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The Construction and Internal Validation of a Model for the Effective Collaboration of Distributed Agile Teams

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by

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A dissertation submitted in partial fulfillment of the requirements
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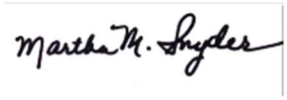
Approval Page

We hereby certify that this dissertation, submitted by Ernesto Custodio conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.



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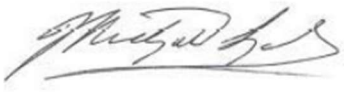

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An Abstract of a Dissertation Submitted to Nova Southeastern University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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by
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Agile approaches to software development have increased steadily over the past decade. Agile processes emphasize iterative and collaborative discovery of requirements and solutions executed by self-organizing, cross-functional teams. Software development using distributed teams, including distributed sub-teams, fully dispersed teams, and partially dispersed teams, has also increased due to benefits such as access to global talent and faster delivery, among others. However, most Agile approaches, models, and frameworks only address the needs of colocated teams. Distributed teams come with unique challenges when it comes to effective collaboration.

The goal was to construct and validate internally a model for the effective collaboration of distributed Agile teams. A Design Science Research (DSR) approach was implemented in three phases. First, a preliminary model was constructed based on a review of the literature and the researcher's experience and expertise in Agile methods. Second, a needs assessment was conducted with stakeholders to further develop the model. Third, the model was updated based on the survey results and validated internally using the Delphi Method. The model was created to help identify the challenges and solutions associated with the three primary types of Agile distribution. These types of distribution included distributed teams, distributed team members, and hybrid compositions. The model was divided into four main categories: tools, roles, events, and artifacts. Each category contained the collaboration challenges and solutions relating to each composition type.

The final distributed Agile collaboration model was designed to help Agile practitioners and managers working in a distributed environment to collaborate effectively. The model was designed to be applied as per the needs of the distributed Agile teams. A five-step implementation process was recommended for teams to use the model: 1) Identify the team's composition type, 2) Select and prioritize the challenges affecting the team, 3) Identify the applicable solutions included in the model, 4) Create a solution implementation plan, 5) Inspect the impact the solution has and adapt according to the observations.

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It took a village to make the highly improbable a reality. The people who have contributed to this achievement are too many to list. First, I am immensely grateful to my committee members for the wisdom and guidance they offered me during the dissertation process. I would like to add a special word of appreciation to my dissertation chair, Dr. Marti Snyder, whose timely advice, and genuine support allowed me not only to complete the study but also to grow from the experience and enjoy the process. To Dr. Ling Wang, whose encouragement and ability to explain the most complex process in a simple form allowed me to always move forward. To Dr. Mike Lohle, whose valuable feedback forced me to elaborate on each topic and make the study more insightful.

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Chapter 1

Introduction

Background

Agile development is implemented through a set of frameworks that emphasize iterative and collaborative discovery of requirements and solutions that are executed by self-organizing and cross-functional teams. The Agile frameworks facilitate iterative development and team collaboration for value delivery. The most widely adopted frameworks include Scrum and XP (VersionOne, 2018). The Agile Manifesto is the primer that guides these different Agile frameworks by defining values and principles that guide the behavior which Agile teams must exhibit to achieve the benefits of Agile development (Bosch-Sijtsema, Ruohomäki, & Vartiainen, 2009). The Agile values and principles are used predominately in software development methods (Sutharshan & Maj, 2011).

Agile has been growing in popularity over the last decade. A Web of Science search for the term Agile returned 4,000 records for a period consisting of the years 2009 to 2013, while the same search returned 6,492 for a more recent period ranging from 2014 to 2018. Organizations are adopting Agile methodologies to deliver business value regularly (Rizvi et al., 2015). In addition, organizations using Agile reported benefits that included accelerated software delivery, enhanced ability to manage changing priorities, and increased productivity, among others (VersionOne, 2018).

A colocated team is a group of individuals working side by side with a common goal. Alternatives to colocated teams include distributed or dispersed teams. These teams have been defined as groups of dispersed employees with a common goal of carrying out interdependent tasks using mostly technology for communication and collaboration (Bosch-Sijtsema et al., 2009; Cramton, 2001). Distributed teams can be composed of multiple teams made of colocated individuals where the teams are separated by distance. Distributed teams can also be composed of remote individuals where the team members telecommute or connect remotely from a location of their choice. It is also possible for a distributed team to have a combination of these two compositions where remote colocated teams, as well as remote individuals, work together as part of one distributed team.

Companies have embraced distributed teams in software development to obtain cheaper labor, faster delivery, access to global talent, increase business, and follow-the-sun development (Rizvi et al., 2015). The benefits of distributed teams, however, are not without challenges. Some of the challenges associated with distributed teams include communication, personnel, culture, time zone differences, trust, and knowledge management (da Silva et al., 2010; Jalali & Wohlin, 2012). Combining the benefits of distributed teams with those of Agile has been shown to increase the quality of the product, the speed of response to change, as well as the performance of the team (Shrivastava & Date, 2010a). Thus, organizations are attempting to combine the benefits of non-colocated teams and Agile by using Agile practices in distributed environments. These distributed Agile teams face their own set of challenges. The Agile Manifesto states that the best way to develop software is through face-to-face interaction and that Agile favors working software over comprehensive documentation (Fowler & Highsmith, 2001). Non-

colocated teams are limited in their ability to connect in face-to-face communication and collaborate. Furthermore, the lack of emphasis on comprehensive documentation requires that Agile teams find interactive ways of collaborating in place of the traditional document-driven methods. Instead of a mechanical or formal process, collaboration is considered to be a social process in Agile software development (Singh et al., 2014). Therefore, the lack of physical interaction limits the benefits of Agile software development in distributed teams for the growing number of companies that are practicing Agile in non-colocated environments, where as many as 81% of surveyed organizations reported having some form of distributed Agile teams (VersionOne, 2020).

Existing Agile frameworks such as Scrum or XP, do not address the necessary practices to implement Agile in non-colocated environments. In addition, frameworks that specialize in scaling Agile such as the Scaled Agile Framework (SAFe) or Scrum at Scale do not specify the practices and techniques for effective collaboration and how distributed teams and distributed individuals can overcome the technical or social challenges associated with the distance that separates them. As a result, organizations attempting to implement Agile development in distributed environments have created their practices to mitigate the challenges they face when using distributed teams (da Silva et al., 2010; Kausar, 2018), such as using desktop sharing applications to hold the required meetings or having designated team leads to attend some of the meetings to mitigate time zone constraints.

The distributed team practices vary extensively from one organization to another. Prior studies identified the most common practices and cataloged them into groups of patterns (da Silva et al., 2010; Kausar, 2018). The catalog of practices and techniques, however, are

numerous and could prove difficult for organizations to navigate, in particular, for organizations seeking to use them in their decision-making process to determine an appropriate course of action that can improve collaboration in their environment (Kausar, 2018). In addition, the catalogs do not differentiate between the different distributed Agile compositions, such as when a team is composed of multiple colocated teams or distributed individuals. To add to the challenge, prior literature offers little distinction between the terms *distributed teams* and *dispersed teams*. In many instances, the terms are used interchangeably, while in other cases, the term, *distributed teams,* is used to refer to individuals working in colocated hubs, where the hubs or remote offices are distributed. On the other hand, the term, *dispersed teams*, is sometimes used to refer to instances where individuals are not colocated with other team members, but instead, connect remotely, or telecommute to perform the work. For this study, the author refers to both scenarios as *remote Agile teams* and offers a description of the composition when applicable.

Problem Statement

The problem is that distributed or non-colocated Agile development is difficult to implement (Shrivastava & Rathod, 2017), and currently available Agile principles are not aligned with distributed environments (Shrivastava & Date, 2010b). Kausar (2018) developed a catalog that identified fifteen patterns that distributed Agile teams follow. Kausar classified the patterns into four categories. These categories included trust, socio-cultural, knowledge transfer, communication, and coordination as the main problem areas for distributed teams. Complications occurred even when careful attention was paid to collaboration challenges, where

difficulties were observed due to communication, personnel, culture, time zone differences, trust, and knowledge management (da Silva et al., 2010; Jalali & Wohlin, 2012).

Global software development also introduces challenges that include coordination complexities, lack of team control, teambuilding hindrance, lack of trust, and language barriers (Conchúir et al., 2006). Other factors that affect global software development include cultural, geographical, and time zone differences (Kotlarsky & Oshri, 2017). Hossain et al. (2009) categorized the risks associated with using Scrum in a distributed environment and identified the lack of synchronization, awareness, communication bandwidth, tool support, collaborative office environment, large project personnel, and an increased number of sites as the main risks (Hossain, Babar, Paik, et al., 2009). Distance also makes it difficult to work across distributed teams due to factors associated with a lack of common ground, collaboration readiness, and organizational management (Bjørn et al., 2014). These challenges and risks combined, decrease the performance of distributed teams when compared to the performance of colocated teams (Rizvi et al., 2015).

Scrum is the most widely adopted Agile framework. The number of companies using Scrum grew from 55% in 2015 to 78% in 2017 (Scrum Alliance, 2018). Scrum is not a process, technique, or methodology. It is a framework with which organizations can implement their processes (Schwaber & Sutherland, 2017). Therefore, Scrum does not address the techniques, methods, and practices companies should use to manage non-colocated Agile teams. Several Agile scaling frameworks such as Scaled Agile Framework (SAFe), Large Scale Scrum (LeSS), Scrum at Scale, and Disciplined Agile Delivery (DAD) have been created to address the need to scale Agile product development in large enterprises (Dingsøyr et al., 2019). These frameworks

focus on the complexities associated with coordinating many Agile teams. The frameworks address the recommended practices to mitigate large-scale Agile implementation but offer little guidance on how to facilitate collaboration in different types of distributed environments. Moreover, whenever the frameworks address distance, they assume the use of distributed teams, where the composition is made of colocated teams separated by distance. The Agile frameworks do not address the needs of distributed individuals, where team members are remote workers and are not colocated with any other team members. As a result of the different challenges that arise, depending on the distributed composition, practitioners have created their own processes and techniques to manage distributed Agile teams (Kausar, 2018). The frameworks also lack the social, cultural, and psychological considerations relevant to different distributed scenarios. There is a need for researchers to provide guidance based on empirical studies that combine prior research from relevant fields such as project management, organizational psychology, and management science (Dingsøyr et al., 2019).

The needs-based approach that organizations have taken to solve the non-colocated Agile challenges has resulted in a disjointed set of industry practices that also make it difficult to choose the solutions that can address the specific problem organizations may be facing. Practitioners need guidelines to determine when and how to use the different practices that address the collaboration challenges associated with Agile in different distributed environments.

Dissertation Goal

The goal of this study was to construct and internally validate a model for the effective collaboration of distributed Agile teams. To the writers' knowledge, there has been no prior attempt to develop a model for implementing distributed Agile team collaboration that addresses

the different types of remote compositions. In the Information Systems (IS) field, design science research (DSR) is used to create and evaluate an artifact that solves an organizational problem. The artifact can be in the form of "constructs, models, methods, and instantiations" (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007, p. 49).

This model was created to address the organizational problem of implementing distributed or non-colocated Agile teams. The model represented a consolidation of the common practices to facilitate collaboration. The model considers the different types of distributions in an Agile team and can be used by organizations to guide them in the successful implementation of Agile in distributed and dispersed environments. The model can also complement current Agile frameworks and methodologies to work in a distributed setting.

Research Questions

The following four research questions guided this investigation.

1) What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?
2) What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?
3) How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?
4) What modifications are needed to improve the proposed model?

Relevance and Significance

Distributed Agile implementation continues to be a challenge for organizations (Rizvi et al., 2015). As the rate of Agile adoption grows, so does the number of companies that need to

combine effective global software development practices with Agile. Research studies were conducted to document and consolidate these practices (Hossain et al., 2011; Kausar, 2018; Shrivastava & Date, 2010a). However, the number of practices was large and varied from study to study, depending on different factors. Factors such as the different types of distributions were not addressed. The number of choices also made it difficult for organizations to choose the most effective practices that apply to their environment (Hossain, Babar, Paik, et al., 2009). These issues made adapting Agile to work in distributed environments a risky endeavor that could fail due to a lack of a clear and applicable set of practices that could help to improve collaboration among distributed teams (Shrivastava & Rathod, 2015). This study added to the body of knowledge in IS by proposing a model that consolidated the practices and interactions that facilitate collaboration which considered the different distributed Agile compositions. The model can be used by organizations to guide them in successful Agile implementations in a remote environment.

Barriers and Issues

The goal was to develop a model to aid in the collaboration of distributed teams using Agile frameworks such as Scrum. This goal was not met by prior studies due to several reasons. First, Agile is a process where practitioners are expected to test, inspect, and adapt. This approach has led to many field best practices based on circumstantial experiences that bypassed theoretical framing. Connecting organizational Agile practice to established theories could prove challenging due to the short-term, adaptive nature of Agile. Second, as Agile development becomes more mainstream, there is still a level of engineering “maturity” the industry must undergo to cement standard practices that can be duplicated across different companies. A large

number of organizations are experimenting with how the frameworks can be adapted to their environment which can result in an Agile process aversion (Malone, 2014). These anti-patterns can be easily confused for distributed Agile challenges. Third, Agile emphasizes working software over comprehensive documentation (Fowler & Highsmith, 2001). The emphasis to document only what is needed has led to a lightweight knowledge management approach that relies on individual interaction and communication, making it difficult for the knowledge gained in one organization to be captured and transferred to another. This approach also makes it difficult for researchers to gain insight based on prior documentation that can lead to the creation of new models and theories.

Assumptions, Limitations, and Delimitations

Assumptions

A necessary assumption made during this study was that the participants are addressing problems relating to their geographical distribution and that they participated in the study with an honest desire to advance the understanding and practices of distributed Agile collaboration. Other personal, corporate, or political problems and challenges at the individual or company level were outside the scope of this study.

Limitations

Reliability may have been a limitation. DSR requires that the researcher observes, adjusts, and iterates the artifact creation. As a result, the researcher is an instrument in the research. Although careful steps have been taken to bracket the researcher's experience, the researcher's bias can influence data collection and analysis and should be considered a risk when conducting qualitative research (Giles et al., 2013). The researcher of this study is an experienced

practitioner in Agile software development. Therefore, a potential limitation of the study was biased since the researcher's experience could have influenced the interpretation of the data. Complimenting qualitative research with a literature review helped to contain bias (Giles et al., 2013). The risk of single-researcher bias was also possible since the study was conducted by one individual (Yin, 2009).

External validity and lack of generalization was another limitation since the general applicability of the model has not been proven. In design-based research, the generalization of the findings could present a limitation and the use of design may require analytical generalization (Oliver et al., 2011). Generalizing is a concern for any research that uses sampling (Lee & Baskerville, 2003). This study was no exception since it used sampling to validate the design and evaluate the proposed model. In design-science research, additional research must build on the foundation of the artifact through rigorous evaluation and through a comparison of alternatives that can be tested in different contexts to claim generalizability (Hevner et al., 2004). Finally, design-science research presented validity difficulties since the environment may impact the performance of an artifact. Lack of attention to the environment can result in an artifact that produces negative or different results in different environments (March & Smith, 1995).

Delimitations

This study focused on Agile teams. These were teams practicing Agile methods to develop products. Teams or individuals practicing other forms of product management methodology or framework, such as waterfall, were not in the scope. Moreover, the focus was on researching teams and individuals practicing Agile product development in a distributed or dispersed environment. Teams that were using Agile in a fully colocated setting were outside of the scope

of this research. Last, this study focused on studying the collaboration challenges faced by distributed Agile teams. Other types of challenges were outside the scope.

Definitions of Terms

Following are definitions of key terms:

1) Artifacts: Material that represents work or value designed to maximize information transparency (Schwaber & Sutherland, 2017).
2) Agile Development: A set of methods that follow an iterative and incremental development approach (Dorairaj et al., 2013).
3) Daily Scrum: A 15-minute daily meeting held by the Scrum development team to plan the work for the day (Schwaber & Sutherland, 2017).
4) Distributed Development: A structure where information systems development members are dispersed along physical, geographical, organizational, or temporal boundaries (Ramesh et al., 2012).
5) Distributed Agile: Software development implemented by combining Agile and distributed development (Shrivastava & Rathod, 2017).
6) Colocated: A sitting arrangement where all team members are located in the same room or office space working together interdependently to accomplish a task (Hinds & McGrath, 2006).
7) Collaboration**:** Two or more individuals working jointly on an intellectual endeavor (Kotlarsky & Oshri, 2017).
8) Communication: Information exchange between two or more subjects that can occur audibly or visually (Author).

9) Design Science Research (DSR): A research method that helps to create and evaluate IT artifacts that address organizational problems (Hevner et al., 2004).
10) Design Science Research Methodology (DSRM): An approach that incorporates principles, practices, and procedures to present design-science research (Peffers et al., 2007).
11) Development Team: The Scrum team members focused on creating or writing the software used in the product (Schwaber & Sutherland, 2017).
12) Disciplined Agile Development (DAD): A hybrid approach that extends Scrum to use other Agile frameworks to scale and focus on producing repeatable results (Vaidya, 2014).
13) Extreme Programming (XP): A software development style that focuses on programming technique excellence, clear communication, and teamwork (Beck & Andres, 2004).
14) Information Radiators: Displays of graphical charts and other information-related items used in Agile projects to design, develop, communicate, and track progress (Paredes et al., 2014).
15) Kanban: An approach for managing the product development process with an emphasis on the continual delivery of value (Al-Baik & Miller, 2015).
16) Large-Scale Scrum (LeSS): A product development framework that extends Scrum with scaling rules and guidelines without losing the original purposes of Scrum (Larman & Vodde, 2013).

17) Needs Assessment: As a subset of Human Performance Technology (HPT), a needs assessment in the business context is used to "identify performance needs and make recommendations for potential solutions" (Wedman, 2014, p. 48).
18) Product Backlog: A list of prioritized product requirements used by the development team to select and deliver product increments (Schwaber & Sutherland, 2017).
19) Product Owner: A Scrum role responsible for representing the customer, creating the product requirements, and prioritizing development items (Schwaber & Sutherland, 2017).
20) Remote: Situation where one or several individuals are not colocated with the rest of the team (Deshpande et al., 2016).
21) Scaled Agile Framework (SAFe): A template that specializes in scaling Agile methods across large enterprises (Hinterberg & Andersson, 2018).
22) Scrum: A process framework for designing, developing, and maintaining products (Schwaber & Sutherland, 2017).
23) Scrum at Scale: A lightweight organizational framework that applies Scrum using a network of Scrum teams (Sutherland, 2021).
24) Scrum Events: A set of meetings used to effectively carry out the Scrum framework (Schwaber & Sutherland, 2017).
25) Scrum Master: A Scrum role responsible for facilitating, coaching, and training the Scrum team (Schwaber & Sutherland, 2017).
26) Sprint: A period, no greater than four weeks, for the team to complete a Scrum integration (Schwaber & Sutherland, 2017).

27) Sprint Backlog: A selected list of the product requirements, along with their decomposed items, that will be developed during a sprint (Schwaber & Sutherland, 2017).
28) Sprint Planning: A meeting held by the Scrum team to plan the work for the upcoming Sprint (Schwaber & Sutherland, 2017).
29) Sprint Retrospective: A meeting for the Scrum team to reflect on their work during the past sprints. This meeting inspects the team, relationships, processes, and tools of Scrum (Schwaber & Sutherland, 2017).
30) Sprint Review: A meeting for the Scrum team to demonstrate the new features created by the development team where the stakeholders provide feedback and discuss upcoming requirements (Schwaber & Sutherland, 2017).
31) Telecommute: The ability to work away from the traditional office using computers and telecommunications facilities to maintain a link to the office (Bélanger, 1999).
32) User Stories: A format for capturing software requirements in a concise manner (Sharp & Robinson, 2008).

List of Acronyms

Following is a list of key acronyms:

1) CSCW: Computer Supported Collaborative Work
2) DAD: Disciplined Agile Development
3) DiCoT: Distributed Cognition for Teamwork methodology
4) DS: Design Science
5) DSR: Design Science Research
6) DSRM: Design Science Research Methodology

7) IS: Information Systems
8) LeSS: Large Scale Scrum
9) SAFe: Scaled Agile Framework
10) XP: Extreme Programming

Summary

Chapter one served as an introduction. Relevant background information was provided to set the context for distributed Agile. The research problem was identified and explained based on how distributed agile introduces new challenges that decrease the performance of Agile teams when compared to colocated teams. Furthermore, the chapter addressed how different types of challenges may arise, depending on the distributed composition type, and how practitioners have created their own processes and techniques to manage distributed team-related challenges. There is a need for researchers to provide empirical guidance on effective collaboration practices for distributed agile teams. The goal of this study was also presented, which was to use a DSR approach to construct and validate internally a model for the effective collaboration of distributed Agile teams.

Chapter 2

Review of the Literature

A literature review guided the identification and refinement of the problem and informed the DSR process on the different models and frameworks used in the context of Agile distributed environments. The review was divided into six main topics: distributed Agile and dispersed teams, growth of distributed Agile teams, challenges with distributed Agile teams, theoretical framework, Computer Supported Collaborative Work (CSCW), and DSR.

Project Management Approaches

"Lean" is considered to be a process improvement methodology used to optimize product and service delivery (Laureani & Antony, 2019). Variations of its definitions exist since there is a lack of consensus on what is meant by Lean as a project management approach (Staats et al., 2011). Like Agile, the methodology focuses on value delivery to the customer (Beck & Andres, 2004). It emphasizes making continuous improvements by analyzing the process and eliminating the unnecessary steps that get in the way of delivering value faster and at a lower cost. It builds on the Toyota Production System (TPS) philosophy, which provides the basis for what is today known as lean thinking. Lean thinking focuses on eliminating all waste in the production line, where waste is defined as anything that is not the minimal amount of equipment, materials, parts, space, and time used to deliver value to the customers (Pepper & Spedding, 2010). The Lean process focuses on product manufacturing by outlining five enterprise-wide processes used to optimize value creation. These processes include the product development process, the supplier

management process, the customer management process, and the policy focusing process (Holweg, 2007). Although the use of Lean has been delivering productivity improvements for the automotive and other manufacturing industries since the late 50s, the approach has been criticized for the inability to generalize the practices and for its implementation difficulties (Al-Baik & Miller, 2015; Hines et al., 2004; Staats et al., 2011).

Six Sigma is a data-driven, process improvement methodology used to achieve stable and predictable business processes (Laureani & Antony, 2019). The methodology was created in the 1980s by Motorola and later adapted by General Electric in the Mid 90s. The approach uses statistics to measure the number of defects produced by the process and aims to lower the number to 3.4 for every million parts, or six sigma. Six Sigma builds on the philosophies of Total Quality Management (TQM) by providing specific business metrics to calculate improvements made in the process (Pepper & Spedding, 2010). The methodology is characterized by five stages of development that include Define, Measure, Analyze, Improve, and Control (DMAIC). Each stage uses techniques to measure, analyze, and improve processes that reduce the number of product defects. Six Sigma by itself, however, emphasizes the scientific approach and ignores the people aspect of the system (Pepper & Spedding, 2010). Therefore, the methodology was integrated with Lean to create a balance between people and the data-driven process.

Lean Six Sigma is a combination of the 'Lean' and 'Six Sigma' business improvement methodologies. The term emerged in 2000 to describe the integration of both business improvement philosophies and is often used in supply chain transformations (Sheridan, 2000). The hybrid business improvement methodology was popularized by its belt system accreditations (yellow, green, black, etc.) that easily identify the practitioners' expertise (Pepper & Spedding,

2010). The approach merges the people-oriented culture of Lean with the data-driven approach of Six Sigma. The combined approach focuses on improving quality, speed, customer satisfaction, and costs by using tools and principles from Lean and Six Sigma. Applying Lean Six Sigma, however, can sometimes lead to an organizational divide where a group of the organization favors the people-oriented aspect of Lean, while other maintain a scientific and quantitative process, where a deeper integration of the two process is still necessary to avoid the divide (Pepper & Spedding, 2010).

The Waterfall model was introduced in 1970 as a process for developing large-scale systems (Royce, 1970). It is a Software Development Life Cycle (SDLC) model used for designing, building, and maintaining systems (Alshamrani & Bahattab, 2015). Waterfall implements seven phases that are executed in sequence. The phases do not overlap, and each phase must be completed before a subsequent one is started. The model is often used in large projects that require quality control due to its focus on long-term documentation and planning. It is, however, considered to be somewhat inflexible and more suitable for projects with little variation and experimentation (Alshamrani & Bahattab, 2015). While describing the Waterfall process, Dr. Winston Royce expressed concerns about the risk of implementation and how it could potentially invite failure due to its lack of interactive and incremental approach. (Morgan, 2018).

"Spiral" is an SDLC method that focuses on minimizing risk (Boehm, 2007). It visualizes the process as it goes through iterations of the different phases. It combines system design and prototyping in stages that benefit from a top-down and bottom-up approach to create the system (Alshamrani & Bahattab, 2015). The development team iterates through sets of requirements by creating incremental prototypes that are analyzed using risk assessment processes to determine

the improvements that can be made in the next iteration or spiral. Although Spiral introduces the concept of iterations, the prototype is not released until all spirals have been completed and the system is don. This is a contrast to Agile where each iteration is expected to generate a potentially shippable product increment (Benediktsson et al., 2006).

Teams also tend to tailor and merge different approaches and methodologies (J M Bass, 2012; Julian M Bass, 2016; Campanelli & Parreiras, 2015). The results are known as hybrid methodologies, which include combining concepts from Lean, Waterfall, and Agile among others to enhance processes that achieve flexibility and lean thinking (Tripp et al., 2018). Water-Scrum-Fall is a common hybrid approach used by organizations to adapt pre-existing processes that benefit from the planning approaches of Waterfall and the flexibility of Agile development (Theocharis et al., 2015). Lean/Agile development is another common hybrid approach where organizations combine the elements of Agile and Lean that best suit their needs (Rodríguez et al., 2014; Tripp et al., 2018).

Distributed Agile and Dispersed Teams

Phalnikar (2009) focused on the challenges associated with offshore Agile teams and outlined differences between distributed development and dispersed development while defining distributed development as cooperation between teams located in different sites. Phalnikar proposed that distributed teams are normally outsourced to other countries while small teams working on the customer site serve as interlocks. Phalnikar also defined dispersed development teams' members as individual developers that are separately located but work together using networking technology. The scope of this study included distributed and dispersed team members such as developers working from home as well as subject matter experts working from

private offices. Thus, team members working in either environment are referenced as being a part of a remote team.

Different types of team compositions were recognized in the disciplined agile delivery (DAD) framework. In the framework, there was a differentiation between colocated, distributed sub-teams, fully dispersed teams, and partially dispersed teams. DAD also included supporting documentation describing the different types of team composition in a distributed or dispersed environment (S. Ambler, 2014; S. Ambler & Lines, 2020). Colocated teams were described as teams working in a single room beside one another. Near-located teams were described as team members that are at a reasonable distance and can get together at a single location each day if desired. Far-located teams were described as teams where the members would need to fly to meet face-to-face. Ambler went on to mention that even when team members are in cubicles nearby or the same office space, they are slightly distributed. This is because walls, not just distance, can add communication barriers (Ambler, 2014).

Sutherland et al. (2009) defined the different Scrum distribution team models as isolated Scrum teams, distributed Scrum of Scrums, and fully distributed Scrum. An isolated Scrum team was one, which was separated from other Scrum teams by geography. Distributed Scrum teams were isolated according to geography but met regularly to coordinate work. Fully distributed Scrum teams had members that spanned different geographical regions as part of the same team. These distribution models helped to further categorize the challenges and practices that were relevant to specific forms of distribution. For example, an offshore software development model was likely to have an isolated Scrum team composition due to the outsource nature of offshoring, while an onshoring model was more likely to have a fully distributed Scrum team composition

due to telecommuting arrangements. Sutherland et al. (2009) also explored whether a distributed offshore team could achieve the same productivity as a colocated team. The scope of the case study included XP practices as well as Scrum. The results showed that the organization was able to achieve similar productivity by temporarily collocating the Agile team and then moving the team members to their distributed location (Sutherland et al., 2009). This research adopted working practices presented in the Sutherland et al. (2009) case study, such as the Scrum of Scrum practice, and incorporated them into the distributed Agile collaboration model.

Lee and Yong's (2010) case study described the successful implementation of a distributed Agile environment. Lee and Yong categorized the different team configurations into Core Scrum and International Scrum. They also categorized the different Scrum roles into local Scrum roles, regional Scrum roles, and chief Scrum roles. The Chief Scrum Role is often used in the Scrum at Scale framework to manage an environment with multiple Product Owners, where the scaled Product Owner is known as the Chief Product Owner. Lee and Yong (2010) expanded this concept to include Chief Scrum Masters and introduced the concept of an international set of roles responsible for bridging the distance between teams. These roles were used differently depending on team configurations. This research adopted working practices presented in Lee and Young (2010), such as the use of a Chief Product Owner role and incorporated them into the distributed Agile collaboration model.

Growth of Distributed Agile Teams

Hoda, Salleh, and Grundy (2018) conducted a systematic literature review representative of the past twenty years of Agile research. Hoda et al. (2018) identified Agile in global software engineering as one of today’s key researched areas. They also explained that Agile has moved

beyond its small and colocated origins, into large-scale, enterprise-level implementations. Ambysoft published survey results that explore the industry state of Agile. The 2016 Agility at Scale Survey results showed an increase of 21% for organizations that were implementing Agile with team members that were considered to be very distant, up from 38% in 2014 to 59% in 2016 (Ambler, 2014, 2016).

Picu and Dinu (2016) analyzed telecommuting trends in the United States (US) and the European Union (EU). They found that communication technology and its adoption were reducing the number of employees who work from a central location. The overall number of employees telecommuting grew from 9% in 1995 to 37% in 2015 in the US. Moreover, flexible work practices continued to increase as organizations offer employees more work-life balance options, with 85% of the surveyed organizations allowing some form of telecommuting option (Picu & Dinu, 2016).

Challenges with Distributed Agile Teams

The practices provided by the Agile frameworks did not address the needs of Global Software Development (GSD) (Pardo-Calvache et al., 2019). Pardo-Calvache et al. (2019) proposed Scrum+, a guide based on Scrum that defines activities, tasks, roles, and criteria to support Agile in distributed projects. The study used an action research method with three cycles and a focus group to validate the Scrum+ guide. The guide considered practices from industry frameworks that included Scrum, Scrum of Scrums, LeSS, and SAFe and harmonized the frameworks to suggest an integrated framework to support Agile in a GSD environment. Pardo-Calvache et al. (2019), however, did not consider the different team compositions and did not differentiate between distributed teams, team members, and distributed hybrid compositions.

This research used elements suggested by Scrum+ as one of the guides to create the needs assessment survey and determine how the factors were used by the different team compositions. This included elements such as tool security and availability considerations.

Khmelevsky, Li, and Madnick (2017) conducted a literature review on software development using Agile and Scrum in distributed teams. The research analyzed case studies from 2011 to 2017 and concluded that although distributed Agile is based on the twelve Agile principles of the Agile Manifesto, the principles are often not followed by distributed teams and do not fit well in distributed environments. Khmelevsky and Madnick also stated that if Agile is to thrive, we must find a way for it to work in distributed environments.

Kausar (2018) identified the common challenges distributed Agile teams faced when implementing Agile in an offshore operating model and proposed that there are four main challenges. The challenges included trust, socio-cultural, knowledge transfer, communication, and coordination issues. Kausar also identified the mitigations they used to solve the problems and categorize the challenges and solutions into 15 different patterns. Kauser focused on offshore teams where the distribution occurred between two sites. Kauser suggested future research should include the need to consider distributed teams in an onshore model or a mix of both models. Kauser also suggested the creation of a decision-making tool that can help practitioners navigate the choices associated with the processes relevant to their environment. Finally, Kauser posited that there is an opportunity to discover additional patterns and compare the results to determine if the catalog of patterns can be improved.

Hossain, Babar, and Paik (2009) conducted a study consisting of a systematic literature review and identified seven major risks and seventeen strategies to mitigate the risks associated

with implementing Scrum in Global Software Development. Hossain, et al. (2009) also proposed the need for a tool to help organize and simplify the decision-making process involved with mitigating distributed teams' challenges. The researchers analyzed twenty papers to create a list of risks. They acknowledged that their list might not be exhaustive and suggested a more comprehensive list of risks and strategies was needed. Hossain et al. recommended that future studies should look beyond the scope of a single project view and consider a portfolio-level set of risks to be more indicative of what is found in global software development. Hossain et al.'s research was used in this study to arrive at a more comprehensive list of challenges and mitigations that influence distributed Agile collaboration.

Shrivastava and Rathod (2017) created a risk management framework for distributed teams. The researchers used an exploratory research approach to identify the risks associated with distributed Agile software development along with their root causes and methods used to manage the risks. Self-administered questionnaires and qualitative interviews were used to capture the perceptions of the risk factors in the participants' organizations. The study sample consisted of 19 individuals belonging to 17 different multinational IT organizations who had experience with distributed Agile teams and held senior roles that included CEOs, senior project managers, Agile coaches, and business analysts. The framework was partially validated in three different organizations to test the perceived value to minimize the risks. Shrivastava and Rathod found a substantial number of risks due to contradictions between distributed development and Agile practices. The risks included group awareness, external stakeholder collaboration, and software development lifecycle. The results included a proposed framework that focused on the risks, contributing factors, and mitigations associated with distributed Agile development. The results

also indicated that the framework was effective in reducing the risks. The study, however, had a threat to validity due to the small sample size as well as the lack of representation from the Agile team members who were performing the work. Because close attention should be paid to the risks associated with distributed team collaboration, Shrivastava and Rathod's work was used in this study to help determine the risks that needed to be addressed in the creation of the distributed Agile collaboration model. This included fostering team collaboration by using rich communication media like video conferencing, web conferencing, and other collaboration tools as well as using regular meetings like scrum-of-scrums to encourage sharing of project status and issues in development.

Olson and Olson (2000) investigated the effect of distance on distributed teams by researching the factors that make working across distances difficult. They compared ten years of colocated and non-colocated collaboration and focused on the socio-technical aspects relevant for effective distributed collaboration. Olson and Olson identified the key concepts that influence successful collaboration in distributed environments including common ground, the coupling of work, collaboration readiness, and collaboration technology readiness. The researchers stated that deviations from the success factors created a strain on the relationships among teammates and required changes in the work or processes of collaboration to succeed and often failed due to the importance that distance played. Bjørn, Esbensen, Jensen, and Matthiesen (2014) conducted a study to validate Olson and Olson's (2000) findings and found that the arguments concerning the coupling of work and collaboration technology readiness changed since their 2000 study and might require refinement. Bjørn et al. (2014) also found that working remotely, tightly coupled work tasks encourage remote workers to spend the extra effort required in the articulation of

work to make the collaboration function. Bjørn et al. uncovered that collaboration readiness, which referred to the participants' motivation to collaborate was not a single entity, but that instead, it was a group of entities that included sites, organizations, competencies, expertise, and politics. Olson and Olson's findings combined with Bjørn et al.'s validation further guided the creation of the model that considered the factors involved with distance and team collaboration.

Computer-Supported Collaborative Work (CSCW)

This section explored CSCW within the context of Agile and how distributed Agile teams use different technologies to overcome collaboration challenges. A large part of the Agile team collaboration occurs using objects that the team can always see and update. These objects are usually post-its that are pasted onto a wall to form an agile board or card wall which contains individual product requirements (Gossage, Brown, & Biddle, 2015). By positioning the post-it in different places on the wall, the team can represent the current state of development for any of the requirements. These objects form information radiators. Information radiators are displayed graphical charts and card walls used in Agile projects to design, develop, communicate, and track progress. They help to increase knowledge sharing and awareness between Agile team members (Paredes et al., 2014).

Software that simulates Agile physical boards is often used by distributed and colocated Agile teams alike because they allow for the integration of reporting and analysis into the Scrum meetings (Rubart, 2014). Prior research in the areas of digital Agile boards explored the team's ability to interact and manipulate tasks via digital cards. Ghanam, Wang, and Maurer (2008) conducted a study that designed and tested an Agile Planner in the form of an electronic tabletop. They observed that the use of these digital boards disrupted the effectiveness of Agile meetings

for colocated team members. This disruption was due to the inconvenience of creating digital cards using a mouse and a keyboard when compared to the ease of use that pen and paper can offer. Physical cards were also easier to manipulate than digital cards. For example, a team member was able to easily grab a stickie note on a physical wall and move it to a new place while other team members watched. Moreover, colocated team members had to change their traditional round table collaboration setting in favor of a shared projected image of the digital cards. The Agile Planner for Digital Tabletops was designed and tested to support Agile meetings without negatively impacting colocated teams by introducing a multiuser, touch-sensitive, tabletop built for Agile planning and collaboration (Ghanam et al., 2008). In this case, task complexity, such as tossing a card, multi-touch support, and simultaneous user interaction were not supported by the system and proved to be a challenge for team members.

Agile distributed teams are aided by a variety of tools and services to facilitate communication. These include instant messaging, teleconferencing, and telepresence systems to collaborate via audio, video, and desktop sharing. Prior studies researched the advantages of video conferencing as a way to replicate face-to-face communication (Isaacs & Tang, 1994; Nakanishi et al., 2017; Olson et al., 2014). When compared to audio-only communication, video conferencing improved understanding, provided nonverbal information, enhanced descriptions, and even managed pauses and attitudes better. Video conferencing was also more effective for interactive communication where nonverbal cues were most helpful, such as when teams were dispersed and needed to collaborate. However, the capabilities of video conferencing were still perceived to not match face-to-face communication due to limitations such as the lack of peripheral cues, difficulty in controlling large groups, and the inability to have side conversations

or point to things. Another limitation specific to telepresence rooms was that they were often used for planned meetings (Esbensen et al., 2015). Therefore, they were usually scheduled and required attendees to step out of their spaces to connect with remote workers. Since Agile teams required frequent communication between team members, telepresence systems limited the ability for distributed teams to collaborate in real-time. Hence, more improvised forms of communication were necessary for effective Agile dispersed team collaboration.

The Multitouch Scrum Taskboard was designed and tested for colocated teams to communicate synchronously during meetings (Rubart, 2014). Unlike the Agile Planner for Digital Tabletops, this system supported simultaneous team members. The cards could also be moved and manipulated using multi-touch displays using natural gestures. The solution, however, targeted colocated teams and did not explore how distributed teams can benefit from its use. It also did not address information radiation or the casual team interaction necessary for Agile team collaboration.

Several studies, such as the 3D-Board researched by Zillner, Rhemann, Izadi, and Haller (2014), explored and concluded that remote collaboration is significantly improved by superimposing life video images of the collaborators on top of a life-size interactive screen (Zillner et al., 2014). Other studies, such as the Immerse Board by Higuchi, Chen, Chou, Zhang, and Liu (2015), focused on face-to-face emulation and the ability for participants to relate to others by simulating eye gaze and gesture direction to improve intention, communication, and agreement level. These studies, however, did not explore the participants' ability to share content such as the Scrum boards (Higuchi et al., 2015).

The dBoard explored the use of collaborative windows technology in the context of distributed Agile teams. Esbensen et al. (2015) designed, implemented, and evaluated the use of a virtual window for a distributed Agile team between two remote sites. The dBoard aimed to create an immersive teleconferencing system that supported a multi-touch and multi-user Scrum board which doubled as an information reradiating porthole to remote sites. The board presented a preformatted Scrum board that could be manipulated by team members and superimposed live video over a digital feed of the team's Scrum board. The dBoard served as a virtual window that both locations could use to see the status of the Scrum tasks. The board helped to passively radiate information across the two locations. The board also helped to provide presence awareness across the two teams by broadcasting a live video of the remote location. Last, the dBoard served as an always-on means for both teams to meet and collaborate. The board was evaluated using experienced Scrum team experts distributed between two locations (Esbensen et al., 2015). The teams found the combination of video and Scrum board useful and the tool was well received by users. The dBoard demonstrated that blending always-on video and Scrum boards improved distributed Agile team collaboration (Esbensen et al., 2015). However, the availability and accessibility of the system to all team members were a challenge in a fully distributed team environment. Hence, this research explored how information radiation and video sharing tools were used to obtain the benefits of the dBoard Scrum board and video features.

Theoretical Framework

Overview

Halverson (2002) suggested that theories can be used to shape an objective study and to highlight relevant issues. Theories provide us with descriptive, theoretical, inferential, and application power (Halverson, 2002). They help us to explain what happened, why it happened, and possibly predict what will happen (March & Storey, 2008).

Gregor (2006) proposed a taxonomy for the different theory types relevant to IS research. The taxonomy (Table 1) defined five different types of theories. The five types range from analysis-based to design and action theories. Gregor's design and action theories were relevant to this study since DSR, which provides specific approaches to construct artifacts and tells you "how to do" something, were used (Gregor, 2006).

Table 1

A Taxonomy of Theory Types in IS Research (Gregor, 2006, p. 620)

Theory Type	Distinguishing Attributes
I. Analysis	Says what is. The theory does not extend beyond analysis and description. No causal relationships among phenomena are specified and no predictions are made.
II. Explanation	Says what is, how, why, when, and where. The theory provides explanations but does not aim to predict with any precision. There are no testable propositions.
III. Prediction	Says what is and what will be. The theory provides predictions and has testable propositions but does not have well-developed justificatory causal explanations.

IV. Explanation and prediction (EP)	Says what is, how, why, when, where, and what will be. It provides predictions and has both testable propositions and causal explanations.
V. Design and action	Says how to do something. The theory gives explicit prescriptions (e.g., methods, techniques, principles of form, and function) for constructing an artifact.

Distributed Cognition

Hutchins (1991) proposed that distributed cognition was not constrained to an individual mental activity, but instead is distributed across individuals, artifacts, objects, and tools in a social setting (Hutchins, 1991, 1995). The theory explains and predicts the behavior of nodes and therefore falls under the explanation and prediction category of Gregor's Taxonomy. Hutchins suggested that knowledge extends beyond an individual mind to include interactions and resources where the environment is exploited to expand an individual's cognitive capacity. To test the hypothesis that the cognitive properties of groups differ from those of the individuals who comprise them, Hutchins created a computer model to evaluate the difference and concluded that there is a significant difference between the two types of cognitions. Hutchins explained that distributed cognition is a collective effort that pursues goals in collaboration with the social and material environment to complete tasks. Most things in our every day and work environment are a result of a coordinated group rather than the product of an individual activity. The division of labor required by the group uses distributed cognition to coordinate the activities executed by the individual participants. Distributed cognitive labor can be divided into two types

of cognitions: the cognition required to perform the task and the cognition that governs the coordination of tasks. In this case, the cognitive properties of the individual participating in the effort may vary depending on the type of labor and the task. According to Hutchins, groups had cognitive properties that differed from the individuals in the group and cognition become the process of how individuals engaged with their environment. Thus, the group's accomplishments depended on the social organization of distributed cognition and not as much on the individuals in the group (Hutchins, 1991, 1995).

Hutchins (1991) used confirmation bias to test that the cognitive properties of a group were different from the one of individuals who make up the group. Confirmation bias is a bias to confirm an already held hypothesis. Hutchins was able to show that the cognitive capabilities of groups depended on how the group distributed the tasks among its members. Some ways of organizing the group accelerated individual bias, while other ways of organizing created new group thinking. Different types of group formation exhibited different distribution and communication properties. Therefore, the group formation influenced factors such as who talked to whom, what they talked about, what they communicated, and even what access they had to external information. The use of these factors, as influenced by the group arrangement, either reinforced current individual bias or created new ones. One would assume that increasing team communication improves the team's performance. Hutchins' model, however, demonstrated that increasing communication between teams may have less favorable results. In a scenario where the teams are in constant communication, there is little opportunity for them to a new interpretation that differs from others and it becomes more important to have a shared common interpretation than to arrive at the correct one. Hutchins concluded that a "horizontal" decision

power structure, one where the teams can reach their own decision but have little hierarchy communication, had a higher potential for diversity of interpretation and a lower potential for decisiveness. Conversely, “vertical” decision power, one where the teams had hierarchy communication but little communication with one another, had a lower potential for diversity of interpretation and a higher potential for decisiveness, which led to a higher potential for interpretation error. Distributed cognition was used to guide this study in understanding how different distributed compositions influenced communication and decision delays.

Distributed Cognition for Teamwork Methodology (DiCoT)

Blandford and Furniss (2006) proposed the Distributed Cognition for Teamwork (DiCoT) framework for supporting distributed cognition analysis to evaluate and enhance existing system designs. The framework provided a structured approach to analyze a complex system using the central ideas of Distributed Cognition. Blandford and Furniss derived a set of three distributed cognition themes covering the physical layout and organization of work, how information flows through the system, and the artifacts that support cognition. Each theme contains a set of principles, an illustrated representation of the system, and a summary of the system containing details, observations, issues, and viewpoints.

Sharp, Giuffrida, and Melnik (2012) performed a virtual ethnographical study that used the DiCoT analysis framework to determine the effectiveness of information flow in a distributed Agile environment when compared to a colocated Agile environment. Sharp et al. (2012) performed interviews and inspected the three main themes and 22 principles of DiCoT against colocated and remote team members working in the same Agile project. Sharp et al. found that although communication was not a problem, information flow within a distributed team member

is more complex than those of colocated team members. The information flow was challenged by the artifacts and tools used by distributed members. Also, distributed members needed to transform information more frequently than their counterparts to effectively accomplish tasks. The researchers suggested studying other dispersed teams as their study only considered one team using DiCoT to analyze the information flow. Table 2 summarizes the DiCoT themes and principles as described by Sharp, Giuffrida, and Melnik (2012).

Table 2

Summary of DiCoT Framework Themes and Principles (Adapted from Sharp, Giuffrida, & Melnik, 2012)

Theme	Principle	Description
Physical layout and organization of work that influences the performance of the system	Space and cognition	How are items arranged to support activities and choices? For example, material layout.
	Perceptual	How do special representations aid in activities and choices? For example, item prioritization.
	Naturalness	How much does the representation match what it's trying to represent? For example, a call transcript compared to a recording of the actual call.
	Subtle bodily supports	How do bodily actions support a process or activity? For example, pointing to a line of code.

	Situation Awareness	How well are members informed based on what is visible, audible, and accessible to them? For example, face-to-face discussions of the situation.
	Horizon of Observation	What can the members see and hear based on their location? For example, able to see other team members interacting.
	Arrangement of Equipment	How does the equipment arrangement affect access to the information? For example, control systems can only be accessed from a specific terminal.
Information flow between participants and through the system	Information Movement	How does information move around the system? For example, text or phone calls.
	Information Transformation	When, how, and why does the information in the system change? For example, meeting minutes.
	Information Hubs	Where are the central places where information channels meet, and decisions are made? For example, a department manager.
	Buffering	Where is information stored until their proper opportunity? For example, a team member's workstation.

	Communication Bandwidth	How is information being communicated and how effective is the medium to convey the information? For example, face-to-face vs. computer-mediated communication.
	Informal Communication	What informal channels are used to communicate information? For example, storytelling.
	Behavioral Trigger Factors	What factors may cause activities to happen without a need for an overall plan? For example, a watercooler conversation.
Artifacts that support cognition	Mediating Artifacts	What artifacts are coordinated to complete a task? For example, incident tickets.
	Creating Scaffolding	How is the environment used to simplify the process? For example, creating stickies to remind us of a task.
	Representation – Goal Parity	How do artifacts allow comparison of the current state with the goal state? For example, progress graphs.
	Coordination of Resources	What structures are coordinated to complete a task? For example, plans, goals, affordance, history, action-effect, and current state.

Deshpande, Sharp, Barroca, and Gregory (2016) used the DiCoT theoretical framework to study collaboration in distributed Agile teams. The study focused on one organization to perform a comparative analysis between colocated team members and remote workers to arrive at the key differences. The researchers found that tools that help in managing Agile artifacts, such as Jira (a project management and planning tool), and Bitbucket (a version-control repository service for source code) played critical roles in supporting meaningful engagement and tight collaboration in a distributed Agile team and that transparency through collaborative platforms was important for remote workers' participation. The study also highlighted that remote workers experienced isolation and knowledge exclusion, while colocated team members were distracted from their objective by social hubs created through informal communication. Inversely, remote workers were able to focus better on tasks, while colocated team members possessed richer information.

DiCoT also helped to understand how distributed Agile teams' collaboration is affected by using Agile artifacts, such as requirements cards. Dingsøyr et al. (2012) and Sharp and Robinson (2008) used DiCoT to analyze how XP cards and their arrangement wall assisted in the collaboration and compared the use of physical requirement cards or user stories with software and virtual cards. Sharp and Robinson (2008) found that XP cards were central to coordination and team collaboration and that a physical wall complemented the collaboration while a digital wall added overhead. The physical cards added simplicity and flexibility of handling that was hard to match by virtual cards. The researchers added that activities were not easily hidden in a physical wall and that the information radiator was available for everyone to see. Conversely, digital walls allowed for security measures and for the information to be shared across larger distances.

Blandford and Furniss' (2006) DiCoT Framework Themes and Principles, as outlined in Table 2, were used to guide the creation of a survey to understand the behavior relevant to a needs analysis for remote Agile team members. The questions used in the framework to support the 18 principles were used to investigate the relevant behavior in distributed teams. For example, how spaces are arranged to support specific activities or how members are informed of changes in the project to increase situational awareness.

Design Science Research (DSR)

Natural science explains how things are a certain way and why they are that way, while Design Science Research (DSR) focuses on the creation of artifacts to obtain goals (March & Smith, 1995). March and Smith (1995) argued that IT research is split between two objectives. Descriptive research corresponds to natural science because it seeks to produce knowledge that helps with the understanding of IT. On the other hand, prescriptive research corresponds to DSR research because it seeks to use knowledge to improve IT performance. March and Smith (1995) reconsolidated these differences by stating that both DSR research and natural science activities are needed for IT research to be relevant and effective. According to March and Smith, DSR can be aided by natural science to offer an understanding of the natural laws that influence an artifact. Subsequently, DSR research can create artifacts that later become targets of natural-science research.

DSR focuses on building and applying artifacts to create innovations that define the ideas, practices, technical capabilities, and products for the analysis, design, implementation, management, and use of IS (Hevner et al., 2004). DSR uses kernel theories to apply, test, modify and extend capabilities through the experience, creativity, and intuition of the researcher (Markus

et al., 2002). March and Smith (1995) defined the scope of artifacts in DSR to include constructs, models, and methodologies. The constructs provided the language to evaluate artifacts, while the models and methodologies used constructs to represent real-world scenarios that help us understand the solution to a problem (Hevner, et al., 2004). Hevner et al. (2004) stated that DSR focuses on the design of artifacts that improve organizational performance by solving a problem. DSR is often used and recognized alongside behavioral science research in the IS field (Hevner, et al., 2004). Its use can help to build and evaluate artifacts, such as models and processes, that enable IT practitioners to describe current organizational situations which lead to action that can help move the organization toward the desired outcome (Hevner, et al., 2004).

DSR has been used to address distributed team and Agile software development challenges. Using DSR, Turetken, Stojanov, and Trienekens (2017) created a Scaled Agile Framework (SAFe) maturity model as an artifact for organizations to evaluate their progress in a SAFe adoption. The researchers began by analyzing the SAFe Big Picture Framework and performing a literature review to create the first phase of the model. The researchers then performed a Delphi study consisting of seven subject matter experts and two rounds of feedback to evaluate and provide suggestions on how to improve the model. Turetken et al. (2017), modified the model based on the Delphi feedback and tested the model in a large corporation, which they reported in the form of a case study. The researchers agreed that DSR and the Delphi method significantly increased the relevancy and validity of the maturity model. Although the literature does not suggest a number of participants in a Delphi study, the researchers believed that seven subject matter experts were a limited number and addressed this concern by using highly specialized industry experts. The researchers also used an anonymous feedback collection to prevent the

experts from influencing each other's views. Turetken et al. (2017) served as a guide to this study by making use of the Delphi approach to evaluate the model through its different phases.

Contribution to the IS Field

Although prior studies have researched and documented the challenges, behavior, and practices of distributed Agile teams, to the researcher's knowledge and as per the academic body of knowledge, no prior research has considered the different forms of distribution to create a model for the effective collaboration of the various distributed agile compositions. Table 3 summarizes related prior studies and the key differences to this study.

Table 3

Related Prior Studies Summary and Unique Differences of this Study

Study	**Contribution**	**Limitations**	**Unique Contributions of this Study**
(Phalnikar et al., 2009)	• Proposed an offshore Agile team structure model	• Only considered offshore challenges • The model was limited to Agile roles and did not include Agile events and artifacts	• Considered additional team compositions that go beyond the challenges of offshore teams

			• Included Agile events and artifacts in addition to roles
Ambler & Lines, 2020	• Proposed different team compositions and suggested practices to reduce risks.	• Not an academic study, which lacked prior literature and theory research • The approach did not consider Agile events and artifacts • Did not propose a model.	• Created a model based on prior literature research, needs analysis, and theories • Considered the different Scrum roles, events, and artifacts in the model
Sutherland et al., 2009	• Defined three different distributed team compositions. • Through a case study, illustrated offshoring collaboration practices that	• Focused on offshore challenges • The case study considered a single company	• Considered practices beyond the needs of offshore teams • Considered the needs of fully distributed team members

	combined Scrum with XP to improve the performance of offshore teams		• Generalized the findings by considering more than one organization's practices
Lee & Yong, 2010	• Proposed a set of roles and practices to improve internationally distributed Scrum teams. • The study considered three different types of distributions	• No model was developed to consolidate the proposed approach • The case study considered a single company	• Generalized the findings by considering more than one organization's practices • Created a model for effective Agile team collaboration
Pardo-Calvache, Chilito-Gómez, Viveros-Meneses, & Pino, 2019	• Proposed a guide for applying Agile in a globally	• Did not consider the different team compositions.	• Considered additional team composition

	distributed environment. • Grouped and harmonized the practices for the different Agile frameworks.	• Proposed a new Agile project management framework but did not create a model to help with distributed collaboration.	beyond offshore teams. • Created a model for effective distributed Agile collaboration.

This study contributed to the IS field by proposing a distributed Agile collaboration model to assist those looking to implement Agile using different distributed compositions. It provided managers and practitioners with a model to navigate the considerations that influence effective collaboration in a distributed Agile environment. Moreover, this study expanded the understanding of the differences between the various types of distributed Agile compositions.

Recent events relating to the COVID-19 pandemic forced citizens around the world to self-quarantine at home and work remotely for as long as one year, depending on their geographical location. Many companies and individuals had to adjust how they perform their work as they worked from home during the quarantine. This means that, for a period, many teams had to change their composition to adjust during the quarantine. Thus, Agile teams that were colocated or partially distributed had the experience of working in fully distributed teams. This presented a unique opportunity to study and compare the challenges and practices faced by the same Agile teams when using different composition types.

Summary

Chapter two described the relevant research literature on the topics of project management approaches, distributed teams, distributed Agile, CSCW, applicable theoretical frameworks, and DSR. The literature review confirmed that ineffective collaboration in distributed Agile teams is a problem and the current Agile framework are silent about the necessary practices and techniques to implement Agile with remote teams. In addition, the body of knowledge does not address the need for the different types of remote team composition. There is a need for a model to guide the successful collaboration of distributed Agile teams, distributed members, and hybrid compositions.

Chapter 3 provides a detailed description of how the investigation was conducted including an overview of the DSR research methodology, specific research methods employed, instruments used, and population and sampling. It also outlined how the data was analyzed and the model was constructed.

Chapter 3

Methodology

Overview

Distributed Agile software development is difficult to implement. The goal of this study was to construct and validate internally a model to aid in the effective collaboration of distributed Agile teams. A primary differentiator of design-science research (DSR) over qualitative, quantitative, and mixed methods research is the expectation of an artifact creation and its application (Hevner et al., 2004; Peffers et al., 2007). It is also common for DSR to make use of these three approaches. It is, however, the applied research nature of design-science as a problem-solving paradigm that made this approach a good fit for the construction and application of the model to address the collaboration problems faced by distributed Agile teams.

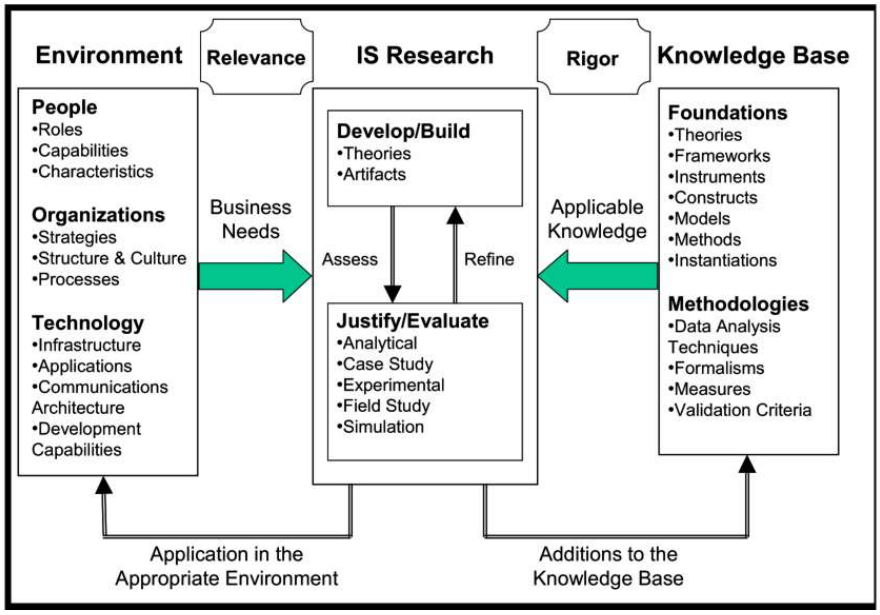
March and Smith (1995) proposed a framework that used design and natural science for relevant and effective research. The framework was divided into two dimensions. The first dimension defined the relevant activities. The activities included build, evaluate, theorize, and justify. Build referred to the construction process of an artifact. Evaluate referred to steps to determine how well the artifacts work to solve a problem. The second dimension defined the outputs. The outputs included constructs, models, methods, and instantiations. Constructs referred to the basic language to characterize the research subject. Models were a higher-level form of constructs used to describe tasks for situations, or artifacts. Methods were a set of activities to achieve a goal. Instantiations were the product benefiting from the implementation

of constructs, models, and methods. March and Smith, however, did not offer clear guidelines to execute the framework. Therefore, this study needed to consider other frameworks.

Hevner, March, Park, and Ram (2004) elaborated on March and Smith's (1995) framework by addressing DSR within the context of IS, analyzing the risks and challenges, making the artifact a required output of the process, and by offering a conceptual framework with clear guidelines to execute the research. Hevner et al. argued that artifacts extend problem-solving capabilities at the individual and organizational levels by serving as intellectual and computational tools. The authors added that IS can serve as a bridge to form a cycle between DS and behavioral science that helps IT with applications to address and solve real-life problems. Hevner et al. built on March and Smith's (1995) research to propose a framework that aimed to inform practitioners on how to conduct, evaluate, and present DS research in IS. Conducting the research includes a series of expert activities to build the artifact. According to Hevner et al., the evaluation stage produces feedback that leads to a better understanding, which improves the product and the design process. The build-and-evaluate loop is carried out numerous times to arrive at the final version of the artifact (Hevner et al., 2004). This cycle is incorporated into the framework to guide the researcher to establish relevance by addressing the environment, which, in turn, helps to define the business needs. It also enforces research rigor by considering the foundations and methodologies used to inform the design. Hevner et al. also noted that DS research is different from routine design. The routine design addresses common problems using existing knowledge, while DSR addresses previously unsolved problems using innovative ways. See **Error! Reference source not found.** for Hevner et al.'s (2004) IS DS framework.

Figure 1

Information Systems DSR Framework (Hevner et al., 2004, p. 80)



Hevner et al. (2004) proposed seven guidelines for conducting and evaluating technology-based artifact design using DS research (**Error! Reference source not found.**). The authors stated that the artifact construction process is a sequence of expert activities that follow an iterative build-and-evaluate loop that uses feedback to improve the quality of the design. Hevner et al. (2004) provided the seven guidelines for designing and applying artifacts using DSR research. The guidelines included the following items:

- The research must produce an artifact.
- It must be a technology-based solution to a relevant business problem.
- The utility of the artifact must be demonstrated through evaluation.
- The research must contribute to the designed artifact or design methodologies.
- Research rigor must be applied to the construction and evaluation of the artifact.

- Available means must be applied to reach the desired artifact.
- The research must be communicated effectively to a technology and management audience.

Figure 2

DSR Guideline (Hevner et al., 2004, p .83)

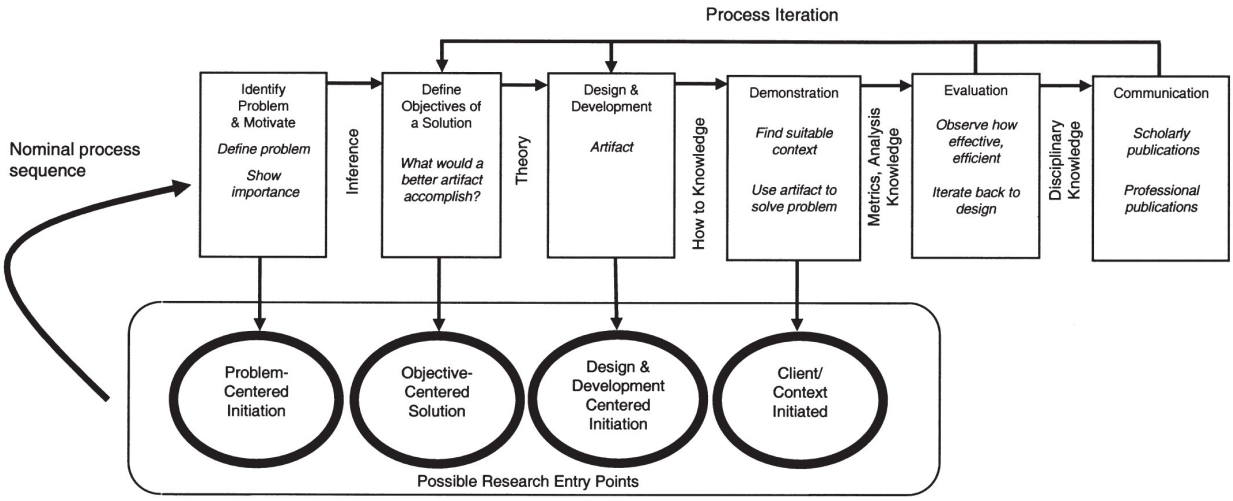
Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Several DSR frameworks and methodologies have been proposed during the DSR evolution (Hevner et al., 2004; March & Smith, 1995; Marthinusen et al., 2014; Nunamaker et al., 1990; Peffers et al., 2007). Peffers et al. (2007) addressed the need to cement DSR in IS research by proposing a methodology that included principles, practices, procedures, and a template for its presentation. The study went on to demonstrate the proposed methodology by using it in several presented case studies. Peffers, et al. (2007) proposed a six-step approach to using the Design Science Research Methodology (DSRM) in IS (**Error! Reference source not found.**). The phases included the following:

1) Identification of the problem.
2) Description of the objectives.
3) Design and development of a new artifact that addresses the problem.
4) Demonstration of the artifact.
5) Evaluating the results of the tests.
6) Communicating the test results.

Figure 3

DSRM Process Model (Peffers et al., 2007, p. 65)



The DiCoT themes and principles were used to guide the preliminary construction of the distributed Agile collaboration model. DiCoT was also useful as a coding guide for the analysis of the needs assessment results. The study also followed Offermann et al.'s (2009) process steps to conduct research that help to create the artifact. Hevner et al.'s (2004) guidelines along with Peffers et al.'s (2007) DSRM Process Model were used to assist in the construction of a distributed Agile collaboration model to follow the steps in the research phases that ensure relevance and rigor.

Research Design

A Design Science Research (DSR) approach was implemented in three phases. First, a preliminary model was constructed based on the problem identification, research goal, a review of the literature, and the researcher's relevant knowledge and expertise with Agile practices. Second, a needs assessment survey that included fixed responses and open-ended questions aimed at further defining the model was conducted with a group of Agile practitioners. Descriptive statistics (Terrell, 2012) and thematic analysis (Braun & Clark, 2012) were used to organize and analyze the survey results. These results were used to revise the preliminary model. Third, the model was validated internally using the Delphi Method (Rand Corporation) and updated to reflect the results of Phase 3.

Phase 1: Preliminary Model Construction

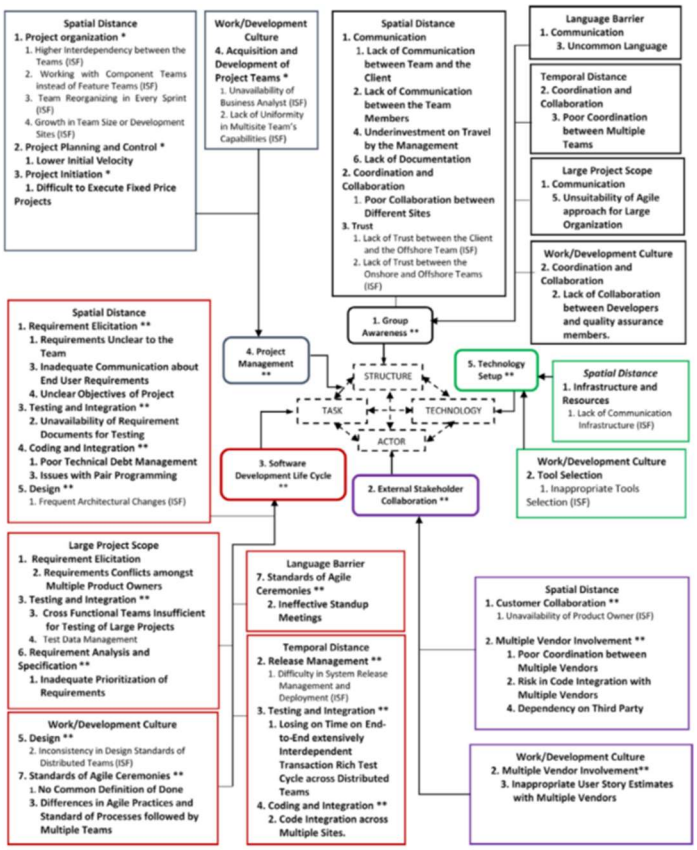
The first phase was understanding the resources available to Agile practitioners. This phase answered research question 1: *What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?* The inputs for this phase included the identification of a relevant problem, definition of the research goal and research questions, a literature review, and the researcher's relevant knowledge and expertise with Agile practices. Given the central role of the researcher as an instrument of data collection, consumers of the research need to understand any biases, assumptions, or underlying expectations that might influence the study's results (Denzin & Lincoln, 2003). Therefore, a description of the researcher's stance was provided in Appendix **A**. The output of Phase 1 was the construction of the needs assessment

survey (Appendix C). **Error! Reference source not found.** shows the Risk management framework for distributed Agile development by Shrivastava and Rathod (2017), which guided the initial creation of the needs assessment survey.

Figure 4

Risk Management Framework for Distributed Agile Development

Adapted from "A Risk Management Framework for Distributed Agile Projects" by S.V. Shrivastava and U. Rathod, 2017, Information and Software Technology, 85 p. 9.



Phase 2: Needs Assessment

The second phase began with a needs assessment of stakeholders (i.e., Agile practitioners). Phase 2 answered research question 2: *What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?* Needs assessments are used to "identify performance needs and make recommendations about potential solutions" (Wedman, 2014, p.48). In business, needs assessments are used to identify why performance is not producing the desired outcome. Results of a needs assessment are usually linked to an organization's strategic business priorities (Wedman, 2014). In the case of Agile distributed teams, a needs assessment was used to better understand what problems existed concerning effective collaboration in agile distributed teams and what could make them more successful. A

needs assessment survey was developed using Google Forms and administered to a group of Agile practitioners through the researcher's contacts on LinkedIn. Before distribution, the needs assessment survey was pilot tested with a small sample of three participants from the target population. The purpose of the pilot test was to ensure that the questions and statements were clear, the format was understandable, that the survey functioned as planned, and to validate the time it took to complete the survey. Results from the pilot test were incorporated into the final needs assessment survey (Creswell, 2015). Descriptive statistics (Terrell, 2012) and thematic analysis (Braun & Clarke, 2012) were used to analyze the results of the needs assessment survey. The results of the analysis were used to revise the preliminary model. The output of Phase 2 was a second revision of the preliminary model.

Phase 3: Model Internal Validation

The third phase was the model validation. Phase 3 answered research question 3: *How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?* and research question 4: *What modifications are needed to improve the proposed model?* Within the context of developing instructional design models, Richey & Klein (2007) recommended that models be validated through a systematic process rather than relying on user testimonials. Richey and Klein (2017, p. 12) described two types of validation including internal and external. The purpose of internal model validation is to "verify the components of the model" while external validation focuses on "documenting the impact of the model's use". The scope of this study was to internally validate the model. Internal validation of the model was conducted using the Delphi Method (Rand

Corporation). Guided by Richey and Klein's (2007) recommendations for internal validation, questions addressed during this phase included:

1) Are there any steps, phases, or elements that are missing from the model?
2) Are there any steps, phases, or elements in the model that are not necessary?
3) To what extent does the model address relevant environmental factors?
4) To what extent is the model usable for a wide range of agile projects and settings?
5) Can the model be implemented efficiently under most working conditions?
6) Is the use of the model cost-effective?

Table 4

Dissertation Research Questions and DSRM Alignment

Dissertation Research Elements	Peffers et al. (2007) Six Steps	Hevner et al.'s (2004) Seven Guidelines	Performed Research Steps	Performed Research Process Iterations
RQ1: What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?	Step #1 - Identify the problem	#2-Problem relevance	1. Literature review 2. Needs assessment survey creation 3. Preliminary Artifact Design	Phase #1- Problem identification
RQ2: What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?	Step #2 – Define the objective of the solution Step #3 – Design and development	#2-Problem relevance	4. Administer needs assessment survey 5. Additional literature review 6. Preliminary artifact design revision	Phase #2- Needs assessment

RQ3: How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?	Step #3 – Design and development Step #4 - Demonstration	#1 -Design as an artifact #3- Design evaluation #4- Research contribution #5- Design rigor	7. Expert Panel Delphi panel round one evaluation 8. Additional literature review 9. Artifact revision	Phase #3– Design & evaluation
RQ4: What modifications are needed to improve the proposed model?	Step #5 – Evaluation	#3-Design evaluation #5- Research rigor #6- Design as a research process	10. Second Expert Panel Delphi round 11. Artifact validation via panel consensus	Phase #3– Design & evaluation
Communication	Step #6 - Communication	#7 –Communication of research	12. Analysis and recommendations 13. Define contributions 14. summarize results 15. Report	Phase #4- Communication

Table 4 outlines how the phases, research questions, and performed research steps aligned with the applicability of Peffers et al.'s (2007) six steps as well as Hevner et al.'s (2004) seven guidelines.

Population

Participants for the needs assessment were identified using the researcher's LinkedIn contacts. Using LinkedIn as a method to recruit research study participants is increasing among researchers. Unkelos-Shpigel, Sherman, and Hadar (2015) pointed out the difficulty in conducting empirical research in industry and suggested that the use of LinkedIn is a useful tool to recruit participants to an online survey. With over 610 million members worldwide, LinkedIn is a source of a diverse population of professionals. A LinkedIn search for professionals containing Scrum Master, Product Owner, or Agile Developer, combined with the term "remote team" resulted in approximately 18,000 practitioners. The researcher's first contacts with the same search criteria resulted in 230. These professionals were contacted and asked to participate in the survey. Refer to Appendix **B** for the participants' recruitment invitation letter.

Boddy (2016) proposed that, in a qualitative study, a sample size of 12 may be enough to reach data saturation among a relatively homogeneous population. This study targeted 50-100 practitioners to participate in the needs assessment to ensure saturation was reached and gain a clear understanding of the needs faced by Agile distributed teams. The researcher had access to a large network of field practicing professionals via LinkedIn first-degree connections that were used to recruit experts to reach the target number of participants. These were English-speaking professionals involved in distributed Agile teams. Their titles included Product Owner, Scrum Master, Agile Developer, and Agile Coach. The target population for the needs assessment was working professionals with various levels of experience and expertise. Snowball sampling was used to reach a broader audience of professionals who were involved in distributed Agile development. Marshall and Rossman (2011) described snowball sampling as a type of sampling

that “identifies cases of interest from people who know people who know what cases are information-rich” (p. 111).

The Delphi method does not depend on statistical analysis. Instead, it uses group dynamics for arriving at a consensus (Okoli & Pawlowski, 2004). Thus, the expert panel for this study targeted 5-10 Agile professionals working in a distributed Agile environment with more than five years working as an Agile practitioner. These included experts in the role of Agile Trainer, Agile Coach, Manager, Scrum Master, Product Owner, and Agile Developer, with at least five years of experience. The Delphi panel was used to gather feedback and to internally validate the artifact. The expert panel participants were a subset of individuals from the needs assessment who opted to participate in the follow-up surveys.

Instrumentation

Asking the relevant and correct questions is critical in research. Therefore, domain understanding is important since a researcher may ask the wrong questions to investigate the problem and reach incorrect or inappropriate conclusions (Nunamaker, Chen, & Purdin, 1990). Given the researcher worked in the field as a consultant in Agile development and scaling Agile among distributed teams, he had domain understanding to guide the inquiry.

Three surveys were created to conduct this study. The first survey was a needs assessment survey. It contained a combination of closed-ended and open-ended questions to determine the needs associated with distributed Agile team collaboration. The use of open-ended questions allowed participants to raise issues that were not covered by the planned questions. The survey asked experts to highlight the needs associated with distributed Agile team collaboration. Also, the questions helped to get an understanding of the team environment and how it facilitated

collaboration. The participants' answers generated a list of factors, which the researcher used to revise the initial model. The questions were drafted using the DiCOT suggested questions as a general guide. The expertise of the participants was also surveyed to identify their experience within their current roles based on the number of years they worked in a distributed Agile team. These data served as the basis for screening practitioners to participate in the subsequent Expert Panel Delphi rounds to validate the revised model. No personal or sensitive information was requested from the participants. Refer to Appendix **C** for the Needs Assessment Survey.

The survey was piloted with three expert participants that fit the target population in case any changes were necessary before administering the survey to the full panel (Ismail Al Alawi et al., 2007). The pilot survey participants were asked to fill out an additional six questions that collected information about the survey. Refer to Appendix **D** for the Needs Assessment Pilot Feedback Survey.

The second survey was used to solicit feedback on the artifact design. At least two Delphi model feedback rounds were conducted to reach consensus. Round one enlisted initial comments and reactions to the proposed model. The rounds were facilitated via LinkedIn chat. The questionnaire was administered using Google Forms. These media were selected due to their fast response time, which is important in a Delphi study due to the elapsed time that normally occurs between rounds (Okoli & Pawlowski, 2004). The model was presented to the panel via the Google form and an explanation of each element was provided. The experts were then asked the perceived usefulness of each element. The questions included if the element should remain as is, be modified, or be removed from the model. The experts were asked to provide an explanation in the case a change or removal of the component was recommended. They were also asked if

additional components should be considered and why. Also, the questionnaire asked experts to list at least six applications or practices that could benefit practitioners to collaborate with distributed team members. This question aimed to uncover additional practices to consider in the revision of the model (Okoli & Pawlowski, 2004). Finally, the questionnaire collected answers regarding one key question: "Do you think the presented model provides a viable solution to the distributed Agile team collaboration challenges?" (Offermann et al., 2009). The questionnaire was piloted with three participants that fit the target population in case any changes were necessary before administering the survey to the full panel. Refer to Appendix **E** for the Initial Model Delphi Feedback questionnaire.

The third survey was used to conduct a second Delphi round to reach a consensus on the revised model and to get additional feedback. This round was facilitated in the same manner as the first round where the participants were contacted via LinkedIn chat and given a link to the Google Form. A revised version of the model was included. The experts were asked to select the list of suggestions they agree with and, once again, asked for their opinion on the elements that should be added, deleted, or revised. The expert panel was also asked to validate the model for final consensus. Refer to Appendix **F** for the model revision feedback questionnaire.

Data Collection

Needs Assessment

For the needs assessment, the survey was administered using Google forms. Based on their LinkedIn profile, the potential participants were contacted via LinkedIn Messaging. They were asked if they wanted to participate in an academic study involving distributed Agile teams. A link to the Google Forms survey was provided if they show interest in participating. The Google

forms survey contained a questionnaire to determine their eligibility. The potential panelists also received a general explanation of the procedure and time commitment. The time asked for the participants was to answer one, 20-minute questionnaire, with an option to opt-in to participate in the Delphi rounds that were estimated to be two 20-minute questionnaires. Google Forms saved survey responses into a spreadsheet that only the administrator of the survey had access to. The researcher was the sole administrator to ensure the anonymity of the participants. The spreadsheet was downloaded to the researcher's laptop, which was password encrypted and deleted from the Google drive to reduce the risk of exposing the data. Also, the names of the participants were replaced by numbers and kept in a separate sheet along with the assigned number that was only accessible by the researcher. This process further anonymized the data, while allowing the researcher to contact participants throughout the study.

Delphi Rounds

Using the Delphi approach provides a consensus among experts and avoids confrontation that can inhibit independent thoughts (Okoli & Pawlowski, 2004). Large, elapsed times during data collections are common when using the Delphi method. Therefore, it was important to use a medium that could accommodate asynchronous, yet rapid communication for faster response time (Okoli & Pawlowski, 2004). The Delphi questionnaires were administered using Google forms. The potential panelists were contacted from the list of needs assessment panelists who opted to participate in subsequent parts of the study. The chosen participants were contacted via LinkedIn Messaging. They were asked if they would like to continue their participation in the academic study involving distributed Agile team collaboration. A link to Google Forms was provided if they show interest in participating. The potential panelists also receive a general

explanation of the procedure and time commitment. The time asked for the participants was to answer two, 20-minute questionnaires, and returning them within seven days of receiving the link. The longitude of their commitment did not expend beyond three months.

The Delphi approach usually requires about one to six rounds of feedback to reach a consensus between participants (Worrell et al., 2013). The initial model was revised using the results of the needs assessment. This revised model was included in the Expert Panel Delphi round #1 where the panel was asked to provide feedback. A link to questionnaire #2 was provided via LinkedIn messaging and participants and given one week to provide their feedback. Maintaining the anonymity of the responses is a key feature of the Delphi method (Rowe & Wright, 1999). After seven days, the author gathered the model feedback questionnaire using the Google Forms reports and followed the same steps used in the needs assessment to ensure the participants' anonymity.

For the Delphi round two, the model was revised using the feedback from round one. A third questionnaire, questionnaire #3 included the revised model and was sent to the Delphi panel. The expert panelists were asked to rank the feedback and answer the questions one more time via Google Forms. The participants were then given one week to complete the second instance of the feedback questionnaire. After seven days, the author gathered the results using Google Forms reports, repeated the data treatment steps, and used the information to revise the model. Table 5 summarizes the data collection steps and timeline.

Table 5

Data Collection Summary

Step	Data Collection Method	Time Allocated

Initial Contact	LinkedIn messaging	One Day
Questionnaire #1 – Needs Assessment	Needs survey via Google Forms	One week
Initial model creation	Needs assessment output	Two weeks
Questionnaire #2 – Model Feedback	Delphi Panel Feedback via Google Forms	One week
Model Revision	Model Feedback Output	Two Weeks
Questionnaire #3– Model Feedback and Final Model Revision	Delphi Panel Feedback via Google Forms	One week
Internal Validation	Model Feedback Output	Two Weeks

Data Analysis

Because the researcher is an experienced Agile practitioner, bias was a potential risk in the study design and conclusion. Therefore, Bracketing was used to avoid bias. Bracketing is a method used in qualitative research to lessen the potential prejudgment that may influence the research process and its results (Tufford & Newman, 2012). Before undertaking the study, the researcher internalized his own experiences as an Agile Coach and his feelings and opinions toward Scrum and remote collaboration. The researcher performed reflexivity to evaluate himself at the start of the research and through each round of analysis (Chan et al., 2013). The researcher proceeded only when two key bracketing questions were internalized to be affirmative:

1) "Am I humble enough to learn about the experiences of other Agile practitioners, including junior members?"
2) "Can I obtain an attitude of ignorance about Agile and remote collaboration?"

Open-ended questions were asked in the survey to further bracket data collection and analysis. The results of the survey were analyzed using MS Word. The researcher marked sections of the survey results that contained key findings. Once the underscoring was completed, codes were assigned to the items using keywords that were created as meaningful groups were discovered. The codes were then grouped into themes by carefully reading the different codes and identifying common meanings that emerged. This process helped to further reduce the possibility of bias arising from the researcher's experience.

Jonas et al. (2010) proposed a methodology for design research, which addresses the evaluation process by considering the design's usability, desirability, and usefulness. In Jonas et al. (2010), dimensions, domains, constraints, and processes relevant to the artifact are considered as the artifact design moves through the steps of research, analysis, synthesis, and realization. Each step in the proposed method contains guidance for conducting the process (**Error! Reference source not found.**). The methods suggested in the synthesis phase, are particularly useful for artifact design (Offermann et al., 2009). These guidelines helped the author with the artifact design in this study.

Figure 5

Design Research Evaluation Process

		Steps of the iterative micro process of learning / designing			
		research	analysis	synthesis	realization
Domains of design inquiry, steps / components of the iterative macro process of designing	ANALYSIS "the true" how it is today	How to get data on the situation as it IS? → data on what IS	How to make sense of this data? → knowledge on what IS	How to understand the situation as a whole? → worldviews	How to present the situation as IS? → consent on the situation
	PROJECTION "the ideal" how it could be	How to get data on future changes? → future-related data	How to interpret these data? → information about futures	How to get consistent images of possible futures? → scenarios	How to present the future scenarios? → consent on problems / goals
	SYNTHESIS "the real" how it is tomorrow	How to get data on the situation as it SHALL BE → problem data	How to evaluate these data? → problem, list of requirements	How to design solutions of the problem? → design solutions	How to present the solutions? → decisions about "go / no go"
	COMMUNICATION "the driver"	How to establish the process and move it forward? How to enable positive team dynamics? How to find balance between action/reflection? How to build hot teams? How to enable equal participation? → focused and efficient teamwork			

The demographic, and closed-ended data, such as the participant level of the agreement, was analyzed using descriptive statistics (Naing, 2003). The data resulting from the surveys' open-ended questions were analyzed using thematic analysis as a qualitative data analysis technique. Sandelowski (2000) suggested using qualitative description methods for reporting straight descriptions from the data. Aronson (1994) described a process of thematic analysis that included the following steps. First, after collecting the data, read it, and list any general patterns of needs. Second, re-read the survey responses to identify all the data that relates to each of the general lists of patterns. Third, combine any related patterns into sub-themes. The final step was to justify the theme choices through a valid argument. This can be done by drawing from the literature to make inferences. Qualitative data were coded using Microsoft Word's revision marking mode features (Saldana, 2009). The data will be coded to identify concepts and grouped

into categories (Saldana, 2009). The concepts and categories will then be compared between participants. Qualitative coding is appropriate, as it has been used to study distributed Agile teams (Julian M Bass, 2016). For example, Bass (2016) used open coding, memoing, constant comparison, and saturation to analyze the data relevant to the evaluation of artifacts and agile method tailoring in large-scale offshore software development teams. This study used similar qualitative analysis methods to analyze the study's qualitative data from the needs assessment survey.

Concerning the internal validation process, Okoli and Pawlowski (2004), outlined a set of steps for using the Delphi Method. These steps help to organize and analyze the data resulting from the Delphi rounds. In combination with Richey and Klein's (2007) recommendations for internal validation of a model, the following steps were followed to administer the Delphi surveys and analyze the data resulting from the Delphi rounds.

Delphi Round 1–Initial Model Feedback

1) Treat experts as individuals, not as teams.
2) Consolidate the lists of feedback from all experts.
3) Remove exact duplicates, and unify terminology.
4) Calculate the mean rank for each element in the model.
5) Refine model using the consolidated list feedback.
6) Assess consensus for each list within each panel.

Delphi Round 2: – Model Revision Feedback

1) Treat experts as individuals, not as teams.
2) Consolidate the lists of feedback from all experts.

3) Remove exact duplicates and unify terminology.
4) Calculate the mean rank for each element in the model.
5) Refine model using the consolidated list feedback.
6) Assess consensus for each list within each panel.
7) Reiterate until panelists reach consensus or consensus plateaus.
8) The result is a refined model.

Formats for Presenting Results

The purpose of this study was to identify the needs, available guidance, and to create a model for the effective collaboration of distributed Agile team members. The data collected through the needs assessment and Delphi surveys were analyzed and the results presented using tables including a summary of the needs model feedback, and the different versions of the model as it evolved through expert panel feedback. Per Blandford and Furniss (2006), this study used DiCoT to help develop the preliminary model. Based on participant feedback, the identified themes were compared to the various principles in DiCoT. Finally, the outcome of the results table was summarized in a re-design model.

Resource Requirements

The resources required to perform this study included access to literature on distributed Agile teams. This resource was available through the NSU library in digital format. The library provided access to publications that included other dissertations on the topic, conference proceedings, and journal publications.

Another necessary resource to execute the study was access to the different frameworks and professional reports to determine the guidance available to Agile practitioners. Access to a

description of these frameworks and reports was obtained by visiting the respective professional websites using an Internet connection.

Access to Agile practitioners was also required to perform the Delphi expert panel rounds. This group came from the author's LinkedIn contacts. Therefore, the researcher's LinkedIn premium account along with its network of professionals was used as part of this study.

This study followed the Institutional Review Board (IRB) standards for data collection involving human subjects. The researcher obtained IRB approval to engage in the proposed study. Refer to Appendix G for the IRB approval letter.

Last, a method for collecting the surveys in a digital form was required to collect feedback from the expert panel. Google Forms was used to create the surveys and collect the data. The author had a Google account that provides access to Google Forms free of charge.

Summary

This chapter outlined the research methods, sample population, and the surveys and data sources used to conduct the study. It also outlined how the data was analyzed and the model was constructed. Last, it outlined how the data was formatted and covered the different resources used to conduct the study.

Chapter 4

Results

The goal of this study was to construct and internally validate a model for the effective collaboration of distributed Agile teams. The researcher captured the needs, challenges, and solutions of Agile practitioners that must be considered when working in different distributed Agile team compositions to support collaboration when working in a remote Agile setting. The research questions were as follows:

RQ1: What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?

RQ2: What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?

RQ3: How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?

RQ4: What modifications are needed to improve the proposed model?

To help answer RQ1 and RQ2, the data were analyzed for all participants. A needs assessment online survey was used to collect the data. The needs assessment survey was first piloted with three participants from the target population. The purpose of the pilot was to ensure that the survey was understood and to validate the time to complete the survey. All three participants responded that they strongly agreed on the purpose of the study and that the instructions were clear. They also agreed that no questions should be removed from the survey.

Furthermore, the pilot participants validated that it did not take them longer than 20 minutes to answer the survey. Last, inspecting the answers allowed the researcher to ensure the survey outputs functioned as expected and that it would be possible to analyze the data from additional participants. This process enabled the researcher to validate the survey and invite the full list of potential participants. All participants were asked to answer questions in the following areas: (1) Demographics, (2) Agile Team Composition, (3) Agile Team Practices, (4) Collaboration Efficiency, and (5) Further Study Participation. Data from each of these sections were analyzed in the context of the research questions.

To help answer RQ3, a model was developed based on the literature review and then revised based on the analysis of the data from the needs assessment survey. To address RQ4, the model was modified according to the feedback provided by a Delphi expert panel who participated in a review process that included two separate rounds. Expert panel consensus was reached in round two. The results are reported in the following sections of this chapter: 1) data analysis; 2) distributed Agile challenges and solutions; 3) findings. This chapter concludes with a summary of the results.

Data Analysis

Descriptive Characteristics and Analysis of the Needs Assessment Survey Data

The number of distributed Agile practitioners who were invited to respond to the needs assessment survey was 222. The total number of respondents from this group was 54, where one survey response was deemed a duplicate and discarded. This brought the total of valid responses to 53, which equated to a 23.87% overall response rate.

Participants were asked to select responses describing their experience using Agile. Most of the participants (88.68%) had over five years of experience using Agile. Most of the participants (92.6%) were using Scrum with their current teams, followed by Kanban (61%). The third most used Agile framework was Scaled Agile Framework (SAFe) (57.4%). Almost half of the participants were Agile coaches (43.40%). This made the survey responses richer, as Agile coaches are expected to be experts in different Agile frameworks, roles, and practices. The second most represented role was the Scrum Master (35.85%). The majority of the participants (43.40%) always work remotely, while 33.96% telecommute at least once a week and 11.32% telecommute at least once per month. Most of the respondents (24.5%) reside in the US and the second-largest country or residence was India (22.6%), followed by the Netherlands with 9.4%. The needs assessment took place in August 2020 and the expert panels Delphi rounds took place through January 2021, which was a period where COVID-19 related quarantines were in place for many countries around the world. Therefore, these data also reflect a number of telecommuters as a result of enforced work from home policies due to COVID-19. Table 6 depicts the number of responses for each question and the percentage from the total of respondents.

Table 6

Experience Descriptive Characteristics of the Needs Assessment Participants (n=53)

Experience	**Count**	**Percent**
More than 5 years	47	88.68%
1-2 years	4	7.55%

3-5 years	2	3.77%
Agile Framework	**Count**	**Percent**
Scrum	50	92.6%
Kanban	33	61.1%
Scaled Agile Framework (SAFe)	31	57.4%
Other	15	27.8%
Extreme Programming (XP)	13	24.1%
Lean Development	12	22.2%
Scrum at Scale	9	16.7%
Feature Driven Development (FDD)	5	9.3%
Role	**Count**	**Percent**
Agile Coach	23	43.40%
Scrum Master	19	35.85%
Other	6	11.32%
Manager Executive	3	5.66%
Product Owner	2	3.77%
Remote Frequency	**Count**	**Percent**
I always work remotely	23	43.40%
A few days per week	18	33.96%
At least one week per month	6	11.32%
I never work remotely	6	11.32%

Country	Count	Percent
USA	13	24.5%
India	12	22.6%
Netherlands	5	9.4%
Brazil	2	3.8%
Poland	2	3.8%
Australia	2	3.8%
Denmark	2	3.8%
UK	2	3.8%
Germany	2	3.8%
Canada	2	3.8%
United Arab Emirates	1	1.9%
Toronto	1	1.9%
Sweden	1	1.9%
France	1	1.9%
Czech Republic	1	1.9%
Singapore	1	1.9%
Bulgaria	1	1.9%
South Africa	1	1.9%
New Zealand	1	1.9%

Participants were asked to select responses describing their current organization. Most of the participants (75.47%) worked for an enterprise organization with more than 500 employees, and a small number of respondents (5.66%) worked for small businesses with five employees or fewer. Furthermore, 34.62% of the participants worked in companies that had more than 50 office locations. This was an important distinction as it showed representation from organizations with a strong need for distributed team collaboration. Table 7 depicts the number of responses for each question relating to the organizational characteristics and the percentage from the total of respondents.

Table 7

Organization Descriptive Characteristics of the Needs Assessment Participants (n=53)

Org Size	**Count**	**Percent**
500+	40	75.47%
201-500	4	7.55%
From 6-50	4	7.55%
From 1-5	3	5.66%
51-200	2	3.77%
Office Locations	**Count**	**Percent**
More than 50	18	34.62%
From 2-5	15	28.85%
From 11-50	10	19.23%
From 5-10	6	11.54%

1 Office	3	5.77%

After providing a brief description of the types of distributed compositions, the participants were asked to select their team's composition. The three types of distributions were represented in similar proportions; 39.62% of the participants worked with teams where all members worked remotely, 32.08% of the participants worked with distributed teams where two or more colocated teams collaborated remotely, and 28.30% worked with hybrid distributed teams, where teams had a combination of distributed members and distributed teams. The frequency of physical meetings held by the teams was also measured to understand the teams' level of remote collaboration; 30.77% of the respondents held daily physical meetings, while 23.08% never held physical meetings. This offered a diverse perspective of the needs that different distributed compositions face. Table 8 outlines the number of responses for each question relating to the team composition and the percentage from the total of respondents.

Table 8

Agile Team Composition of the Needs Assessment Participants (n=53)

Team Composition	**Count**	**Percent**
Distributed Members	21	39.62%
Distributed Teams	17	32.08%
Hybrid Distribution	15	28.30%
Physical Meeting Frequency	**Count**	**Percent**
Daily	16	30.77%

Never	12	23.08%
Quarterly	10	19.23%
Weekly	6	11.54%
Monthly	4	7.69%
Yearly	4	7.69%

The qualitative data analysis showed that the three types of composition faced challenges in four primary areas that were codified as challenge themes. These themes, in order of occurrence frequency, included Agile-related Tools (148), Roles (101), Events (95), and Artifacts (64). An exemplar that illustrates each of the qualitative themes is noted here. Further detail about these themes is provided later in this chapter.

- Tools: “We often have problems accessing the tools.”
- Roles: “The Business Analyst is an additional role in our Scrum team and it is sometimes hard to define responsibilities between the Product Owner and the Business Analyst.”
- Events: “It is difficult to get engaging and involving events.”
- Artifacts: “The biggest challenge here is making sure everyone knows where the artifacts are and then making it a habit to refer to them / use them.”

Agile frameworks refer to core meetings as Events (Schwaber & Sutherland, 2017). Thus, in this study, Agile meetings are referred to as Events. The least used events were the Scrum of Scrums events where 38% of the participants did not practice it as marked by the Not Applicable (N/A) response, followed by the Executive Synch Up (23%). This was due to the Agile

framework used by the teams, where the Daily Scrum of Scrums and the Executive Synch up events are mostly related to the Scrum@Scale framework. A similar pattern occurred for teams not using the Scaled Agile Framework (SAFe) where the Weekly Scrum of Scrums (21%), Program Increment Planning (21%), and Agile Portfolio Planning (19%) were not used. The preferred format for the rest of the events was online meetings, where every event received a higher response for online execution than mixed or physical meetings. The most used online events were the Daily Scrum (53%), Release Planning (51%), Sprint Planning (49%). It is important to note that, although social meetings are not part of any Agile framework, all of the respondents practiced some form of social gathering. This also came through for those that selected "others," where three additional respondents entered items such as "check-in," "Lean Coffee," and "Virtual Social Hour." Appendix **I** shows the number of teams using the different events.

The least used artifact practice was the keeping of a responsibility matrix known as the RACI Matrix, where items in the workflow are matched against the roles and categorized as Responsible, Accountable, Consulted, and Informed (RACI). A total of 30.19% of the participants did not use a RACI Matrix. This was due to the Agile frameworks not requiring a RACI Matrix as an artifact. The artifacts that were kept in online tools the most were Test Cases (98.11%), followed by the Product Backlog (96.22%) and the Sprint Backlog (94.34%). For every listed artifact, over 90% of the participants reported that their team kept the artifacts in online tools. The least common method for artifact storage and maintenance was the usage of a physical board, ranging from Release Burndown/Up Charts and Test Cases at 0% to the Team Working agreement at 7.55% physical board usage. The use of local files was a close second for

the least used artifact storage method, ranging from Product Backlogs and Sprint Backlogs at 0% to the RACI Matrix at 9.43% local file usage. The high use of online tools to store artifacts also points to the need that distributed Agile teams have for tools and the shift from physical boards to online-based solutions. Appendix **J** outlines the number of teams using the different artifacts.

For the tool types that were used daily, Email Tools (98.11%), Online Project Planning Tools (92.45%), Web Conferencing Tools (90.57%), and Instant Messaging Tools (90.57%) were used the most. The majority of participants reported that most of the tool types provided were used daily with the only exception being Estimating Tools with only 7.55% reporting daily usage. Estimating Tools may be an outlier because many teams will only use these tools during Sprint Planning. The least used tool type was Online Whiteboarding tools where 28.30% of participants reported not using them. Estimating tools, with 22.64% of participants not using them, were second for least used tools. Estimating Tools, however, had the highest use for weekly frequency. This is likely due to the refinement session, where estimating normally takes place, occurring on a weekly cadence. The majority of participants agreed that there were no other tool types that they frequently used, while the ones who reported using other tool types gave extraneous responses or tools that could be grouped into the existing categories. Appendix **K** shows the number of teams using the different tools.

Decision-making was a democratic process used in all the Agile compositions. Team consensus was the most popular approach to making decisions where 71.7% of the respondents worked with teams that made decisions via team consensus. This was followed by 20.75% of the participants encouraging individuals to make decisions, and only 7.55% depending on their leadership to make decisions.

Participants were asked to evaluate how effective their teams were at collaborating. The hybrid composition, where teams had a combination of colocated and distributed team members showed to be the most effective collaboration composition, where 27% of the hybrid team members considered their teams to be very effective collaborators, 73% considered their teams to be effective collaborators, and none considered their teams to be ineffective collaborators. Distributed Members and Distributed Teams compositions also considered themselves to be effective collaborators, with 19% and 24% respectively. **Table *9*** outlines the numbers based on their collaboration effectiveness and composition.

Table 9

Collaboration Effectiveness by Team Composition

Effective Level	**Distributed Members**	**%**	**Distributed Teams**	**%**	**Hybrid Distribution**	**%**	**Total Count**	**%**
Very	4	19%	4	24%	4	27%	12	23%
Effective	13	62%	12	71%	11	73%	36	68%
Ineffective	4	19%	1	6%	0	0%	5	9%
Total	21	100	17	100	15	100	53	100

The survey collected responses about the length of the Sprints or iterations the teams practiced. This helped to understand if there was a relationship between effective collaboration and the amount of time the teams spent iterating. Most of the teams were practicing 1–2-week iterations (88.68%), with only a few teams practicing 2–3-week iterations (7.55%).

The data suggested that there was a strong correlation between shorter iterations and effective remote collaboration. Out of the 47 teams that practiced 1–2-week iterations, 10 (21%) considered themselves very effective collaborators, 32 (68%) effective collaborators, and five (10.63%) were considered ineffective collaborators. Further study is recommended before generalizing this potential finding due to the low number of teams practicing longer iterations and therefore making it difficult to compare the two groups. Appendix **L** outlines the number of responses for each question and the percentage from the total of respondents.

The techniques used by the different teams varied greatly. Encouraging video sharing during online meetings was the preferred method to improve online collaboration. A majority (78.8%) of all teams practiced this technique. The second most preferred collaboration technique was getting team members together periodically (73.1%). Time-boxing, a method of allocating a specific amount of time to a discussion or activity, was third on the list of preferred techniques. Table 10 shows the number of responses for each technique and the percentage from the total of respondents.

Table 10

Collaboration Techniques Used by Teams (n=53)

Choose additional techniques your team uses to improve its online collaboration		
	Count	**Percent**
Encouraging video sharing during meetings	41	78.8%
Periodically getting team members together	38	73.1%
Enforcing time-boxes during meetings	37	71.2%

Posting information ahead of the Scrum event	28	53.8%
Pairing remote team members	25	48.1%
Providing ways to contact team members during off-hours	17	32.7%
Consolidating some of the Scrum events to take advantage of meeting times	17	32.7%
Enforcing mandatory hours that ensure work overlap between different time zones	15	28.8%
Have team ambassadors travel between sites regularly	13	25%
Keeping a permanent virtual meeting room open at all times	12	23.1%
Holding more than one daily Scrum call to accommodate different time zones	9	17.3%
Using a virtual "talking stick"	7	13.5%
Keeping different regional product backlogs	3	5.8%
Having each member speak during online meetings	1	1.9%
Holding games for team bonding	1	1.9%
Using a dedicated teams channel	1	1.9%
Inviting time-boxes adherence	1	1.9%
Retrospectives and team workshops	1	1.9%
Recording sessions	1	1.9%

Tools and technology received the highest preference when looking at the factors to consider that could improve collaboration. A total of 61.54% of the participants strongly agreed that it

should be considered and 38.46% agreed that tools should be considered when crafting solutions to improve remote collaboration. Most of the participants also agreed that remote Agile events and facilitation should be considered, where 38.46% strongly agreed and 50% agreed regarding Agile events. Roles and responsibilities also received a high preference, where 50% strongly agreed and 40.38% agreed. The participants provided a similar response concerning the Agile artifacts, where 41.18% strongly agreed and 50.98% agreed that artifacts should be considered. Last, team composition also had significant consideration, with 52.94% of the participants strongly agreed and 41.18% agreed that team composition was an important consideration for distributed Agile collaboration. Trust, working agreements, and team willingness were also agreed to be influencing factors. Appendix **M** lists the number of responses for each collaboration factor and the percentage from the total of respondents.

Tools Related Challenges and Solutions

The challenges associated with the different distributed Agile compositions were collected using multiple choices and qualitative data from the open-ended questions. Appendix **N** outlines the response count for the different tool-related challenges experienced and the solutions used by the different team compositions.

The top tool-related challenges experienced by the distributed team composition, where one or more teams were colocated and collaborated with other remote co-located teams, included sporadic tool adoption (29%), missing advanced tool features (23.5%), low tool efficacy (17.6%), unable to locate information (17.6%), and information overload (17.6%).

The qualitative data were first compiled in a Microsoft Word document and organized into their respective team compositions (e.g., Distributed Teams) and organized into codes and

themes. Refer to Appendix H for a snapshot of the coding process. The main challenge-related themes that were validated in the responses were Tools, Roles, Events, and Artifacts. The challenges were codified for common categories using Microsoft Word.

Tools related challenges and solutions were highlighted by participants' comments such as:

- "We have multiple repositories for the same information, I don't know where I can find the most up-to-date information."
- "The main challenge has been the sheer number of tools and different people preferences, using an excel sheet over a Jira Kanban board, for example."
- "Sometimes there are too many channels to follow."
- "Not being aware of the tool collaboration features and causing unnecessary mass emailing is a problem."
- "It's difficult to find a balance between locally preferred tools over globally preferred tools."
- "We need to agree on what tool to use for what task and how to use it."
- "Clients and development teams have different tools to collaborate."
- "The client has provided IBM Rational (migrating to JIRA) for SDLC and compliance tracking. Once the team members have overcome the client environment access issues, they are free to adjust Kanban board/statuses and view/edit the backlogs."

In addition to the tool challenges faced by distributed teams, those collaborating with a distributed team member composition also faced frequent challenges relating to access and

technical problems (33.3%) and inconsistent use of tool features (19%). These were highlighted by participants' comments such as:

- "There are some problems to access the tools."
- "Getting tool licenses for everyone is very expensive."
- "We have infrastructure challenges in setting up remote teams, such as creating their Virtual Desktop (VDI)."
- "We have server synch ups and refreshing issues."
- "Most of the collaboration tools are maintained by corporate IT but on this government contract the tools are hosted on a government server and the team must maintain them. Thankfully, as the Scrum Master, I have some management experience of the collaboration tools, so I am able to perform most of the administration tasks."

Last, the hybrid team composition was not as challenged by the inability to locate information nor information overload. They were, however, uniquely impacted by a lack of corporate security and compliance (20%), where some of the qualitative comments included:

- "Meeting security requirements is a challenge."
- "Microsoft Teams can be flaky and have no breakout rooms plus not really well for mob programming. But we have to use it due to company rules."

The top solutions put in place to address tool challenges included outlining a tool governance process, with 13.3% of hybrid teams preferring this approach, the use of corporate-approved tools, with 17.6% of the distributed team preferring the solution, and streamlining tool choices as

well as defining “must-have” requirements for tool evaluations with each receiving a score of 26.7% for hybrid teams. These findings were further validated by participants’ qualitative responses. In addition, the need for a tool subject matter expert or a tool technical lead surfaced as a common solution in the qualitative data:

- “We came to a common understanding for what we need out of a tool and then by agreeing to continuously examine the tool and being open to changing.”
- “I am the tool subject matter expert and I either fix issues that the team members cannot (due to permissions) or I coach them in how to use the tool.”
- “Scrum Master and coach should lead by example and show the team and business teams how to use the tool and how to use the new features.”
- “Coaching everyone on when to use what tool for what purpose and how to use it efficiently made life easier.”
- “Frequent training on tools, explore the new tools or features and brainstorming sessions on how to use those newfound answers within the team made working life easier.
- “After training and trial and error it all worked well.”
- “Collaboration tools including Cisco Jabber and WebEx and company email have been helpful, however, the team had to establish a communication plan because some team members were using Microsoft Teams while others were using Cisco Jabber, some were using UberConference while others were using WebEx.”

Roles Related Challenges and Solutions

Appendix **O** outlines the role-related challenges and occurrences by composition as well as the solutions applied by each. The top role-related challenges faced by the distributed team composition included low team cohesion (52.9%), team members being too passive during events that required interaction (41.2%), team creating smaller team silos or sub-teams that excluded other members (41.2%). On the other hand, distributed teams were less challenged by Sprint interruptions due to urgent requests (11.8%), experiencing pressure to overcommit on their workload (11.8%), and delays in onboarding team members (11.8%). Participants' responses included comments such as:

- "Working together from a distance is difficult if you don't know each other."
- "Getting communication started and getting both the onsite and remote team members to work as a team and not group or silos is challenging."
- "Developers were not using their voices during retros."

The distributed member composition challenges also included low team cohesion (76.2%), infrequent communication with their teammates (57.1%), and lack of leadership support (47.6%). Distributed members, however, were less challenged by time zone misalignment (14.3%). This could be due to the schedule flexibility individuals have when they can work from home instead of the more structured office-hour scheduled.

- "The biggest challenge is being able to collaborate on an ad hoc basis outside of regularly occurring meetings."
- "The team is challenged by command-and-control leadership."

- “The leadership fear of losing control or importance is a challenge.”
- “Another challenge is getting management support.”

Hybrid teams experienced all the challenges faced by the other two compositions in various degrees. Low team cohesion was the top challenged faced by hybrid distribution (80%) along with infrequent communication (66.7%), while delays in onboarding team members scored the lowest but impacting 20% of the hybrid composition respondents.

It is worth noting that although time-zone differences were not the top challenge for any of the compositions, they occurred frequently among all three compositions. The qualitative responses often referenced challenges associated with time zone misalignment. These comments included:

- “Managing time zones between IST, PST, and EST is challenging.”
- “Our entire development team is split into 2 teams that are located over various locations and work in different time zones (9.5 hours difference). Regular interaction and discussions/code reviews/handover of tasks/clarifications are our everyday issues.”
- “Distributed teams across different time zones have a key challenge in time overlap.”
- “A challenge is that the product team is in a different country and time zone.”
- “All team members are in the USA but are in all time zones from Eastern to Pacific, which presents a challenge.”

The top solutions put in place to address the role-related challenges included training the organization on the proper use of the Agile roles and responsibilities with 17.6% of the distributed team participants, 23.8% of the distributed members, and 33.3% of the hybrid

composition members using the solution. Similarly, assigning people to dedicated roles received an identical score. Also, solutions such as establishing a remote working agreement received a high score, with 23.5% of the distributed team participants using the solution and 19% of the distributed members using it, followed by 13.3% of hybrid team participants. Similarly, agreeing to use synchronous and asynchronous tools for frequent and casual communication was a popular solution with 17.6% of the distributed team composition, 23.8% of the distributed members, and 13.3% of the hybrid team members using this approach.

The qualitative data supported these findings as common replies included solutions relating to training, role clarifications, having a team working agreement, and tool implementation:

- “We worked with the organization to get viable PO's assigned.”
- “We worked with management to get testers assigned to teams.”
- “Communication tools have helped.”
- “Improve collaboration and transparency as both onsite and remote team have communication tools that allow them to catch up at any time e.g., Slack, Azure DevOps, Skype, etc.”
- “Get management to understand why we need to do what we need to do and how they have to contribute to this journey, then it would not hamper the progress and the effectiveness.”
- “Getting all parties together and on the job coaching and constantly supporting them to slowly attain the agile mindset is the key. Training, certifications, coaching should be an ongoing process towards success."

- "Talk with individuals, train and coach people about the role, talk and define responsibilities."

Events Related Challenges and Solutions

Appendix **P** outlines the events-related challenges and occurrences by composition as well as the solutions applied by each. The top event-related challenge experienced by the distributed team composition was ineffective communication (29%), with time zone coordination, low engagement, longer event duration, unclear event logistics, delayed decisions, and difficulty performing team brainstorming, all tying for the second most common challenge (17.6%). Distributed members saw similar results with ineffective communication, missing team members and stakeholders, and delayed decisions as the most common types of event challenges (42.9%). Team members reported a significant spike in delayed decisions compared to the other compositions. The top challenges for hybrid teams were similar to distributed members, with ineffective communication (46.7%), missing team members and stakeholders (40.0%), and low engagement ranking among the highest event challenges.

The qualitative data supported these findings as common replies included challenges referencing lack of team member engagement, attendance, and time zone differences:

- "Maintaining engagement in the meetings is the biggest challenge as it can be easy to tune out in virtual meetings."
- "Having passive listeners was a problem, where members are physically present but not mentally."

- “The challenge is to improve collaboration because now we are fully remote. The question we had to answer was: how to duplicate the same interactions that we had before being together in a room to a remote environment without losing valuable insights.”
- “Team members showing up on time, being prepared for the meetings, being focused on the agenda, and maintaining effective communication in the meetings were our biggest challenges.”
- “People don't respect the time zone differences."
- “The largest challenge was getting people to show up to the ceremonies.”

The top solutions used by the distributed team composition to address event-related challenges included the use of asynchronous communication tools (23.5%) to collaborate, training teams on cultural awareness (17.6%), and promoting remote equality by observing other time zones (17.6%). The least used solutions, where none of the distributed team compositions used the solutions, included maintaining a permanently open virtual room, using breakout rooms, calling participants by name, sharing custom agendas for events, making attendance mandatory, establishing a co-created working agreement, and creating a DRACI matrix.

For distributed members, using an asynchronous communication tool (23.8%) and encouraging participants to share video during events (23.8%) were the most used solutions. Holding anonymous voting sessions was not a solution used by the distributed member composition to make decisions. This lack of decision-making approach was intriguing, seeing as how delayed decisions were among the top challenges reported by distributed members.

Hybrid teams encouraged participants to share video during meetings (40.0%), used asynchronous communication tools (33.3%), and showed the artifacts via desktop sharing during events (33.3%) as the top events-related solutions. Consolidating events and keeping a timebox were not solutions used by hybrid teams. A common theme for all compositions was the use of asynchronous communication tools, fitting into the top solutions for all three compositions.

The qualitative data pointed to three main solution areas. These include tools, time zone management, and engagement techniques.

Typical tool-related solutions included integrating tools to communicate synchronously and asynchronously to communicate effectively. It also included the use of whiteboarding and knowledge repository tools:

- "Cadence and collaboration tools were put in place to facilitate asynchronous communication, as this was a challenge with our distributed teams."
- "We had to bring whiteboard tools such as Mural, content sharing tools and incorporate these in our daily work and events."
- "The team is using Jira and Confluence to store knowledge in a central place and to improve transparency"
- "Team is distributed across 3 countries, communication tools are employed to make the meetings more effective."

Teams also tended to make the events shorter to accommodate the time zone differences. Some teams opted to work during a common time zone, while others tried to practice tolerance to other time zones noting the following:

- “Large meetings and virtual training now take place across multiple days for shorter spans of time to accommodate more time zones.”
- “Decomposing events to several days to allow for concurrent planning.”
- “The solution is to understand and respect the time zone differences.”
- “Our client is based in the Eastern time zone, so all meetings are referenced from there.”

To maintain engagement and attendance, teams enforced working agreements that kept members accountable. In addition, social time and keeping the scheduled meeting times were also common solutions:

- “I would coach on why they needed to be there and the importance of them attending for the whole team. Eventually, management had to get involved to let them know it would be part of their performance review to attend all ceremonies as a member of a scrum team. That's when they all started attending. We try to do breakouts and have smaller groups and do some fun things.”
- “We've tried to address participation by making sure everyone has their camera's on and announcing meeting rules at the beginning of a meeting.”
- “What seems to help is icebreakers and to always let the team know it is a safe space to voice their opinions.”
- “We have tried to be more strict with our meeting start and end times, keep on point .”

Artifacts Related Challenges and Solutions

Appendix **Q** outlines the artifact-related challenges and occurrences by composition as well as the solutions applied by each. The artifacts-related challenges for all three compositions were relatively similar. Distributed teams faced a lack of artifact visibility (17.6%), outdated information (17.6), and lack of access to artifacts (17.6%) the most, while an unprepared product backlog (11.8%) was the least common challenge. Distributed members reported an unprepared product backlog (28.6%) as the most common challenge and reported lack of access to artifacts (14.3%) as the least common challenge. The top challenge for hybrid teams was a lack of access to artifacts (33.3%), while an unprepared product backlog (6.7%) was the least reported challenge. A lack of access to artifacts and an unprepared backlog seems to have an inverse relationship, whereas one is more prevalent, the other is less common. This may be due to the team's inability to collaborate on backlog readiness due to lack of access.

The challenge of keeping a source of truth for the artifacts and being able to find the information was a clear problem for all three compositions. Participants comments that highlighted this challenge included:

- "We had challenges around multiple possible repositories for information-"where can I find the most up to date information?"
- "We can't see the artifacts in the system."
- "We have multiple artifacts at multiple locations and miss the big picture."
- "We currently do not have a solution for information radiators now that we are 100% working from home."
- "Sometimes it can be hard to find the artifacts as we have many places to save it."

The inconsistent use of the tools that hosted the artifacts was also a major challenge that participants frequently highlighted. This also included the challenge of having team members update the digital artifacts for others to have updated information to the work from:

- “The team wasn't at all disciplined about putting tasks into Jira.”
- “The largest challenge was getting the Product Owner and Teams to utilize Jira/RTC correctly.”
- “The tools need to be understood and used!"
- “Availability and constant keeping the page up to date is a challenge.

Last, members commented on the challenge of maintaining a refined product backlog to guide requirements and prioritization, noting the following:

- “Keeping the product backlog ready for the next sprint is a challenge.”

The top solutions used to address event-related challenges that distributed teams reported were purchasing enterprise licenses for tools (23.5%), inspecting artifacts, and reminding members to update them during each event (23.5%). Reducing dependencies between backlog items (0.0%) was the only solution unused by the distributed teams in the participant pool.

Distributed members reported the use of a digital product backlog management tool (28.6%) as the most common solution while keeping an artifacts WIKI page (4.8%), outlining a Definition of Ready (4.8%), and reducing dependencies between backlog items (4.8%), were the least reported solutions.

The top solutions for hybrid teams were exclusively using digital artifacts (46.7%), using a digital product backlog management tool (40.0%), and using whiteboarding tools to post artifacts (33.3%). SME review sessions (6.7%), outlining a Definition of Ready (6.7%), reducing dependencies between backlog items (6.7%), having a proxy artifact owner (6.7%), and assigning an artifact support technical lead (6.7%) were the least common solutions for hybrid teams.

The qualitative responses reinforced that the use of Agile digital tools was one of the main ways to address artifact related challenges:

- "Tool instruction sessions are provided and the Scrum Masters focus on the proper use of the tools."
- "The Development Manager keeps a list of priorities, which in the past wasn't accessible to the team but is now posted to Confluence and will be converted into Jira."
- "Jira and Confluence prove very useful."

Finding the right information and artifacts and making them accessible has been addressed through information visualization techniques, governance, and communication:

- "We created a Big Visual Information Radiator (BVIR) in Mural/Miro."
- "We use one central repository and maintain it."
- "Establishing daily standups to show them the board will resolve this for us."
- "We've addressed this by making links to everything very easy to find in Slack/Google drive and then referencing the artifacts regularly during our meetings."

Maintaining the information up to date is normally addressed through governance, training, and group updates during the events:

- "Online tool should be the single source of truth and everyone should update the items and artifacts on the online tool on a daily basis and Scrum Master or coach to validate and remind the team on regular basis to how to do it efficiently and teach them about why the updates on the online tool are important."
- "In Video Conferencing (VC) sessions we use at all locations large screens to share the data from the tools (and the faces in the VC) for clearness of the administrative data in the tools. Data is maintained during the VC-sessions."
- "All the work done along with status is updated regularly in RTC (IBM tool to track the stories) by developers so that status is visible to everyone at any point of time. All the clarifications we receive from business stakeholders are shared in common group mails and uploaded in common repositories so that everyone has access at all times."

Findings

The information found in the literature review regarding Agile teams' collaboration needs as well as their potential solutions, combined with the results from the needs assessment survey, provided the basis for the researcher to develop a model for the effective collaboration of distributed Agile teams that took into consideration the needs and solutions of the Agile teams' composition: distributed teams, distributed members, and hybrid teams. The model covered the main challenge areas as it pertained to their respective team compositions as per the data analysis. The model also provided applicable solutions as used by the participants.

Model Development Description Resulting from the Needs Assessment Data Analysis

The literature review showed limited guidelines on the challenges and solutions for the effective collaboration of the different Agile team compositions. The review also showed that the Agile frameworks were silent on the topic of distributed team collaboration. Most of the existing research on distributed Agile collaboration groups the different distributed composition into a single set of challenges and potential solutions and do not address the needs of the individual team compositions.

The results of the data analysis showed four key areas that need to be considered for effective distributed Agile team collaboration. The challenges associated with these areas were evaluated using guidance from the DiCoT framework. The researcher considered DiCoT principles such as horizon of observation, arrangement, information flow, hubs, buffering, informal communication, and coordination of resources.

Main challenge areas identified in the proposed Distributed Agile Team Collaboration model:

1) Tools. The Tools element addresses the challenges and solutions faced when implementing the different tools used by Agile teams.
2) Roles. The Role elements relate to the individuals performing the work. These are the roles as described by the various Agile frameworks. The solutions portion also includes new roles as identified by the needs assessment data.
3) Events. The Events elements refer to the Agile meetings as guided by the popular Agile frameworks such as Scrum, SAFe, and Scrum@Scale. The solutions portion also includes observed challenges that are not addressed by the Agile frameworks but were identified by the needs assessment and expert survey.

4) Artifacts. The artifacts elements refer to the digital objects created and used by Agile teams to perform the work.
    a. Different team compositions, however, face different challenges. It is possible that a team may not face all the challenges listed for their respective composition. Therefore, the proposed model was developed to allow practitioners to use the list of challenges and their respective solutions independently. This allows individuals to select a potential challenge based on their composition and apply potential solutions applicable to their respective needs.

Expert Panel Delphi Round One Descriptive Characteristics and Analysis

The next step in the development of the distributed Agile team collaboration model was to refine and internally validate the initial model through an expert panel using the Delphi method. Per DSRM, several iterations took place to refine and validate the model. Two Delphi rounds were conducted to validate, collect feedback, and reach consensus.

Participants of the needs assessment survey were asked if they would be willing to participate in a follow-up survey to validate the resulting model. Out of the 21 participants that opted to participate in the follow-up expert panel, six participants completed the Delphi panel review. The participants completed the survey with improvements and recommendations within two weeks.

The initial proposed model was presented to the participants using Google forms. Refer to Appendix **E** for the survey used to validate the initial model. Questions were asked to gain consensus among the participating members of the Delphi expert panel. Close-ended questions such as “Do you think the model presented above provides a viable solution for remote Agile

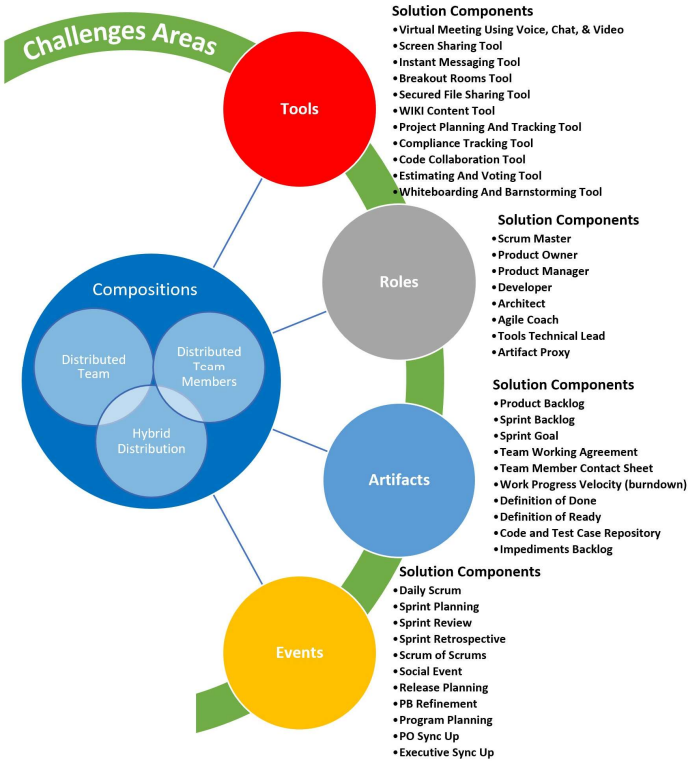
collaboration challenges?" were asked to determine the level of agreement among participants. The participants were also asked if the model should be modified and were asked open-ended questions to collect additional feedback if they selected yes to modify the model.

Round One of Delphi Expert Panel Validation

The initial model was divided into four sections; the first section simply referred to as the Distributed Agile Team Collaboration Model, outlined the composition, challenge areas, and solutions. Refer to Figure 6 for the Distributed Agile Team Collaboration Model presented to the participants of the expert panel Delphi round one.

Figure 6

Initial Distributed Agile Team Collaboration Model Proposal



Distributed Agile Team Collaboration Model Expert Panel feedback:

Do you think the model presented above provides a viable solution for remote Agile collaboration challenges?

a. "Yes" – Five participants
b. "No' – Zero participants
c. "Blank" – One participant
d. Feedback: "Heading all items Solution Components is confusing. Put a less generic header on each section (e.g., Tools Components, Roles Components)."
    i. Change made: integrated the first part of the model with the other four parts to simplify the model and avoid confusion. This allowed the researcher to delete the section.
e. Feedback: "Communications Protocol and/or Working Agreement should be added"
    i. Change made: The team working agreement was added to its respective challenges and this section was deleted for ease of reading.
f. Feedback: "Team member contact sheet is obsolete; this should be known to team members."
    i. Change made: Deleted the solution from the model.

The other three sections of the model were divided by their respective compositions: Distributed Teams, Distributed Team Members, and Hybrid Teams. Each part contained the challenges and solutions applicable to their composition. The challenges and solutions were also grouped based on the four themes: tools, roles, events, and artifacts.

The distributed team composition challenges and solutions part of the model was presented to the expert panel and feedback was collected. **Figure** *7* shows the challenges and solutions for each theme area as it applies to the distributed team composition.

Figure 7

Distributed Teams Challenges and Solutions

DT. Distributed Teams	
DTTC. Tools Challenges	**DTTS. Tools Solutions**
DTTC1. Security and corporate compliance	DTTS1a. Outline tools governance process
	DTTS1b. Use of corporate approved tools
DTTC2. Sporadic tools through the organization	DTTS2a. Establish a tool governance board
DTTC3. Inconsistent use of the tool	DTTS3a. Provide team with tools training
DTTC4. Low tool efficacy	DTTS4a. Train on how to use the tools
	DTTS4b. Coach on how to use the tool
	DTTS4c. Share screens to demonstrate tool use
DTRC. Role Challenges	**DTRS. Role solutions**
DTRC1. Lack of Communication and sync up	DTRS1a. Use tools for frequent casual communication
	DTRS1b. Hold a daily Scrum of Scrums meeting
	DTRS1d. Enforce regular artifacts updating
	DTRS1c. Radiate information via group mail and WIKI boards
	DTRS1d. Encourage members to speak during events
DTRC2. Urgent requests interruptions	DTRS2a. Add an interrupt buffer to the sprint capacity
DTRC3. Lack of team cohesion	DTRS3a. Have team members travel to other team sites
DTRC4. Overlapping roles	DTRS4a. Coach on the responsibilities of each event
DTRC5. Time zone differences	DTRS5a. Agree to use a single time zone
	DTRS5b. Hold a time neutral daily Scrum of Scrums meeting
	DTRS5c. Enforce time zone overlap hours
	DTRS5d. Practice flexible work schedule
DTEC. Event Challenges	**DTES. Event Solutions**
DTEC1. Time zone differences	DTES1a. Choose a standard time zone
	DTES1b. Use asynchronous communication tools
	DTES1c. Post information ahead of meetings
	DTES1d. Have shorter, more frequent meetings
	DTES1e. Consolidate events
	DTES1f. Find common times in the different time zones
	DTES2a. Encourage participants to share video in meetings
	DTES2b. Have dedicated A/V or video laptops at each site
DTEC2. Low engagement	DTES2c. Keep a permanent virtual room open
DTEC3. Language barrier	DTES3. Post information ahead of meeting
	DTES4a. Send a custom agenda ahead of each event
DTEC4. Out of scope conversations	DTES4b. Train and coach on the purpose of each event
DTEC5. Lack of consensus	DTES5a. Hold anonymous voting sessions during events
DTAC. Artifacts Challenges	**DTAS. Solutions**
DTAC1. Unclear requirement descriptions	DTAS1a. Observe a Definition of Done and Definition of Ready
DTAC2. Low transparency	DTAS2a. Purchase enterprise licenses for tools
	DTAS2b. Screen-share artifacts during meetings
	DTAS3c. Keep an artifacts WIKI page
DTAC3. Outdated information	DTAS4a. Have a proxy artifact owner
	DTAS4b. Add artifact management expectations to the working agreement
	DTAS4c. Inspect and remind to update during each event

The expert panel provided feedback based on the presented portion of the model and the researcher made adjustments to the model to incorporate the feedback. Following is a summary of the feedback provided by the expert panel and the changes made by the researcher to address the feedback relating to Distributed Teams' composition:

Please select applicable answers as it applies to the Distributed Teams' items and fill in the information if it applies to your selection?

1) “Items should remain as is” – Three participants.
2) “Items should be modified” – Three participants.
3) “Blank” – Zero participants
4) Feedback: “DTRC3 is the most important problem area. Only physical meetups are not enough. Think of annual 'get2gethers' where you can organize social events. Special (online) sessions for fun.”
    a) Change made: Added DTRS3a. Allocate time during meetings for social time AND DTRS3b. Hold team annual get-together events (team outings).
5) Feedback: “Under roles, perhaps under communication, need a solution for clarity of decision rights (perhaps using a DACI-Decide, Approve, Consult, Inform format)”
    a) Change made: Added DTRS4a. Create a Decider, Responsible, Accountable, Consulted, Informed (DRACI) Matrix.
6) Feedback: “Unclear Requirements is suspect. I think that the requirement paradigm has passed and the new paradigm is that these are decisions to be negotiated. Thus, the category is really unclear decisions/no closure and the solution is to make decisions concerning acceptance criteria and design clear in refinement and planning. Refinement should be an open forum to gain clarity & exit criteria should be the correct level of specificity and clarity necessary to build.”
    a) Change made: Changed “Unclear requirements” to “unprepared backlog”

The distributed member composition challenges and solutions part of the model was presented to the expert panel and feedback was collected. Figure 8 shows the challenges and solutions for each theme area as it applies to the distributed members’ composition.

Figure 8

Distributed Members Challenges and Solutions

DM. Distributed Members	
DMTC. Tools Challenges	**DMTS. Tools Solutions**
DMTC1. Unable to locate information	DMTS1a. Create a tool index page
DMTC2. Information overload	DMTS2a. Streamline tool choices
DMTC3. Inconsistent use of the tool	DMTS3a. Provide team with tools training
DMTC5. Security and corporate compliance	DMTS4a. Outline tools governance process
	DMTS4b. Use corporate approved tools
DMRC. Role Challenges	**DMRS. Role solutions**
DMRC1. Role confusion	DMRS1a. Train on role responsibilities
	DMRS1b. Assign people to dedicated roles
DMRC2. Delays in onboarding team members	DMRS2a. Pair onsite and remote team members
DMRC3. Time-zone differences (coordination)	DMRS3a. Agree to use a single time zone
	DMRS3b. Meet less frequently (alternate days)
	DMRS3c. Establish a remote working agreement
	DMRS3d. Enforce time zone overlap hours
	DMRS3e. Practice flexible schedule
DMRC4. Members are too passive during events	DMRS4a. Coach team members
	DMRS4b. Encourage safe and open retrospective discussions
	DMRS4c. Call on members to speak during events
DMRC5. Lack of remote collaboration	DMRS5a. Use synchronous and asynchronous collaboration
	DMRS5b. Have clear Product Backlog Item decomposition
DMRC6. Insufficient communication and sync up	DMRS6a. Use tools for frequent and casual communication
	DMRS6b. Enforce regular artifacts updating
	DMRS6c. Post information via group mail and WIKI boards
DMRC7. Low team cohesion	DMRS7a. Allocate time during meetings for social time
	DMRS7b. Have members travel to other team sites when possible
	DMRS7d. Create common goals (sprint goal)
DMEC. Event Challenges	**DMES. Event Solutions**
DMEC1. Longer event duration	DMES1a. Timebox events and decision
	DMES1b. Have members post information ahead of the event
	DMES1c. Send a custom agenda ahead of the each event
	DMES1d. Train and coach on the purpose of each event
DMEC2. Unable to attend from home	DMES2a. Improve home connectivity
	DMES2b. Offer flexible meeting times
DMEC3. Scheduling and missing members	DMES3a. Observe events' cadence
	DMES3b. Add virtual attendee options to all meeting invites
	DMES3c. Require members to check in via email or text message
	DMES3d. Make event attendance mandatory
DMEC4. Time-zone differences (coordination)	DMES4a. Hold shorter, more frequent events
	DMES4b. Have multiple instances of the same events
	DMES4c. Consolidate different events
	DMES4d. Record meetings for future reviewing
DMEC5. Cultural differences	DMES5a. Have members co-create a team working agreement
DMEC6. Lack of participation	DMES6a. Use video sharing
	DMES6b. Hold icebreaking segments
	DMES6c. Use breakout rooms
	DMES6d. Hold trust building retrospective exercises
	DMES6e. Call on participants by name
DMAC. Artifacts Challenges	**Artifacts Solutions**
	DMAS1a. Use whiteboarding tools to post artifacts
	DMAS1b. Screen-share artifacts during meetings
DMAC1. Low transparency	DMAS1c. Keep an artifacts reference WIKI page
	DMAS2a. Schedule Refinement meetings on cadence
	DMAS2b. Use of a digital Product Backlog management tool
	DMAS2c. Have SME reviews sessions
DMAC2. Unprepared product backlog	DMAS2e. Outline a Definition of Ready (DoR)
DMAC3. Outdated information	DMAS3a. Add artifact management to the working agreement
	DMAS3b. Inspect and remind to update during each event

The expert panel provided feedback based on the presented portion of the model. Subsequently, the researcher adjusted the model to incorporate the feedback. Following is a summary of the feedback provided by the expert panel and the changes made by the researcher to address the feedback relating to distributed members' composition:

Please select applicable answers as it applies to the Distributed Members' items and fill in the information if it applies to your selection?

a. “Items should remain as is” – One participant.
b. “Items should be modified” – Five participants.
c. “Blank” – Zero participants
d. Feedback: “Coaching, ongoing evaluation, and fast feedback are very valuable for addressing complex problems. Consider adding ongoing coaching, evaluation, and fast feedback mechanisms to all of the solutions. Given that humans are involved, I'd propose these additions are critical to allowing the other interventions to work effectively.”
    i. Change made: Added Coaching as a solution that applies to the four different themes.
e. Feedback: “Seems like cultural differences should fit in roles as these differences are about people rather than events. Under communication seems like there should be a solution concerning a communications plan to ensure people communicate the right thing to the right person at the right time.”
    i. Change made: Added “observe a communication agreement” but left cultural differences under the event's theme since the data showed that meetings are where cultural differences tend to manifest.
f. Feedback: "delays in onboarding" might be caused by a lack of clarity around the skills needed for a new team member.”

The hybrid team composition challenges and solutions part of the model was presented to the expert panel and feedback was collected. Figure 9 shows the challenges and solutions for each theme area as it applies to the hybrid teams’ composition.

Figure 9

Hybrid Teams Challenges and Solutions

HD. Hybrid Distribution	
HDTC. Tools Challenges	**HDTS. Tools Solutions**
HDTC1. Missing advanced tool features	HDTS1a. Define "must-have" requirements for tool evaluations
HDTC2. Lack of permissions and experience technical problems	HDTS2a. Assign a team member as a tool technical leader
HDRC. Role Challenges	**HDRS. Role solutions**
HDRC1. Subteams formations	HDRS1a. Provide constant communication venues
HDRC2. Lack of leadership support	HDRS2a. Train leaders in the Agile value and principles
HDRC3. Pressure to overcommit	HDRS3a. Establish Work In Progress (WIP) limits HDRS3b. Perform iteration capacity planning
HDEC. Event Challenges	**HDES. Event Solutions**
HDEC1. Lack of venue preparation	HDES1a. Include physical & virtual attendance information in the invite
HDEC2. Ineffective communication	HDES2a. Have a dedicated facilitator (SM) HDES2b. Use a shared room A/V system
HDEC3. Lack of engagement	HDES3a. Screen-share the artifacts during events
HDEC4. Frequent distractions	HDES4a. Use video sharing
HDEC5. Disengagement	HDES5a. Balance participation between onsite and remote members
HDEC6. Low retrospective outcomes	HDES6a. Create a safe place for physical and remote members
HDAC. Artifacts Challenges	**HDAS. Artifacts Solutions**
HDAC1. Lack of access	HDAS1a. Have enough tool licenses HDAS1b. Assign a tool support technical lead
HDAC2. Outdated duplicated artifacts	HDAS2a Only use digital artifacts

The expert panel provided feedback based on the presented portion of the model. As with the previous sections, the researcher made adjustments to the model to accommodate the feedback. Below is a summary of the feedback provided by the expert panel and the changes made by the researcher to address the feedback relating to hybrid teams' composition:

Please select applicable answers as it applies to the hybrid teams' items and fill in the information if it applies to your selection?

a. "Items should remain as is" – Three participants.

b. "Items should be modified" – Three participants.

c. "Blank" – Zero participants

d. Feedback: Under ineffective communication, the important part is how communication should take place. Not enough that we have a tool, how are we going to use it?

    i. Change made: rearranged the model into segments that grouped the four themes and identified their applicable composition for improved legibility.

Expert Panel Delphi Round Two Descriptive Characteristics and Analysis

The next step in the development of the distributed Agile team collaboration model was to refine the model based on the expert panel's first round of feedback and present it back to the expert panel for further validation. All six participants of the round one expert panel were invited to validate and to provide feedback on the revised model. The participants completed the survey with improvements and recommendations within two weeks.

The revised model was presented to the participants using Google forms. Refer to Appendix **F** for the survey used to validate the initial model. Once again, questions were asked to try to reach a consensus among the participating members of the Delphi expert panel. Close-ended questions such as "Do you think the model presented above provides a viable solution for remote Agile collaboration challenges?" were asked to determine the level of agreement among participants. The participants were also asked if the model should be modified and were asked open-ended questions to collect additional feedback if they selected yes to modify the model.

In addition to the changes outlined in the previous data analysis section, this revised model consolidated the different compositions into three columns and created a single table divided into the main four themes that outlined the challenge and solutions relating to tools, roles, events, and artifacts. The applicable challenges for each team composition were selected based on the number of responses for each challenge. Response counts below 15% were considered to be too low and were not considered relevant. Counts of 15% or greater were considered relevant to the composition.

Refer to Figure 10 for the Revised Distributed Agile Team Collaboration Model presented to the participants of the expert panel round two of the validation processes.

Figure 10

Revised Distributed Agile Team Collaboration Model

Distributed Teams	Distributed members	Hybrid	Distributed Agile Collaboration Model	
			TC. Tool Challenges	**TS. Tool Solutions**
		●	TC1. Lack of corporate security and compli	TS1a. Outline tool governance process TS1b. Use of corporate approved tools
	●	●	TC2. Inconsistent use of tool features	TS2a. Provide team with tool training
●		●	TC3. Sporadic tool adaption	TS3a. Establish a tool governance board
●	●	●	TC4. Low tool efficacy	TS4a. Train on how to use tools TS4b. Coach on how to use the tool TS4c. Share screens to demonstrate tool use
●	●		TC5. Unable to locate information	TS5a. Create a tool index page
●	●		TC6. Information overload	TS6a. Streamline tool choices
●	●	●	TC7. Missing advanced tool features	TS7a. Define "must-have" requirements for tool evaluations
	●	●	TC8. Access and technical problems	TS8a. Assign a team member as a tool technical leader
			RC. Role Challenges	**RS. Role solutions**
●	●	●	RC1. Low team cohesion	RS1a. Start events earlier to allow for social time to take place RS1b. Schedule dedicated virtual social events RS1c. Hold periodic physical team get together events (team outings) RS1d. Have members travel to other team sites when possible RS1e. Have team "Ambassadors" travel between sites RS1f. Create common goals (Sprint Goal)
●		●	RC2. Time zone misalignment	RS2a. Agree to observe a single time zone RS2b. Hold a daily Scrum of Scrums meeting at a neutral time RS2c. Meet less frequently (alternate days) RS2d. Establish a remote working agreement RS2e. Enforce time zone overlapping hours RS2f. Practice flexible work schedule
●	●	●	RC3. Infrequent communication	RS3a. Use synchronous and asynchronous tools for frequent and casual communication RS3b. Hold a daily Scrum of Scrums meeting RS3c. Enforce regular artifacts updating RS3d. Post information via group e-mail and WIKI boards RS3e. Encourage members to speak during events
	●	●	RC4. Interruptions due to urgent requests	RS4a. Add interrupt buffer to sprint capacity for urgent requests
●	●	●	RC5. Overlapping roles	RS5a. Create a Decider, Responsible, Accountable, Consulted, Informed (DARCI) Matrix RS5b. Coach on the expectations of each Agile role
●	●	●	RC6. Role confusion	RS6a. Train on role responsibilities RS6b. Assign people to dedicated roles
	●	●	RC7. Delays in onboarding team members	RS7a. Pair onsite and remote team members RS7b. Outline onboarding process RS7c. Create a training material library
●	●	●	RC8. Passive members during events	RS8a. Coach team members RS8b. Encourage safe and open retrospective discussions RS8c. Call on members to speak during events
●	●	●	RC9. Subteams formations	RS9a. Provide venues for constant communication
●	●	●	RC10. Lack of leadership support	RS10a. Train leaders in the Agile value and principles RS10b. Hire Agile-like minded people that uphold the Agile values
	●	●	RC11. Pressure to overcommit	RS11a. Establish Work In Progress (WIP) limits RS11b. Perform iteration capacity planning RS11c. Train the teams and stakeholders on the Agile values RS11e. Build trust through reliable iterative delivery

Distributed Agile Collaboration Model

Distributed Teams	Distributed members	Hybrid	EC. Event Challenges	ES. Event Solutions
●		●	EC1. Difficult time zone coordination	ES1a. Choose a standard time zone ES1b. Use asynchronous communication tools ES1c. Post information ahead of meetings ES1d. Have shorter, more frequent meetings ES1e. Consolidate events ES1f. Find common times in the different time zones ES1g. Record meetings for future reviewing ES1h. Have multiple instances of the same events
●	●	●	EC2. Low engagement	ES2a. Encourage participants to share video in meetings ES2b. Have dedicated A/V or video capable PC at every site ES2c. Keep a permanent virtual room open ES2d. Start with an icebreaker activity ES2e. Use breakout rooms for more focused discussions ES2f. Hold trust building retrospective exercises ES2g. Call on participants by name ES2h. Screenshare the artifacts during events ES2i. Balance participation between onsite and remote members ES2j. Practice remote equality by observing other time zones
			EC3. Language barrier	ES3a. Post information ahead of meeting ES3b. Use breakout rooms
	●	●	EC4. Out of scope conversations	ES4a. Send a custom agenda ahead of each event ES4b. Train and coach on the purpose of each event
●	●	●	EC5. Longer event duration	ES5a. Timebox events and discussions ES5b. Have members post information ahead of the event ES5c. Send a custom agenda ahead of the each event ES5d. Train and coach on the purpose of each event
	●	●	EC6. Missing team members and stakehold	ES6a. Schedule events on cadence (predictability) ES6b. Add virtual meeting link to all invites ES6c. Make event attendance mandatory ES6d. Require absentee members to check in via email or text message
			EC7. Conflict due to lack of cultural underst	ES7a. Train team members on cultural awareness ES7b. Have members co-create a team working agreement
●	●	●	EC8. Unclear event logistics	ES8a. Include physical & virtual attendance information in the invite
●	●	●	EC9. Ineffective communication	ES9a. Have a dedicated facilitator (SM) ES9b. Use a shared room A/V system
	●	●	EC10. Low retrospective outcomes	ES10a. Create a safe phycological environment for physical and
	●	●	EC11. Lack of common understanding	ES11a. Hold open discussion sessions ES11b. Share meeting agenda ahead of each event
●	●	●	EC12. Delayed Decisions	ES12a. Identify mandatory attendees ahead of the event ES12b. Create a Decider, Responsible, Accountable, Consulted, Informed (DRACI) Matrix ES12c. Hold anonymous voting sessions to reach consensus during
			EC13. Overbearing participants	CT13a. Use a virtual "talking stick" during meetings to facilitate discussions
●	●	●	EC14. Difficulty performing team brainstormi	CT14a. Use real-time whiteboarding collaboration tools
			AC. Artifact Challenges	**AS. Artifact Solutions**
●	●	●	AC1. Lack of artifact visibility	AS1a. Purchase enterprise licenses for tools AS1b. Use whiteboarding tools to post artifacts AS1c. Screen-share artifacts during meetings AS1d. Keep an artifacts WIKI page
	●	●	AC2. Unprepared product backlog	AS2a. Schedule Refinement meetings on cadence AS2b. Use of a digital Product Backlog management tool AS2c. Have SME reviews sessions AS2e. Outline a Definition of Ready (DoR) AS2f. Reduce dependencies between backlog items
●	●	●	AC3. Outdated information	AS3a. Have a proxy artifact owner AS3b. Add artifact management expectations to the working agreement AS3c. Inspect and remind to update during each event
●		●	AC4. Lack of access to artifacts	AS4a. Have enough artifact tool licenses AS4b. Assign an artifact support technical lead AS4c. Only use digital artifacts

In this round, when asked, “Do you think the model panels presented above provide a viable solution for remote Agile collaboration challenges?” 100% of the participants answered “yes.” This indicated that the expert panel reached a consensus and the model had been completed.

Summary

The goal was to identify the needs, challenges, and solutions applicable to the distinct types of remote Agile team compositions to create a distributed Agile team collaboration model that could assist different types of distributed compositions. The three types of distribution included distributed teams, distributed members, and hybrid teams. A needs assessments survey was designed and administered to 222 practitioners with experience working in distributed Agile environments. A total of 53 practitioners responded. The participants were professionals working in various Agile roles in large and small companies from around the world. Next, a model was created based on the analysis of the data resulting from the needs assessments survey. Analysis of the data revealed four main themes as areas of challenges for different compositions: tools, roles, events, and artifacts.

The model was then iteratively refined and internally validated through two expert panel Delphi rounds. The consensus was reached after two separate expert panel Delphi rounds. The final model is presented in Figure 10.

Chapter 5

Conclusions, Implications, Recommendations, and Summary

The purpose of this study was to construct and internally validate a model for the effective collaboration of distributed Agile teams. The study was guided by the DSR approach, which was implemented in three phases. The researcher captured the needs, challenges, and solutions of Agile practitioners that must be considered when working in different distributed Agile team compositions to support collaboration when working in a remote Agile setting. The study also included the application of qualitative methods to identify the needs of the participants along with the solutions they apply to meet the needs when working with the different Distributed Agile compositions.

The results of the data analysis enabled the researcher to draw conclusions and guided the creation of a model for the effective collaboration of distributed Agile teams. This model was also reviewed and validated internally by a subset of study participants, providing a final model that could be used by organizations to improve their distributed Agile collaboration. Chapter 5 presents conclusions, implications, and recommendations for future research and application. The chapter concludes with a summary of the research study.

Conclusions

Hossain et al. (2009) performed a literature review and created a model that categorized the risks associated with using Scrum in a distributed environment. The researchers identified the lack of synchronization, awareness, communication bandwidth, tool support, collaborative office

environment, large project personnel, and an increased number of sites as the main risks (Hossain, Babar, Paik, et al., 2009). This study validated that distributed Agile teams are impacted by a lack of synchronous communication and use different solutions to address the challenge. It also validated that project awareness is a challenge due to the low information radiation in a distributed environment where distributed teams have to find creative ways to maintain and radiate artifacts containing key information updates. The office environment, personnel, and multiple site considerations were also observed as the different team compositions played a role in how distributed teams collaborated and the different challenges they faced. This study also aligned with Shrivastava and Rathod's (2017) findings, who advocated for fostering team collaboration by using rich communication media like video conferencing, web conferencing, and other collaboration tools.

Olson and Olson (2000) researched the factors that make working across distances difficult. Olson and Olson identified common ground, the coupling of work, collaboration readiness, and collaboration technology readiness as the key concepts that influence successful collaboration in distributed environments. This study further substantiates Olson and Olson’s findings concerning distributed Agile teams. Effective distributed team collaboration requires remote worker equality, or common ground, for team members to be effective collaborators. In addition, distributed Agile teams need shorter and more frequent meetings to support coupling work. Last, distributed Agile teams must ensure that they exercise tools, or technology readiness, and maintain the competency to collaborate successfully.

The findings also supported Sharp and Robinson’s (2008) conclusion that digital tools hide information and therefore make it difficult to create information radiators. The preferred

technology used by teams to radiate information between two or more sites included the use of whiteboarding tools such as Miro, as well as digital project management tools such as Jira. The use of these tools combined with video conferencing tools such as Zoom provided distributed teams and members with technology comparable to the dBoard created by Esbensen et al. (2015) while allowing other team members to gain access without the need for additional technology. The rest of the conclusions of this study are organized by the research questions and their respective results.

Research Question 1: *What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?*

The inputs to answer this research question included the identification of the problem, a literature review, and the researcher's relevant knowledge and expertise with Agile practices. The problem is that distributed or non-colocated Agile development is difficult to implement and currently available Agile practices are not aligned with distributed environments. This problem is further complicated by the fact that Distributed Agile is composed of two main types of team composition. These include distributed development team members and distributed teams. There are also implementations where both types of composition are used and are referred to as hybrid distribution. These implementations introduced different roles and practices to accommodate these needs of the different compositions.

Different studies have proposed frameworks and models to improve the performance of distributed Agile teams. For example, Shrivastava and Rathod (2017) and Hossain et al. (2009) created risk management frameworks for distributed teams. However, these studies focused on risks and did not consider the different types of distributed Agile compositions. Shrivastava and

Rathod found a substantial number of risks due to contradictions between distributed development and Agile practices.

The literature review demonstrated that distributed Agile teams are affected by trust, cultural, knowledge transfer, communication, coordination, communication, personnel, time zone differences, knowledge management, lack of team control, lack of synchronization, lower awareness, teambuilding hindrance, language barriers, low collaboration readiness, lack of organizational management support, and no common ground. The literature review also included considerations from the various methodologies available to the practitioners. Lean thinking has informed manufacturing since the 50s, but its practices are not easily generalized for the adoption of distributed Agile teams. Six Sigma emphasizes the process approach and ignores the people aspect that is an important component of Agile development. Lean Six Sigma merges the people aspect of Lean with the process-oriented Six Sigma. Lean Six Sigma, however, tends to create a divide in the organization. Since cross-functional team collaboration is an essential part of Agile, the Lean Six Sigma hybrid framework is not a good fit to address distributed Agile challenges. Other considerations include the Waterfall Model. The Waterfall Model, however, is considered inflexible because it lacks an incremental approach. This approach is at odds with Agile software development, which emphasizes iterative and incremental development to reduce risk. The Spiral approach gets closer to Agile by adding iterations to the process. The Spiral iterations, however, are executed in sequence to produce one large project deliverable. This is a contrast to Agile development, where each iteration is expected to deliver incremental value at the end of each iteration.

Scrum is the most popular Agile framework used today. Scrum, however, is silent on the practices and techniques necessary for the different distributed agile compositions to collaborate effectively. Other frameworks such as SAFe, LeSS, Scrum at Scale, and DaD also offer little guidance on the best practices and techniques for distributed teams. Other attempts have been made to address the challenges with distributed Agile, such as Scrum +, which defines activities, tasks, roles, and criteria in a distributed environment. These enhanced frameworks, however, do not address the diverse types of team compositions. Therefore, practitioners have adapted their own processes and techniques to address the challenges associated with distributed Agile collaboration.

Research Question 2: *What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?*

A needs assessment was conducted to determine the needs of practitioners collaborating with distributed Agile teams. A Google survey was used to collect the data. The survey results indicated that different team compositions experienced different problems and implemented different solutions to address them. Based on the results of the data, it was also clear that participants faced collaboration challenges when working with distributed Agile tools, roles, events, and artifacts. These elements needed to be addressed for the successful collaboration of distributed Agile teams.

Distributed Agile requires a balance between oversight and self-organization. The need for this balance was more pronounced when considering the tools used to collaborate, where the most common tool need for the distributed member composition was tool alignment. This included challenges such as inconsistent tool adoption by different team sites. Streamlining the

choice of tools, where fewer choices, instead of more, proved to be advantageous for distributed team collaboration. Special attention, however, should be paid to the tools that are chosen based on factors such as functionality, security, and efficacy. Low tool efficacy proved to be an area of challenges that were coupled with technical problems often experienced by distributed members and hybrid teams. These needs were supported by comments such as “Members are not all aware of the tool collaboration features and causing unnecessary mass emailing.” These challenges were often solved through training, coaching, and establishing a Tool Administrator role to assist the team with technical problems. These tools-related challenges point to the need for a role or board that focuses on tool governance, training, and support.

Lack of leadership support proved to be a key challenge for the distributed team member composition, where managers micromanaged distributed team members and exhibited command-and-control behaviors that are counter to the self-organizing mindset that distinguishes Agile development. This composition has a need for leadership coaching that teaches and reinforces the self-organizing nature of Agile.

A consistent role-related need across the different team compositions was associated with time zone misalignment. These challenges were often addressed through a common team agreement that included rules such as overlapping working hours and how the various synchronous and asynchronous tools would be used to improve communication. Thus, distributed Agile teams also have a need for a team working Agreement that covers time zone handling and tool communication methods.

The teams also faced event-related challenges. These challenges can be grouped into areas relating to low engagement during a team meeting that included low attendance, time zone

misalignment, and ineffective communication. Low engagement was particularly pronounced in hybrid team compositions where at least one team member is remote and other members are colocated. Participants reference the lack of equality that is often present in hybrid team composition as a root cause and commented that the recent quarantine brought by the Covid-19 pandemic forced teams into a distributed member composition. The quarantine created common ground and equality between colocated and remote team members where one participant commented:

"A success factor has been that due to Covid-19, everybody now works remote and online, so everybody is in the same situation, that has created a new common ground where team members experience more remote equality."

It was also clear that the use of tools to collaborate proved to be a necessity for all team compositions. Teams made use of tools for synchronous and asynchronous communication. Advanced collaboration tools' features such as meeting recordings were also used to overcome time zone challenges, where teams would record meetings and share them with members that could not attend due to time zone differences. New tool adoption to improve remote collaboration included the use of real-time whiteboarding tools to facilitate brainstorming and information sharing. Finally, the format of the events was often changed to hold shorter and more frequent meetings to accommodate different time zones and engagement.

Relating to artifact-related challenges, having a structured agreement governing the use of the artifacts was necessary for effective distributed agile collaboration.

Finding, accessing, and maintaining up-to-date artifacts was a key challenge faced by all three compositions. All teams concluded that having enough software licenses to access and use

digital tools to host and maintain the artifacts, instead of having a physical board or a combination of both, was a more effective way of collaborating. Establishing a source of truth and having a team working agreement to update them in near-real-time proved to be a solution that helped all three compositions to collaborate more effectively.

Furthermore, the access and maintenance of the product backlog artifact was an area where distributed members were challenged. Thus, ensuring that distributed members have access to the product is critical to successful collaboration for distributed members, as communicated by a participant who stated, "Keeping the product backlog ready for the next sprint is a challenge." The challenge for distributed teams to have a refined product backlog may also be due to the product backlog refinement not being an official event in Scrum and tends to happen as a casual collaboration activity. These casual encounters are more likely to occur in a colocated environment, while remote collaboration requires a scheduled approach to get the team together and collaborate on refining the product backlog. Thus, treating product backlog refinement as an event that occurs on a scheduled and regular basis might be necessary for distributed members as stated by a participant:

"Sessions have been set up in advance and it pushes the product owner to ensure the stories are logged on JIRA and they have gone through the necessary technical architects."

Research Question 3: *How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?*

The models and frameworks related to distributed Agile teams found in the literature focused on specific use cases such as outsourcing and did not address the needs of the different

distributed compositions. Therefore, an initial model was constructed with input from the literature review as well as the needs assessment survey. The needs assessment consisted of 53 participants and helped to identify the needs that were specific to each type of distributed composition. It also helped to identify the common solutions used to address the challenges. The data analysis surfaced four main challenge areas that required to be addressed by the model. These areas included the tools, roles, events, and artifacts used by distributed teams. Thus, the four main areas, combined with the top challenges and solutions as experience by the different distributed Agile compositions gave way for the design of the model.

The model was presented to an expert panel composed of six participants and used the Delphi method to obtain feedback and reach consensus. Five out of the six expert panel participants agreed that the model provided a viable solution for remote Agile collaboration challenges, while one participant did not answer the question. Additional feedback was provided by the expert panel participants and used to revise the model. As a result of the expert feedback, some of the terms were either deleted or modified to make them consistent with present practices. In addition, the headers and rendering of the model were modified from a graph to a table list to accommodate feedback included in the respondents' comments.

Research Question 4: *What modifications are needed to improve the proposed model?*

The researcher addressed the feedback and simplified the model to delineate the challenges and solutions faced by the distributed composition as per the four major areas of challenge as shown in **Figure *10***. The revised model helped to reach consensus in a second Delphi round composed of four expert participants, where all four participants answered yes to the question "Do you think the model panels presented above provide a viable solution for

remote Agile collaboration challenges?" This confirmed that the expert panel had reached a consensus and the model had been internally validated.

Implications

This study helped to identify the needs faced by practitioners using Agile development in a distributed environment. The literature review, needs assessment, and expert Delphi panel guided the creation of a model outlining the categories where distributed Agile implementations are impacted. The model listed the challenges and solutions faced by the different types of distributed Agile team compositions. Given the growth of remote workers and distributed Agile, this model can guide and help to improve how distributed teams collaborate in a remote setting. This model provides a way to easily navigate the solutions that can be used by Agile practitioners and organizations who are considering or are working in an Agile environment using remote workers or globally distributed teams. When asked if the model should include the challenges and solutions' percentage of occurrence for each team composition one expert panelist commented "no, I like the simplicity of the model. This makes it very easy to use."

Furthermore, COVID-19 forced many organizations to adopt telecommuting practices for all of their staff. This made organizations using Agile, a distributed member organization overnight. Organizations can use this model to identify their challenge areas and to put in place solutions that can address them. It is also expected that organizations will also support a hybrid telecommuting schedule as employees can return to the office. The hybrid schedule allows employees to work from home a few days of the week and go into the office the rest of the time. For organizations practicing Agile, this would make them a hybrid composition Agile

organization. The proposed model that resulted from this study can help guide these organizations as they adopt a new form of hybrid work.

This study also furthered the understanding of Agile teams and their behaviors. It provided insight into how agile teams tend to collaborate and adopt practices to accommodate their needs. These practices included how they use tools to collaborate, the different roles and responsibilities that are shared among team members, the events and meetings held by the teams, and the artifacts used to share information in a distributed environment.

Last, this study contributed to the DSR body of knowledge and its applicability in IS. DSR methods were used to identify the needs of distributed Agile teams and create an artifact in the form of a model that helped to solve an organizational problem. It consolidated recommended steps of DSR and DSRM to construct and internally validate an artifact in the form of a model for the effective collaboration of distributed Agile teams. A Design Science Research (DSR) approach was implemented in three phases. First, a preliminary model was constructed based on a review of the literature and the researcher's experience and expertise in Agile methods. Second, a needs assessment was conducted with relevant stakeholders to further develop the model. Third, the model was updated based on the survey results and validated internally using the Delphi Method.

Recommendations

The recommendations are presented in two sections. The first section makes recommendations regarding future research. The second part makes recommendations regarding the future implementation of the model.

Future Research

This study focused on the creation and internal validation of a model for the effective collaboration of distributed Agile teams. Thus, the model was not externally validated and is not currently generalizable. Future studies should externally validate the model before it can be considered generalizable.

The implementation and external validation of the model can be a future study in itself. Each challenge area can also be further explored to expand and update the list of challenges and solutions. For example, the list of tools and how these tools are used by distributed teams is likely to change as new tools become available. Future studies can explore how the use of these new tools influence distributed Agile teams' collaboration and expand the model.

Other research can also explore how teams' collaboration changes as Agile teams transition from one composition to another. For example, Agile teams that are using an all-distributed team member composition might start to use a hybrid composition as some team members return to work in the office while others remain at home. A longitudinal study can explore the effectiveness and efficiencies of the model as the same teams transition in and out of different composition types.

Last, additional studies can expand the list of challenges and solutions associated with each composition type. This study used 53 participants for its needs assessments. A larger sample may reveal additional needs in the form of new challenges. The same study can explore the common practices used by distributed teams to address these challenges and expand the model.

Implementation Recommendations

The model was designed to allow organizations and practitioners to use any part of the model independently. The teams implementing the model may choose which area is most beneficial to them depending on their specific challenges and composition. The recommended approach to implement the model is presented in the following five steps.

Step 1: Identify the team's composition type. The team should first agree on the type of composition that applies to them. For example, a team might currently be in a colocated environment but is planning to hire new remote team members. This would make the team a hybrid distributed team from that point forward. Plans related to challenges and solutions in the model should then be evaluated based on how they apply to a hybrid distributed composition. Therefore, the team should first align on distributed composition that applies to them.

Step 2: Determine the team's challenges. Distributed teams should first determine which areas and challenges listed in the model are impacting them the most as per their team composition. This will allow them to create a plan that prioritizes the most egregious challenges first. For example, a hybrid composition team might be struggling with how to collaborate using tools and determine that frequent technical problems are one of the most frequent challenges they face. If so, the team should prioritize solving this challenge first. The team should then repeat the process to find the subsequent challenges and create a prioritized list of challenges to address.

Step 3: Identify the solutions. The model lists the most common solutions used to address the challenges. The team members should find the solutions associated with the challenges

and agree on which ones they would like to implement to address the highest impacting challenges first.

Step 4: Create a solution implementation plan. The team should create a list that combines the challenges and agreed on the solutions to address them. A target date can be set to implement each solution and a plan on how to implement the solutions should be discussed. For example, if an agreed solution were to create a tools technical leader role, the team should set a plan to work with the rest of the organization to identify the individual, the operating process, and implementation dates.

Step 5: Inspect and adapt. The team should monitor the progress it is making as it implements the different solutions. The progress can be measured by reassessing the teams' challenges and comparing them to the original list of challenges. This would allow the team to discuss alternative solutions depending on how they progress.

Below is a hypothetical example to demonstrate how the model can be used by a Scrum team to improve distributed collaboration. The researcher has chosen the name Transformers for this hypothetical team:

The Blazers are practicing Scrum and had all team members working out of the same office in Seattle until last month when management decided to hire two new developers, one developer located in Austin and the other in India. The Blazers began losing productivity shortly after and members are complaining that it has become difficult to collaborate with the rest of the Scrum team. The Scrum Master uses the proposed model to identify that they are now a hybrid composition because they have two remote team members while the rest of the team is collocated. The Scrum Master holds a retrospective Scrum event attended by all Blazer

members. By going through the challenges listed in the model for hybrid teams, the members of the Scrum team vote on the items that are affecting them the most. They determine that their biggest challenge is the outdated information in the Sprint backlog. Because remote team members are not able to move physical stickies in the Sprint board, they are not able to update the status of the backlog items as they complete tasks. This is leading to a list of tasks on the wall that is not reflecting their current state. To address the challenge, they decide to follow the solution recommended in the model, which is to only use digital artifacts, and layout a plan to convert their physical board to a digital board for their product backlog management. They decide to adopt Jira as their backlog management tool and set a target to roll out Jira by the end of the next Sprint. They roll out the tool and outline a process to use the tool. Once the tool has been implemented, the Scrum Master will perform a similar retrospective event to determine if the challenge has been mitigated and to identify the next biggest challenge that might be affecting the team and repeat the process.

Summary

The goal of this study was to construct and validate internally a model to aid in the effective collaboration of distributed Agile teams. External validation of the model was out of scope for this study and has been suggested as part of a future study. The study used DSR to create the artifact and expand on its application per Hevner et al., 2004 and Peffers et al., 2007.

The following four research questions guided this investigation.

RQ1: What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?

RQ2: What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?

RQ3: How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?

RQ4: What modifications are needed to improve the proposed model?

Guided by DSR methodologies, this study was performed in three phases:

Phase 1: Preliminary Model Construction

The first phase was to understand the resources available to Agile practitioners and to design the preliminary model. This phase helped to answer research question 1: *What guidance is currently available for use by distributed Agile teams to facilitate effective collaboration?* The inputs for this phase included the identification of a relevant problem, definition of the research goal and research questions, and a literature review, along with the researcher's relevant knowledge and expertise with Agile practices. The output of this phase was the construction of a preliminary model and a needs assessment survey.

Phase 2: Needs Assessment

The second phase conducted a needs assessment of stakeholders. This phase helped to answer research question 2: *What needs to be considered to design a model that can be used to facilitate effective collaboration among distributed Agile teams?* The needs assessment survey was conducted using Google Forms and administered to a group of Agile practitioners through the researcher's contacts on LinkedIn. Descriptive statistics were used to analyze the survey results and thematic analysis was be used to analyze the qualitative survey results of the needs assessment survey. The results of the analysis were then used to revise the preliminary model.

Phase 3: Model Internal Validation

The third phase was the model validation. This phase helped to answer research question 3: *How do potential stakeholders (e.g., managers and team members) of the proposed model perceive its effectiveness in collaboration among distributed Agile teams?* and research question 4: *What modifications are needed to improve the proposed model?* The internal validation of the model was conducted using an expert panel and administered using the Delphi method. Two Delphi rounds were conducted with the expert panel to collect feedback, perform modifications of the model, and reach panel consensus to obtain internal validation. Guided by Richey and Klein's (2007) recommendations for internal validation, the questions that were addressed in this phase included:

1) Are there any steps, phases, or elements that are missing from the model?
2) Are there any steps, phases, or elements in the model that are not necessary?
3) To what extent does the model address relevant environmental factors?
4) To what extent is the model usable for a wide range of agile projects and settings?
5) Can the model be implemented efficiently under most working conditions?
6) Is the use of the model cost-effective?

To address the needs of distributed Agile collaboration, the researcher created the model to help Agile practitioners and managers identify the challenges and solutions associated with the three primary types of Agile distribution. These forms of distribution included distributed teams, distributed team members, and hybrid compositions. Furthermore, the model was divided into

four main categories: tools, roles, events, and artifacts. Last, the model identified the collaboration challenges and solutions relating to each composition type.

The final distributed Agile collaboration model was designed to help Agile practitioners and managers working in a distributed environment to collaborate effectively. The model was designed to be applied as per the needs of the distributed Agile teams' using the model. Therefore, a five-step implementation process was recommended for teams to use the model: 1) Identify the team's composition type, 2) Select and prioritize the challenges affecting the team, 3) Identify the applicable solutions included in the model, 4) Create a solution implementation plan, 5) Inspect the impact the solution is having and adapt according to the observations.

Appendix A

Researcher's Stance

I have over 25 years of experience working in the IT field. My past roles include Engineering Manager, Product Manager, Software Development Manager, Business Development Manager, Project Management, Agile Coach, and Agile Trainer. I have worked in startups and Fortune 500 Companies to drive Agile software development transformations and manage geographically dispersed teams. These initiatives included directing departments to change from using a Waterfall project methodology to use Agile development frameworks that included Scrum, Kanban, Scrumban, XP, and SAFe. In this capacity, I have worked with Vice President-level executives, product managers, engineering teams, and business units to design, roadmap, and create IS solutions using Agile frameworks. I have also trained over 1,000 students in public professional classes on the use of different Agile frameworks.

My current professional certifications include:

1) Licensed Scrum Master Trainer (LSMT) from Scrum Inc.
2) Certified Scrum@Scale Trainer (CS@T) from Scrum@Scale
3) Certified Scrum@Scale Practitioner (CS@SP) from Scrum@Scale
4) Certified SAFe® Program Consultants (SPCs) from Scaled Agile Inc.
5) Certified Scrum Professional – Scrum Master (CSP-SM) from The Scrum Alliance
6) Certified Scrum Professional – Product Owner (CSP-PO) from The Scrum Alliance
7) Certified ScrumMaster (CSM) from The Scrum Alliance
8) Certified Scrum Product Owner (CSPO) from The Scrum Alliance

9) Project Manager Professional (PMP) from The Project Management Institute (PMI)

I understand the challenges of working remotely in an Agile team. However, I lack the understanding of a structured framework that can assist with the challenges faced by distributed team members. I want to understand more about what Agile practitioners experience in distributed environments, how their collaboration with distant co-workers can be enhanced, and how they can adapt common Agile practices to a distributed environment. Through this research, I would like to bring clarity to those experiencing similar difficulties.

Appendix B

Participants' Recruitment Invitation

Invitation to participate in the research project titled: "The Construction and Internal Validation of a Model for the Effective Collaboration of Distributed Agile Teams"

Dear [Agile Practitioner Name],

I am a doctoral candidate in Information Systems at Nova Southeastern University. My dissertation chair is Dr. Martha M. Snyder. I am conducting a survey as part of a research study to increase our understanding of how distributed Agile teams collaborate. As an Agile practitioner who has worked in a distributed team, you are in an ideal position to give us valuable firsthand information from your perspective.

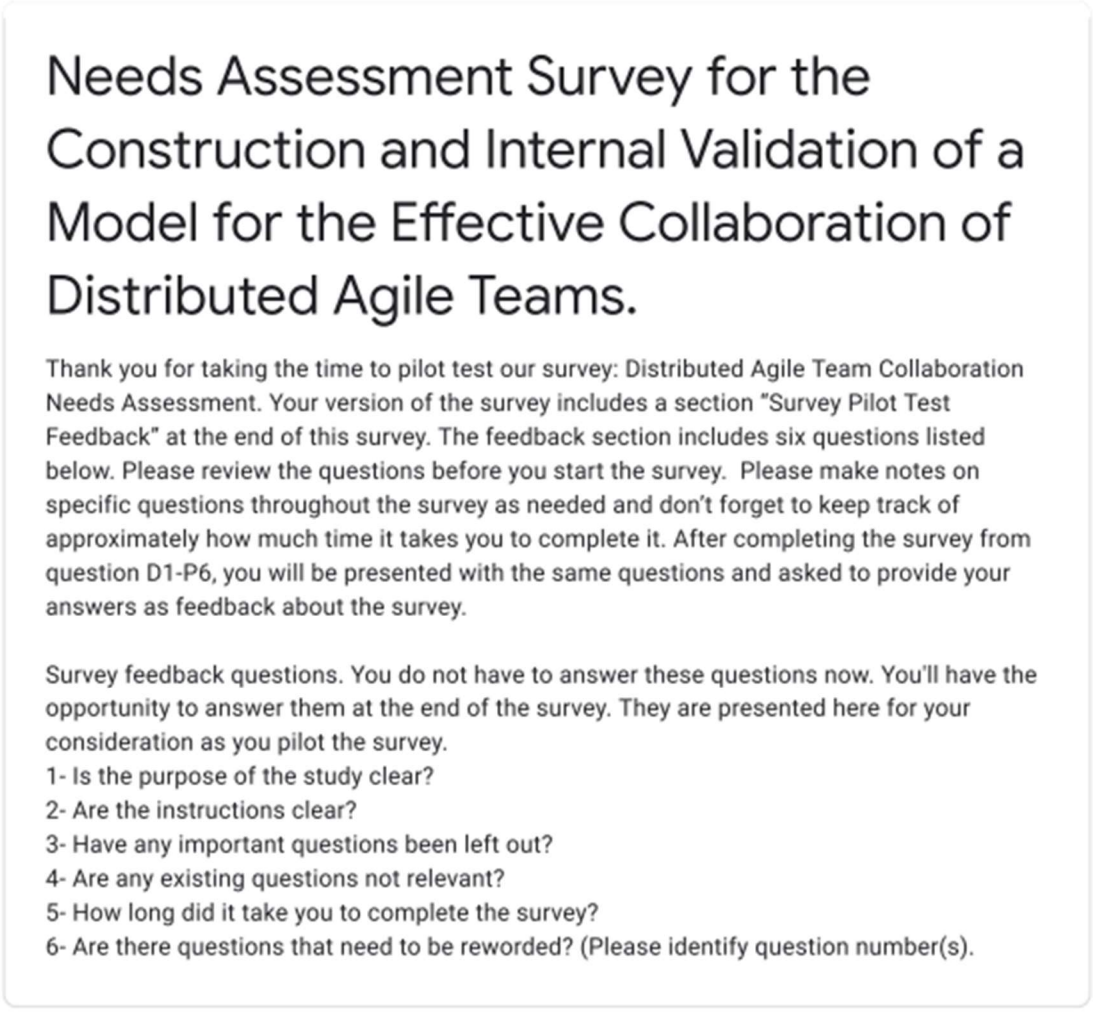
The survey takes around 20 minutes to complete. My goal is to capture your thoughts and perspectives on being a part of a distributed Agile team. Your responses to the questions will be kept confidential. Each survey will be assigned a number code to help ensure that personal identifiers are not revealed during the analysis and write-up of the findings.

There is no compensation for participating in this study. However, your participation will be a valuable addition to our research and findings which could lead to a model that can be used to improve remote collaboration among distributed Agile teams and provide a greater public understanding of how distribution affects collaboration. It is anticipated that results will also be helpful for researchers who have an interest in distributed Agile team collaboration.

If you are willing to participate, please click the link below to fill out the survey. If you have any questions, please do not hesitate to contact me via LinkedIn or by emailing me at ec656@mynsu.nova.edu. Survey Link: https://forms.gle/Ruucc938A884cMyGA

Appendix C

Needs Assessment Survey



Needs Assessment Survey for the Construction and Internal Validation of a Model for the Effective Collaboration of Distributed Agile Teams.

Thank you for taking the time to pilot test our survey: Distributed Agile Team Collaboration Needs Assessment. Your version of the survey includes a section "Survey Pilot Test Feedback" at the end of this survey. The feedback section includes six questions listed below. Please review the questions before you start the survey. Please make notes on specific questions throughout the survey as needed and don't forget to keep track of approximately how much time it takes you to complete it. After completing the survey from question D1-P6, you will be presented with the same questions and asked to provide your answers as feedback about the survey.

Survey feedback questions. You do not have to answer these questions now. You'll have the opportunity to answer them at the end of the survey. They are presented here for your consideration as you pilot the survey.

1- Is the purpose of the study clear?
2- Are the instructions clear?
3- Have any important questions been left out?
4- Are any existing questions not relevant?
5- How long did it take you to complete the survey?
6- Are there questions that need to be reworded? (Please identify question number(s).

Research Consent

Thank you for agreeing to participate in this research study. This page outlines the purposes of the study, provides a description of your involvement, and outlines your rights as a participant. This research study is monitored by Nova Southeastern University IRB (IRB #2020-315) for research compliance. This survey should take approximately 15-20 minutes to complete.

The purposes of this questionnaire are to:
•Identify needs relating to the effective collaboration of distributed Agile teams.
•Determine what elements need to be included in a model used to guide decisions made regarding the effective collaboration of distributed Agile teams.

The following conditions will be met:
•Your participation in this research is voluntary; you have the right to withdraw at any point of the study, for any reason, and without any prejudice.
•The information you submit will be stored securely; however, the data may not be transmitted securely due to keylogging and other spyware technology that may exist on the computer used for submission.
•You will not be compensated for your participation.
•Your responses will remain anonymous and used in the aggregate for research reporting.

Risks and Benefits
There is a minimal risk that the security of any online data may be breached, but the survey host, Google Forms, uses strong encryption and other data security methods to protect your information. Only the researchers will have access to your information. No identifying information will be collected or connected with your responses, which will be anonymous. The only identifying information will be your name and contact information should you decide to participate in a follow-up interview. However, if you choose to participate in the interview, no identifying information will be captured or reported. The benefits of this study should provide the Agile practitioner community useful information about the unique needs of distributed agile teams and what they need to collaborate effectively. This information will be used to develop a model that can be used with existing Agile frameworks to offer guidance on practices to implement Agile in non-collocated environments and the practices and techniques for effective collaboration, and how distributed teams and distributed individuals can overcome the technical or social challenges associated with the distance that separates them.

Whom to contact if you have a question about the study:
•Ernesto Custodio, Doctoral Student at Nova Southeastern University ec656@mynsu.nova.edu or (954) 632-2800
•Martha M. Snyder, Ph.D., Dissertation Chair at smithmt@nova.edu or (954) 262-2074.

The survey will remain open until [date here].

Whom to contact about your rights as a research participant in the study:
[NSU IRB information here.]

Demographic Information

Please tell us about you and your current organization. If you are not currently a part of an organization, please tell us about the last organization where you were a member of an Agile team.

D1: What is your current city and country of residence?

Your answer

D2: How long have you been an Agile practitioner?

Choose

D3: How many employees does your organization have?

Choose

D4: How many office locations does your company have?

Choose

AGILE TEAM COMPOSITION

Please base your answers on your current Agile team. If you are not currently working in an Agile team, please answer the questions based on the last Agile team you worked on.

T1: What Agile framework or method is your team using? Please choose all that apply.

- [ ] Scrum
- [ ] Lean Development
- [ ] Feature Driven Development (FDD)
- [ ] Scrum@Scale
- [ ] Kanban
- [ ] Extreme Programming (XP)
- [ ] Scaled Agile Framework (SAFe)
- [ ] Other

T2: If you selected "Other" for question T1, please specify.

Your answer

T3: Select your role in the Agile team

Choose

T4: If you selected "Other" for question T3, please specify.

Your answer

T5: How often do you work from a remote location?

Choose

T6: Choose the composition that best describes how your team works.

Choose

T7: Tells us about your team composition. Please choose all that apply

	Always works collocated with the team	Works some days collocated and other days remotely	Always works remotely but from the same time-zone	Works remotely from a different time-zone	Not Applicable
Scrum Master	○	○	○	○	○
Product Owner	○	○	○	○	○
Product Manager	○	○	○	○	○
Architect	○	○	○	○	○
Manager/Executive	○	○	○	○	○
Agile Coach	○	○	○	○	○
Developer #1	○	○	○	○	○
Developer #2	○	○	○	○	○
Developer #3	○	○	○	○	○
Developer #4	○	○	○	○	○
Developer #5	○	○	○	○	○
Additional Team Member(s)	○	○	○	○	○
Other Scrum Team(s)	○	○	○	○	○

T7: Tells us about your team composition. Please choose all that apply

	Always works collocated with the team	Works some days collocated and other days remotely	Always works remotely but from the same time-zone	Works remotely from a different time-zone	Not Applicable
Scrum Master	○	○	○	○	○
Product Owner	○	○	○	○	○
Product Manager	○	○	○	○	○
Architect	○	○	○	○	○
Manager/Executive	○	○	○	○	○
Agile Coach	○	○	○	○	○
Developer #1	○	○	○	○	○
Developer #2	○	○	○	○	○
Developer #3	○	○	○	○	○
Developer #4	○	○	○	○	○
Developer #5	○	○	○	○	○
Additional Team Member(s)	○	○	○	○	○
Other Scrum Team(s)	○	○	○	○	○

T8: How often does your team get together physically?

Choose

T9: Tell us about the challenges faced by the different roles in your team and the solutions that were put in place to address them.

Your answer

AGILE TEAM PRACTICES

Tell us about your team's Agile practices. Please base your answers based on the Agile team referenced in question #T1-T9.

P2: How long are your team iterations?

Choose

P3- How does your team execute its Agile related meetings?

	Online Attendees	Onsite Attendees	Online and Onsite Attendees	Not Applicable
Daily Scrum / Stand up	○	○	○	○
Sprint Planning	○	○	○	○
Sprint Review	○	○	○	○
Retrospectives	○	○	○	○
Daily Scrum of Scrums	○	○	○	○
Weekly Scrum of Scrums	○	○	○	○
Effort Estimating	○	○	○	○
Release Planning	○	○	○	○
Product Road Mapping	○	○	○	○
Story Mapping	○	○	○	○
Agile Portfolio Planning	○	○	○	○
Social events / Team Building	○	○	○	○
Other	○	○	○	○

P4: If you selected "Other" for question P3, please specify.

Your answer

P5: Tell us about the challenges when carrying out your team events and the solutions that were put in place to address them.

Your answer

P6- How does your team keep its artifacts

	Online Tool	Physical Board	Local File	Not Applicable
Product Backlog	○	○	○	○
Sprint Backlog	○	○	○	○
Burndown/up chart	○	○	○	○
Velocity chart	○	○	○	○
Release Burndown/up chart	○	○	○	○
Test Cases (scripts & results)	○	○	○	○
Definition of Done	○	○	○	○
Definition of Ready	○	○	○	○
Team working agreement	○	○	○	○
Impediment Backlog	○	○	○	○
RACI Matrix	○	○	○	○
Other	○	○	○	○

P7: If you selected "Other" for question P6, please specify.

Your answer

P8: Tell us about the challenges using your team's artifacts and the solutions that were put in place to address them.

Your answer

P9- Please Indicate the frequency by which you use the following types of tools to collaborate with your Agile team members

	Daily	Weekly	Monthly	Never
Online project planning tools such as Jira	○	○	○	○
Code collaboration tools such as Bitbucket	○	○	○	○
Estimating tools such as planningpoker.com	○	○	○	○
Web conferencing tools such as Zoom	○	○	○	○
Instant messaging tools such as Slack	○	○	○	○
Email tools such as Outlook	○	○	○	○
Unified communication tools such as Teams	○	○	○	○
Bulletin board tools such as Confluence	○	○	○	○
Other	○	○	○	○

P10: If you selected "Other" for question P9, please specify.

Your answer

P11: Tell about the challenges with the tools used by your teams and the solutions that were put in place to address them.

Your answer

P12: How are decisions made in the team?

Choose

Collaboration Efficiency

Tell us about how your team collaborates

C1: How do you feel about the following statements

	Strongly agree	Agree	Disagree	Strongly Disagree
My team collaborates very effectively	○	○	○	○
Making decisions is an easy process for my team	○	○	○	○
My team has all the tools necessary to collaborate	○	○	○	○
My team has all the skills necessary to collaborate	○	○	○	○
Our leadership continues to find ways to improve how teams' collaborates	○	○	○	○
Our leadership supports individuals when they fail	○	○	○	○
Cultural differences are considered by my team	○	○	○	○
I feel safe openly discussing obstacles with colleagues	○	○	○	○
I trust the people in my team to complete tasks	○	○	○	○
The team finds it difficult to make	○	○	○	○

decisions

C2: Describe the collaboration challenges faced by the team.

Your answer

C3: Describe the factors that have contributed to successful collaboration in the team.

Your answer

C4: What collaboration needs does your team have that are not met by your current Agile processes?

Your answer

C5: To what degree do you believe the following aspects should be considered to design a solution that improves collaboration.

	Strongly agree	Agree	Disagree	Strongly Disagree
Tools and technology	○	○	○	○
Remote Agile events	○	○	○	○
Remote facilitation	○	○	○	○
Roles and responsibilities	○	○	○	○
Agile artifacts	○	○	○	○
Team composition	○	○	○	○
Cultural differences	○	○	○	○
Language	○	○	○	○
Organizational readiness	○	○	○	○
Team willingness	○	○	○	○
Work coordination	○	○	○	○
Trust levels	○	○	○	○
Time zone differences	○	○	○	○
Geographical distance	○	○	○	○
Risks	○	○	○	○
Working	○	○	○	○

agreements

Other	○	○	○	○

C6: If you selected "Other" for question C6, please specify.

Your answer

C7: Tell us how the recent COVID-19 pandemic has changed your Agile practices and what additional changes you anticipate will need to be made to improve collaboration.

Your answer

FURTHER STUDY PARTICIPATION

F1: Would you be willing to participate in two 20-minute follow-up expert panel surveys to help us further validate the usefulness of a model for the effective collaboration of distributed Agile teams?

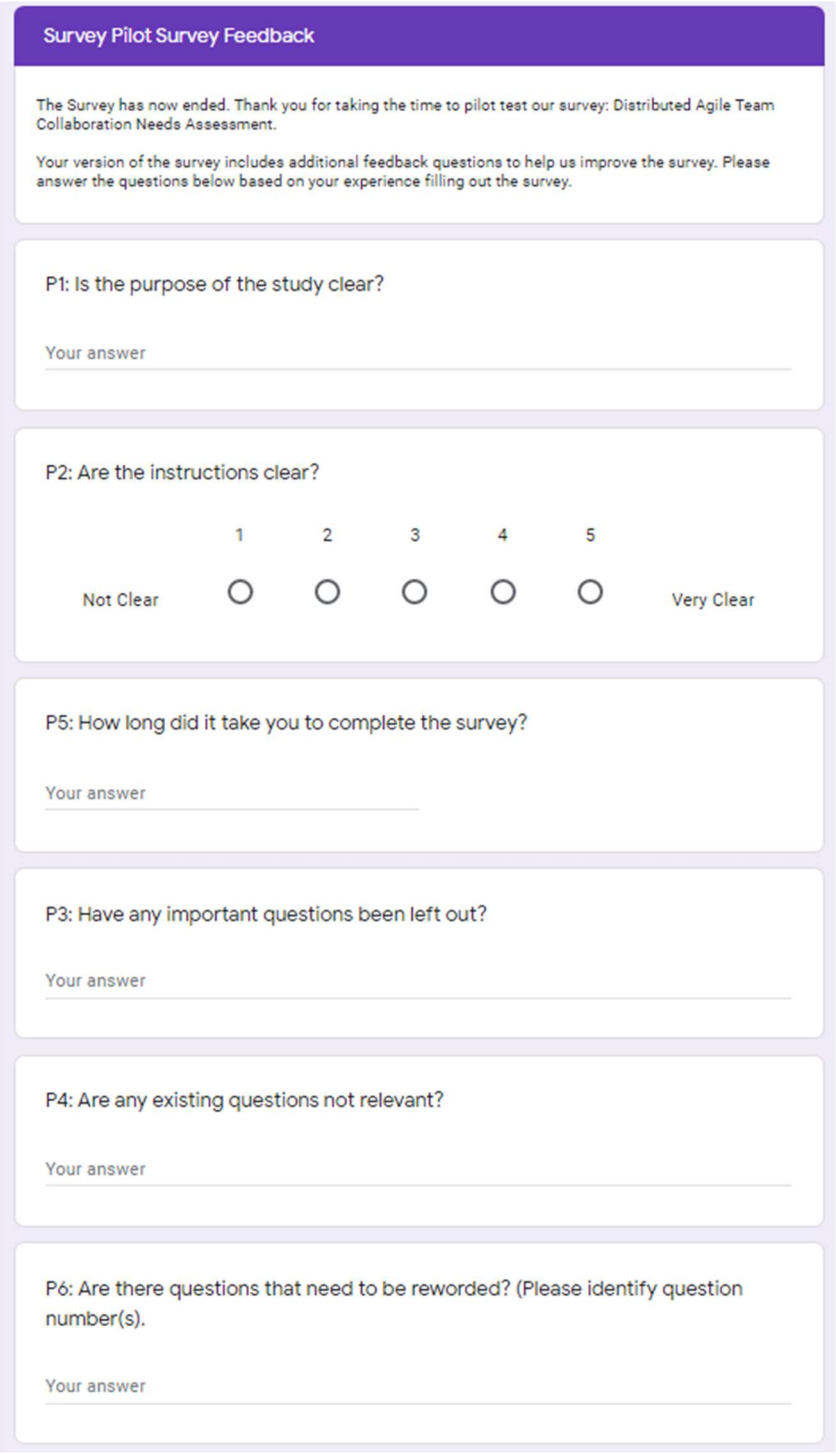
- ○ Yes
- ○ No

F2: If you answered "yes" to question F1, please provide us with your full name so that we may reach you via LinkedIn.

Your answer

Appendix D

Needs Assessment Pilot Feedback Survey



Survey Pilot Survey Feedback

The Survey has now ended. Thank you for taking the time to pilot test our survey: Distributed Agile Team Collaboration Needs Assessment.

Your version of the survey includes additional feedback questions to help us improve the survey. Please answer the questions below based on your experience filling out the survey.

P1: Is the purpose of the study clear?

Your answer

P2: Are the instructions clear?

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

P5: How long did it take you to complete the survey?

Your answer

P3: Have any important questions been left out?

Your answer

P4: Are any existing questions not relevant?

Your answer

P6: Are there questions that need to be reworded? (Please identify question number(s).

Your answer

Appendix E

Delphi Survey–Round 1

Research Consent:

Thank you for agreeing to participate in this research study. This page outlines the purposes of the study, provides a description of your involvement, and outlines your rights as a participant. This research study is monitored by Nova Southeastern University IRB (IRB #:2020-315) for research compliance. This survey should take approximately 15-20 minutes to complete.

The purposes of this questionnaire are to:

- Validate the elements that can help with a model for the effective collaboration of distributed Agile teams.
- Determine what elements need a change in a model that can help with the effective collaboration of distributed Agile teams.
- Determine what elements need to be included in a model that can help with the effective collaboration of distributed Agile teams.

The following conditions will be met:

- Your participation in this research is voluntary; you have the right to withdraw at any point of the study, for any reason, and without any prejudice
- The information you submit will be stored securely; however, the data may not be transmitted securely due to keylogging and other spyware technology that may exist on the computer used for submission.
- You will not be compensated for your participation.

- Your responses will remain anonymous and used in the aggregate for research reporting.

Risks and Benefits

There is a minimal risk that the security of any online data may be breached, but the survey host, Google Forms, uses strong encryption and other data security methods to protect your information. Only the researchers will have access to your information. No identifying information will be collected or connected with your responses, which will be anonymous. The only identifying information will be your name and contact information should you decide to participate in a follow-up survey. However, if you choose to participate in the survey, no identifying information will be captured or reported. The benefits of this study should provide the Agile practitioner community useful information about the unique needs of distributed agile teams and what they need to collaborate effectively. This information will be used to develop a model that can be used with existing Agile frameworks to offer guidance on practices to implement Agile in non-colocated environments and the practices and techniques for effective collaboration, and how distributed teams and distributed individuals can overcome the technical or social challenges associated with the distance that separates them.

Whom to contact if you have a question about the study:

- Ernesto Custodio, Doctoral Student at Nova Southeastern University ec656@mynsu.nova.edu or (954) 632-2800
- Martha M. Snyder, Ph.D., Dissertation Chair at smithmt@nova.edu or (954) 262-2074.

The survey will remain open until [date here].

Whom to contact about your rights as a research participant in the study:

[NSU IRB information here.]

Please base your answers based on your current Agile team. If you are not currently working in an Agile team, please answer the questions based on the last Agile team you worked on. LEFT

Model Element A & a brief explanation of the element	1- Please select one answer as it applies to Element A and fill in the information if it applies to your selection. a) This element should remain as is. b) This element of the model should be modified. Please provide modification suggestions_____ _____ _.

Distributed Teams	
TCDT. Tools Challenges	**TSDT. Tools Solutions**
TCDT1. Security compliance	TSDT1a. Outline tools governance process TSDT1b. Use of corporate approved tools
TCDT2. Sporadic tools through the organization	TSDT2. Establish a tool governance board
TCDT3. Inconsistent use of the tool	TSDT3. Provide team with tools training
TCDT4. Low tool efficacy	TSDT4a. Training on how to use the tools TSDT4b. Coaching on how to use the tool TSDT4c. Sharing screens to demonstrate tool use
RCDT. Role Challenges	**RSDT. Role solutions**
RCDT1. Lack of Communication and SyncUP	RSDT1a. Using tools for frequent casual communication RSDT1b. Agreeing to use a single time zone RSDT1c. Holding a Daily Scrum of Scrums meeting RSDT1d. Enforcing regular artifacts updating RSDT1e. Radiate information via group mail and WIKI boards RSDT1f. Enforcing time zone overlap hours RSDT1g. Practicing flexible schedule RSDT1h. Encouraging members to speak during events
RCDT2. Urgent requests interruptions	RSDT2. Adding an interrupt buffer to the sprint capacity
RCDT3. Lack of team cohesion	RSDT3.Team members traveling toother team sites
RCDT4. Overlapping roles	RSDT4. Coaching on the responsibilities of each event
RCDT5. Pressure to overcommit	RSDT5a. Establishing Work In Progress (WIP) limits RSDT5b. Performing iteration capacity planning
ECDT. Event Challenges	**ESDT. Event Solutions**
ECDT1. Time zone differences	ESDT1a. Choosing a standard time zone ESDT1b. Using asynchronous communication tools ESDT1c. Posting information ahead of meetings ESDT1d. Having shorter, more frequent meetings ESDT1e. Consolidating events ESDT1f. Findings common times in the different time-zones
ECDT2. Low engagement	ESDT2a. Encouraging particopants to video sharing in meetings ESDT2b. Having dedicated video laptops at each site ESDT2c. Keeping a permanent virtual room open
ECDT3. Language barrier	ESDT3. Posting information ahead of meeting
ECDT4. Off tangent conversations	ESDT4. Training and coaching on the purpose of each event
ECDT5. Lack of consensus	ESDT5. Holding anonymous voting sessions during events
ACDT. Artifacts Challenges	**ASDT. Solutions**
ACDT1. Unclear requirement descriptions	ASDT1. Observing a Definition of Done and Definition of Ready
ACDT2. Low transparency	ASDT2a. Purchasing enterprise licenses for tools ASDT2b. Screen-sharing artifacts during meetings
ACDT3. Outdated information	ASDT3a. Having an artifact proxy team member ASDT3b. Crafting and observing a team working agreement

	c) This element should be removed from the model. Please provide reasons for suggesting removing the element_____ _____.
Model Element B & a brief explanation of the element	2- Please select one answer as it applies to Element B and fill in the information if it applies to your selection. d) This element should remain as is. e) This element of the model should be modified. Please provide

DM. Distributed Members	
DMTC. Tools Challenges	**DMTS. Tools Solutions**
DMTC1. Unable to locate information	DMTS1a. Create a tool index page
DMTC2. Information overload	DMTS2a. Streamline tool choices
DMTC3. Inconsistent use of the tool	DMTS3a. Provide team with tools training
DMTC5. Security and corporate compliance	DMTS4a. Outline tools governance process DMTS4b. Use corporate approved tools
DMRC. Role Challenges	**DMRS. Role solutions**
DMRC1. Role confusion	DMRS1a. Train on role responsibilities DMRS1b. Assign people to dedicated roles
DMRC2. Delays in onboarding team members	DMRS2a. Pair onsite and remote team members
DMRC3. Time-zone differences (coordination)	DMRS3a. Agree to use a single time zone DMRS3b. Meet less frequently (alternate days) DMRS3c. Establish a remote working agreement DMRS3d. Enforce time zone overlap hours DMRS3e. Practice flexible schedule
DMRC4. Members are too passive during events	DMRS4a. Coach team members DMRS4b. Encourage safe and open retrospective discussions DMRS4c. Call on members to speak during events
DMRC5. Lack of remote collaboration	DMRS5a. Use synchronous and asynchronous collaboration DMRS5b. Have clear Product Backlog Item decomposition
DMRC6. Insufficient communication and sync up	DMRS6a. Use tools for frequent and casual communication DMRS6b. Enforce regular artifacts updating DMRS6c. Post information via group mail and WIKI boards
DMRC7. Low team cohesion	DMRS7a. Allocate time during meetings for social time DMRS7b. Have members travel to other team sites when possible DMRS7d. Create common goals (sprint goal)
DMEC. Event Challenges	**DMES. Event Solutions**
DMEC1. Longer event duration	DMES1a. Timebox events and decision DMES1b. Have members post information ahead of the event DMES1c. Send a custom agenda ahead of the each event DMES1d. Train and coach on the purpose of each event
DMEC2. Unable to attend from home	DMES2a. Improve home connectivity DMES2b. Offer flexible meeting times
DMEC3. Scheduling and missing members	DMES3a. Observe events' cadence DMES3b. Add virtual attendee options to all meeting invites DMES3c. Require members to check in via email or text message DMES3d. Make event attendance mandatory
DMEC4. Time-zone differences (coordination)	DMES4a. Hold shorter, more frequent events DMES4b. Have multiple instances of the same events DMES4c. Consolidate different events DMES4d. Record meetings for future reviewing
DMEC5. Cultural differences	DMES5a. Have members co-create a team working agreement
DMEC6. Lack of participation	DMES6a. Use video sharing DMES6b. Hold icebreaking segments DMES6c. Use breakout rooms DMES6d. Hold trust building retrospective exercises DMES6e. Call on participants by name
DMAC. Artifacts Challenges	**Artifacts Solutions**
DMAC1. Low transparency	DMAS1a. Use whiteboarding tools to post artifacts DMAS1b. Screen-share artifacts during meetings DMAS1c. Keep an artifacts reference WIKI page
DMAC2. Unprepared product backlog	DMAS2a. Schedule Refinement meetings on cadence DMAS2b. Use of a digital Product Backlog management tool DMAS2c. Have SME reviews sessions DMAS2e. Outline a Definition of Ready (DoR)
DMAC3. Outdated information	DMAS3a. Add artifact management to the working agreement DMAS3b. Inspect and remind to update during each event

modification suggestions_____ _____ _.

3- This element should be removed from the model. Please provide reasons for suggesting removing the element_____ _____.

Model Element B

& a brief explanation of the element

4- Do you think the model presented on the left panel provides a viable solution to remote Agile collaboration? Yes ____ No____

HD. Hybrid Distribution	
HDTC. Tools Challenges	**HDTS. Tools Solutions**
HDTC1. Missing advanced tool features	HDTS1a. Define "must-have" requirements for tool evaluations
HDTC2. Lack of permissions and experience technical problems	HDTS2a. Assign a team member as a tool technical leader
HDRC. Role Challenges	**HDRS. Role solutions**
HDRC1. Subteams formations	HDRS1a. Provide constant communication venues
HDRC2. Lack of leadership support	HDRS2a. Train leaders in the Agile value and principles
HDRC3. Pressure to overcommit	HDRS3a. Establish Work In Progress (WIP) limits HDRS3b. Perform iteration capacity planning
HDEC. Event Challenges	**HDES. Event Solutions**
HDEC1. Lack of venue preparation	HDES1a. Include physical & virtual attendance information in the invite
HDEC2. Ineffective communication	HDES2a. Have a dedicated facilitator (SM) HDES2b. Use a shared room A/V system
HDEC3. Lack of engagement	HDES3a. Screen-share the artifacts during events
HDEC4. Frequent distractions	HDES4a. Use video sharing
HDEC5. Disengagement	HDES5a. Balance participation between onsite and remote members
HDEC6. Low retrospective outcomes	HDES6a. Create a safe place for physical and remote members
HDAC. Artifacts Challenges	**HDAS. Artifacts Solutions**
HDAC1. Lack of access	HDAS1a. Have enough tool licenses HDAS1b. Assign a tool support technical lead
HDAC2. Outdated duplicated artifacts	HDAS2a Only use digital artifacts

5- Are there any steps, phases, or elements that are missing from the model?

6- Are there any steps, phases, or elements in the model that are not necessary?

7- To what extent does the model address relevant environmental factors?

8- What additional changes would you make to the model for addressing effective distributed Agile collaboration?

9- Do you think the presented model provides a viable

	solution to the distributed Agile team collaboration challenges? 10- To what extent is the model usable for a wide range of distributed agile projects and settings? 11- Can the model be implemented efficiently under most working conditions? 12- Is the use of the model cost-effective?

Appendix F

Delphi Survey–Round 2

T. Distributed Agile Teams' Collaboration Model (Tools)

Distributed Agile Collaboration Model		Distributed Teams	Distributed members	Hybrid
TC. Tool Challenges	**TS. Tool Solutions**			
TC1. Lack of corporate security and compliance	TS1a. Outline tool governance process TS1b. Use of corporate approved tools	●	●	●
TC2. Inconsistent use of tool features	TS2a. Provide team with tool training	●	●	●
TC3. Sporadic tool adaption	TS3a. Establish a tool governance board	●		●
TC4. Low tool efficacy	TS4a. Train on how to use tools TS4b. Coach on how to use the tool TS4c. Share screens to demonstrate tool use	●		●
TC5. Unable to locate information	TS5a. Create a tool index page		●	●
TC6. Information overload	TS6a. Streamline tool choices		●	●
TC7. Missing advanced tool features	TS7a. Define "must-have" requirements for tool evaluations			●
TC8. Access and technical problems	TS8a. Assign a team member as a tool technical leader			●

R. Distributed Agile Teams' Collaboration Model (Roles)

Distributed Agile Collaboration Model		Distributed Teams	Distributed members	Hybrid
RC. Role Challenges	**RS. Role solutions**			
RC1. Low team cohesion	RS1a.Start events earlier to allow for social time to take place RS1b. Schedule dedicated virtual social events RS1c. Hold periodic physical team get together events (team outings) RS1d. Have members travel to other team sites when possible RS1e. Have team "Ambassadors" travel between sites RS1f. Create common goals (Sprint Goal)	●	●	●
RC2. Time zone misalignment	RS2a. Agree to observe a single time zone RS2b. Hold a daily Scrum of Scrums meeting at a neutral time RS2c. Meet less frequently (alternate days) RS2d. Establish a remote working agreement RS2e. Enforce time zone overlapping hours RS2f. Practice flexible work schedule	●	●	●
RC3. Infrequent communication	RS3a. Use synchronous and asynchronous tools for frequent and casual communication RS3b. Hold a daily Scrum of Scrums meeting RS3c. Enforce regular artifacts updating RS3d.Post information via group e-mail and WIKI boards RS3e. Encourage members to speak during events	●	●	●
RC4. Interruptions due to urgent requests	RS4a. Add an interrupt buffer to the sprint capacity to address urgent requests	●		●
RC5. Overlapping roles	RS5a. Create a Decider, Responsible, Accountable, Consulted, Informed (DRACI) Matrix RS5b. Coach on the expectations of each Agile role	●		●
RC6. Role confusion	RS6a. Train on role responsibilities RS6b. Assign people to dedicated roles		●	●
RC7. Delays in onboarding team members	RS7a. Pair onsite and remote team members RS7b. Outline onboarding process RS7c. Create a training material library		●	●
RC8. Passive members during events	RS8a. Coach team members RS8b. Encourage safe and open retrospective discussions RS8c. Call on members to speak during events		●	●
RC10. Subteams formations	RS10a. Provide venues for constant communication			●
RC11. Lack of leadership support	RS11a. Train leaders in the Agile value and principles RS11b. Hire Agile-like minded people that uphold the Agile values			●
RC12. Pressure to overcommit	RS12a. Establish Work In Progress (WIP) limits RS12b. Perform iteration capacity planning RS12c. Train the teams and stakeholders on the Agile values RS12e. Build trust through reliable iterative delivery			●

DTATCM0. Do you think the model panels presented above provides a viable solution for remote Agile collaboration challenges?

- ◯ Yes
- ◯ No

DTATCM1. Please select applicable answers as it applies to the distributed team model above and fill in the information if it applies to your selection.

- ◯ The model should remain as is.
- ◯ Items in the model should modified.
- ◯ Items in the model should be removed.

DTATCM2. If items in the model should be modified, please provide the suggested modification below.

Long answer text

DTATCM3. If items should be removed from the model, please provide which elements should be removed and reasons for suggesting to remove the element

Long answer text

Appendix G

IRB Approval Letter

NSU NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board

MEMORANDUM

To: **Ernesto Custodio**

From: **Ling Wang, Ph.D.,**
Center Representative, Institutional Review Board

Date: **July 1, 2020**

Re: **IRB #: 2020-315; Title, "The Construction and Internal Validation of a Model for the Effective Collaboration of Distributed Agile Teams"**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt 2: Interviews, surveys, focus groups, observations of public behavior, and other similar methodologies)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and Ling Wang, Ph.D., respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

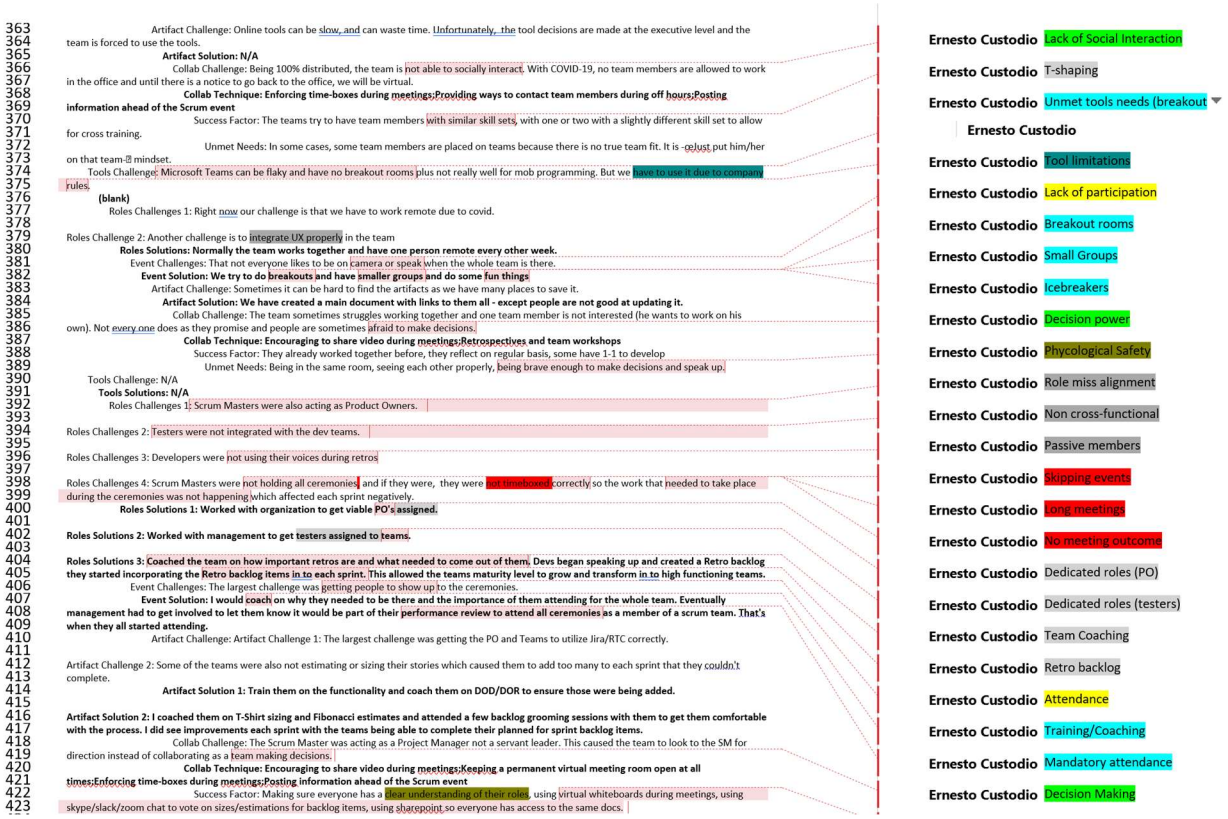
The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Marti Snyder, Ph.D.
Ling Wang, Ph.D.

3301 College Avenue • Fort Lauderdale, Florida 33314-7796
(954) 262-0000 • 800-672-7223, ext. 5369 • Email: *irb@nova.edu* • Web site: www.nova.edu/irb

Appendix H

Qualitative Data Codification Snapshot



Appendix I

Agile Team Meeting Applicability and Format of the Needs Assessment Participants

How does your team execute its Agile-related meetings? (n=53)					
Agile Meeting	N/A	Mixed	Online	Onsite	Total Responses
Daily Scrum of Scrums	20	10	17	4	51
Executive Sync Up	12	12	17	7	48
Weekly Scrum of Scrums	11	16	20	3	50
Program Increment Planning	11	16	20	3	50
Agile Portfolio Planning	10	14	20	7	51
Story Mapping	6	19	20	4	49
Product Owner Sync Up	4	19	20	6	49
Product Road Mapping	3	14	24	8	49
Social Events / Team Building	3	17	16	15	51
Effort Estimating	2	23	24	3	52
Release Planning	2	18	27	5	52
Impediment Escalation	2	21	21	6	50
Sprint Planning	1	22	26	4	53
Sprint Review	1	22	26g	3	52
Daily Scrum	0	21	28	4	53
Retrospectives	0	21	26	6	53

Appendix J

Artifact Use Metrics from the Needs Assessment Participants (n=53)

How does your team keep its artifacts? (n=53)

Artifacts	**N/A**	**Online Tool**	**Physical Board**	**Local File**	**Total Responses**
Test Cases (scripts and results)	0	52	0	1	53
Product Backlog	0	51	2	0	53
Sprint Backlog	0	50	3	0	53
Burndown/Up Chart	2	48	2	1	53
Definition of Done	1	48	2	2	53
Impediment Backlog	1	48	1	3	53
Velocity Chart	3	47	2	1	53

Release Burndown/Up Chart	3	47	0	3	53
Team Working Agreement	0	45	4	4	53
Definition of Ready	3	44	2	3	52
RACI Matrix	16	26	1	5	48
Other	14	7	1	0	22

Appendix K

Tool Use Metrics from the Needs Assessment Participants (n=53)

What is the frequency by which you use the following types of tools to collaborate with your Agile team members? (n=53)					
Tools	**N/A**	**Daily**	**Weekly**	**Monthly**	**Total Responses**
Email Tools (e.g., Outlook)	1	52	0	0	53
Online Project Planning Tools (e.g., Jira)	2	49	1	1	53
Web Conferencing Tools (e.g., Zoom)	3	48	0	1	52
Instant Messaging Tools (e.g., Slack)	2	48	0	1	51
Unified Communication Tools (e.g., Teams)	7	42	2	1	52
Code Collaboration Tools (e.g., Bitbucket)	9	38	3	0	50
Bulletin Board Tools (e.g., Confluence)	5	36	8	2	51
Online Whiteboarding Tools (e.g., Miro or Mural)	15	21	8	6	50
Estimating Tools (e.g., planningpoker.com)	12	4	29	5	50
Other	15	3	1	0	19

Appendix L

Collaboration Efficiency Metrics from the Needs Assessment Participants (n=53)

How long are your team iterations? (n=53)	**Count**	**Percent**
1-2 weeks	47	88.68%
3-4 weeks	4	7.55%
Longer than 4 weeks	1	1.89%
Not applicable	1	1.89%
Making decisions is an easy process for my team	**Count**	**Percent**
Disagree	11	20.75%
Agree	36	67.92%
Strongly Agree	6	11.32%
My team has all the tools necessary to collaborate	**Count**	**Percent**
Disagree	4	7.69%
Agree	27	51.92%
Strongly Agree	21	40.38%
My team has all the skills necessary to collaborate	**Count**	**Percent**
Disagree	7	13.21%
Agree	34	64.15%
Strongly Agree	12	22.64%

Our leadership continues to find ways to improve how teams collaborate	**Count**	**Percent**
Strongly Disagree	5	9.43%
Disagree	8	15.09%
Agree	31	58.49%
Strongly Agree	9	16.98%
Our leadership supports individuals when they fail	**Count**	**Percent**
Strongly Disagree	1	1.89%
Disagree	11	20.75%
Agree	34	64.15%
Strongly Agree	7	13.21%
Cultural differences are considered by my team	**Count**	**Percent**
Disagree	9	16.98%
Agree	30	56.60%
Strongly Agree	14	26.42%
I feel safe openly discussing obstacles with colleagues	**Count**	**Percent**
Disagree	2	3.77%
Agree	33	62.26%
Strongly Agree	18	33.96%
I trust the people in my team to complete tasks	**Count**	**Percent**
Disagree	3	5.66%

Agree	32	60.38%
Strongly Agree	18	33.96%
The team finds it difficult to make decisions	**Count**	**Percent**
Strongly Disagree	4	7.55%
Disagree	32	60.38%
Agree	13	24.53%
Strongly Agree	4	7.55%

Appendix M

Factors to Consider for Effective Collaboration (n=53)

To what degree do you believe the following aspects should be considered to design a solution that improves collaboration.		
Tools and technology	**Count**	**Percent**
Agree	20	38.46%
Strongly Agree	32	61.54%
Remote Agile events	**Count**	**Percent**
Disagree	6	11.54%
Agree	26	50.00%
Strongly Agree	20	38.46%
Remote facilitation	**Count**	**Percent**
Disagree	5	9.62%
Agree	23	44.23%
Strongly Agree	24	46.15%
Roles and responsibilities	**Count**	**Percent**
Strongly Disagree	1	1.92%
Disagree	4	7.69%
Agree	21	40.38%
Strongly Agree	26	50.00%

Agile artifacts	**Count**	**Percent**
Disagree	4	7.84%
Agree	26	50.98%
Strongly Agree	21	41.18%
Team Composition	**Count**	**Percent**
Disagree	3	5.88%
Agree	21	41.18%
Strongly Agree	27	52.94%
Cultural Differences	**Count**	**Percent**
Disagree	8	15.38%
Agree	20	38.46%
Strongly Agree	24	46.15%
Language	**Count**	**Percent**
Disagree	4	7.69%
Agree	25	48.08%
Strongly Agree	23	44.23%
Organizational Readiness	**Count**	**Percent**
Disagree	2	3.85%
Agree	18	34.62%
Strongly Agree	32	61.54%
Team willingness	**Count**	**Percent**

Agree	19	36.54%
Strongly Agree	33	63.46%
Work coordination	**Count**	**Percent**
Disagree	6	11.54%
Agree	22	42.31%
Strongly Agree	24	46.15%
Trust levels	**Respondents**	**Percentage of Total**
Disagree	1	1.92%
Agree	12	23.08%
Strongly Agree	39	75.00%
Time zone differences	**Count**	**Percent**
Strongly Disagree	1	1.92%
Disagree	6	11.54%
Agree	23	44.23%
Strongly Agree	22	42.31%
Geographical differences	**Count**	**Percent**
Strongly Disagree	3	5.88%
Disagree	15	29.41%
Agree	23	45.10%
Strongly Agree	10	19.61%

Risks	**Count**	**Percent**
Disagree	9	17.31%
Agree	30	57.69%
Strongly Agree	13	25.00%
Working agreements	**Count**	**Percent**
Disagree	2	3.85%
Agree	23	44.23%
Strongly Agree	27	51.92%
Other	**Count**	**Percent**
Strongly Disagree	7	50.00%
Disagree	1	7.14%
Agree	2	14.29%
Strongly Agree	4	28.57%

Appendix N

Tool Related Challenges and Solutions

P11: Tool related challenges	**Number of Distributed Teams Occurrences**	**Number of Distributed Members Occurrences**	**Number of Hybrid Occurrences**	**Total Occurrences**
TC8. Access and technical problems	2	7	4	13
TC7. Missing advanced tool features	4		3	12
TC3. Sporadic tool adaption	5	3	3	11
TC4. Low tool efficacy	3	4	4	11
TC2. Inconsistent use of tool features	2	4	4	10
TC6. Information overload	3	5	2	10
TC5. Unable to locate information	3	4	2	9
TC1. Lack of corporate security and compliance	2	3	3	8
P11: Tool related solutions				
TS1b. Use of corporate approved tools	3	0	3	6
TS6a. Streamline tool choices	2	0	4	6
TS7a. Define “must-have” requirements for tool evaluations	2	0	4	6
TS8a. Assign a team member as a tool technical leader	1	2	1	4
TS1a. Outline tool governance process	0	1	2	3
TS2a. Provide team with tool training	1	1	1	3
TS4a. Train on how to use tools	1	1	1	3
TS4b. Coach on how to use the tool	1	1	1	3
TS3a. Establish a tool governance board	0	1	1	2
TS4c. Share screens to demonstrate tool use	0	0	1	1
TS5a. Create a tool index page	0	0	1	1

Appendix O

Role Related Challenges and Solutions

T9: Role challenges	**Number of Distributed Teams Occurrences**	**Number of Distributed Members Occurrences**	**Number of Hybrid Occurrences**	**Total Occurrences**
RC1. Low team cohesion	9	16	12	37
RC3. Infrequent communication	6	12	10	28
RC8. Passive members during events	7	8	6	21
RC9. Sub-teams formations	7	7	7	21
RC6. Role confusion	5	9	6	20
RC10. Lack of leadership support	4	10	5	19
RC5. Overlapping roles	6	7	5	18
RC4. Interruptions due to urgent requests	2	8	5	15
RC2. Time zone misalignment	5	3	4	12
RC11. Pressure to overcommit	2	6	4	12
RC7. Delays in onboarding team members	2	6	3	11
P11: Role solutions				
RS6a. Train on role responsibilities	3	5	5	13
RS6b. Assign people to dedicated roles	3	5	5	13
RS5b. Coach on the expectations of each Agile role	3	4	4	11
RS10a. Train leaders in the Agile value and principles	3	4	4	11
RS2d. Establish a remote working agreement	4	4	2	10
RS3a. Use synchronous and asynchronous tools for frequent and casual communication	3	5	2	10

RS8a. Coach team members	3	3	4	10
RS9a. Provide venues for constant communication	3	4	3	10
RS11c. Train the teams and stakeholders on the Agile values	2	3	5	10
RS2f. Practice flexible work schedule	2	4	3	9
RS10b. Hire Agile like-minded people that uphold the Agile values	2	4	2	8
RS3c. Enforce regular artifacts updating	2	2	3	7
RS1a. Start events earlier to allow for social time to take place	2	2	2	6
RS3e. Encourage members to speak during events	2	2	2	6
RS8b. Encourage safe and open retrospective discussions	2	2	2	6
RS1b. Schedule dedicated virtual social events	1	1	3	5
RS3d. Post information via group e-mail and WIKI boards	2	2	1	5
RS1f. Create common goals (Sprint Goal)	1	2	1	4
RS2b. Hold a daily Scrum of Scrums meeting at a neutral time	2	1	1	4
RS3b. Hold a daily Scrum of Scrums meeting	2	1	1	4
RS7b. Outline onboarding process	2	1	1	4
RS8c. Call on members to speak during events	2	1	1	4
RS1c. Hold periodic physical team get together events (team outings)	1	1	1	3
RS2e. Enforce time zone overlapping hours	1	1	1	3
RS7a. Pair onsite and remote team members	1	2	0	3
RS7c. Create a training material library	1	1	1	3
RS11b. Perform iteration capacity planning	1	1	1	3
RS11e. Build trust through reliable iterative delivery	1	2	0	3

RS11a. Establish Work In Progress (WIP) limits	0	1	1	2
RS1d. Have members travel to other team sites when possible	1	0	0	1
RS2a. Agree to observe a single time zone	0	1	0	1
RS2c. Meet less frequently (alternate days)	0	1	0	1
RS4a. Add an interrupt buffer to the sprint capacity to address urgent requests	0	0	1	1
RS5a. Create a Decider, Responsible, Accountable, Consulted, Informed (DRACI) Matrix	1	0	0	1
RS1e. Have team "Ambassadors" travel between sites	0	0	0	0

Appendix P

Events Related Challenges and Solutions

P5: Events Related challenges	Distributed Teams	Distributed Members	Hybrid Distribution	Total
EC9. Ineffective communication	5	9	7	21
EC2. Low engagement	3	8	6	17
EC6. Missing team members and stakeholders	2	9	6	17
EC12. Delayed Decisions	3	9	3	15
EC14. Difficulty performing team brainstorming	3	8	4	15
EC5. Longer event duration	3	7	4	14
EC11. Lack of common understanding	2	7	4	13
EC8. Unclear event logistics	3	4	5	12
EC4. Out of scope conversations	2	5	4	11
EC1. Difficult time zone coordination	3	3	3	9
EC10. Low retrospective outcomes	2	4	3	9
EC3. Language barrier	2	3	2	7
EC7. Conflict due to lack of cultural understanding	2	3	2	7
EC13. Overbearing participants	2	3	2	7
P5: Events Related Solutions				
S1b. Use asynchronous communication tools	4	5	5	14
ES2a. Encourage participants to share video in meetings	2	5	6	13
ES2h. Screenshare the artifacts during events	1	4	5	10
ES1g. Record meetings for future reviewing	2	3	4	9
ES14a. Use real-time whiteboarding collaboration tools	2	3	4	9

ES2j. Practice remote equality by observing other time zones	3	2	3	8
ES6e. Record and share the meeting for later review	2	2	4	8
ES8a. Include physical & virtual attendance information in the invite	2	3	3	8
ES1c. Post information ahead of meetings	2	3	2	7
ES1d. Have shorter, more frequent meetings	2	3	2	7
ES2b. Have dedicated A/V or video-capable PC at every site	1	3	3	7
ES3a. Post information ahead of meetings	2	3	2	7
ES5b. Have members post information ahead of the event	2	3	2	7
ES6b. Add virtual meeting link to all invites	1	3	3	7
ES9b. Use a shared room A/V system	1	3	3	7
ES11a. Hold open discussion sessions	2	3	2	7
ES2c. Keep a permanent virtual room open	0	3	3	6
ES2e. Use breakout rooms for more focused discussions	0	4	2	6
ES2i. Balance participation between onsite and remote members	1	3	2	6
ES3b. Use breakout rooms	0	4	2	6
ES4b. Train and coach on the purpose of each event	2	2	2	6
ES5d. Train and coach on the purpose of each event	2	2	2	6
ES7a. Train team members on cultural awareness	3	2	1	6
ES1f. Find common times in the different time zones	2	1	2	5
ES2d. Start with an icebreaker activity	1	2	2	5
ES2f. Hold trust-building retrospective exercises	1	2	2	5

ES6c. Make event attendance mandatory	0	3	2	5
ES9a. Have a dedicated facilitator (SM)	1	2	2	5
ES10a. Create a safe phycological environment for physical and remote members	1	2	2	5
ES13a. Use a virtual "talking stick" during meetings to facilitate discussions	1	2	2	5
ES2g. Call on participants by name	0	2	2	4
ES5a. Timebox events and discussions	2	2	0	4
ES5c. Send a custom agenda ahead of each event	1	2	1	4
ES6a. Schedule events on cadence (predictability)	2	1	1	4
ES6d. Require absentee members to check-in via email or text message	0	2	2	4
ES13b. Timebox discussions using a shared clock tool	2	2	0	4
ES1a. Choose a standard time zone	1	1	1	3
ES1e. Consolidate events	1	2	0	3
ES1h. Have multiple instances of the same events	1	1	1	3
ES4a. Send a custom agenda ahead of each event	0	2	1	3
ES7b. Have members co-create a team working agreement	0	1	2	3
ES11b. Share meeting agenda ahead of each event	0	2	1	3
ES12a. Identify mandatory attendees ahead of the event	0	2	1	3
ES12b. Create a Decider, Responsible, Accountable, Consulted, Informed (DRACI) Matrix	0	2	1	3
ES12c. Hold anonymous voting sessions to reach consensus during events	1	0	2	3

Appendix Q

Artifacts Related Challenges and Solutions

P11: Artifacts Related Challenges	**Distributed Teams**	**Distributed Members**	**Hybrid Distribution**	**Total**
AC1. Lack of artifact visibility	3	5	4	12
AC3. Outdated information	3	5	3	11
AC4. Lack of access to artifacts	3	3	5	11
AC2. Unprepared product backlog	2	6	1	9
P11: Artifacts Related Solutions				
AS2b. Use of a digital Product Backlog management tool	3	6	6	15
AS3d. Only use digital artifacts	3	4	7	14
AS4c. Only use digital artifacts	3	4	7	14
AS1a. Purchase enterprise licenses for tools	4	4	3	11
AS1c. Screen-share artifacts during meetings	3	4	4	11
AS4a. Have enough artifact tool licenses	4	4	3	11
AS1b. Use whiteboarding tools to post artifacts	1	4	5	10
AS3c. Inspect and remind to update during each event	4	3	3	10
AS3b. Add artifact management expectations to the working agreement	3	4	2	9
AS3a. Have a proxy artifact owner	2	4	1	7
AS4b. Assign an artifact support technical lead	2	4	1	7
AS1d. Keep an artifacts WIKI page	2	1	3	6
AS2a. Schedule Refinement meetings on cadence	2	2	2	6
AS2c. Have SME reviews sessions	1	4	1	6

AS2d. Outline a Definition of Ready (DoR)	1	1	1	3
AS2e. Reduce dependencies between backlog items	0	1	1	2

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