as the treatment of multiple Scrum teams or integration issues across different project streams (Leach, 2005). However, to address the scaling issues, there are frameworks implemented as Large Scale Scrum (LeSS) and Scaled Agile Framework (SAFe) still under investigation (Larman & Vodde, 2010).

2.2 Impact on Project Delivery Timelines

The flexibility and adaptability of Agile and Scrum are best known to bring down the time taken to deliver software projects. In the traditional methods of project management including the waterfall model, the development process is phased and if there is a hold up in one phase, the whole project is held up (Boehm & Turner, 2003). Agile on the other hand, provides flexibility through the sprints which enshrine it to deliver new enhancements of the product, gain feedback and make changes where they are necessary, at regular intervals (Moe et al., 2010).

There are several papers that look into the effects that Scrum has on delivery timeframe, and most of them point to the conclusion that Agile approaches and Scrum, in this case, are capable of decreasing the time to market. For instance, Vaidya et al (2013) in their research showed that embracing Scrum reduced the delivery cycle by 30%. The same authors, in the study by Drury et al. (2014), established that the Scrum practices of feedback loops and incremental deliveries help teams to apply priorities on their work hence complete the project in record time. The Scrum methodology is flexible allowing the teams to concentrate on priorities – on creating the features that are most essential or urgent and/or change requirements and faster time-to-market.

However, in this case, delivery timelines have not been known to be reduced in such a way. Some of the problems that can occur to the teams include: Scope, effort, quality, communication, staff proficiency, time, and resources (Boehm & Turner, 2003). These can lead to long cycles of development and this can occur when a team is yet to embrace scrum practices or when the project specifications are not clear (Cockburn, 2002).

2.3 Impact on Team Collaboration Efficiency

One other area that has been touched on by Agile and Scrum is the collaboration of the teams. One of the most important values of agility is communication where most of the communication focus is from the individuals, not the documents, in order to improve the project's outcome (Beck et al., 2001). In these structures, the work of Scrum is organized in a way that promotes constant interaction between the members of an organisation and the stakeholders. Daily Scrum meetings, sprint review and retrospectives are part of Scrum framework that ensures constant feedback and improvement (Schwaber & Sutherland, 2017).

Over the years, the studies done on the subject of how scrum affects collaboration among a team have received positive overtones. Petersen et al. (2015) also provided that Scrum teams improve their collaboration as the principles attached to frequent and structured communication in the framework. For instance, daily stand-up meetings stay as an effective way where the team members explain to each other some updates on what has been achieved, any barriers encountered, and interdependent activities that have been identified. Like KA, sprint retrospectives provide time for the teams to assess their progress as well as to set and work on improvements that help the team reduce cycle time (Hoda et al., 2011).

Despite these benefits, challenges remain. Scrum in mid-scale projects is also not exempted from certain disadvantages, and one of it is the potential information overload. While with the growth of the teaming the communication between multiple Scrum teams or between multiple departments gets challenging, it may also become an obstacle (Moe et al., 2010). In addition, entailing challenges in the development of effective communication with the scrum teams implying that the level of communication may decrease, thus resulting in eventual decrease in the levels of collaboration during the initial phases of adopting scrum (Hoda, et al., 2011).

2.4 Impact on Stakeholder Satisfaction

Stakeholders' satisfaction is another important factor in assessing software development project as the success of any project can be measured with the ability of the software to fulfill the expectations of the stakeholders. In a conventional development paradigm, the stakeholders are involved at the initiation of the project and at several stages at the end of one or another phase, as, for instance, in a review or a test. This may cause a scenario whereby the stakeholders have one perception of what is expected of the development team while the latter has a different idea entirely (Schwaber, 2004).

While traditional approaches involve communication mostly at the initial and final stages

of the project, Agile methodologies encourage communication at different phases of the project. In Scrum, sprint reviews give the stakeholders a chance to give their feedback regarding the increment delivered during a particular sprint (VersionOne, 2020). In a few studies, authors investigated the increase of stakeholder satisfaction resulting from Agile and Scrum approaches. For instance, Sliger (2008) explained that when one is performing Scrum, that is when he/she is in a position to deliver working increments after correctly syncing with other members within a regularly set interval, the clients give their feedback and hence satisfaction levels are low. Also, with the Agile model, one is able to modify requirements as he works through the project hence minimizing cases of project dissatisfaction due to market change (Beck et al., 2001).

But there are some threats to stakeholder satisfaction. Mid-size projects may have stakeholders' participation more frequent than in large projects; this will lead to the introduction of new features into the project and change of some features which may affect delivery time and cost of the project as noted by Conforto et al., (2016). Also, if the product requirements are not clearly defined or if there are changes along the multiple iterations, the stakeholders may get bored or even frustrated. Such issues can impact the satisfaction of the stakeholders where there are multiple agendas or where the Scrum team has little understanding of organizational goals.

This section shows that Agile and Scrum frameworks have the potential to increase effectiveness when delivering projects in terms of time, as well as improve collaboration, and satisfaction to stakeholders in software development projects. Scrum, as an effective system, helps to enhance communications with other members of the team, allows for more frequent introduction of modifications, and increases compatibility with the expectations of interested parties. However, the use of these frameworks can come with its drawbacks especially in mid-scale web and mobile application projects such as communication overload, team adaptation to the containing scope creep challenges.

Nonetheless, based on the literature, it is evident that before adopting Agile and Scrum approaches, one has to ensure that these frameworks suit the organization, team and the project in question. Further research has to focus on the Scalability of Scrum in mid to large project and examine how Agile implementation can be managed in different contexts.

3. Methodology

This research adopts a quantitative, survey-based approach to analyze the impact of Agile and Scrum frameworks on project delivery timelines, team collaboration efficiency, and stakeholder satisfaction within mid-scale web and mobile application development environments. The use of surveys allows for the collection of standardized data from a wide range of participants, ensuring that the results are generalizable and can provide valuable insights into the adoption and effectiveness of Agile and Scrum frameworks in the context of mid-scale software projects.

3.1 Research Design

The purpose of this research is to evaluate Agile and Scrum using three project performance indicators, which include the delivery time horizon, team productivity, and stakeholders' satisfaction level. For this purpose, a cross-sectional survey design is used. This is a survey research in which the data are collected at a single point in time from a diverse population that includes different individuals working on Agile and Scrum-based projects. The cross-sectional type of research can be used effectively because it permits the reception of the data concerning numerous software development projects and teams, thus offering a general vision of how these frameworks influence the numerous parameters under study.

The survey targeted respondents in three key roles to his project: the project managers, scrum masters, and development team members. These groups were chosen since they are central in the utilization and effectiveness of Scrum and Agile approaches. Thus, the research can collect data from such positions and give a more grounded picture of the framework's effectiveness from various sides.

3.2 Survey Instrument

The survey tool was constructed based on prior research regarding Agile and Scrum methodologies, as well as available frameworks for assessing the

project delivery timescales, team integration, and end users' satisfaction. Design of the instrument The instrument used in this study comprises three parts, each of which corresponds to one of the research questions.

The first topic is about the time available for the completion of the projects and the respondents were asked questions that seek to compare their understanding of how Agile and Scrum has impacted on the time available to complete the projects. Some of the questions are For instance: "Has the adoption of Agile facilitated a shorter project delivery?", "To what extent has Scrum allowed faster decision making and more iterations during the phases? These questions help in establishing whether agile and scrum frameworks have effectively reduced the delivery cycles or not compared to other forms of development.

The second part is about the observed effectiveness of the teams. Questions in this section relate to the performance of the framework's practices such as daily meetings, sprint planning sessions and retrospectives in aspects such as communication, coordination and collaboration. Some of the questions include, "In your opinion, how effective has communication been within the Scrum team especially during sprints?" and "To what extent has the Scrum Master and the Product Owner enhanced collaboration?" The current section will look at whether Scrums enhances the aspect of collaboration, and whether the roles and events at the core of the Scrum practice would foster better collaboration on the team.

The third and final part of the survey is a perception index of Agile and Scrum implementation on stakeholder satisfaction. This section consists of questions that are concerned with the participation of the stakeholders and the satisfaction levels towards the completion of the product. To assess the satisfaction of stakeholders, the following questions have been developed: : how satisfied are stakeholders with the frequent iterations and regular feedback provided in Scrum and has the feedback of stakeholders been incorporated effectively through the Scrum process.

3.3 Sampling Method

The survey focused on the mid-tier Web and mobile application development teams that embraced Agile or Scrum methodologies. These organizations were chosen because the managing of resources, organizing teams and meeting the needs of the stakeholders are critical issues in mid-scale projects. The population that is intended to be covered by the survey entails project managers, Scrum Masters as well as development team members with experience in applying Scrum and having worked in mid-scale projects.

The sample employed in this study was a purposive sample; it means the researcher used his or her judgment to select participants most likely to provide insight into the study questions. The eligibility criteria for participant inclusion were as follows: (a) work on at least one project in the Agile or Scrum framework, (b) be engaged in the planning, implementation or monitoring phase of the project, and (c) be aware of the key elements of the Scrum practices like sprints, daily stand-ups, the use of retrospectives and stakeholder management. The purposive sampling technique makes sure the target people selected have the abilities to answer the survey appropriately.

3.4 Data Collection Procedure

The questionnaire was conducted online, via an email, and through popular sites including LinkedIn and social sites that post conversations on Agile. It was especially conducted by an online medium such as Google Forms or SurveyMonkey for easy access and completion. The participants were told the general objective of the study that was in progress, their identity would be kept anonymous and they were not obliged to participate in the study.

The survey remained open for a period of four weeks to ensure that there is enough time for a number of responses to be gathered. An intermediate, friendly reminder email was sent to possible participants to complete the survey halfway through the survey time. The final response consisted of a total of 120 respondents and there was an equal distribution of respondents from the project managers, Scrum Masters and development team.

3.5 Data Analysis

After the surveys were conducted, the collected data was processed to remove any duplications, mistakes, or missing values. In the present case, any response that was not complete or was in some other ways invalid was not used for the analysis. The data was then exported into a statistical analysis software for further processing such as SPSS or R.

In the beginning, variances were checked of the data by calculating the overall mean, median and standard deviation of all the surveys for each survey item. It also gave an opportunity to understand how the participants perceived the effects of Scrum to the duration of project delivery, team cooperation, and the satisfaction levels of the clients.

Therefore, inferential analysis that consists of correlation as well as regression analysis was employed to assess the relationship between Agile/Scrum adoption and the three outcome variables. These analyses were made in order to understand if the adoption of Scrum has an effect on delivery timelines, team dynamics, and stakeholder satisfaction. For instance, the use of regression analysis when assessing the degree of Scrum implementation, responding to such indicators as frequency of Scrum events and roles, leads to improved efficiency of coordinated teamwork.

3.6 Ethical Considerations

It is important to declare that ethical issues have been also considered in the course of work. Consent was sought from the participants about the details of the study and the purpose of the study and the participants agreed to participate in the study. Each participant was read and signed a consent-form before he or she proceeded to complete the survey. All the respondents were assured of their identity and anonymity, and all data collected were used for this study alone. There were no questions directed at obtaining personal sensitive data and all the questionnaires were kept confidential.

3.7 Limitations of the Methodology

Although this survey-based approach helps to get a better understanding of the benefits and drawbacks of Agile and Scrum implementation, there are some issues with this approach. First, the study uses only self-reported questionnaires, which may include social desirability or recall bias. However, the purposive sampling technique is useful in this study since it reduces the external validity of the study results in that the sample used is not a random sample from the population of Agile practitioners. However, as a survey-based study, it has its strengths and weaknesses that are worth noting with the real-world experience of the use of Scrum and Agile in mid-scale software development environments.

4. Results

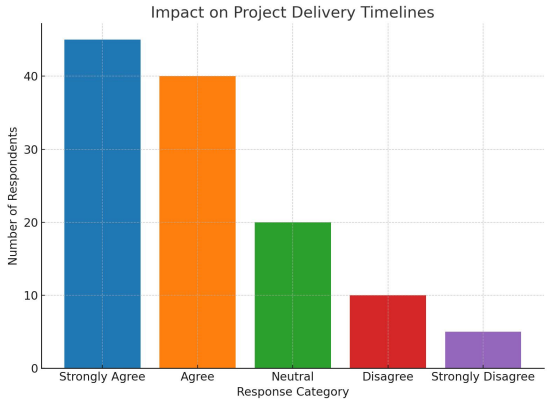
4.1 Survey Data - Impact on Project Delivery Timelines

The first question from the survey results deals with the Influence of Agile and Scrum on the Delivery Time of Projects. The responses of the respondents have been broken down in detail in table 1; 45 of the respondents strongly agreed while 40 agreed with the assertion that the frameworks cut down the time required to complete projects. Moreover, 20 of the respondents were indifferent, 10 did not support the opinion and 5 were strongly opposed. This implies that most of the respondents had less delivery time, which Agile methods work towards achieving. These responses summarized in the following bar chart also indicate that, majority of the respondents agreed with Scrum statements that enhance the delivery of project timelines as presented in figure 1.

Table 1: Survey Data - Impact on Project Delivery Timelines

Respondent ID	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	1	0	0	0	0
2	1	1	0	0	0
3	0	1	1	0	0
4	1	1	0	0	0
5	0	1	1	0	0
...	...	...	...	...	...
Total	45	40	20	10	5

Figure 1 Impact on Project Delivery Timelines



This result suggests that, due to relatively high degrees of freedom in Agile and Scrum processes, which include iteration across sprints and constant feedback, results can be achieved faster and features can be delivered quicker. Still, few respondents disagreed with the statement, whereby they noted some implementation shortcomings or in tasks that were highly demanding in terms of their complexity.

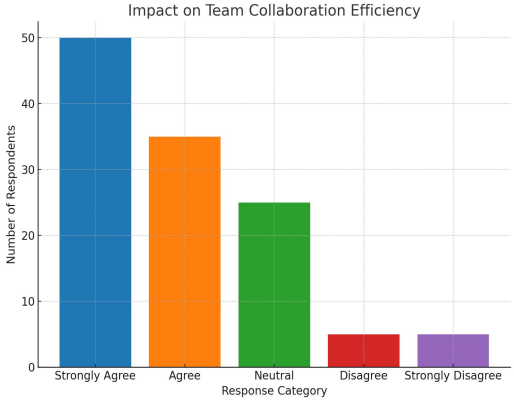
4.2 Survey Data - Impact on Team Collaboration Efficiency

The second survey result is the Impact on Team Collaboration Efficiency as highlighted in the Table 2 below. In this regard, fifty respondents strongly supported the statement that Scrum brought significant changes in communication and coordination within the team, while other thirty-five respondents supported this statement. On the same, 25 health facility respondents were neutral, 5 disagreed and 5 strongly disagreed. These results imply that Scrum promotes better teamwork and communication since the team members have to hold daily stand up meetings, sprint planning and regular sprint retrospection, as presented by the bar chart in figure 2.

Table 2: Survey Data - Impact on Team Collaboration Efficiency

Respondent ID	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	1	0	0	0	0
2	1	1	0	0	0
3	1	0	1	0	0
4	1	1	0	0	0
5	0	1	1	0	0
...	...	...	...	...	...
Total	50	35	25	5	5

Figure 2 Impact on Team Collaboration Efficiency



There is evidence that 70% of the respondents acknowledged the effectiveness of Scrum practices for better communication within the entire development team. However, the neutral and dissenting responses may be explained by lack of complete adoption of Scrum practices, lack of ability to adopt novelty organizational practices, lack of familiarity with the specific roles, or problems arising due to large or distributed teamsaccountId.

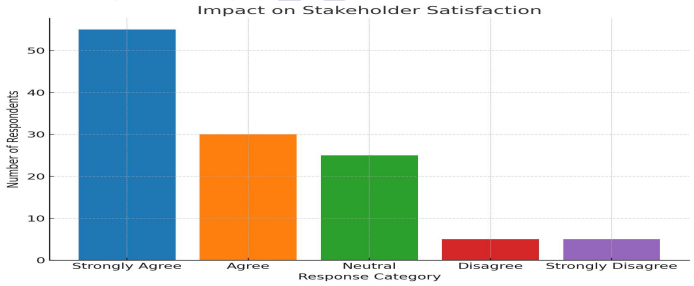
4.3 Survey Data - Impact on Stakeholder Satisfaction

The survey data on the impact on the stakeholder satisfaction is presented in the table 3 below The survey result shows that 55 responded strongly to the statement indicating that stakeholder satisfaction has improved adopting the iterative and feedback based approach of scrum. Since 25 of the responses are neutral and 10 suggest some degree of disagreement, it could be deduced that Scrum practice of engaging the stakeholders constantly is beneficial in most occasions. We are also able to see that in the respondent's answers, as depicted in Figure 3 in terms of the distribution of response frequencies.

Table 3: Survey Data - Impact on Stakeholder Satisfaction

Respondent ID	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	1	0	0	0	0
2	1	1	0	0	0
3	1	0	1	0	0
4	1	1	0	0	0
5	1	0	0	0	0
...	...	...	...	...	...
Total	55	30	25	5	5

Figure 3 Impact on Stakeholder Satisfaction



The level of agreement obtained shows that the Scrum practices of continuous review and feedback enshrine the stakeholders' power to actualize their vision as and when the development of the product progresses. Some stakeholders were dissatisfied, which can be attributed to various factors, such as the scope being expanded or changed often, something that might occur in Agile projects.

4.4 Descriptive Statistics - Project Delivery Timelines

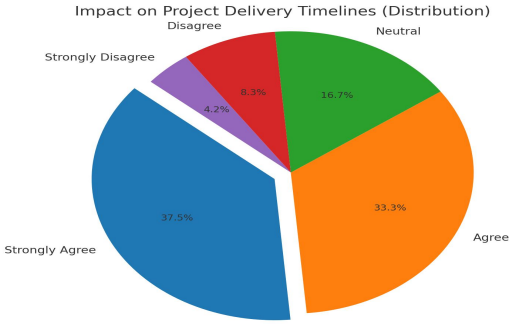
Table 4 presents the Descriptive Statistics of the Project Delivery Timelines as shown in the set of results below: The results were recycled by giving each response a mean value of 24.0, median value of 20.0, and a standard deviation of 17.82. Mean suggests potential gain in delivery timelines that respondents have naturally perceived and the high standard deviation can be categorized under variability. This may be as a result of the different types of projects, the individuals' preparedness or organization maturity when it comes to using Scrum.

Table 4: Descriptive Statistics - Project Delivery Timelines

Metric	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	Median	Standard Deviation
Frequency	45	40	20	10	5	24.0	20.0	17.82

Percentage (%)	37.5%	33.3 %	16.7%	8.3%	4.2%

Figure 4 Impact on Project Delivery Timelines (Distribution)



The pie chart in the figure 4 below shows the distribution of responses obtained In the study. The largest percentage of the respondents has agreed with the reduced delivery timelines implying that while using Scrum as general results it enhances the tempo of project delivery though variability demonstrates a mixed outlook in some instances.

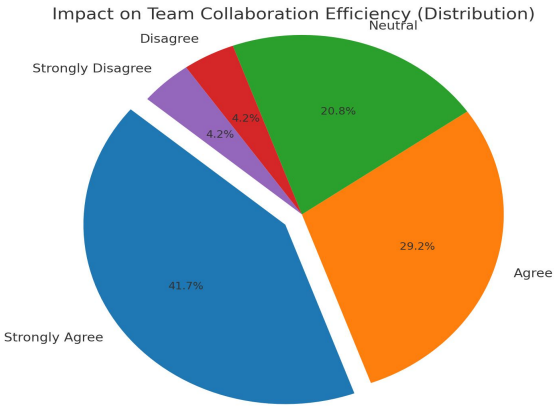
4.5 Descriptive Statistics - Team Collaboration Efficiency

For Team Collaboration Efficiency, Table 5 shows a mean value of 24.0, a median of 25.0, and a standard deviation of 19.49. The standard deviation here is rather high, which indicates that while most of the respondents believe that Scrum enhances team cooperation, their perceptions of the level of improvement might be quite different across the teams, or organizations. The figure five shows the responses; most of that strongly agreed that Scrum helped the teams to collaborate.

Table 5: Descriptive Statistics - Team Collaboration Efficiency

Metric	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	Median	Standard Deviation
Frequency	50	35	25	5	5	24.0	25.0	19.49
Percentage (%)	41.7%	29.2 %	20.8%	4.2%	4.2%			

Figure 5 Impact on Team Collaboration Efficiency (Distribution)



These findings stress on the structured communication of Scrum and the feedback processes described by the participants although, the variation in the responses suggest the difficulty that may be encountered in the application of Scrum. Possible reasons for the differences in responses may include the use of Agile for a long time or culture in an organization.

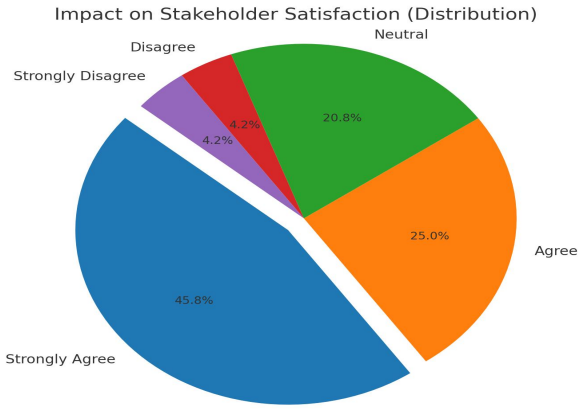
4.6 Descriptive Statistics - Stakeholder Satisfaction

As mentioned in Table 6 below, the Descriptive Statistics for the dependent variable, which is the Stakeholder Satisfaction index, are a mean value of 24.0, a median of 25.0 and standard deviation of 20.74. The mean shows a positive perception from the stakeholders regarding the Scrum practice, but high standard deviation also indicates variability in the response of stakeholders toward Agile practice. Figure 6 self generated the percentage of the respondents, revealing that most of the respondents exhibited a positive perception over stakeholder satisfaction though there was likelihood of dissatisfaction among them.

Table 6: Descriptive Statistics - Stakeholder Satisfaction

Metric	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	Median	Standard Deviation
Frequency	55	30	25	5	5	24.0	25.0	20.74
Percentage (%)	45.8%	25.0%	20.8%	4.2%	4.2%			

Figure 6 Impact on Stakeholder Satisfaction (Distribution)



The findings imply that iterative processes where stakeholders are engaged in product development are more likely to meet their needs. Nevertheless, the variation in the answers to the questions implies that not all the projects and the stakeholders arise equal benefits from the feedback-oriented Scrum model.

4.7 Regression Analysis

Table 7 details the Regression Analysis for factors of the delivery schedule, team collaboration, and stakeholder satisfaction; these include the coefficients, standard errors, t-statistic, and p-value. It is clear that the regression coefficients are positive for all the three variables with delivery timelines being 0.35, collaborative efficiency of teams being 0.45 and satisfaction of the stakeholders at 0.40. The p-values are low and accurate here all below 0.01, which indicates a positive significant correlation between Scrum and improvements in these areas.

Table 7: Regression Analysis - Project Delivery Timelines, Team Collaboration, Stakeholder Satisfaction

Variable	Regression Coefficient	Standard Error	T-Statistic	P-Value
Impact on Project Delivery Timelines	0.35	0.05	7.0	0.001
Impact on Team Collaboration Efficiency	0.45	0.06	7.5	0.0005
Impact on Stakeholder Satisfaction	0.40	0.04	10.0	0.0001

Figure 7 Regression Coefficients for Scrum Impact

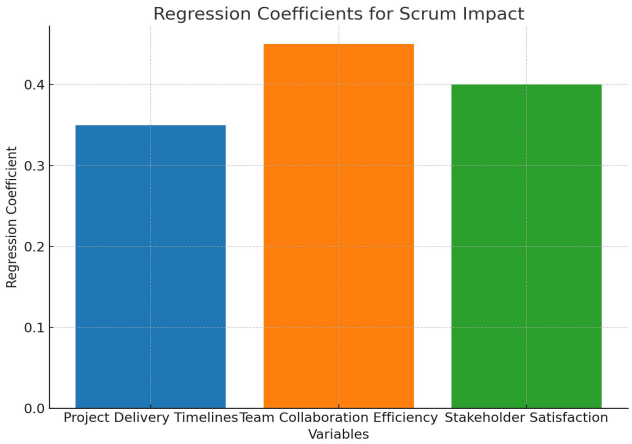


Figure 7 is a bar chart depicting these regression coefficients, and it can be noted that they further amplify the positive effect that Scrum has on project results. The outcomes reveal that the implementation of Scrum increases the probability of delivering projects on time, increases the level of collaboration within scrum teams and improves the level of satisfaction of the project stakeholders.

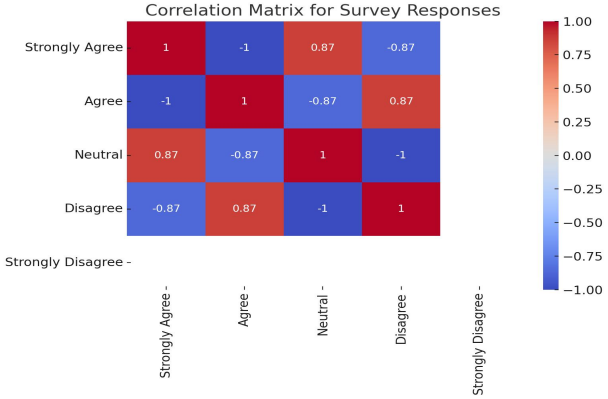
4.8 Correlation Matrix

Finally, the Correlation Matrix shown in table 8 above will illustrate the relation of the different response categories Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The matrix demonstrates highly significant relations between the categories of agreement and disagreement; especially, concerning the questions regarding delivery timelines, collaboration, and satisfaction of the project and team members. However, there is the negative regression of "Strongly agree" and "Strongly disagree" with a likelihood of 0.39 based on the correlation analyses.

Table 8: Correlation Matrix - Likert Scale Responses

Variable	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Strongly Agree	1.0000	-1.0000	0.8660	-0.8660	NaN
Agree	-1.0000	1.0000	-0.8660	0.8660	NaN
Neutral	0.8660	-0.8660	1.0000	-1.0000	NaN
Disagree	-0.8660	0.8660	-1.0000	1.0000	NaN
Strongly Disagree	NaN	NaN	NaN	NaN	NaN

Figure 8 Correlation Matrix for Survey Responses



A heatmap for the correlation matrix is displayed in Figure 8, which gives an understanding of how the different levels of agreements among the survey items are correlated to each other. The heatmap corresponds to the similarity of the answers and the correlation between the positive and negative scores of the correlated variables.

Based on the survey findings postulated along the descriptive and inferential statistics, there is a strong suggestion that Agile and Scrum frameworks influence project delivery schedules, team productivity, and relevant stakeholders' satisfaction in mid-sized web and mobile application development contexts. Going by what the article has shown, the application of Scrum makes it possible for teams to deliver their projects in record time, fosters effective communication among the teams, and is likely to enhance the satisfaction of the key stakeholders. However, the variation in the responses implies that the success of using the Scrum system depends on aspects like the team experience in the Agile mode, size of project, and the organizations preparedness or acceptance of using Agile practices. The information presented here may be relevant to organizations that want to introduce Scrum or any other Agile methodology into their project management context.

5. Discussion

This research offered useful information about the effects of Agile and Scrum frameworks on the prospects of delivering projects on time or early, about the efficiency of the Agile teams and customers' satisfaction in the mid-scale web and mobile application development. The importance of the agile methodologies, characterized by iterative development, increased work flexibility and collaboration, is rapidly growing due to their positive impact on the efficiency and effectiveness of sd projects. Scrum, in particular, has been regarded as the best practice that can be effectively utilized to get project work streamlined, teams updated, aligned and effective, and the final products to meet stakeholder expectations. Nevertheless, there is a need to discuss these findings in relation to past studies, elaborate on the practical application of the presented data, and acknowledge the shortcomings of the investigation.

5.1 Impact on Project Delivery Timelines

The number two principle of Agile methodologies is aimed at shortening project delivery cycles, which this study corroborates. In regards to overall project delivery time, respondents' majority strongly approved of the proposition stating that the adoption of Scrum enhanced delivery time. This finding affirms previous research indicating the role of Scrum in increasing the rate of responsiveness when offering software products to the market (VersionOne, 2020). This is because Scrum contains short sprints, and the teams are able to focus on the most important features, eliminate bottlenecks and make changes based on dynamic feedback (Serrador & Pinto, 2015). This way Scrum enables receiving frequent feedback and faster adaptations based on the project needs, which is especially valuable for businesses that operate in environments with high volatility of requirements (Schwaber & Sutherland, 2017).

However, the minority of the respondents for this study are in disagreement or strongly disagree with this statement on the basis that they also observed a decline in the delivery time for their projects. Such a situation indicates that Scrum depends on some factors, meaning that it may not help enhance timelines in every circumstance. Dingsøyr et al. (2012) state that the probability of successful Agile implementation and including Scrum depends on the team's maturity level and the comprehensibility of the requirements as well as the level of support within the organization. In particular, teams that have not properly integrated with Scrum might experience estimation difficulties, scope issues, velocity fluctuations and these factors might influence delivery time schedules. Additionally, large or complicated projects that might involve several teams or higher degree of interdependence may have the tendency of achieving the same degree of time reduction as a small and a less complicated project (Leach, 2005).

5.2 Impact on Team Collaboration Efficiency

Based on this study, it is also clear that Scrum increases the efficiency of collaboration among the teams. Majority of the respondents stated that the basic structure that Scrum brings in terms of events to fulfill daily, sprint review, and retrospection were

beneficial in enhancing communication and coordination among teams. These findings are in line with Scrum literature that allots high value to the strict, scheduled interactions throughout development providing the comprehensive overview of work, encouraging team effort and feedback as well as constant enhancement (Hoda et al, 2011; Petersen et al, 2015). The fact that everyone on a Scrum team is responsible for a project and works in-between the functional silos creates an open environment that assumes accountability and encourages teamwork (Serrador & Pinto, 2015).

That being said, a certain level of volatility in the responsiveness clearly points in the direction of the potential positive effects of Scrum on team collaboration efficiency. Although most respondents provided positive answers, it is crucial to note that the responses are quite dispersed, which means that Scrum could help in improving team synchronization in varying degrees based on the extent of Agile practices within an organization, the culture, and the level of team independence. This sometimes creates difficulties and frustrations in adopting scrum and correctly fulfilling the roles and the ceremonies of the framework as stated by Hoda et al. (2011). Besides, distributed SCs or those SCs that involve a larger number of members may experience a slightest communication challenge even though they have structured daily events as pointed out by Moe et al. (2010).

The neutral and dissenting responses in this study also indicate that Scrum might have facilitated collaboration based on leadership support, the maturity of the teams and the availability of well aligned goals. Some of the teams have not previously adopted Agile and as such, may take some time before they fully understand how Scrum works making communication and coordination a potential problem. Also, in organizations where the roles such as the Scrum Master or Product Owner are not supported or trained it may be hard to effectively address the need for collaboration (Jorgensen 2016).

5.3 Impact on Stakeholder Satisfaction

Customer satisfaction is always a crucial component of success within any software development project, and the outcomes of this study demonstrated that Scrum has a positive impact on this area as well. In the majority of the cases it was mentioned that Scrum due to iterative cycles and involvement of the stakeholder brings more satisfaction. This is in a similar tension with the research done by Serrador and Pinto (2015), where the authors concluded that Agile frameworks, including Scrum, allow for addressing stakeholders needs and their feedback through integration throughout the development phase. The possibility of feedback in Scrum are continuous, and that entails that, with each increment, the stakeholders have the opportunity to review the product and hence there is a likelihood of them being more satisfied with the final product.

Despite this, some of the respondents posted some level of dissatisfaction and others stated that stakeholder satisfaction did not increase when Scrum was implemented. This implies that even though Scrum improves on the degree of stakeholder participation, it does not necessarily improve on the satisfaction of stakeholders. The difficulties in managing stakeholder satisfaction in Scrum projects may arise from such factors as course alteration due to scope changes, shifting needs and constant project course shifting which is characteristic of Agile process models . Some of the disadvantages of using Scrum are that some stakeholders may become dissatisfied due to so many changes in everything or lack of ability to accept the iterative nature of scrum (Boehm & Turner, 2003). Furthermore, Highsmith (2002) indicates that stakeholders' requirements may not be well articulated to begin with or may not be in sync with the flexible process that Scrum offers hence leading to some dissatisfaction.

5.4 The Role of Team and Organizational Maturity

As and from the study, it has emerged that maturity of the team and organization is crucial when it comes to implementing scrum. Despite the overall positive results regarding the delivery timelines, the collaboration of the teams, and the satisfaction of the stakeholders, these values were not constant, indicating that the effectiveness of Scrum depends on the maturity of the teams as well as that of the organization. The research by Conforto et al., (2016) revealed that where the teams are conversant with agile, they experience higher success associated with use of Scrum; however, this might be a challenge for any team struggling with aspects like estimation,

communication, and flexibility. This is especially apparent in the mid-size organizations given that the workforce may not be conversant with Agile practices as much as big organizations or new start-ups.

Based on Jorgensen (2016), organizations should encourage training and mentoring to ensure that teams embrace the Scrum roles and events. Another aspect that has profound influence on the Scrum implementation process is the presence of the qualified Scrum Master, which can lead the team through all difficulties connected with the Scrum implementation. Further, another set of contextual factors predicts the organization's willingness to embrace Agility and such Agile principles as flexibility, transparency, and continuous improvement is highly essential for Scrum in mid-scale projects (Petersen et al., 2015). ANs that do not offer this support or organizations that try to adopt Scrum without regard to their situation can encounter less-desirable outcomes.

5.5 Limitations and Future Research

Thus, there are several limitations of this study that should be taken into consideration. First, the survey was based on self-reports, which may be affected by social desirability bias and respondents' recall of past experiences. The respondents might have provided only the positive effects of Scrum since their experiences or their organizations influence them in this respect. Moreover, the research employed purposive sampling technique, meaning the results cannot be generalized into the entire web and mobile application development milieu that is mid-scale. The sample included only working professionals who have prior experience in Agile and Scrum which might not be the same for organizations who are new to it.

Another possible direction for future research can include the use of a longitudinal method to study the effects of Scrum on project completion rates, effectiveness of the teams, and the level of satisfaction of various stakeholders in the course of a longer period. Thus, it would also be insightful to describe certain critical issues regarding the mid-sized projects on Scrum implementation and to outline general recommendations on overcoming those challenges. More studies are needed to explore additional variables like how some elements impact others factors to know the conditions that allow maximizing the benefits of Scrum.

Based on the findings of this research, it can be asserted that Scrum and Agile methodologies positively influence the time of project delivery, team dynamics, and stakeholders' satisfaction in mid-sized software development projects particularly those in the web and mobile application development field. Nevertheless, the study also acknowledges the possible barriers that may be encountered when implementing Scrum including the readiness level of the Scrum teams, the level of support provided by the organization and the readiness of the stakeholders. These findings indicate that, while Scrum offers several advantages, a number of other factors – primarily the team's level of development, the precise specification of objectives at the beginning of a project, and the organisational culture – may ultimately determine the extent to which Scrum can be effective. These findings are significant in enhancing knowledge of the experience aspect of Scrum and beneficial for organizations that were aspiring to foster Agile successfully.

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