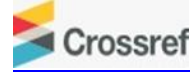# The Impact of Teamwork Quality (TWQ) on Agile Software Development Team Performance

Alexander Larbie Mensah

AJP

The Impact of Teamwork Quality (TWQ) on Agile Software Development Team Performance

Alexander Larbie Mensah
Capella University

Abstract

Purpose: The study examined the extent to which teamwork quality (TWQ) impacts team performance in the Agile software development space in the U.S. and how the TWQ factors (Communication, coordination of expertise, cohesion, trust, mutual support & value sharing) are ranked in terms of importance to team performance

Materials and Methods: The study used correlation and regression analysis to determine the degree of the relationship and the effect of the extended TWQ factors on Agile software team performance. Additionally, the study assessed the relative importance of the TWQ factors to team performance. Participants in the study included IT workers from the software development team in U.S. companies with in-house teams using the Agile methodology. Data was collected using an online survey through survey monkey. The data was presented through descriptive statistics and analyzed using regression analysis.

Findings: The study found all the extended TWQ factors were strongly correlated to the team performance. The analysis showed that a statistically significance predictive relationship exists between the extended TWQ factors and

Agile software development team performance. However, only mutual support and value sharing contributed statistically significantly to the model. Among these factors, mutual support was ranked as the most important TWQ factor in relation to team performance, while trust was ranked as the least.

Implications to Theory, Practice and Policy: This empirical study tested and extended the TWQ model on team performance in the Agile software development space in the U.S. for software development teams and how these TWQ factors are ranked in terms of importance to team performance. The findings provide insight to project teams and team leaders, product owners, scrum masters, and project managers about the TWQ model from the perspective of agile software development teams. The findings also address the critical TWQ factors that are needed for building effective and efficient Agile software development teams.

Keywords: *Agile, Teamwork Quality (TWQ), Project Management, Team Performance, Collaboration*

JEL Code: M54, O33, H43

1.0 INTRODUCTION

Agile, an iterative method for managing software development projects, focuses on flexible and continuous releases incorporating customer feedback (Fustik, 2017). While software projects have failed due to the choice of unsuitable project management approaches, an Agile methodological approach can have a more positive impact on project success (Ahimbisibwe et al., 2015; Hayat & Qureshi, 2015; Serrador & Pinto, 2015). Agile teams are self-organized and collaborate intensely with a common purpose, mutual trust, and respect within and across the boundaries of an organization (Cockburn & Highsmith, 2001). Improving the efficiency and quality of software delivery in an era where many information technology (I.T) organizations embrace Agile methodology will not be achieved when there is a lack of collaboration within and between teams (Denning, 2013; Ghani & Bello, 2015). The Agile approach focuses on collaboration in teamwork. Collaboration is critical in leveraging a team's effectiveness, characterized by inclusion, integration, compromise, and open communication (Cole et al., 2019).

Previous studies have found human factors, such as team capability, to be a critical success factor for quality software delivery and project success (Garousi et al., 2019). According to Tanner and Dauane (2017), complications due to the varying backgrounds among team members, different time zones, and different communication strategies could contribute to the lack of collaboration among members of a team or even across multiple teams, which could result in delays or errors as things are rushing through the process to deliver on time. Additionally, the lack of collaboration within and between teams could stem from unequal work contribution, lack of trust, different working styles, lack of motivation, and poor project management (Tanner & Dauane, 2017).

Agile methodology promotes better team communication, knowledge sharing, and quality teamwork, leading to motivation and innovation (Kakar, 2017; Omar et al., 2019). Similarly, Fatema and Sakib (2017) argued that team effectiveness and motivation are among the factors that impact teamwork productivity. Agile requires team collaboration for project success, and the teamwork quality (TWQ) model provides a comprehensive concept of collaboration within teams, focusing solely on the quality of interaction within teams rather than the team members' tasks/activities (Hoegl & Gemuenden, 2001). This study examined the extent to which the TWQ factors impact team performance in the Agile software development space in the U.S. for software development team members and how these TWQ factors are ranked in relative importance to team performance. The original TWQ factors include communication, coordination, the balance of member contributions, mutual support, effort, and cohesion. Weimar et al. (2013, 2017) extended the TWQ model by introducing three new factors: Trust, value sharing, and coordination of expertise to replace coordination, the balance of member contributions, and efforts in the original TWQ model. The other three remaining factors in the extended TWQ model are communication, mutual support, and cohesion.

Previous studies have used Hoegl and Gemuenden's TWQ model except for Weimar et al. (2017), who used the extended TWQ model for the software development team (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2018). Though Lindsjørn et al. (2018) conducted their study with an Agile software development team, they used Hoegl and Gemuenden's original TWQ model. None of the studies have examined the extended TWQ in Agile software development

teams. The current study considered the team performance of an Agile software development team using the extended TWQ model. While previous studies found a significant relationship between coordination, cohesion, and collaboration and team performance, Haaskjold et al. (2020) did not find any significance between collaboration and team performance in terms of quality, cost, and schedule (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2018; Weimar et al., 2017). Though previous studies have examined the original TWQ model in software development teams, there is a lack of research on the extended TWQ model's impact on Agile software development teams.

Testing the impact on team performance in the Agile software development space in United States for software development teams and how these extended TWQ factors (communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) are ranked in terms of importance to team performance provide insight that advances and extends the knowledge on the TWQ model. Additionally, ranking the TWQ factors in terms of importance to Agile software team performance provides a good understanding of the relative importance of each of these factors to the TWQ theoretical model.

Problem Statement

Despite the known benefits of Agile methodologies, there is limited research on the impact of extended TWQ factors on Agile software development team performance in the U.S. The thread of literature selected for this study is software development teams in relation to team performance. While software projects have failed due to the choice of unsuitable project management approaches, an Agile methodological approach can have a more positive impact on project success (Ahimbisibwe et al., 2015; Hayat & Qureshi, 2015; Serrador & Pinto, 2015). Researchers have found human factors, such as team capability, to be critical success factors for quality software delivery and project success (Garousi et al., 2019), and that TWQ has significant effect on team performance and innovation (Hoegl & Gemuenden, 2001; Weimar et al., 2017). The issue of interest is the extent to which TWQ factors initially developed by Hoegl and Gemuenden (2001) and extended by Weimar et al. (2013, 2017) impact team performance in the Agile software development space in the U.S. Also, to examine how these TWQ factors are ranked in terms of importance to team performance.

Agile methodology promotes better team communication, knowledge sharing within teams, and quality team work leading to team motivation and innovation (Kakar, 2017; Omar et al., 2019). Similarly, Fatema and Sakib (2017) argued that team effectiveness and motivation are part of the factors that impact teamwork productivity. Though previous studies found significant relation between coordination, cohesion, and collaboration and team performance, Haaskjold et al. (2020) did not find any significance between collaboration and team performance in terms of quality, cost, and schedule (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2018; Weimar et al., 2017).

Previous studies have used the Hoegl and Gemuenden's TWQ model except for Weimar et al. (2017), who used the extended TWQ model for software development team (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2018). Though Lindsjørn et al. (2018) conducted

their study with an Agile software development team, the study used Hoegl and Gemuenden's original TWQ model. None of the studies have looked at the extended TWQ in Agile software development teams. The current study considered the team performance of Agile software development team using the extended TWQ model. While several studies have examined the original TWQ model in software development teams, there is a lack of research on the extended TWQ model's impact on Agile software development teams.

2.0 LITERATURE REVIEW

Software Development Life Cycle (SDLC)

The process involving the various phases of developing software, such as planning, designing, developing, testing, and deploying, is known as the software development life cycle (SDLC). The SDLC models provide essential means for developing software in a systematic and disciplined manner (Ateeq & Shuaib, 2014). There are various approaches to software development, such as the traditional Waterfall and the Agile methodologies. The processes involved in the Waterfall model are conception, initiation, analysis, design, building, testing, implementation, and maintenance (Banica et al., 2017). According to Andrei et al. (2019), the Waterfall methodology is appropriate when the project is small, and the requirement is well-defined with fixed delivery time, scope, and budget, while the Agile methodology is best used when the requirement is not well-defined and there is continuous delivery. Unlike the traditional Waterfall approach, Agile is used to develop software in increments and iterations. Understanding how knowledge is generated and shared among a team will allow the right software development methodology to be chosen that aligns with an organization's strategy (Balle et al., 2018).

Indeed, one methodology will not fit all projects, and it is equally valid that choosing the wrong methodology would impact the project's success. According to Ateeq and Shuaib (2014), when the appropriate SDLC is used, project managers can regulate the whole development strategy of the software for success. Ahimbisibwe et al. (2015) attributed the wrong project management approach to why software projects fail. An inappropriate SDLC could increase project costs and schedules and reduce software quality (Sasankar & Chavan, 2011).

The Agile Methodology

Agile is an iterative method for handling software development projects that integrates customer feedback for continuous and flexible releases (Fustik, 2017). Organizations use Agile to improve the process and quality of software delivery (Ghani & Bello, 2015). An Agile mindset helps organizations to build and sustain competitive advantage and profit from their ability to rapidly develop products as customer needs emerge (de Borba et al., 2019). According to Krehbiel and Miller (2018), an Agile methodology is a legitimate approach to improving and managing quality. Agile software development is a lightweight methodology that lets an organization overcome the complications associated with developing software while reducing overheads and costs and providing the flexibility for effective change management (Al-Saqqa et al., 2020). Additionally, Agile provides an organization with the means to respond quickly to unexpected change (Kamepally & Nalamothu, 2016).

In a critical analysis of the various software development models, Fatima and Gupta (2018) concluded that each model has its advantages and disadvantages, but each has its advantages and disadvantages. The waterfall model suits small projects, and spiral and prototype models suit large and complicated projects. Similarly, a study by Dasoriya (2017) to determine the significance of software development models concluded that the models could be better and that the project's success depends on characteristics such as the nature of the project, the developer's skills, and management support. Serrador and Pinto (2015) used a data sample of 1002 projects across multiple industries and countries to test the Agile use effect in organizations on two dimensions of project success: Efficiency and overall stakeholder satisfaction against organizational goals. On the contrary, the study found that Agile methods positively impact both dimensions of project success.

Previous studies have associated the TWQ to Agile team performance and concluded that TWQ is critical to the success of Agile projects (Dingsøyr et al., 2016; Lindsjørn et al. 2016; Lukusa et al., 2020). For instance, a study conducted by Lindsjørn et al. (2016) found a marginal impact of TWQ on team performance of Agile teams compared to the traditional teams. Similarly, Lindsjørn et al. (2018) found correlation between the TWQ and Agile team performance for small projects consisting of one or two Agile teams as well as large projects consisting of ten or more Agile teams.

An analysis conducted by Hummel et al. (2013) to gain insight into the role of communication in Agile projects found communication as an important team factor within Agile projects. According to Yagüe et al. (2016), communication is more critical in Agile Global Software Development (AGSD) in which communication plays a primary role due to the frequent meetings prescribed by Agile. Similar to communication, coordination help Agile teams reach common goals such as problem solving, decision making, agree on a sprint backlog, and review a sprint and Scrum methodology (Qureshi et al., 2018). According to Xu (2009), the coordination activities in Agile focus on informal management style where close interaction among team members lead to effective and quicker way of spotting and resolving issues. The key to successful Agile teams is effective coordination where team members rely on frequent interactions and mutual adjustment to manage the dependencies between team activities (Sporsem & Moe, 2022).

On the Agile concept, each team member constitutes a cross-functional team where members are required to contribute to the team's success (Wibowo & Ruldeviyani, 2022). According to Sjøberg (2018), the balance of member contribution which is central to Agile team performance, in both small and large projects, has a positive association to team performance. From their analysis, Wibowo and Ruldeviyani (2022) concluded that the balance of member contribution has significant impact on Agile (Scrum) team member success.

Mutual support is critical in Agile teams since the intensive collaboration of individuals is not driven by competition but cooperation (Aksekili & Stettina, 2021). According to Silva et al. (2021), mutual support is one of the essential factors required for the success of Agile software team, and that managers need to promote practices that foster it. A study to determine the impact of team size on TWQ in software team concluded that mutual support in smaller teams is greater than in larger teams (Subramaniam & Nakkeeran, 2016). Hence, mutual support is expected to be

greater in Agile teams since Agile teams have smaller team size. For an Agile software team, mutual support is an important component of the team for the team to reach its goals (Salfarina et al., 2021).

Similar to the balance of member contribution, Wibowo and Ruldeviyani (2022) concluded that effort has significant impact on Agile (Scrum) team member success. Bechtel et al. (2021) found that high effort is evident in the output of teams using the Agile practices. Cohesion is an important TWQ factor for software development using Agile, where high-quality collaboration is gained as a result of team member's feelings of belongingness and togetherness (Ibrahim et al., 2018). A study to determine the model of team's cohesion for teams using Agile practices, teamwork efficiency is increased as a result of team cohesion (Bach-Dąbrowska & Pawlewski, 2014).

Theoretical Orientation for the Study

The theoretical model for this study was the TWQ model (Hoegl & Gemuenden, 2001). The critical success factor (CSF) theory serves as the best theory for framing the conceptual framework for the study on the impact of TWQ factors on Agile software development team performance. A seminal article authored by Bullen and Rockart (1981) on the concept of the CSF argue that CSFs are the key areas where suitable outcomes are absolutely necessary to ensure that the individual, department, or organization achieved successful competitive performance. According to Ram and Corkindale (2014), the CSFs concept allows for finding the crucial areas that need continuous and careful attention of leadership to ensure that the organization's performance goals are achieved. The TWQ model which was used for this study is based on the concept of the CSF theory. The concept of the CSF provides the bases for determining the critical Agile TWQ factors that lead to high performing team and software development success.

The TWQ model was used to determine the influence of the quality of Agile teamwork on team performance. Hoegl and Gemuenden's TWQ model is a comprehensive concept of collaboration within teams, focusing solely on the quality of interaction within teams rather than the team members' tasks/activities. The original TWQ model consists of six factors: Communication, coordination, the balance of member contributions, mutual support, effort, and cohesion (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2016; Lindsjørn et al., 2018; Radu, 2019; Weimar et al., 2017).

The TWQ model was extended by the work of Weimar et al. (2013) by incorporating three different factors: Trust, value sharing, and coordination of expertise. These additional factors are critical for Agile teams as they enhance trust, ensure alignment of values, and optimize the use of team members' expertise. In an empirical study to validate these three additional TWQ factors, Weimar et al. (2017) found that trust, value sharing, and coordination of expertise were relevant factors for inclusion in the Hoegl and Gemuenden's original TWQ model. Mayer et al. (1995, as cited in Weimar et al., 2017) defined trust as the "willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trust, irrespective of the ability to monitor or control the other party" (p. 9). According to Weimar et al. (2017), trust should be included in the TWQ model because of its importance to team performance.

"Value sharing (diversity) arises when team members have a different perspective on the team's task, goal, or mission, leading to relationship, task, or process conflict" (Weimar et al., 2017, p. 10). Value sharing involves team members having diverse perspectives on tasks, goals, or missions, which can lead to both constructive discussions and conflicts, ultimately fostering innovation and comprehensive problem-solving. According to Weimar et al. (2013), effort, as initially included in the TWQ, is one of the multiple aspects of expectations shared by a team. However, value sharing (diversity) is of a higher order than effort because it prioritizes the goal of team task and mission. Hence, effort was replaced by value sharing in the extended TWQ model. Instead of coordination and balance of member contributions used in the original TWQ model, Weimar et al. (2017) used coordination of expertise as a factor in the extended TWQ model because it is a broader concept including knowing the expertise of a team, the need for expertise, and making good use of the expertise.

Therefore, the extended TWQ model developed by Weimar et al. (2017) includes the following TWQ factors: Communication, coordination of expertise, cohesion, trust, mutual support, and value sharing (Figure 1).
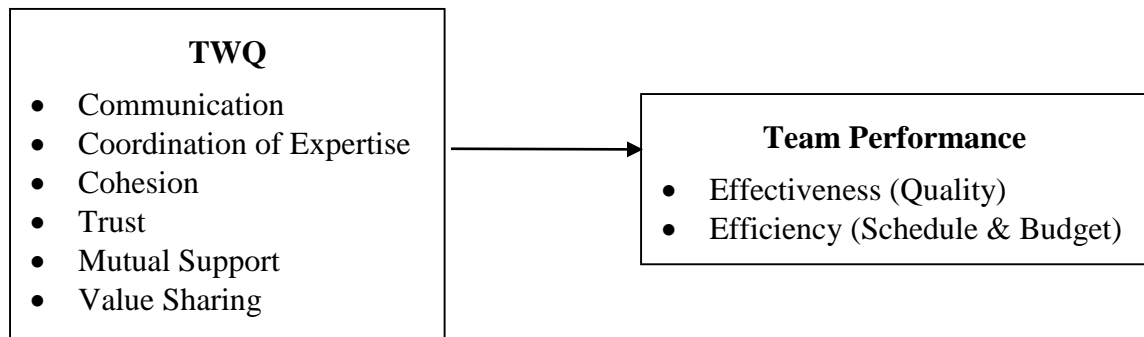

Figure 1: Conceptual Framework (Weimar et al., 2017)

Teamwork and Team Performance

According to Omar et al. (2019), the wide range of human activities and processes that involve teams for software development makes it critical to understand the teamwork factors that influence performance. A study to examine the benefits of the Agile practices in embedded space system development projects concluded that the main benefits of the Agile approach are better communication and knowledge sharing within teams and extended teamwork where team member felt empowered to take the opportunity to contribute to their way of working (Könnölä et al., 2016). A study by Kakar (2017) found that the motivation and innovation of teams adopting an Agile approach for software development are significantly higher than those using a plan-driven method. Using a system dynamic (S.D.) approach, Fatema and Sakib (2017) found from the perspective of Agile team members that the most influencing factors impacting teamwork productivity are team effectiveness, team management, motivation, and customer satisfaction.

A study by Omar et al. (2019) to gain insight into what constitutes quality teamwork and examine the impact that communication and socialization have on team performance found that active communication stimulates socialization, which increases and maintains team members' morale and

motivation. Similarly, Haaskjold et al. (2020) examined the relationship between collaboration and project performance in terms of cost, time, and quality. The constructs used to examine collaboration quality were trust, communication, teamwork, and coordination. Though the study found a significant and strong relationship between collaboration quality and project quality performance, it did not find any significant relationship between collaboration quality, cost, and schedule performance.

In a seminal study, Hoegl and Gemuenden (2001) validated the TWQ model by interviewing 575 team members, team leaders, and managers of 145 software development teams in Germany using a standardized five-point scale questionnaire. Team performance was defined in terms of effectiveness, the extent to which the team can meet quality expectations of output and efficiency, and the adherence to schedules and budgets. The study found a significant relationship between TWQ and project success, including team performance and team members' success. The study also found significant differences in how team performance was rated by team members, team leaders, and managers.

Similarly, to determine the factors that significantly impact the software development team's performance, Ahmad et al. (2016) conducted a quantitative study where participants were selected through stratified sampling. Teamwork factors included in this study were communication, coordination of expertise, mutual support, and value diversity. Team performance was defined in terms of efficiency and effectiveness. The study found that coordination of expertise, communication, and mutual support positively impact the software development team performance. However, the study found no significant influence of value diversity on team performance.

The focus of a related study by Lindsjørn et al. (2018) was to determine the extent to which the size of the development project impacts TWQ on performance. The study used the TWQ constructs consisting of communication, coordination, the balance of member contribution, mutual support, effort, and cohesion and measured team performance by the extent to which the team meets product quality requirements, cost, and time objectives. The study found that team performance in small and large projects is influenced differently by the effect of different teamwork quality variables. This finding suggests previous findings on teamwork in Agile development in small projects would not apply to larger projects. The study also found a positive effect of teamwork quality on product quality for large projects when it was rated by team members and negatively rated by team leaders.

Weimar et al. (2017) explored additional factors to the TWQ model to examine their influence on software team performance. The study introduced three new factors: Trust, value sharing, and coordination of expertise to replace coordination, the balance of member contributions, and efforts in the six-factor TWQ model. The other three remaining factors were communication, mutual support, and cohesion. The team performance was measured using team members' and stakeholders' ratings on effectiveness and efficiency. The study found that TWQ has a significant relationship with team performance. The study also found that trust, shared values, and expertise coordination are essential factors for high-quality software.

Software Development Teams

Human activities that involve teams are critical for project success and the performance of software teams (Omar et al., 2019). Collaboration is needed within and between software teams to guarantee software quality and project success. In a seminal article, Aoyama (1998, April) argues that speed is a weapon for the software industry, and to remain competitive, the teams involved must collaborate and work in real-time using Agile processes. Similarly, according to Miller (2001, July), the Agile software processes are people-oriented (favoring people over process and technology) and collaborative (communication among team members to work towards the finished product). Similarly, according to Cockburn and Highsmith (2001), human factors such as amicability, talent, skill, and communication are the main emphasis of Agile. Collaboration is critical in leveraging a team's effectiveness, characterized by inclusion, integration, compromise, and open communication (Cole et al., 2019).

A study to empirically investigate how the critical success factors (CSFs) are correlated to software project success used an online survey to collect data from 101 software projects in the software industry in Turkey. The CSFs used for the study included team factors. The study found that the most significant CSFs associated with variables describing success were team experience with the software development methodologies, team expertise with the task, and project monitoring and controlling. A similar study by Chiyangwa and Mnkandla (2017) examined the critical success factor for successful software development using the Agile methodology in South Africa. The CSFs for the study were grouped into organizational factors, actual factors, process factors, human factors, technological factors, project factors, and performance expectancy factors. The study found human factors directly related to performance expectancy factors to practice Agile software development.

Software provides an effective means of running an organization. In this digital era and a competitive environment, it is not certain that an organization that does not invest in I.T. to support its structure, processes, procedures, and operations would succeed. Global and multinational firms attract professionals from different countries, backgrounds, ethnicities, and demographics. According to Al-Zaidi and Qureshi (2017), global software development teams face many challenges, including communication, cultural diversity, coordination, geographical distance, time zone differences with culture, and loss of communication being the most challenging. Global software development organizations have the vital role of understanding these challenges to consider ethical, demographic, and cultural differences in decision-making. Culture plays a crucial role in determining the success of software development projects (Fazli & Bittner, 2017). According to Nguyen (2016), organizations that are culture-sensitive would succeed in minimizing miscommunication among team members and increase overall team collaboration and performance. Ochieng and Price (2009) posit that the variation in team expectations is influenced by the cultural differences within the team, which impacts team building, language, participation, conflict management, and team evaluation.

To determine the factors that significantly affect software development team performance, Ahmad et al. (2016) used stratified sampling to select participants of software developers in the five telecommunication industries in Iraq. Communication, coordination of expertise, mutual support,

and value diversity were the teamwork factors for this study. The study concluded that coordination of expertise, communication, and mutual support positively affect software development team performance. Furthermore, the study did not find any significant effect on team performance by team value diversity.

3.0 MATERIALS AND METHODS

Study Design

The study used a non-experimental correlational quantitative research design to answer the research questions and test the hypotheses formulated from the extended TWQ model in relation to Agile software development team performance in this study. A non-experimental quantitative study is a case where the independent variables are not manipulated either for ethical reasons or because they are abstract (Khaldi, 2017). Similarly, correlational research is an example of non-experimental research that helps predict and explain the relationship among variables (Seeram, 2019). According to Simion (2016), the quantitative method is a research approach where the researcher is interested in collecting numerical data and using mathematical means to analyze the data. Similarly, according to Rutberg and Bouikidis (2018), quantitative research may be used to determine the relationship between variables.

The research question for this study was:

R.Q. What is the extent to which the teamwork quality (TWQ) factors (Communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) predict team performance in the Agile software development space in the U.S. for software development team members?

$H_{01:}$ There is no statistically significant predictive relationship between the TWQ factors (Communication, coordination of expertise, cohesion, trust, mutual support, value sharing) and Agile software development team performance.

$H_{02:}$ A statistically significant predictive relationship exists between the TWQ factors (Communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) and Agile software development team performance.

Population and Sample

A 2014 American community survey by the U.S. Census Bureau (Beckhusen, 2016) determined that 1.1 million U.S. I.T. workers were developing application and system software. The study sourced participants for study from the U.S. I.T. workers population. The population for the study was sourced through SurveyMonkey, an online survey panel, to include I.T. workers from software development teams in U.S. companies with in-house teams using the Agile methodology. Participants included those who were 18 or older and had at least three years of work experience in a software development team using Agile methodology.

SurveyMonkey used random sampling techniques to select participants. Random sampling is a probability sampling technique that allows a researcher to select a sample from a population for a study. According to Etikan and Bala (2017), every sample in the population has an equal chance

of being selected in random sampling. The researcher conducted a power analysis to determine the optimal sample size to be drawn from the population for this study using G* power software. The minimum sample size calculated from the G* Power analysis was 146. G* Power provides the program for a free power analysis for various statistical tests (Faul et al., 2009). Estimating power and sample size are necessary to determine the optimal participants for answering the research question (Jones et al., 2003). According to Suresh and Chandrashekara (2012), using the appropriate sample size for a study will provide the necessary power needed for statistical significance.

A sample size of 165 participants was used for this study to provide approximately 10 percent over the G* Power requirement to cover incomplete data or responses. Jones et al. (2003) posited that more participants for a study lead to a more precise outcome closer to the actual values of the population.

Participant Selection

The population from which the researcher drew the sample for this study included all software development professionals who are members of the SurveyMonkey panel. Participants must have at least three years of experience working with Agile methodology and in a U.S. company with in-house teams to participate in this study. The researcher requested a sample size of 165 from the SurveyMonkey audience who met the inclusion criteria.

Screening questions based on the inclusion criteria for potential research participants were given to SurveyMonkey to recruit qualified members from its audience. SurveyMonkey sent the recruited participants the link to the screening questions, informed consent, and survey questionnaire. The participants who failed to meet the inclusion criteria were not allowed to proceed with the survey. However, those who met the inclusion criteria were directed to the informed consent page and were required to check a box at the beginning of the survey to indicate their consent to participate in the study. The survey was either advanced or closed based on the participant's willingness to continue.

The questionnaire, administered online through SurveyMonkey to participants, included all the instruments for measuring the constructs of the extended TWQ factors and team performance. Additionally, a cover letter introduced the study and its purpose to the participants. Participation was voluntary, and participants responded to the questions at their convenience. Once submitted, respondents could not edit or make changes to their responses.

Data Collection

The study used a quantitative research design. SurveyMonkey, an online survey panel, randomly selected participants from its audience for this study. The study adopted a survey approach for the data collection. According to Creswell and Creswell (2018), a survey design allows a researcher to quantitatively describe trends, attitudes, and opinions of a population or to test for relationships among variables of a population by studying a sample of that population. SurveyMonkey was responsible for recruiting and administering the survey to its audience who met the inclusion criteria. The survey questions were a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly*

agree). SurveyMonkey distributed the questionnaire online, and participants were required to consent to participating in this study voluntarily.

The researcher targeted 165 responses with an estimated qualifying rate of 50% to 74%. Based on this estimate, SurveyMonkey recruited 305 participants for this study, but 133 (43.6%) of the recruited participants were disqualified based on the screening questions. Out of the 172 participants who qualified based on the screening questions, seven (7) did not consent to participate and voluntarily exited the survey, and five (5) did not complete the survey. Hence, 160 participants completed the survey and submitted their responses, making a 52.5% completion rate.

Instruments

Existing and validated scales used by Weimar et al. (2017) for validating the extended TWQ model were used to measure the TWQ factors and team performance. According to Weimar et al. (2017), a Cronbach alpha test conducted to control for internal consistency of the instruments for this study showed that all the scales had high reliabilities with all $\alpha \geq 0.79$. Communication was measured using five items adapted from Liang et al. (2012). The questions for measuring communication were focused on communication frequency, its naturalness, satisfaction with the timeliness of the information received by team members, the precision of communication, and its usefulness (Weimar et al., 2017). Coordination of expertise was measured using four items: the knowledge of expertise location, three items for identifying the need for expertise, and four items for engaging expertise to good use (Faraj & Sproull, 2000; Weimar et al., 2017). Cohesion was measured with the Perceived Cohesion Scale (PCS) (Bollen & Hoyle, 1990; Chin et al., 1999; Weimar et al., 2017). The PCS included six items that were used to ask team members whether they feel they belong to the team, are happy to be part of the team, see themselves as part of the team, consider the team to be one of the best, feel they are a member of the team, and if they are content to be part of the team (Weimar et al., 2017).

Trust was measured by five items: asking team members if they considered the feelings of others on the team and if team members were friendly, reliable, and trustworthy (Jarvenpaa & Leidner, 1999; Weimar et al., 2017). The six items of mutual support measured the degree of coordination in the team by considering the extent to which team members supported each other, respected and further developed suggestions and contributions of other team members, and whether the team was able to reach consensus on important issues (Hoegl & Gemuenden, 2001; Weimar et al., 2017). Six items adopted from Jehn (1994) and Jehn et al. (1999) measured value sharing. Team members were asked if similar values were seen in all team members, whether the team as a whole has similar work values if the team as a whole has similar goals, if the team members have strongly held beliefs about what is important within the team, whether the team members have similar goals, and whether all team members agree on what is important to the team. High scores will represent low-value diversity. Team performance was measured using seven items based on the scales developed by Henderson and Lee (1992). Team performance was measured as the extent to which the goals of the project are achieved, the expected amount of work is completed, a high level of quality is delivered, the schedule is followed, the operations are carried out efficiently and within schedule, and on budget (Jones & Harrison, 1996; Weimar et al., 2017).

4.0 FINDINGS

Demographic Description

Out of the 160 respondents who completed the survey, 47.50% were male, and 52.50% were female. There were more female (N = 84) participants than male (N = 76). Most of the participants were in the 18-29 age group with N = 85 (53.13%), followed by the 30-44 age group with N = 58 (36.25%), then the 45-60 age group with N = 13 (8.13%), and the least being 60 years and above with N = 4 (2.50%).

Hypothesis Testing

Multiple regression was the statistical analysis used to test the hypothesis for answering the research question. This analysis focuses on determining the effect of the TWQ factors on Agile software development team performance. According to Field (2013), multiple regression is a linear model with two or more predictors of the dependent variable. The F-statistics with a .05 significance level was used to test whether to accept or reject the null hypothesis. The null hypothesis is accepted when the *p*-value is statistically significant ($p > .05$). Otherwise, it is rejected in favor of the alternative hypothesis if it has *p*-values less than .05 ($p < .05$).

Descriptive Statistics of the Variables

All the variables were measured using a 5-point Likert scale. The raw data was saved in a .csv format and loaded into JAPS 0.17.3 for data transformation and analysis. The descriptive statistics of the data for the independent variables (Communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) and the dependent variable (team performance) are presented in Table 1. The skewness and kurtosis of all the variables are within the acceptable range of normality of ±2 (George & Mallery, 2018).

Table 1: Descriptive Statistics of Variables

	Trust	Communication	Coordination	Cohesion	Mutual Support	Value Sharing	Team Performance
Valid	160	160	160	160	160	160	160
Mean	3.728	3.927	3.714	4.031	3.971	3.919	3.974
Std. Error of Mean	0.059	0.069	0.061	0.068	0.066	0.068	0.066
Std. Deviation	0.751	0.876	0.772	0.857	0.831	0.864	0.830
Skewness	-0.551	-1.156	-0.780	-1.167	-1.077	-0.964	-1.145
Std. Error of Skewness	0.192	0.192	0.192	0.192	0.192	0.192	0.192
Kurtosis	0.327	1.755	1.700	1.745	1.872	1.181	1.938
Std. Error of Kurtosis	0.381	0.381	0.381	0.381	0.381	0.381	0.381

Regression Analysis

Regression analysis is a statistical tool for investigating the relationship between variables to find the causal effects of one variable on another (Sykes, 1993). Multiple regression was an appropriate technique for answering the research question because the dependent and independent variables were continuous. A test was conducted for the assumptions of linearity, outliers, homoscedasticity,

normality, independence of error, and multicollinearity. All the assumptions for multiple regression analysis were met, validating the appropriateness of parametric tests for the hypothesis testing.

Multiple regression was analyzed to determine the predictive effect on team performance by communication, coordination of expertise, cohesion, trust, mutual support, and value sharing. The study data was screened to ensure that the assumptions for linear regression were met before the multiple regression analysis. All assumptions about linearity, homoscedasticity, normality, independence of errors, multicollinearity, and outliers were met. All the independent variables were strongly correlated to the dependent variable.

The model summary, as presented in Table 2, shows the multiple regression correlation coefficients, $R = 0.906$, indicating a very strong relationship between the observed and model-predicted value of team performance. Additionally, the coefficient of determination, $R^2 = 0.822$, indicated that all six independent variables explained 82.2% of the total variance in team performance. The multiple regression model statistically significantly predicted team performance, $F(6,150) = 115.15$, $p < .001$, adj.$R^2 = 0.814$ (Table 2 & 3). Therefore, the multiple regression model was a better predictor of team performance than the mean model, which represents a model without predictor variables such as communication, coordination of expertise, cohesion, trust, mutual support, and value sharing. Additionally, about the data, the model is a statistically significantly better fit than the mean model. The current multiple regression improved the mean model predicting team performance by $R^2 = 0.822$.

Table 2: Model Summary – Team Performance

Model	R	R²	Adjusted R²	RMSE	R² Change	F Change	df¹	df²	p
H_0	0.000	0.000	0.000	0.827	0.000		0	156	
H_1	0.906	0.822	0.814	0.356	0.822	115.148	6	150	$< .001$

Table 3: ANOVA

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	87.641	6	14.607	115.148	$< .001$
	Residual	19.028	150	0.127		
	Total	**106.669**	**156**			

Note. The intercept model is omitted, as no meaningful information can be shown.

The regression coefficients and standard errors presented in Table 4 show the individual contributions of the predictor variables in the outcome. Out of the six predictor variables in the model, only mutual support [$b = 0.511$, $t(156) = 6.099$, $p < .001$] and value sharing [$b = 0.170$, $t(156) = 2.418$, $p = .017$] statistically contributed significantly at below 0.05 to the model. The four remaining predictors: Communication [$b = 0.044$, $t(156) = 0.630$, $p = .053$], coordination of expertise [$b = 0.080$, $t(156) = 1.318$, $p = .189$], cohesion [$b = 0.138$, $t(156) = 1.687$, $p = .094$], and

trust [$b = 0.014$, $t(156) = 0.217$, $p = .829$] did not contribute statistically significantly at below 0.05 to the model.

Table 4: Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p	Collinearity Statistics	
							Tolerance	VIF
H_0	(Intercept)	3.986	0.066		60.399	< .001		
H_1	(Intercept)	0.204	0.169		1.211	0.228		
	Trust	0.014	0.065	0.013	0.217	0.829	0.348	2.877
	Communication	0.044	0.070	0.047	0.630	0.530	0.214	4.682
	Coordination	0.080	0.061	0.075	1.318	0.189	0.367	2.727
	Cohesion	0.138	0.082	0.144	1.687	0.094	0.163	6.143
	MutualSupport	0.511	0.084	0.512	6.099	< .001	0.169	5.929
	ValueSharing	0.170	0.070	0.177	2.418	0.017	0.221	4.527

Null Hypothesis

The hypothesis formulated to answer the research question for this study stated that there was no statistically significant predictive relationship between the TWQ factors (Communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) and Agile software development team performance. As presented in the overall model summary with all the six factors of the extended TWQ model (Table 3), $R^2 = 82.2\%$, with an adjusted $R^2 = 81.4\%$. The R^2 value shows that the model explains 82.2% of the total variance in team performance. As shown in Table 3, the model held statistical significance where all the six independent variables predicted team performance, $F(6,150) = 115.15$, $p < .001$. Hence, the null hypothesis claiming no statistically significant predictive relationship exists between the TWQ factors and Agile software development team performance was rejected.

The standardized coefficient from the model is used to rank the TWQ factors in terms of importance to team performance. The standardized coefficient was better for determining the relative importance of factors predicting team performance (Grace et al., 2018). The result from the regression analysis for the overall model (Table 4) suggests that mutual support (β = 0.512) was the most important predictor of team performance. Mutual support was followed by value sharing (β = 0.177), cohesion (β = 0.144), coordination of expertise (β = 0.075), and communication (β = 0.047), with trust (β = 0.013) being the least important.

Discussion of the Results

All the extended TWQ factors had a significant and strong relationship with team performance. The six TWQ factors collectively accounted for 82.2% of the variances in team performance, supporting the research question's alternative hypothesis. This finding is consistent with the finding by Weimar et al. (2017), where the extended TWQ factors accounted for 81.1% of the variances in team performance when rated by team members. However, only some of the TWQ

factors statistically contributed significantly to the model in the current study. Only mutual support [$b = 0.511$, $t(156) = 6.099$, $p < .001$] and value sharing [$b = 0.170$, $t(156) = 2.418$, $p = .017$] statistically contributed significantly to the model.

The finding from this study regarding the existence of a predictive relationship between the TWQ factors and team performance supports similar findings from earlier studies. Ahmad et al. (2016), Hoegl and Gemuenden (2001), Lindsjørn et al. (2016), Lindsjørn et al., 2018, and Weimar et al. (2017) found a significant relationship between TWQ factors and team performance. Hoegl and Gemuenden (2001) found from their research that all the original TWQ factors (communication, coordination, the balance of member contributions, mutual support, effort, and cohesion) contributed significantly to team performance. Similarly, Weimar et al. (2017) found all the extended TWQ factors (communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) to have a significant relationship with team performance. According to Weimar et al. (2017), as rated by team members, TWQ accounted for 81.1% of the variances in team performance. Contrary to previous findings, Ahmad et al. (2016) found no significant influence of value sharing (diversity), one of the extended TWQ factors, on team performance. Similarly, the current study did not find all the extended TWQ factors to contribute significantly to team performance. Only mutual support and value sharing (diversity) contributed significantly to predicting team performance in the current study. This finding did not support the finding by Ahmad et al. (2016) because value sharing (diversity) contributed significantly to team performance.

The findings from this study support the argument that the TWQ model has the capability of predicting team performance (Ahmad et al., 2016; Hoegl & Gemuenden, 2001; Lindsjørn et al., 2016; Lindsjørn et al., 2018; Weimar et al., 2017). Additionally, the extended TWQ model predicts team performance better than the original TWQ model (Hoegl & Gemuenden, 2001; Weimar et al., 2017). A study by Hoegl and Gemuenden (2001) found that the original TWQ model accounted for 41% of the variance in team performance when rated by team members. However, the extended TWQ model, which replaced coordination, the balance of member contributions, and efforts with trust, value sharing (diversity), and coordination of expertise in the TWQ model, accounted for 81% of the variance in team performance (Weimar et al., 2017). Weimar et al. (2017) suggested that the adjustment in the extended TWQ model explained team performance better than the constructs of the original TWQ alone. The findings from the current study support that argument in that the extended TWQ model explained 82.2% of the variance in Agile software team performance. Including trust, value sharing, and coordination of expertise in the extended TWQ model contributed more to explaining team performance.

Previous studies found that all six TWQ factors statistically contributed significantly to team performance (Hoegl & Gemuenden, 2001; Lindsjørn et al., 2016; Lindsjørn et al., 2018; Weimar et al., 2017). However, Ahmad et al. (2016) did not find value sharing (diversity) statistically contributing significantly to team performance. On the contrary, the current study found only mutual support and value sharing (diversity) to contribute statistically significantly to predicting team performance. Communication, coordination of expertise, trust, and cohesion did not contribute statistically significantly to predicting team performance.

The current study ranked mutual support as the most important TWQ factor in team performance. Mutual support was followed by value sharing, cohesion, coordination of expertise, and communication, while trust was ranked as the least. The finding of mutual support as the most important factor in predicting team performance is consistent with previous studies. Lindsjørn et al. (2016) found that mutual support has the most significant effect on team performance. Similarly, Weimar et al. (2017) found mutual support as one of the two most important factors in team performance compared to the other TWQ factors.

Limitations

The study was limited to the use of Agile methodology for software development. It did not make any distinction between the various Agile methodologies such as scrum, Dynamic Systems Development Method (DSDM), eXtreme Programming (XP), and Adaptive Software Development (ASD). Only the six extended TWQ factors were considered as part of the independent variables for determining their effects on team performance for this study. No other team factors that have been found in previous studies to have an impact on team performance were considered for this study.

The study was limited to the pool of audience within SurveyMonkey panel. This audience pool might not have been a good representation of the broader population of I.T. professionals using Agile methodology for software development. Additionally, the study could have been more extensive in the sample size, though the sample size slightly exceeded the minimum sample size calculated by the G* power analysis.

The study was limited to I.T. professionals with U.S. organizations. I.T. professionals outside of the U.S. were excluded from participating in this study. The results, findings, and conclusions drawn from the study were based on the assumption that respondents provide honest and truthful responses to the survey questions. Despite these limitations, the study adopted and met rigorous scientific and empirical research requirements. Therefore, the findings from the study are valid and provide helpful insight into the predictive capabilities of the TWQ factors on team performance.

Implications for Theory

This empirical study tested and extended the TWQ model on team performance in the Agile software development space in the U.S. for software development teams and how these TWQ factors are ranked in terms of importance to team performance. The primary data collected was analyzed using correlation and regression analysis to investigate the extent to which the TWQ factors influence team performance and the ranking in terms of the importance of these factors to team performance. The findings from this investigation support the argument that the TWQ factors have a significant and strong relationship with team performance and that these factors significantly predict team performance. These findings support previous empirical studies (see, e.g., Hoegl and Gemuenden, 2001; Lindsjørn et al., 2016; Weimar et al., 2017) that found the TWQ to have a significant relationship to team performance. Most of the previous studies were conducted outside the U.S. However, this current study was conducted in the U.S. to test, validate, and extend the TWQ model in a different country and from a different perspective. Additionally,

the findings provide insight into the TWQ model from the perspective of Agile software development teams.

The current study ranked the TWQ factors (communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) in terms of importance to team performance and found mutual support to be the most important and trust to be the least. This finding provides insight that advances and extends the knowledge of the TWQ model. Additionally, it provides a good understanding of the relative importance of each of these factors to the TWQ model. According to Boer et al. (2015), "a valid contribution to theory would consist of a better or more inclusive explanation of observed, or observable, phenomena" (p.1248).

Implications for Practice

The study significantly contributes to the literature on teamwork and collaboration in the Agile environment. Team capability has been found in previous studies to be a CSF for team performance and project success (Aldahmash et al., 2017; Chevers, 2018; Chiyangwa & Mnkandla, 2017; Garousi et al., 2019; Ghanbari et al., 2018). The study's findings have implications for project team leaders and members, product owners, scrum masters, and project managers responsible for Agile software development. This study addressed the critical TWQ factors for building effective and efficient Agile software development teams. Additionally, the results from the study provide useful information for improving Agile software development team quality towards team performance for project success.

5.0 CONCLUSION AND RECOMMENDATIONS

Conclusion

This non-experimental correlational quantitative research design explored the extent to which the extended TWQ factors (communication, coordination of expertise, cohesion, trust, mutual support, and value sharing) predict team performance. An online survey was conducted using SurveyMonkey to collect data for this study. In all, 160 participants provided complete responses to the questions. The collected data from participants was examined using descriptive statistics, correlation, and multiple regression analysis. The results from the analysis showed that the extended TWQ factors had a significant and strong relationship with team performance. The results also found that the TWQ factors have a statistically significant predictive relationship with team performance. However, only mutual support and value sharing contributed statistically significantly to team performance. Ranking the extended TWQ factors in terms of their relative importance to team performance yielded mutual support as the most important predictor of team performance, followed by value sharing, cohesion, coordination of expertise, and communication, with trust being the least important. This study contributes to the research on the TWQ model developed by Hoegl and Gemuenden (2001) and extended by Weimar et al. (2017).

Recommendations for Further Research

The current study used a non-experimental correlational quantitative research design to explore the extent to which the extended TWQ factors predict team performance. The overall model from

the study found that the TWQ factors collectively explained 82.2% of the variance in team performance. However, only mutual support and value sharing (diversity) were statistically significant. Therefore, more studies are needed for the extended TWQ model to confirm and support these findings or prove otherwise.

Replicating this study with a larger sample size in the future is recommended. A larger sample will show a good representation of the broader population of I.T. professionals using Agile methodology for software development. A larger sample size will help support or not support the findings from this study. Previous studies found team factors to be CSF for the success of software development projects. Studies have also shown that organizations use Agile to improve the process and quality of software delivery. The study did not make any distinction between the various Agile methodologies such as scrum, Dynamic Systems Development Method (DSDM), eXtreme Programming (XP), and Adaptive Software Development (ASD). Future research to examine if any differences exist between the various Agile methodologies for the TWQ factors and team performance is recommended.

REFERENCES

Ahimbisibwe, A., Cavana, R. Y., & Daellenbach, U. (2015). A contingency fit model of criticalsuccess factors for software development projects. *Journal of Enterprise Information Management, 28*(1), 7-33. https://doi.org/10.1108/JEIM-08-2013-0060

Ahmad, M., Abdulmajeed, V., Omar, M., Yasin, A., Baharom, F., Mohd, H., & Darus, N.M. (2016). Examining the influence of teamwork factors on team performance for software development in telecommunication industry. *Journal of Telecommunication, Electronic and Computer Engineering*, *8*(8), 121-124. http://repo.uum.edu.my/20507/1/JTEC%208%208%202016%20121%20124.pdf

Aksekili, A. Y., & Stettina, C. J. (2021). Women in agile: The impact of organizational support for women's advancement on teamwork quality and performance in Agile software development teams. In *Lean and Agile Software Development: 5th International Conference, LASD 2021, Virtual Event, January 23, 2021, Proceedings 5* (pp. 3-23). Springer International Publishing. https://doi.org/10.1007/978-3-030-67084-9_1

Aldahmash, A., Gravell, A. M., & Howard, Y. (2017, September). A review on the criticalsuccess factors of Agile software development. In *European conference on software process improvement* (pp. 504-512). Springer. https://doi.org/10.1007/978-3-319-64218-5_41

Al-Saqqa, S., Sawalha, S., & AbdelNabi, H. (2020). Agile software development: Methodologiesand trends. *International Journal of Interactive Mobile Technologies*, *14*(11) 246–270. https://doi.org/10.3991/ijim.v14i11.13269

Al-Zaidi, A., & Qureshi, R. (2017). Global software development geographical distancecommunication challenges. *Int. Arab J. Inf. Technol.*, *14*(2), 215-222. https://iajit.org/PDF/Vol%2014,%20No.%202/8063.pdf

Andrei, B., Casu-Pop, A., Gheorghe, S., & Boiangiu, C. (2019). A study on using waterfall and Agile methods in software project management. *Journal of Information Systems & Operations Management, ,* 125-135. https://web.rau.ro/websites/jisom/Vol.13%20No.1%20-%202019/JISOM-SU19-A12.pdf

Aoyama, M. (1998, April). Agile software process and its experience. In *Proceedings of the 20thInternational Conference on Software engineering* (pp. 3-12). IEEE. https://doi.org/10.1109/ICSE.1998.671097

Ateeq, S., & Shuaib, M. (2014). Comparison of various SDLC models. *GlobalJournal of Multidisciplinary Studies, 3*(11), 176-181. https://www.researchgate.net/profile/Mohammad-Suaib/publication/272945026_COMPARISON_OF_VARIOUS_SDLC_MODELS/links/54f413160cf24eb8794d222f/COMPARISON-OF-VARIOUS-SDLC-MODELS.pdf

Bach-Dąbrowska, I., & Pawlewski, P. (2014). Optimization model of agile team's cohesion. *Procedia Computer Science*, *35*, 1577-1585. https://doi.org/10.1016/j.procs.2014.08.241

Balle, A. R., Oliveira, M., Curado, C., & Nodari, F. (2018). How do knowledge cycles happen in software development methodologies? *Industrial and Commercial Training, 50*(7), 380-392. https://doi.org/10.1108/ICT-04-2018-0037

Banica, L., Radulescu, M., Rosca, D., & Hagiu, A. (2017). Is DevOps another projectmanagement methodology? *Informatica Economica, 21*(3), 39-51. https://doi.org/10.12948/issn14531305/21.3.2017.04

Bechtel, J., Kaufmann, C., & Kock, A. (2021). Agile projects in nonagile portfolios: How project portfolio contingencies constrain agile projects' teamwork quality. *IEEE Transactions on Engineering Management*, *69*(6), 3514-3528. https://doi.org/10.1109/TEM.2021.3130068

Beckhusen, J. (2016). *Occupations in information technology.* US Department of Commerce,Economics and Statistics Administration, US Census Bureau. https://www.census.gov/content/dam/Census/library/publications/2016/acs/acs-35.pdf

Boer, H., Holweg, M., Kilduff, M., Pagell, M., Schmenner, R.W., & Voss, C.A. (2015). Makinga meaningful contribution to theory. *International Journal of Operations & Production Management, 35*, 1231-1252. https://doi.org/10.1108/IJOPM-03-2015-0119

Bollen, K. A., & Hoyle, R. H. (1990). Perceived cohesion: A conceptual and empirical examination. *Social Forces, 69*(2), 479– 504. https://doi.org/10.1093/sf/69.2.479

Bullen, C. V., & Rockhart, J. F. (1981). *A primer on critical success factors* [Working Paper No. 69], Massachusetts Institute of Technology, Sloan School of Management, Center for Information Systems Research, Cambridge, Massachusetts. https://dspace.mit.edu/bitstream/handle/1721.1/1988/SWP-1220-08368993-CISR-069.pdf?sequen

Chevers, D. A. (2018). A mixed method approach to investigate the antecedents of software quality and information systems success in Canadian software development firms. *Electronic Journal of Information Systems Evaluation, 21*(2), 109-130. https://academic-publishing.org/index.php/ejise/article/view/133

Chin, W. W., Salisbury, W. D., Pearson, A. W., & Stollak, M. J. (1999). Perceived cohesion in small groups: Adapting and testing the perceived cohesion scale in a small-group setting. *Small Group Research, 30*(6), 751-766. https://doi.org/10.1177/104649649903000605

Chiyangwa, T. B., & Mnkandla, E. (2017). Modelling the critical success factors of Agile software development projects in South Africa. *South African Journal of Information Management, 19*(1) 1-8. https://doi.org/10.4102/sajim.v19i1.838

Cockburn, A., & Highsmith, J. (2001). Agile software development, the people factor. *Computer, 34*(11), 131-133. http://sunnyday.mit.edu/16.355/highsmith-people.pdf

Cole, M. L., Cox, J. D., & Stavros, J. M. (2019). Building collaboration in teams through emotional intelligence: Mediation by SOAR (strengths, opportunities, aspirations, and results). *Journal of Management and Organization, 25*(2), 263-283. https://doi.org/10.1017/jmo.2016.43

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed method approaches* (5th ed.). SAGE.

Dasoriya, R. (2017). Significance of software development models. *International Journal of Advanced Research in Computer Science, 8*(8), 732-736. https://doi.org/10.26483/ijarcs.v8i8.4839

de Borba, J. C. R., Trabasso, L. G., & Pessôa, M. V. P. (2019). Agile management in product development. *Research Technology Management, 62*(5), 63–67. https://doi.org/10.1080/08956308.2019.1638488

Denning, S. (2013). Why Agile can be a game changer for managing continuous innovation in many industries. *Strategy & Leadership, 41*(2), 5-11. https://doi.org/10.1108/10878571311318187

Dingsøyr, T., Fægri, T. E., Dybå, T., Haugset, B., & Lindsjørn, Y. (2016). Team performance in software development: Research results versus Agile principles. *IEEE software*, *33*(4), 106-110. https://doi.org/10.1109/MS.2016.100

Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal, 5*(6), 215 - 217. http://doi.org/10.15406/bbij.2017.05.00149

Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science, 46*(12), 1554–1568. https://doi.org/10.1287/mnsc.46.12.1554.12072

Fatema, I., & Sakib, K. (2017, December). Factors influencing productivity of Agile software development teamwork: A qualitative system dynamics approach. In *2017 24th Asia-Pacific Software Engineering Conference (APSEC),* 737-742. https://doi.org/10.1109/APSEC.2017.95

Fatima, A., & Gupta, S. (2018). Critical analysis on various software development models. *International Journal of Advanced Research in Computer Science*, 9, 157-161. https://doi.org/10.26483/ijarcs.v9i0.6157

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods*, *41*(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Fazli, F., & Bittner, E. A. C. (2017, January). Cultural influences on collaborative work insoftware engineering teams. In *Proceedings of the 50th Hawaii international conference on system sciences*. https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/e1ed1f1e-99db-4c2f-af3e-ddbfdf167031/content

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

Fustik, V. (2017). The advantages of Agile methodologies applied in the ICT development projects. *International Journal on Information Technologies & Security*, 9(4), 51–62.

Garousi, V., Tarhan, A., Pfahl, D., Coşkunçay, A., & Demirörs, O. (2019). Correlation of critical success factors with success of software projects: An empirical investigation. *Software Quality Journal, 27*(1), 429-493. http://doi.org/10.1007/s11219-018-9419-5

George, D., & Mallery, P. (2018). *IBM SPSS statistics 25 step by step: A simple guide and reference*. Taylor & Francis Group.

Ghanbari, H., Vartiainen, T., & Siponen, M. (2018). Omission of quality software development practices: A systematic literature review. *ACM Computing Surveys (CSUR), 51*(2), 1-27. https://doi.org/10.1145/3177746

Ghani, I., & Bello, M. (2015). Agile adoption in IT organizations. *KSII Transactions on Internet & Information Systems*, 9(8), 3231–3248. https://doi.org/10.3837/tiis.2015.08.029

Grace, J. B., Johnson, D. J., Lefcheck, J. S., & Byrnes, J. E. K. (2018). Quantifying relative importance: Computing standardized effects in models with binary outcomes. *Ecosphere, 9*(6). https://doi.org/10.1002/ecs2.2283

Haaskjold, H., Andersen, B., & Langlo, J. A. (2020). In search of empirical evidence for the relationship between collaboration and project performance. *The Journal of Modern Project Management, 7*(4) 120-152. https://doi.org/10.19255/JMPM02206

Hayat, M., & Qureshi, M. R. J. Q. (2015). Measuring the effect of CMMI quality standard on Agile scrum model. *International Journal of Information Engineering and Electronic Business, 7*(6), 46-52. http://doi.org/10.5815/ijieeb.2015.06.07

Henderson, J. C., & Lee, S. (1992). Managing I/S design teams: A control theories perspective. *Management Science, 38*(6), 757-777. https://doi.org/10.1287/mnsc.38.6.757

Hoegl, M., & Gemuenden, H. G. (2001). Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization Science, 12*(4), 435-449. https://doi.org/10.1287/orsc.12.4.435.10635

Hummel, M., Rosenkranz, C., & Holten, R. (2013). The role of communication in Agile systems development: An analysis of the state of the art. *Wirtschaftsinformatik*, *55*, 347-360.

Ibrahim, Z., Johar, M. G. M., & Rahman, N. R. A. (2018). The quality of teamwork on methodology in software development workflow. *Int. J. Eng. Technol*, *7*(4). https://doi.org/10.14419/ijet.v7i4.28.22641

Jarvenpaa, S. L., & Leidner, D. E. (1999). Communication and trust in global virtual teams. *Organization Science (Providence, R.I.), 10*(6), 791-815. https://doi.org/10.1287/orsc.10.6.791

Jehn, K. A. (1994). Enhancing effectiveness: An investigation of advantages and disadvantagesof value-based intra-group conflict. *International Journal of Conflict Management, 5*(3), 223-238. http://doi.org/10.1108/eb022744

Jehn, K. A., Northcraft, G. B., & Neale, M. A. (1999). Why differences make a difference: Afield study of diversity, conflict and performance in workgroups. *Administrative science quarterly*, *44*(4), 741-763. https://doi.org/10.2307/2667054

Jones, M. C., & Harrison, A. W. (1996). IS project team performance: An empirical assessment. *Information & Management, 31*(2), 57–65. https://doi.org/10.1016/S0378-7206(96)01068-3

Jones, S., Carley, S., & Harrison, M. (2003). An introduction to power and sample size estimation. *Emergency Medicine Journal: EMJ, 20*(5), 453. https://doi.org/10.1136/emj.20.5.453

Kakar, A. K. (2017). Assessing self-organization in Agile software development teams. *The Journal of Computer Information Systems, 57*(3), 208-217. http://doi.org/10.1080/07362994.2016.1184002

Kamepally, A. K., & Nalamothu, T. (2016). Agile methodologies in software engineering and web engineering. *International Journal of Education and Management Engineering, 6*(5), 1. https://doi.org/10.5815/ijeme.2016.05.01

Khaldi, K. (2017). Quantitative, qualitative or mixed research: Which research paradigm to use? *Journal of Educational and Social Research*, *7*(2), 15. https://doi.org/10.5901/jesr.2017.v7n2p15

Könnölä, K., Suomi, S., Mäkilä, T., Rantala, V., & Lehtonen, T. (2016). Can embedded space system development benefit from Agile practices? *EURASIP Journal on Embedded Systems, 2017*, 1-16. https://doi.org/10.1186/s13639-016-0040-z

Krehbiel, T. C., & Miller, D. P. (2018). Should Agile be part of your quality management system? *Journal of International Technology and Information Management, 27*(1), 2-28.

https://doi.org/10.58729/1941-6679.1342

Liang, T. P., Wu, J. C. H., Jiang, J. J., & Klein, G. (2012). The impact of value diversity on information system development projects. *International Journal of Project Management, 30*(6), 731-739. https://doi.org/10.1016/j.ijproman.2011.11.006

Lindsjørn, Y., Sjøberg, D. I., Dingsøyr, T., Bergersen, G. R., & Dybå, T. (2016). Teamworkquality and project success in software development: A survey of Agile development teams. *Journal of Systems and Software*, *122*, 274-286. https://doi.org/10.1016/j.jss.2016.09.028

Lindsjørn, Y., Bergersen, G. R., Dingsøyr, T., & Sjøberg, D. I. (2018). Teamwork quality and team performance: Exploring differences between small and large Agile projects. In *Proceedings of the 19th International Conference on Agile Processes in Software Engineering and Extreme Programming, Springer, Porto, Portugal* (pp. 267-274). https://doi.org/10.1007/978-3-319-91602-6_19

Lukusa, L., Geeling, S., Lusinga, S., & Rivett, U. (2020, October). Teamwork and project success in Agile software development methods: A case study in higher education. In *Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 885-891). https://doi.org/10.1145/3434780.3436648

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review, 20*(3), 709-734. https://doi.org/10.2307/258792

Miller, G. G. (2001, July). The characteristics of Agile software processes. In *Technology of Object-Oriented Languages, International Conference on* (pp. 0385-0385).

Nguyen, D. S. (2016). Workplace factors that shape Agile software development team project success. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *17*(1), 323-391. https://core.ac.uk/download/pdf/235049863.pdf

Ochieng, E. G., & Price, A. D. (2009). Framework for managing multicultural project teams. *Engineering, Construction and Architectural Management, 16*(6), 527-543. https://doi.org/10.1108/09699980911002557

Omar, M., Rejab, M. M., & Ahmad, M. (2019). The effect of teamwork quality on team performance in global software engineering. In M. Rehman, A. Amin, A. R. Gilal, & M. A. Hashmani (Eds.), *Human factors in global software engineering* (pp. 322-331). IGI Global. https://doi.org/10.4018/978-1-5225-9448-2.ch013

Qureshi, R., Basheri, M., & Alzahrani, A. A. (2018). Novel framework to improve communication and coordination among distributed agile teams. *International Journal of Information Engineering and Electronic Business*, *10*(4), 16. https://doi.org/10.5815/ijieeb.2018.04.03

Radu, L. (2019). Effort Prediction in Agile software development with Bayesian networks [Paper presentation]. In *Proceedings of the 14th International Conference on Software Technologies - ICSOFT* (pp.238-245). SciTePress. https://doi.org/10.5220/0007842802380245

Ram, J., & Corkindale, D. (2014). How "critical" are the critical success factors (CSFs)? Examining the role of CSFs for ERP. *Business Process Management Journal*, *20*(1), 151-174. https://doi.org/10.1108/BPMJ-11-2012-0127

Rutberg, S., & Bouikidis, C. D. (2018). Focusing on the fundamentals: A simplistic differentiation between qualitative and quantitative research. *Nephrology Nursing Journal*, *45*(2), 209-213. www.researchgate.net

Salfarina, A., Yusmadi Yah, J., Sazly, A., & Marzanah, A. J. (2021). Cultivating the ideal teamwork through real software development project experience. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(3), 1923-1929. https://turcomat.org/index.php/turkbilmat/article/view/1024

Sasankar, A. B., & Chavan, V. (2011). SWOT analysis of software development process models. *International Journal of Computer Science Issues (IJCSI), 8*(5), 390-399. https://tigosoftware.com/sites/default/files/2020-09/SWOT_Analysis_of_Software_Development_Process_Mode.pdf

Seeram, E. (2019). An overview of correlational research. *Radiologic technology*, *91*(2), 176-179. https://pubmed.ncbi.nlm.nih.gov/31685592/

Serrador, P., & Pinto, J. K. (2015). Does Agile work? - A quantitative analysis of Agile project success. *International Journal of Project Management, 33*(5), 1040-1051. https://doi.org/10.1016/j.ijproman.2015.01.006

Silva, M., Freire, A., Perkusich, M., Albuquerque, D., Guimaraes, E., Almeida, H., ... & Gorgônio, K. (2021, March). Measuring agile teamwork: A comparative analysis between two models. In *Proceedings of the 36th Annual ACM Symposium on Applied Computing* (pp. 1475-1483). https://doi.org/10.1145/3412841.3442022

Simion, K. (2016). *Qualitative and quantitative approaches to rule of law research*. SSRN https://doi.org/10.2139/ssrn.2817565

Sjøberg, D. I. (2018). Teamwork quality and team performance: Exploring differences between small and large agile projects. *Agile Processes in Software Engineering and Extreme Programming*, *267*.

Sporsem, T., & Moe, N. B. (2022, June). Coordination strategies when working from anywhere: A case study of two agile teams. In *International Conference on Agile Software Development* (pp. 52-61). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-08169-9_4

Subramaniam, R., & Nakkeeran, S. (2016). Identifying the impact of team size on team work quality (TWQ) in software teams through an empirical approach. *Asian Journal of Research in Social Sciences and Humanities*, *6*(4), 151-171. https://doi.org/10.5958/2249-7315.2016.00051.4

Suresh, K. P., & Chandrashekara, S. (2012). Sample size estimation and power analysis for clinical research studies. *Journal of human reproductive sciences, 5*(1), 7-13. https://doi.org/10.4103/0974-1208.97779

Sykes, A. O. (1993). *An introduction to regression analysis* (Coase-Sandor Institute for Law & Economics Working Paper No. 20). Coase-Sandor Institute for Law and Economics, University of Chicago Law School. https://chicagounbound.uchicago.edu/

Tanner, M., & Dauane, E. M. (2017). The use of Kanban to alleviate collaboration and communication challenges of global software development. *Informing Science and Information Technology*, 14, 177-197. https://doi.org/10.28945/3716

Weimar, E., Nugroho, A., Visser, J., & Plaat, A. (2013, April). Towards high performance software teamwork. *EASE '13: Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering*, 212-215. https://doi.org/10.1145/2460999.2461030

Weimar, E., Nugroho, A., Visser, J., Plaat, A., Goudbeek, M., & Schouten, A. P. (2017). The influence of teamwork quality on software team performance. *arXiv preprint* https://doi.org/10.48550/arXiv.1701.06146

Wibowo, A. F., & Ruldeviyani, Y. (2022). Factors affecting success of team members in Indonesia scrum implementation. In *Proceedings of the 1st International Conference on Emerging Issues in Technology, Engineering and Science - ICE-TES* (pp. 279-285). https://doi.org/10.5220/0010751900003113

Xu, P. (2009). Coordination in large agile projects. *Review of Business Information Systems (RBIS)*, *13*(4). https://doi.org/10.19030/rbis.v13i4.4310

Yagüe, A., Garbajosa, J., Díaz, J., & González, E. (2016). An exploratory study in communication in Agile Global Software Development. *Computer Standards & Interfaces*, *48*, 184-197.

License