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FACTORS AFFECTING SUCCESSFUL ADOPTION OF SCRUM IN SOFTWARE COMPANIES

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Thesis submitted in partial fulfilment of the requirements for the degree MBA in Information Technology

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DECLARATION

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ABSTRACT

There are number of software development methodologies such as Waterfall, Rapid prototyping, Spiral, Incremental, Evolutionary Delivery, etc. However, these traditional methodologies were not flexible enough to develop complex and critical software systems with frequently changing requirements. Therefore, alternative software development methodologies gradually emerged and are used in practice.

Agile is the most suitable software development methodology for the frequently requirement changing environment. There are number of variants developed based on the Agile framework. Scrum is the most famous Agile variant with an incremental iterative process.

Main objectives of the project are to identify the factors towards the successful adoption of Scrum software development processes and their relative importance. The research contains three phases. Phase one is based on the literature review, formulation of the theoretical framework and hypothesis development. The theoretical framework is developed based on the literature review. The hypothesis is developed based on the research questions. In second phase a questionnaire is designed. This research examined the validity of the questionnaire based on Cronbach alpha, which is calculated using pilot survey responses. Web based survey was conducted for the collection of data. The research eliminated five questions to improve the validity of the questionnaire on alpha value. Phase three of the research is the data analysis. It is based on Pearson correlation and linear regression. The statistical analysis results show the correlation between identified factors and verify the success of the project.

The results of the study show that the key factors, such as Scrum technology, communication, people, process and organization culture are having positive contribution towards adopting Scrum software development process in Sri Lanka. The study further reveals the percentage importance of each factor towards the success of Scrum. Such as people factor contributes 10%, process factor contributes 7%, technology factor contributes 28%, communication factor contributes 23% and organization culture factor contributes 6%.

Keywords: Agile variants, history, Scrum methodology, Scrum success factors, Software Project success.

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CHAPTER 1: INTRODUCTION

Software development is the process of developing software through successive phases in an ordered method. This process has multiple phases such as identification of requirement, requirement analysis, design, implementation, testing and maintenance. There are number of software development methodologies such as Waterfall, Spiral, Incremental, Rational Unified Process (RUP), Rapid Application Development (RAD), Agile software development, and Rapid Prototyping (Bassil, 2012). Waterfall software development methodology, which has immerged more than 30 years ago. In that era, Waterfall development model was mainly used in the manufacturing and in the construction industries instead of software development. However, these traditional methodologies were not flexible enough to develop complex and critical software systems with dependable requirements. Therefore, other software development methodologies gradually emerged and have been used in practice. Agile software development methodology has the capability of handling category of systems mentioned above. Therefore, most of the software developing companies tend to follow more flexible software development methodologies such as Agile software development.

1.1 Background of Agile

The word ‘‘Agile’’ by itself means that something is flexible and responsive. Therefore, Agile methods imply its ability to survive in an atmosphere of constant change and emerge with success. Agile methods deal with unstable and volatile requirements by using number of techniques. The most notable techniques such as: simple planning, short iteration, earlier release, and frequent customer feedback. These characteristics enable Agile methods to deliver product releases in a shorter period of time compared to the Waterfall approach (Huo et al., 2004). Therefore, most software developing

companies tend to follow more flexible software development methodologies such as Agile software development that supports changes and iterative development.

Agile methodology is based on iterative and incremental development that breaks tasks into small increments. Iterations could be described as short time frames that typically last from one to four weeks. Each iteration involves a team working through a full software development cycle. The success factors of Agile methodology referring to previous studies are described in the literature review in chapter 2. There are number of Agile variants developed based on Agile framework. Section 2.2, the Literature Review chapter gives a brief description about the Agile variants. Those variants are featured driven development, Lean, Scrum, XP and etc. However, all these methods are not suitable for the entire software development requirement. According to past research and surveys Scrum is the most famous Agile software development methodology. According to the 8th annual Agile survey (The 8th Annual "State of Agile" Survey, 2014) Scrum is the most popular Agile variant used by companies. It is shown in Figure 1.1. According to the Figure 1.1, 55% of the companies use Scrum methodology for their software development. It is more than half of the IT companies. Next conventional variant is the Scrum/XP hybrid version.

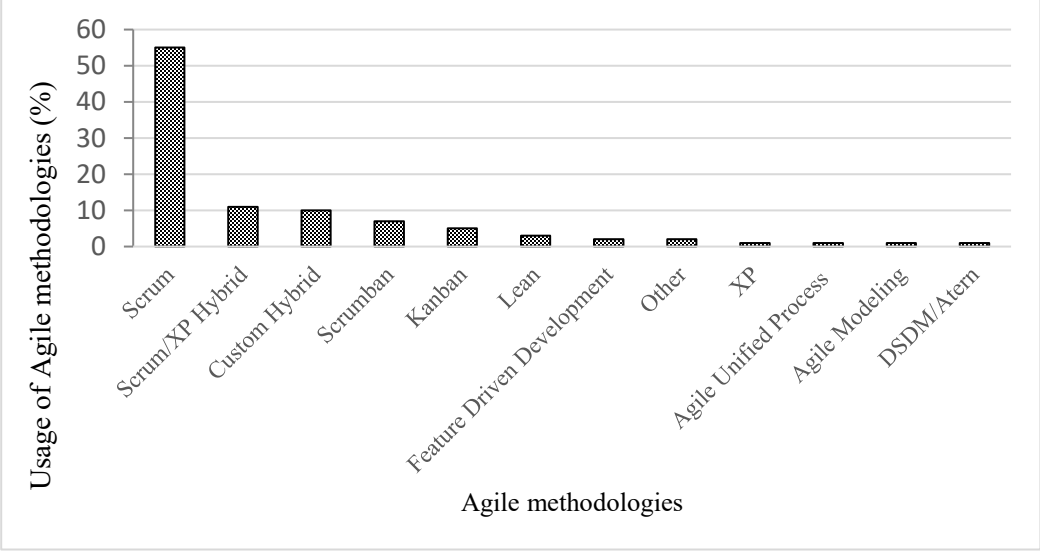

Figure 1.1: Percentage usage of Agile methodologies (The 8th Annual "State of Agile" Survey, 2014)

1.2 Research Problem

Developing software system is a challenge with rapid change of requirements. The Agile software development methodology supports frequent changes during product development process. The Agile manifesto announces principles that motivates and makes software developers powerful by depending on excellent technical features and simple designs to create business value and delivering working software to end user constantly at regular short time intervals. However, these Agile principles should not reduce the productivity and the creativity of the team members. Majority of the research conducted in this field concludes that, Agile challenges have become almost obvious. However, in practice still there are some projects which face challenges during their process and some success factors do not seem to be effective enough. Several researches have been conducted identifying the problems and challenges associated with Agile methodology (Hajjdiab & Taleb, 2011)

According to the 8th annual state of Agile survey 55% of projects use Scrum variant of the Agile methodologies (The 8th Annual "State of Agile" Survey, 2014). Therefore, this research considers the practical process of Scrum base software project to figure out the success factors. The main objectives of the research are to identify and provide insight into success factors of Scrum variant that helps software development projects to complete the development process with more accomplishment and also to find the relative importance of each factor.

1.3 Research Questions

Research questions help to reach the goals of the project. The research problems of this work are described as follows:

- Q1: What are the factors towards the successful adoption of Scrum software development processes?
- Q2: What is the relative importance of each factor when compared with each other?
- Q3: Is there any different impact from each different category?

Solutions for the above questions will be based on a survey. Successful completion of this research will provide answers for the research questions achieving project objectives.

1.4 Research Objectives

Main objective of this project is to find factors affecting successful adaption of the Scrum in IT companies in Sri Lanka. In addition to that, this research mainly targets on finding below mentioned points.

- Identify the factors towards the successful adoption of Scrum software development processes in Sri Lanka.
- Relative effect of different categories on the success of the project

1.5 Importance and Benefits of study

- Scrum is the most commonly used Agile variant among software developments (The 8th Annual "State of Agile" Survey, 2014). Therefore, identifying success factors of Scrum will help many in software industry. By using a proper methodology, the project managers increase the probability to deliver client expectations, while accommodating the time and budget restrictions. Therefore, it is very important to identify proper methodology to adopt Scrum in projects.

- Scrum is an iterative and incremental software development methodology dissimilar to Waterfall. Therefore, companies are able to deliver products to the customers faster and in a more effective way. At the end of each sprint customer feedback can be incorporated to improve the process. Therefore, this helps to keep customers closely involved and engaged. This is a main advantage of using Scrum successfully over other software development methodologies.

- Scrum improves the return of investment by reducing cost. The speed of deliverables is higher than other development methodologies. This helps to improve return of investment.

- Another benefit of adopting Scrum is improving individual performance by conducting daily meetings.

1.6 Structure of Research

This report contains five chapters. Each chapter is described in the section below. The first chapter gives an introduction of the study and describes about the objectives of the research and advantages. The second chapter investigates the literature review. Literature review is used to identify the dependent and independent variables of the study. Third chapter is about theoretical framework, which is created based on dependent and independent variables. It also contains details about the sample size calculation, hypotheses and the data collection methodology. The fourth chapter contains the statistical analysis results. Statistical analysis is used to prove the hypotheses. Final chapter is about the conclusion. It describes about the research outcome, limitations, research policy level implication and future work.

1.7 Summary

This chapter gives an introduction of the research. It contains six sections namely background of Agile, research problems, research questions, research objectives, importance of study, and structure of the report. Agile software development methodology, on the other hand, supports to develop software systems that change frequently in iteratively and repetitively. There are number of Agile variants developed based on Agile framework. Scrum is the most commonly used methodology. Therefore, main objective of the research is to identify and provide insight into success factors of Scrum and relative importance of those factors. Next chapter describes about the literature review used to identify the success factors.

CHAPTER 2: LITERATURE REVIEW

At present business environment varies rapidly; a frozen methodology for software development does not accommodate changes in the business practices. A flexible approach based on Agile software development framework, which supports rapid changes that can be applied to overcome the associated challenges in software development.

According to Jiang and Eberlein (2009) software development methodologies are grouped in to two categories.

1) Classical software methodologies: These methodologies are referred to as heavy-weight or plan-driven and require upfront requirements definition, documentation and detailed plans. Two prominent examples are the waterfall model and the spiral model.

2) Agile methodologies: These methodologies are often called light-weight or Agile. This category includes XP (Extreme Programming) and Scrum.

Agile methodologies significantly emphasise the continuous planning, empowered teams, collaboration, evolving design, early testing, associated philosophy and frequent delivery of working software in short, rapid iterations compared to traditional software development with up-front planning and detailed requirements. The development of the Agile is described in the below sections.

2.1 History of Agile

In early 1990s, with the initiation of PC computing proliferation in the enterprise, software development was faced a crisis. During that period, it was widely referred as the application development crisis. The reason was identified as the period of time taken

to complete the product is unacceptable. Majority of the engineering community was frustrated due to the extensive time requirement to achieve a software output. Therefore, significant effort has been made over the last decade in identification of the good practices, models and methods that lead for more efficient software development. Next, is the Waterfall methodology, which use the incremental and iterative development concepts. Afterwards, the light weight Agile methodologies came to picture. The word ‘‘Agile’’ itself means that something is flexible and responsive, so Agile methods imply its ability to survive in an atmosphere of constant change and emerge with success. The terms “Agile” and “Agility” could be traced back to the manufacturing industry in 1991 where “Lean development” emerged in manufacturing with the aim of eliminating waste and empowering teams. This lean development method is based on Japanese Toyota production system. It was introduced during the recovery period after the Second World War. Similarly, group of iterative development methodologies were introduced by several groups. In February 2001, group of 17 process experts, representing DSDM, XP, Scrum, FDD, and others, interested in promoting modern, simple iterative methods and principles met in Utah to discuss common ground. After the discussion the group introduced the phrase named as “Agile methods” (Larman & Basili, 2003).

There are set of Agile methodologies. The Agile term covers a family of emerging lightweight software development methods such as Scrum, Extreme Programming, DSDM, FDD, Crystal, and Adaptive Software Development (Lindstroma & Jeffriesb, 2004).

Larman and Basili (2003) stated the iterative and incremental development was in use from early 1957. Hence, iterative and incremental development is not a novel approach. Although Agile methods are new as a whole, the principles and concepts have been used in the past as well. Further more Agile concepts were suggested as an alternative approach by the conventional methods by the critics. Unfortunately, these alternative approaches had not been treated seriously enough. Below paragraphs discuss about experience of the people related to the Agile methodologies. Furthermore, from the

long-time back it has been identified the drawbacks of heavyweight process and have tried to move on to Agile practices.

Ken Schwaber is the one developer of Scrum. He has described his experience while he was managing a software company in early 1990s. He stated that their requirements were frequently changing and their customer's methodology did not aid, instead it slowed the process. In order to solve the problem, he showed these methodologies to process theory experts at the DuPont Experimental station in 1995 (Abbas et al., 2008).

Similarly, Kent Beck, founder of XP, experienced a scenario. In April 1996, he was hired to help Chrysler in a payroll system. The project was in a state where two months away from production. The development team was not "computing the right answers yet". The development team along with the CIO of Chrysler, decided to start process from scratch with a smaller team. Ron Jeffries became the first XP coach with the help of Martin Flower in analysis and testing. As a result, the first XP project took off. They worked on the basis of three weeks' iteration, where they implemented stories chosen by the domain experts. In April 1997, the system was live, and it was reasonable, cheap and easy to maintain and to extend. Beck stated "it was a technical and business success (Abbas et al., 2008).

Another scenario is from Alistair Cockburn, one of the Agile Manifesto authors. In 1991, IBM Consulting Group asked him to write a methodology for object technology projects. He decided to interview the project teams. He found out that their stories were different from what was mentioned in methodologies and books. He found that "close communication, morale, and access to end users separated in stark, contrast the successful projects visited from the failing ones" (Abbas et al., 2008).

Based on all above discussion and examples we can conclude that Agile principles and concepts have been in practice from long ago. People who criticized heavy weight methodologies proposed different alternatives those are very similar to Agile approach.

Agile approach also contains strengths and weaknesses. Below paragraphs describe about the strengths and the weaknesses of Agile process.

Dingsøyr (2012) explains how Agile brought unprecedented changes to the software engineering field. The research further discusses about the myriad implications of Agile software development. It says the articulation of the Agile manifesto in 2011 – a little over a decade ago – has brought unprecedented changes to the software engineering field. Main advantages are distinct move towards collaborative development, with people being accorded privileges over processes that formerly constrained them, documenting only what was absolutely necessary and nothing more, customers' ability to actively shaped and guided the evolution of the end software product or service and acceptance of the fact that uncertainty was a part and parcel of software development. The transformation that the manifesto has brought in its wake is quite remarkable. Sixty-three countries have been engaged in Agile research. Most studies focused on XP and very few on the Scrum development process but majority use Scrum variant in Agile. The study urges Agile researchers to embrace a more theory based approach in the future when inquiring into these promising research areas of Agile development.

As mentioned earlier, there are number of benefits moving from traditional to Agile. But according to Subhas, Vinod and Uma (2002) companies can't move straight from traditional software development methods to Agile due to the amount of challenges. The study did not reveal any substantial difference in importance of changes in culture, changes in management style, changes in knowledge management strategy and changes in development processes. The authors believe that this is an important finding because it is indicative of not isolating one class of changes from another in practical transition exercises. However, another noteworthy observation was that transitioning from heavily process-centric to short, iterative, test-driven, and people-centric development was considered by the largest percentage of respondents to be very important. The open-ended questions in the study also revealed three additional classes of changes. Those are

changes in personal characteristics, changes in customer attitude, and changes in knowledge and education of stakeholders.

The incompatibility with large projects is the main disadvantage of the Agile. The key elements of project size are determined by project budget, duration and project team of the organization. The larger the team or more budget you need, the bigger the project is. Thus compiling more requirements, requiring more people and more coordination. Heavyweight methodologies support this by providing plans, documentation and processes for better communication and coordination across large groups. The Agile and heavyweight methodologies both have their strengths and weaknesses. People usually follow either one of these methodologies or follow their own customized methodology. There are major factors affecting methodology decision and selecting which is suitable for various conditions.

Agile covers a family of emerging lightweight software development methods. Below section describes those variants of Agile in detail.

2.2 Variants of Agile Software Development

The various Agile methodologies share much of the same philosophy, as well as many of the same characteristics and practices. But from an implementation standpoint, each has its own recipe of practices, terminology, and tactics. This section has summarized the main Agile software development methodology contenders

- Scrum

Scrum is the most famous Agile variant with an incremental iterative process (The 8th Annual "State of Agile" Survey, 2014). In Scrum, product development is done in iterative cycles called Sprints. Sprints are typically one to four weeks in length, and the time box is not extendable. After planning the sprint Scrum does not allow changes into

their sprints. Scrum methodology has main three roles. Those are Scrum master, product owner and team.

The product owner: Product owners are the champions for their product. They are focused on understanding the business and the market requirements. Accordingly prioritize the work to be done by the engineering team.

The Scrum master: Scrum masters are the champions about Scrum within their team. They coach the team and the product owner, identify the ways to apply the scrum process to the business and find the ways to fine-tune it.

The Scrum team: Scrum teams are the champions of sustainable development practices. The most effective Scrum teams are tight-knit, co-located.

- Extreme Programming (XP)

Extreme Programming (XP) is unique among the Agile methods as it is focused on software development and does not consider as a project methodology.

XP based software development methodology is not suitable for teams larger than 10 members. XP sprint duration can vary from one to two weeks. This allows changes during the sprint and work in a strict priority order. Here, the developers cannot change the order of development.

- Rational Unified Process (RUP)

Rational Unified Process (RUP) is an iterative software development process framework created by the Rational Software Corporation, and now by IBM since 2003 (Kruchten, 2004). RUP is not a single concrete prescriptive process, but rather an adaptable process framework, intended to be tailored by the development organizations and software project teams that will select the elements of the process that are appropriate for their needs. RUP is a specific implementation of the unified process and it is an object-

oriented and web-enabled program development methodology. According to Rational, RUP is similar to a mentor that provides guidelines, templates, and examples for all aspects and stages of program development (Rational Unified Process: Best Practices for Software Development Teams, 2016).

- Dynamic System Development Method (DSDM)

Dynamic System Development Method (DSDM) is one of the earliest Agile frameworks. It was developed as a structured approach to Rapid Application Development which is a popular software development methodology of the early 1990s. In 2007 DSDM became a generic approach to project management (Strickland, 2011). The usual DSDM project consists of one or two teams, where any second team might take the responsibility to run tests on the development team products. Organizational research suggests that more than 5 people. The DSDM development process consists of 7 phases. Those are pre-project, feasibility study, business study, functional model iteration, design and build iteration, implementation and pre-project. DSDM contrasts with some Agile methods by its strict enforcement of "time boxes," with pre-set start and end dates and preselected team. DSDM employs a strict method for prioritizing requirements, which categorizes features as "must have, should have, could have, and want to have". Here, functionality can change but time and team composition cannot. Therefore, DSDM's emphasis on feature priorities helps teams focus on the features that deliver business value (Voigt, Glinz, & Seybold, 2004).

- The Crystal Light family

Alistair Cockburn is the developer of the collection of methodologies known as Crystal Methods. In Cockburn's words, "Crystal is a family of human-powered, adaptive, ultra-light, 'stretch-to-fit' software development methodologies. This is mainly developed for small teams. Crystal Methods is primarily focused on communication, with special focus on interaction, community, people, and skills. It has family of methods based on the project size and criticalities. The Crystal family of methodologies consists of the

following variants: Crystal Clear, Crystal Yellow, Crystal Orange, Crystal Orange Web, Crystal Red, Crystal Maroon, Crystal Diamond and Crystal Sapphire. All Crystal methods begin with a core set of roles, work products, techniques, and notations, and this initial set is expanded as the team grows or the method hardens.

Team size: The Crystal Family accommodates any team size; however, Cockburn puts a premium on premium people.
Iteration length: Up to 4 months for large, highly critical projects.
Support for distributed teams: Crystal Methodologies have built in support for distributed teams.
System criticality: Crystal supports 4 basic criticalities: failure resulting in loss of comfort, discretionary money, essential money, and life.
(Cohen, Lindvall, & Costa, 2004).

- Feature-Driven Development (FDD):

Feature Driven Development arose in the late 1990s from collaboration between Jeff DeLuca and Peter Coad (Cohen, Lindvall, & Costa, 2004). While just as applicable for small teams, Jeff designed FDD from the ground up to work for a larger team. Larger teams present different challenges. For example, a small team of disciplined and highly skilled developers by definition is likely to succeed regardless of which Agile method they use. In contrast, it is unrealistic to expect that everyone in a larger team is equally skilled and disciplined. Such reasons like this, FDD makes different choices to Scrum and XP in number of areas.

FDD focuses on design and planning, which differentiates it from other development approaches. FDD provides guidelines, tasks, techniques and other five sequential processes: develop an overall model, build a feature list, plan by feature, design by feature and build by feature. FDD software development focuses on iterative design and construction of the software product (Qumer & Henderson-Sellers, 2008).

- Lean Software Development (Lean SD)

Lean Development (LD), started by Bob Charette, based on the success Lean Manufacturing found in the automotive industry in the 1980s. While other Agile Methods look to change the development process, Charette believes that to be truly Agile need to change how companies work from the top down. The following 12 principles of Lean Development's focus on management strategies:

1. Satisfying the customer is the highest priority
2. Always provide the best value for the money
3. Success depends on active customer participation
4. Every LD project is a team effort
5. Everything is changeable
6. Domain, not point, solutions
7. Complete, do not construct
8. An 80 % solution today instead of 100 % solution tomorrow
9. Minimalism is essential
10. Needs determine technology
11. Product growth is feature growth, not size growth
12. Never push LD beyond its limits

Because LD is more of a management philosophy than a development process, team size, iteration length, team distribution, and system criticality are not directly addressed (Cohen, Lindvall, & Costa, 2004).

- Adaptive Software Development (ASD)

Adaptive software development (ASD) is a software development process that grew out of rapid application development work by Jim High smith and Sam Bayer (Singh & Chana, 2013). It embodies the principle that continuous adaptation of the process to the work. It replaces the traditional waterfall cycle with a repeating series of speculate, collaborate, and learn cycles (Singh & Chana, 2013). This dynamic cycle provides for continuous learning and adaptation to the emergent state of the project. The characteristics of an ASD life cycle are mission focused, feature based, iterative, time boxed, risk driven, and change tolerant.

The main objective of the project is to identify the factors towards the successful adoption of Scrum software development processes and their relative importance. Therefore, next section will describe about the Scrum methodology in detail.

2.3 Scrum Methodology

Scrum is a term originated from rugby sport. Ken Schwaber and Jeff Sutherland developed Scrum methodology. Ken Schwaber, one of the developers of Scrum, described his experience while he was managing a software company in early 1990s. He stated that their requirements were varying frequently and their customer's methodology did not help, instead it slowed them down. In order to solve this problem, he introduced the Scrum process as a solution. Scrum is an innovative approach to getting task completed. Scrum is an Agile framework for completing complex projects. Scrum was originally formalized for software development projects, but functions work greatly well for any complex, innovative projects.

According to 8th annual Agile survey (The 8th Annual "State of Agile" Survey, 2014) Scrum is the most popular Agile variant used by companies and according to Scrum.org "Scrum is a management and control process that cuts through complexity to focus on building software that meets business needs. Management and teams are able to get their hands around the requirements and technologies, never let go, and deliver working software, incrementally and empirically. Scrum itself is a simple framework for effective team collaboration on complex software projects." Below section describes the steps and roles involved in Scrum methodology.

Scrum is consisted with three main roles namely product owner, development team and Scrum master. The product owner represents the stakeholders and the voice of the customer. The development team is responsible for delivering potentially shippable increments of product at the end of each sprint. Sprint is a time box or duration. Scrum is facilitated by a Scrum master, who is accountable for removing impediments to the ability of the team to deliver the product goals and deliverables. The Scrum master is not a traditional team leader or project manager, but he acts as a buffer between the team and in any distracting influences. Figure 2.1 shows the process of Scrum in detail.

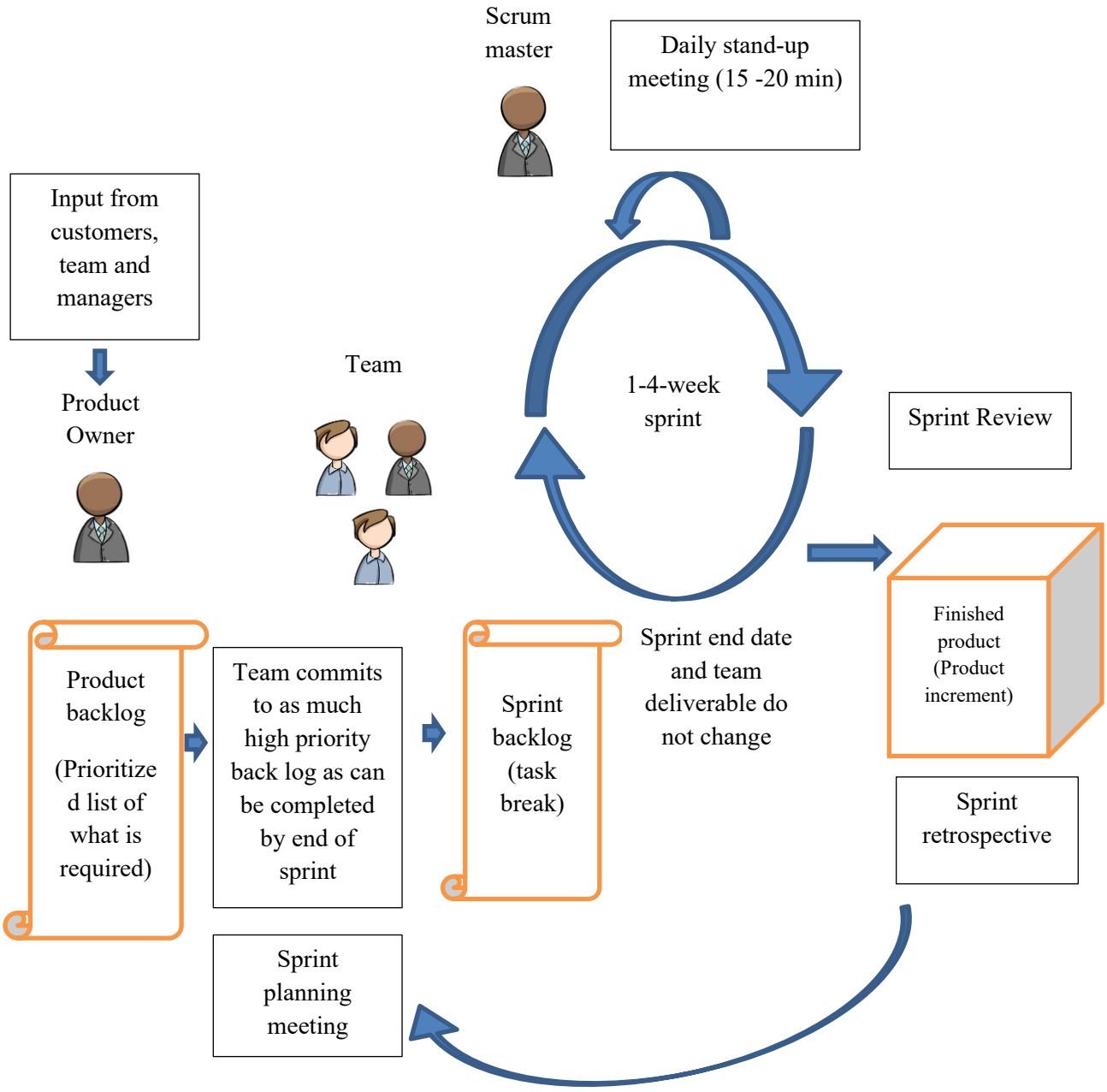

Figure 2.1: Scrum process

Scrum starts with user stories. User stories are user requirements in the plain customer's language without including too excessive details. After completing the story add it to the project backlog. After creating project backlog start planning the release. A release is a

time-boxed activity in which certain high ranked user stories are set to be completed. A release planning meeting is arranged, so team could identify what product owner and stakeholders want to achieve in a specific time. In release planning identify the stories based on the priority. After that, starts the sprint planning meeting. The sprint planning meeting occurs at the beginning of the iteration. The development team selects a higher priority user story and divides it into one or many tasks. Tasks are created and assigned by the developers. This happens until the end of sprint backlog. Duration of a sprint varies from team to team. One to four weeks' iteration can be selected but mostly two weeks' iteration is popular in Agile. The sprint stand-up meetings are held daily to determine given below information. The duration of the meeting varies form 15 minutes to 30 minutes.

1) What items were completed since the last Scrum Meeting?
2) What issues or blocks have been found that need to be resolved.
3) What new assignments make sense for the team to complete until the next Scrum Meeting?

At the end of each sprint product output is produced and demonstrated to the customer in sprint review meeting. Furthermore, at the end of each sprint retrospective is performed to review the Scrum process within Scrum team. The sprint retrospective is facilitated by Scrum master. The team discusses the just-concluded sprint and determines what could be changed, that might make the next sprint more productive. Effort is made to identify the information stated below during the sprint retrospective.

- What went well during the sprint cycle?
- What went wrong during the sprint cycle?
- What could we do differently to improve?

Based on the answers for the above questions team can improve the next sprint.

2.4 Success of Scrum Software Development

All software development methodologies become successful based on set of factors. These factors can be nature of the project, people, organization, communication and etc. Therefore, it is very vital to select the appropriate methodology for the particular project based on these factors. Main aim of the study is to identify the factors that help to adopt Scrum successfully. Therefore, this section explains about the successful factors identified by former researches to make Scrum project successful.

Chow and Cao (2008) conducted a survey among Agile professionals, gathering survey data from 109 Agile projects from 25 countries across the world. This helped to identifying six critical success factors hypothetically related to Agile project success. Those factors are team environment, team capability, customer involvement, project management process, Agile software engineering techniques, and delivery strategy.

França, Silva and Mariz (2010) further studied the research done by Chow and Cao. They found all the factors identified by Chow and Cao, do not have effect on success of the Scrum process. They grouped the Agile attributes in a set of nine higher level factors using principal component analysis. Management style, software process, team structure, technology, team capability, customer commitment, delivery strategy, team location, customer awareness was considered as critical factors for the success of the project.

Similarly, Cohen, Lindvall and Costa (2004) mentioned the three most success factors identified are culture, people and communication. The above research paper states that the culture of the organization has a major effect on the success of Agile process. If culture is not suitable then the organization or project is unable to conduct Agile. The team should be also competent. Apart from that, the organization should provide facilities to team members to communicate effectively. Another important fact in Agile

process is process documents to retain critical information. Goal should be to communicate efficiently and documentation should be one of the last options to fulfil the goal. Therefore, according to the study culture, people, communication, organizational support and team capability are critical factors for the success of Scrum project.

Similarly, Subhas C. Misra, Vinod Kumar and Uma Kumars (2010) also studied the success factors of software development. In the study organizational factors, people factor and technical factor are considered as the success factors of the Scrum development.

El-Emam, Goldenson, McCurley and Herbsleb (2001) observed that the most important factor in distinguishing between success and failure of software process improvement efforts is the extent to which the organization is focused in its improvement effort, with clearly defined goals and consistent directions set by senior management.
Also factors that may be worth exploring for Scrum adoption include:

- Lack of management commitment: Goodman believes this problem occurs, because of the people involved in the quality programs, discuss about the quality rather than business in terms that managers relate to. Discussion of Scrum in terms of engineering rather than business concerns could lead to a similar problem.

- Lack of clearly defined goals: Goals depend on a clear statement of the desired benefit to be obtained by adopting a new technology, which provides a foundation for the measuring progress and determining the success.

- Staff inexperience: The skill required to solve technical problems can be very different from the skills necessary to successfully manage human resource,

especially when changing management paradigms from control oriented approach to an empowered, coaching style.

• Lack of training: Investing in the necessary training to enable new methods and techniques to flourish is a common problem. Agile methods such as Scrum require new skills in management, technical and teamwork areas.

• The Pilot Syndrome: The effects of pilots may take many months to assess. Any benefits they deliver will be confined to the pilot area and will not impact the overall business management commitment. The delay between investing in improvement activities and reaping the benefits is a general problem with working smarter versus working harder.

• A lack of measurement: Evidence based management supports the adoption of successful new technologies based on objective evidence Agile methods. However, they are not known for their use of data in decision making, including quantitative or statistical arguments for why to adopt Agile methods.

Adaptive Software Development (ASD) is also belonging to the Agile software development family. Misra et al. (2009) has done a similar research to find the success factors of using ASD. In this paper, research is performed by conducting a survey-based ex-post-facto study to identifying factors from the perspective of the ASD practitioners that will influence the success of projects which adopt ASD practices. The research creates a hypothetical framework to create the questionnaire and use statistics to prove the truth of the success factors. The study was conducted using an unprecedentedly large-scale survey-based methodology, consisting of respondents who practice ASD and who had experience practicing plan driven software development in the past. The approach for data analysis was quantitative in nature, with some qualitative analysis of the data collected through replies to the open ended questions in the questionnaire.

According to the study the important success factors that were identified could be listed as: customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, control, personal characteristics, societal culture, training and learning.

There are many practical examples to show successful Scrum adoption in software development projects. Spotify, a popular music streaming service headquartered in London and Stockholm that is used by over 60 million users worldwide and employs over 1,200. They use the Scrum process successfully. Organization culture is very important in practicing Scrum according to the Spotify consultants. They say organization culture is very important in practicing Scrum. They have specified ten teachings for Agile followers.

- Agile coaches, squads and the importance of autonomy:
    - They called teams as squads and Scrum master as Agile coach. Team consisted of no more than eight people who were given full autonomy to operate as a cross-functional and self-organising unit.

- Adjusting the outer environment to reflect what the company values:
    - Members share the same work area and have access to shared lounges with white boards called huddle rooms, for private meetings.

- Local decision taking makes squads more productive:
    - Autonomy is expressed in practice by giving squads the ability to bypass committees and layers of management and make and act upon the decisions the members reach together. This allows the company to scale easily without being held back by dependencies and coordination problems.

- High autonomy, high alignment:
    - Spotify maps organisation cultures across a two dimensional matrix that measures levels of autonomy on one axis and alignment on the other axis.

- Cross-pollination of ideas and techniques:
    - Spotify squads use many work processes and tools. Each squad is free to experiment with any Agile method.

- Mutual respect and sharing of credit
- Constant motivation
- Squads, Tribes, Chapters and Guilds

- Community over hierarchy
    - The leader's role is more similar to servant-leader, coach and mentor, rather than the more traditional boss or manager.

- Test automation and continuous delivery

(ReQtest, 2015)

According to above points, it could be stated that organization culture, communication, people quality, process and technology are significant for the success of the Scrum projects.

Adobe Premiere Pro is an another example. It began Agile adoption in 2008 and gained in product quality, team work-life balance, and market fitness and responsiveness.
According to the company opinion, communication is a very important factor for the success. All the team members should have well communication bandwidth. If one member of the team has a low communication bandwidth limit such as phone or video

conferencing, then the entire team throttles their communication paths to match that bottleneck. This can hinder collaboration. Apart from that, breaking the problems vertically to fit the sprint is also recommended (Green, 2012).

Similar to advantages Agile software development framework also has limitations. According to Turk, France and Rumpe (2014) Agile methodology has to face below mentioned limitation.

- Limited support for distributed development environments.
- Limited support for subcontracting.
- Limited support for building reusable artefacts.
- Limited support for development involving large teams.
- Limited support for developing safety-critical software.
- Limited support for developing large, complex software.

According to 8th annual Agile survey, (The 8th Annual "State of Agile" Survey, 2014) Scrum is the most popular Agile variant used by companies. The percentage of usage is more than fifty. Therefore, it is very valuable to identify the required factors to achieve success of Scrum projects.

In addition to the success factors of Scrum, it is necessary to identify the methods of measuring the success of the project. Objective measures of cost and benefit would be preferred and will be collected to the degree available, but rigorous measures of value are frequently lacking in industry projects. Therefore, it is very important to identify a method to measure the success of the project.

In general projects are carried out under certain constraints. Those are time, cost and scope and quality. Recently, the triangle has allowed a project management diamond as

in Figure 2.2: cost, time, scope, and quality are now the four vertices, with customer expectations as customer satisfaction (Duncan Haughey, 2011).

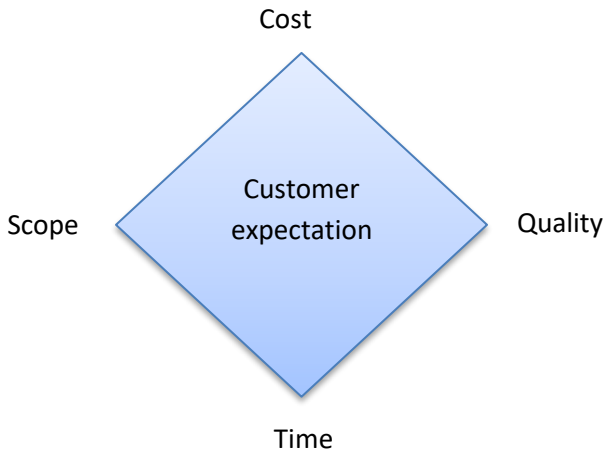

Figure 2.2: Four vertices, with customer expectations as customer satisfaction

Shenhar, Levy, and Dvir (1997) identified below mentioned dimensions for project success.

- Customer satisfaction: meeting requirements, fulfilling customer needs
- Budget and schedule (cost): meeting time and budget goals
- Business success (scope): the level of commercial success or market share
- Future potential: opening new markets, developing new technologies

After considering all the above literature, it is clear that, there are many common success factors identified by the entire researcher. Those are communication, people skill, organization culture, process of the organization and technology used. Project success is measured based on time, scope, cost, quality and customer relationship.

2.5 Summary

This chapter contains the details of the literature review. It contains five sections: history of Agile, variants of Agile software development, Scrum methodology, success of Scrum software development and summary. Although Agile methods are new as a whole, their principles and ideas have been around long time ago, and people who criticized the traditional methods suggested alternative approaches which were nothing but Agile ideas. Scrum is the most popular Agile variant. According to the main objective the study identified success factors based on the literature review. Those success factors are communication, process, people, technology and organizational culture. Next chapter describes about the research methodology followed by the study.

CHAPTER 3: RESEARCH METHODOLOGY

The main objective of the project is to identify the factors of successful implementation of Agile practices in software projects. The research measures the success of the project based on reduced time, reduced cost, and increased quality factors that are connected to the success of the project. The independent variables of success factors are validated using data collected from surveys. Survey based research methodology is a conventional technique used in management information systems. Broadly, it consists of the following three phases:

Phase I: Complete literature review, Formulation of the research question, construction of a framework and the development of hypotheses based on the research question.

Phase II: Designing the survey instrument and the collection of data through surveys.

Phase III: Analysis of the data collected as part of Phase II.

This research uses the hypothetical framework and the hypotheses to design a questionnaire, which is used for gathering data from the field. The data gathering was mainly based on web based questionnaire. The data gathered was statistically analysed using suitable data analysis techniques. The statistics are used to gain an understanding of the important factors responsible for the success of projects that want to adopt Scrum practices. The collection of data was focused only on the IT industry as such the project main target is to find the success factors of the software development projects. Hence the questionnaire is distributed among the IT sector.

3.1 Theoretical Framework

Organizational, people, process, technology and communication as independent factors are identified as independent factors in successfully adapting Scrum software development process after completing the literature survey. Project success is the dependent factor. Success of the project measured based on quality, scope completion, time, cost, and customer relationship. Table 3.1 shows the independent and dependent variables used for successful adaption of Scrum software development projects.

Table 3.1: Theoretical Framework

Variables	**Dimension**	**Type**	**Reference**
Organizational	Team Location, Team structure, Cooperate culture	IV	Chow and Cao (2008), França, Silva & Mariz (2010), El-Emam, Goldenson, McCurley, and Herbsleb (2001)
People	People skills and knowledge, Team size, Collaboration/involvement, Commercial pressure, Leadership guidance	IV	Chow and Cao (2008), França, Silva & Mariz (2010), Cohen, Lindvall, & Costa (2004), Misra, S. C., Kumar, V., & Kumar, U. (2010), El-Emam, Goldenson, McCurley, and Herbsleb (2001)
Process	Management style, Delivery Strategy, Decision making, Customer commitment, Customer awareness	IV	Chow and Cao (2008), França, Silva & Mariz (2010) Misra, S. C., Kumar, V., & Kumar, U. (2010), França & L. M. R. (2010)
Technology	Training and learning, Project technologies	IV	França, Silva & Mariz (2010) Misra, S. C., Kumar, V., & Kumar, U. (2010). Chow and Cao (2008), El-Emam, Goldenson, McCurley, and Herbsleb (2001)
Communication	Frequency of Scrum meeting, Visibility, Opportunity	IV	Cohen, Lindvall, & Costa (2004), Kelle, E., Visser, J., Plaat, A., & Wijst, P (2015), Green (2012)
Success of the project	Quality, Scope, Time, Cost, Customer relationship	DV	Chow and Cao (2008), Shrnhur, Levy, and Dvir (1997), Duncan Haughey (2011)

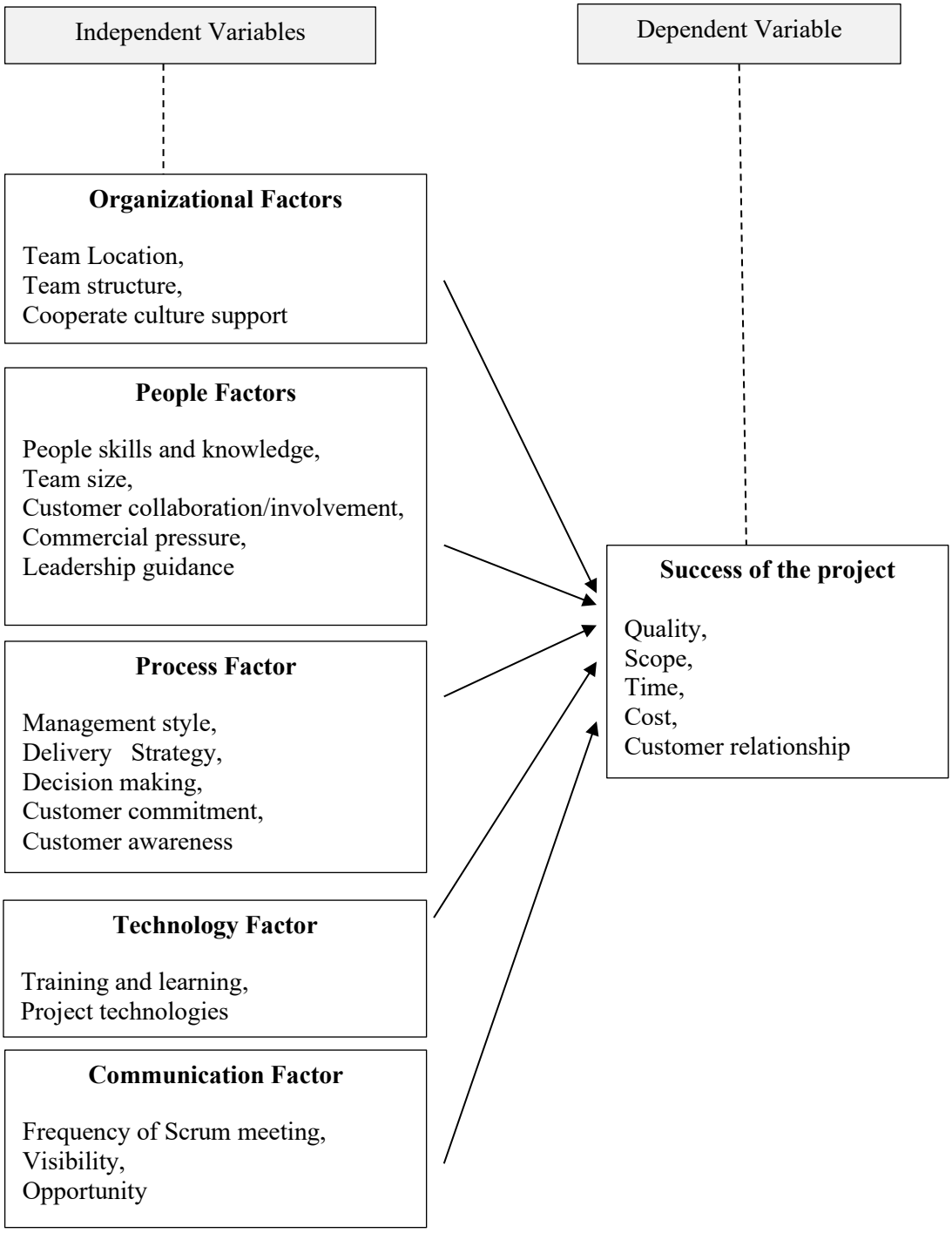

Figure 3.1: Research model with independent and dependent variables

3.2 Hypothesis

Above theoretical framework was used to derive below mentioned five hypotheses. These hypotheses need to be tested based on the collected data. The null hypothesis denoted as H0 is considered as true, when there is no statistical significant. The alternative hypothesis Ha is accepted as a result of rejection of null hypothesis.

Hypothesis 01 (H1)

1. H0: There is no significant relationship between communication factors and the success of the Scrum project.

   Ha: There is a significant relationship between communication factors and the success of the Scrum project.

Hypothesis 02 (H2)

2. H0: There is no significant relationship between technology factors and the success of the Scrum project.

   Ha: There is a significant relationship between technology factors and the success of the Scrum project.

Hypothesis 03 (H3)

3. H0: There is no significant relationship between process factors and the success of the Scrum project.

   Ha: There is a significant relationship between process factors and the success of the Scrum project.

Hypothesis 04 (H4)

4. H0: There is no significant relationship between people factors and the success of the Scrum project.

   Ha: There is a significant relationship between people factors and the success of the Scrum project.

Hypothesis 05 (H5)

5. H0: There is no significant relationship between organizational cultural factors and the success of the Scrum project.

   Ha: There is a significant relationship between organizational cultural factors and the success of the Scrum project.

3.3 Determine Sample Size

The main purpose of the project is to identify the success factors of adapting Scrum in software development process. Therefore, before starting the research, completed a preliminary survey to identify the Scrum practicing companies in Sri Lanka. In order to identify the success factors of Scrum, the respondents should have in-depth knowledge about the Scrum process. Therefore, the target population for the research is the software professionals working in the Scrum based software organizations. According initial study, there are about 105 IT companies. However, only about 25 companies practice Scrum with around 6900 employees. As a result, the population size used for the analysis is 6900. The sample size is computed using below parameter values and equations.

$$\text{Sample size} = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Population = 6900

Z = Z value (e.g. 1.96 for 95% confidence level) = 1.96

p = Standard deviation = 0.5

c = confidence interval (margin of error) = 0.09

Then modified sample size based on the population using below equation.

$$\text{New sample size} = \frac{\text{Sample size}}{1 + \frac{\text{Sample size} - 1}{\text{population}}}$$

Then calculated sample size as 117 with the above parameters using "Rasoft" tool and above mentioned equations (Raosoft.com, 2016).

3.4 Design of Questionnaire

The questionnaire (Appendix A) consists with demographic questions in addition to factor based questions. Demographic questions are used to understand the sample. In addition, questionnaire contains questions to collect data related to independent and dependent variables identified during the literature survey. Questionnaire consist five point Likert scale questions to measure the variables. After designing the questionnaire instrument, a pilot study was carried out based on 42 responses. After that, using pilot survey responses verified the validity of questionnaire using Cronbach alpha calculation. Cronbach alpha calculation is explained in chapter 4. Table 3.2 shows the questions created for each factor.

Table 3.2: Questions designed for each factor

Variables	**Questions**
Organizational	1. Our organization management empowers the development team to do it work using the Scrum method successfully 2. Organization infrastructure is compatible with Scrum style work environment ** 3. Organization reward system helps to make Scrum process successful 4. Organization face to face communication helps to improve the communication and negotiation in Scrum environment 5. Our projects have mechanisms that enable employees to communicate and negotiate quickly and effectively.
People	1. Are you comfortable in working in Scrum process without help? ** 2. Our team generally consists of technically competent and experienced people who help to deliver product on time. 3. Organization managers have knowledge about Scrum system which help to reduce cost 4. Team member's good customer relationship helps to manage the deliverable quality and scope 5. Highly motivated team members complete the tasks with good quality 6. Coherent, self-organizing teamwork help provide quality deliverables using Scrum 7. The number of employees in your team is
Process	1. We strive to make important project decisions rapidly 2. Our management support the decisions of the developers which help to improve the quality of deliverable 3. Organization Scrum based requirement management process successfully manage the scope of project 4. Organization follow Scrum oriented project management process to manage time and cost 5. Organization follow Scrum based configuration management process to achieve success 6. Organization track progress of the project continuously which helps to monitor the scope. 7. Customer's full authority over the process helps to manage scope 8. Our customers are committed to the project, they are motivated, active, and consider themselves to be responsible elements of the project which is a key factor of the success of project
Technology	1. Our team members are in general always willing to continuously learn from one another and train them through training programs to improve

	quality of deliverable 2. We use latest technologies and tools in our projects to reduce time 3. Project has rigorous refactoring activities to maintain scope and quality of project 4. Organization has appropriate training team for technical people to improve the quality of work 5. Quality of deliverables are gained by good coding standards ** 6. Project delivers most important features first to maintain customer relationship 7. The project has clearly stated and measurable goals and objectives
Communication	1. We have daily Scrum meeting in our project ** 2. Daily Scrum duration is 3. All team members can participate in sprint alignment 4. All team members have the visibility to Scrum process 5. Projects have right amount of documentation to improve the project visibility
Success of the project	1. Less number of high/medium severity defects in sprint plan delivery shows successful adaption of Scrum 2. Efficient use of time improves the product delivery 3. Scope monitoring improves the customer relationship 4. Project manages always completes the project within allocated budget to achieve successful project ** 5. Strong customer commitment, relationship is very important for a successful project

All the questions are based on likert scale mentioned in table 3.3, 3.4 and 3.5. Full questionnaire available in appendix A.

Table 3.3: Measures of independent variables

Variables	**Dimension**	**Scale**
Organizational	Team location	Five point Likert scale
	Team structure	Five point Likert scale
	Cooperate culture	Five point Likert scale
People	People skills and knowledge	Five point Likert scale
	Team size	Ratio scale
	Customer collaboration/involvement	Five point Likert scale
	Commercial pressure	Five point Likert scale
	Leadership guidance	Five point Likert scale
Process	Management style	Five point Likert scale

	Delivery Strategy	Five point Likert scale
	Decision making	Five point Likert scale
	Customer commitment,	Five point Likert scale
	Customer awareness	Five point Likert scale
Technology	Training and learning	Five point Likert scale
	Project technologies	Five point Likert scale
Communication	Frequency of Scrum meeting	Ratio scale
	Visibility	Five point Likert scale
	Opportunity	Five point Likert scale

Table 3.4: Measures of dependent variables

Variables	**Dimension**	**Scale**
Success of the project	Quality	Five point Likert scale
	Scope	Five point Likert scale
	Time	Five point Likert scale
	Cost	Five point Likert scale
	Customer relationship	Five point Likert scale

Table 3.5: Scale

Scale	**Rank**
Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly Disagree	1

Scale for stand-up meeting duration	**Rank**
15 min	5
20 min	4
30 min	3
45 min	2
More than 45	1

3.5 Data Collection Method

Software professionals with experience in Scrum methodology in Sri Lanka are selected as the population for the survey. Quantitative methodology and questionnaire are the two techniques frequently used for the data collection by the former researchers. The population is considerably greater. Therefore, questionnaire is the most appropriate technique to gather data.

The survey was conducted as an anonymous on-line survey, based on Google forms. This is offered over period of two months for survey participants. Type of survey questions are closed end and are based on Likert Scale. The survey furthermore contains demographic questions to understand the respondents. Demographic questions collected the information related to participant's Scrum adherence, work experience, educational qualification and their perception towards Scrum. Complete questionnaire given in Appendix A. The online survey invitation distributed among Scrum practicing companies through email communication. The main aim was to get many responses from different Scrum roles.

3.6 Summary

This chapter covers details of research methodology using five sections. Those sections are theoretical framework, hypothesis, determine sample size, design of questionnaire and data collection method. Theoretical framework is designed based on the success factors identified in literature survey. Communication, technology, process, project and organization culture are the dependent variables and project success is the dependent variable. The questionnaire contains questions to cover all the dependent and independent variables. The study contains five hypotheses to determine the correlation between factors and the success of the project. Data collection was purely based on web and distributed through email communication. Next chapter explains the statistical analysis result of the research.

CHAPTER 4: DATA ANALYSIS

The main objective of the project is to identify the factors towards the successful adoption of Scrum software development processes and their relative importance. The study initiated with the literature review to understand already identified success factors of Scrum adaption process in software developing projects. Afterwards, the theoretical framework for the questionnaire is developed based on the identified success factors. After that, IT companies in Sri Lanka are selected for data collection. Finally, Cronbach Alpha Analysis ('Cronbach's Alpha | Real Statistics Using Excel', n.d.) is used to validate the questionnaire. This is further explained in section 4.1. The validity of questionnaire is very important for the collection of relevant data. The data collection was mainly performed using a web based questionnaire. Questionnaire survey was mainly conducted in between October 2015 and January 2016.

4.1 Cronbach Alpha Calculation

It is essential to validate the questionnaire. Questionnaire contains multiple questions. These questions aid understanding and proving the validity of success factors. The challenge is to ask questions that vary enough to measure the different sides of the factors, yet still relate to the same factor. If survey questions are inappropriate consequently the data produced will be misleading, therefore it will lead to inaccurate interpretations. Therefore, Cronbach alpha analysis helps to identify whether different questions, all measure the same factor. Below section describes about the Cronbach alpha analysis.

The population sample size of the analysis is 117. Therefore, Cronbach alpha analysis is computed using 42 (around 10% from the sample size) responses. Based on Cronbach alpha analysis valid questionnaire should have a Cronbach value equal to or greater than 0.7. The questionnaire is based on the identified factors such as organization culture,

people, technology, process, communication and project success. After that, the validity of questions was verified under each factor using calculated Cronbach alpha values. Below table (Table 4.1) shows the commonly accepted values of Cronbach.

Table 4.1: Commonly accepted Cronbach values

Cronbach's alpha	**Internal consistency**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Questionnaires with alpha value equal or greater than 0.7 are acceptable. Table 4.2 shows the Cronbach alpha analysis results of 42 responses.

Table 4.2: Cronbach values of each factor

Factor	**Cronbach's alpha Value (α)**
Organization culture	0.686 (After removing question 2)
People	0.705 (After removing question 1)
Process	0.663
Technology	0.686 (After removing question 5)
Communication	0.723 (After removing question 1)
Project success	0.731 (After removing question 4)

Higher the Cronbach alpha values higher the validity of questions. Therefore, to increase the values, the questions marked with asterisks were eliminated from the questionnaire in Table 2. Further details of the Cronbach alpha analysis of factors available in appendix B.

4.2 Descriptive Analysis

Descriptive analysis is very import to visualize raw data, especially when there are lot of data. Descriptive statistics is the term given for the analysis of data that helps to describe, show or summarize data in a meaningful manner. For example, patterns could emerge from the data. Descriptive statistics do not allow us to make conclusions beyond the analysed. Also it doesn't allow to reach conclusions regarding any hypotheses. They are simply a way to describe our data.

Therefore, this section present background information related to Scrum based software development companies. Figure 4.1 shows the distribution of gender of the data set used.

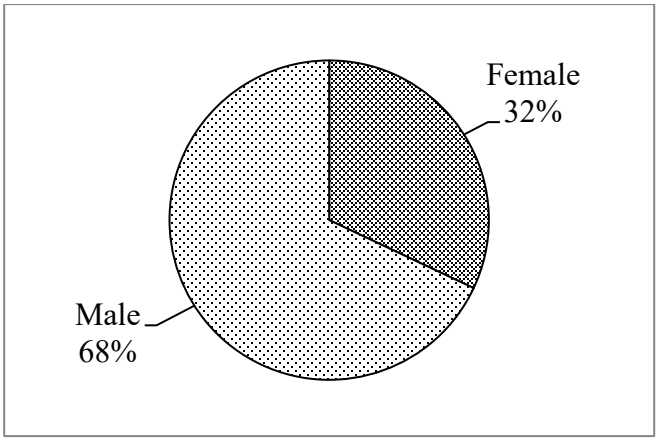

Figure 4.1: Female and male distribution in the sample

According to the pie chart the male representation is higher in the data set. Dataset contains only around 32% of the females. Figure 4.2 shows the participants' number of years of experience in Scrum. According to the table majority of the people in the sample are with 1-3 years of experience in Scrum development projects. Therefore, we can guarantee the accuracy of their responses.

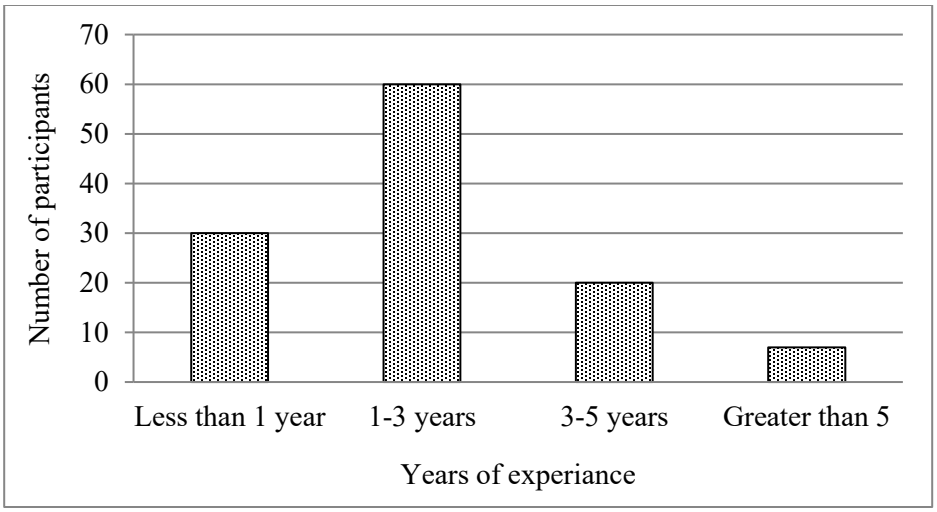

Figure 4.2: Number of years of Scrum experience

Figure 4.3 shows the total years of experience in IT industry. Most of the participants have 6 to10 years of working experience in IT industry. Then next set of majority has 1 to 5 years of experience. Therefore, the participants can be considered as matured employees in the IT industry.

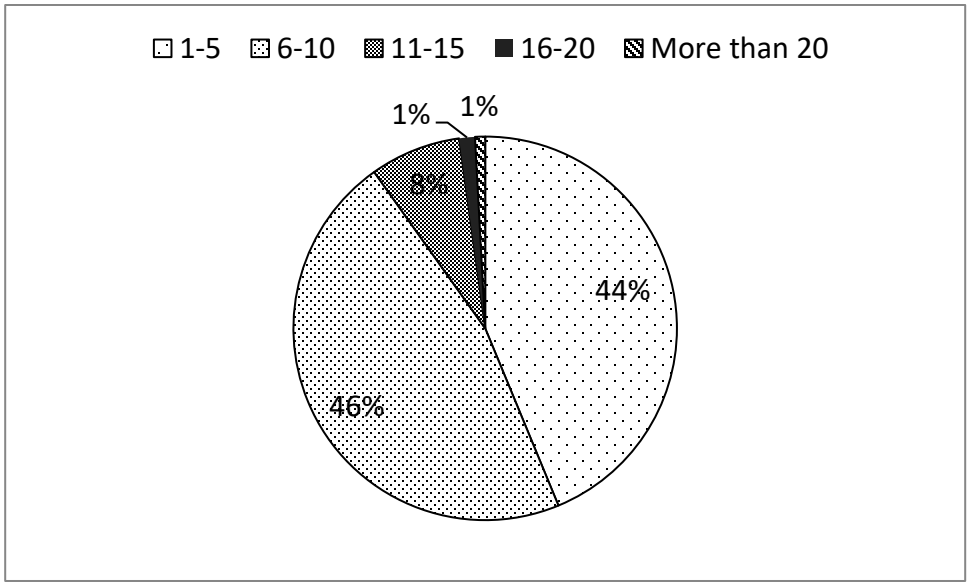

Figure 4.3: Number of years of experience in IT

Figure 4.4 shows the Scrum experience duration of the selected sample. According to the graph most of the teams have Scrum meeting around 15 to 20 minutes. One team has the Scrum daily meeting for about 45 minutes. After analysing further, it was identified that particular team doesn't conduct daily Scrum meetings. Therefore, it is clear that most of the teams follow the theoretical standard of Scrum daily standard meeting duration of 15 minutes.

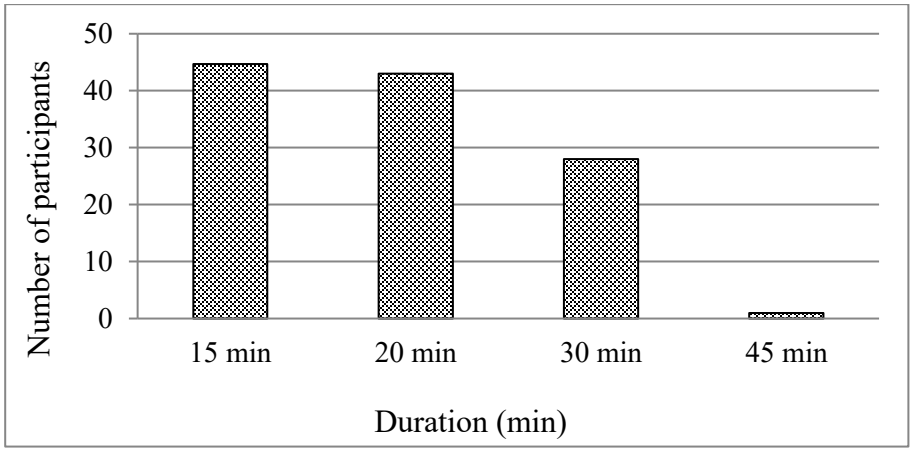

Figure 4.4: Scrum daily stand up meeting duration

Figure 4.5 shows the number of team members in the Scrum team. According to the sample majority of the teams consists with 5 to 10 members. Which is the standard team size of Scrum project. After that most of the teams are consists with 11 to 20 members.

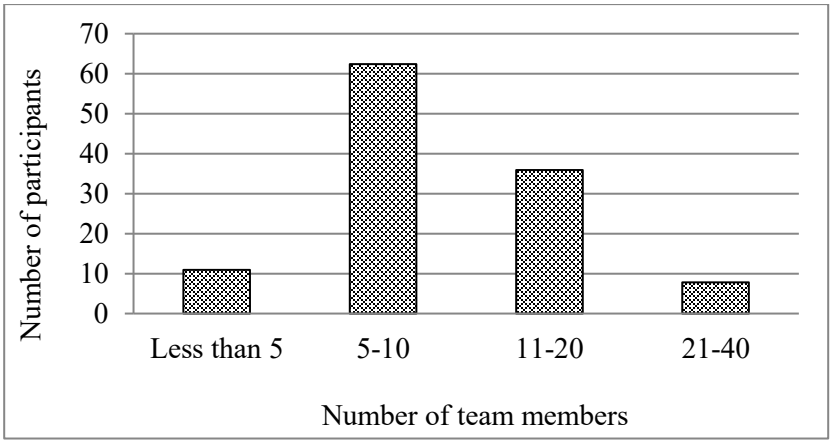

Figure 4.5: Number of team members in sample

Figure 4.6 shows the survey participants Scrum team roles.

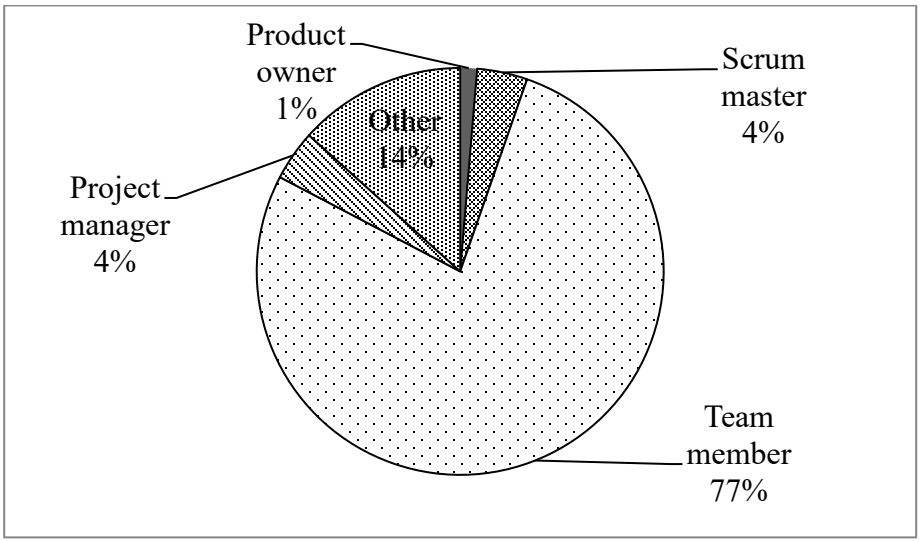

Figure 4.6: Percentage of each Scrum team roles.

According to Figure 4.6 most of the participants play team member role. Generally, quantity of the team members is larger than the other roles in software development. Then next highest percentage is allocated to other roles.

Figure 4.7 explains the level of qualification of the sample. Majority in the sample have bachelor's degree and the master's degree. There are no participants with a doctorate.

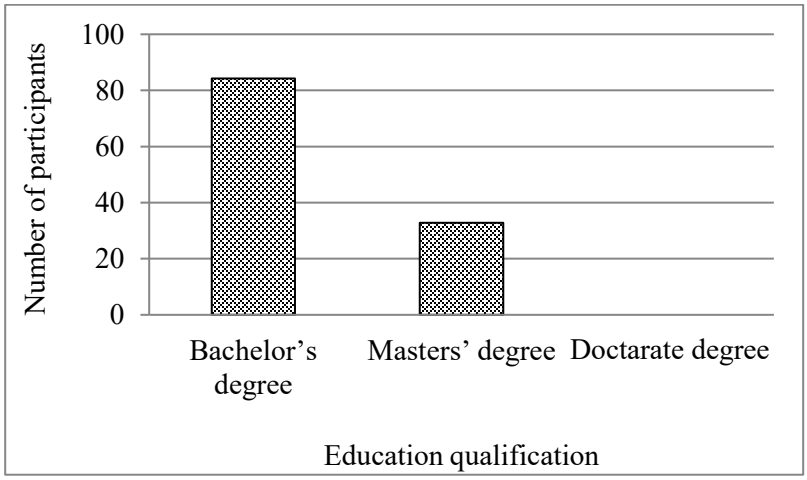

Figure 4.7: Educational qualification.

Figure 4.8 shows the number of employees of the organizations of the sample participants. Most of them are from organizations with number of employees ranging from 101 to 500.

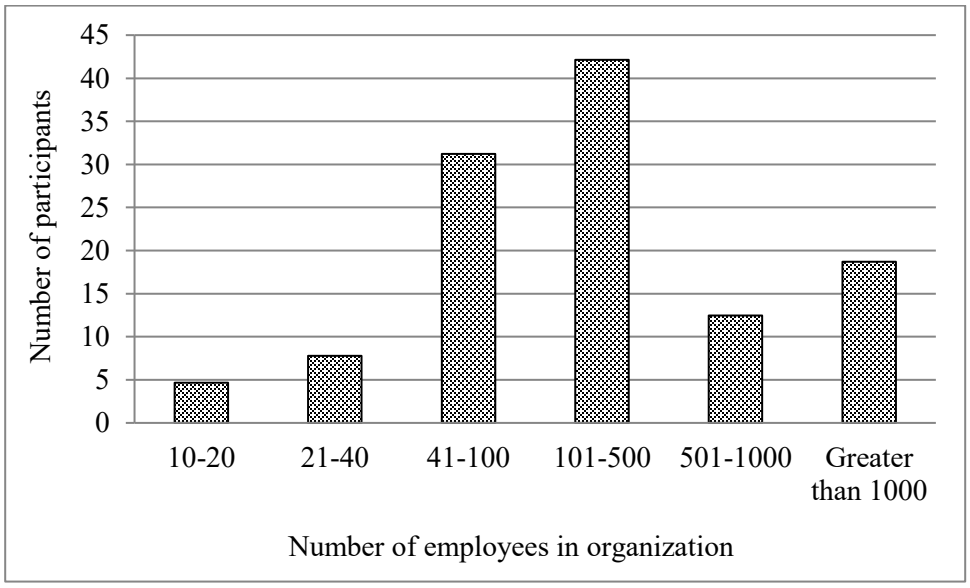

Figure 4.8: Number of employees in the organization.

4.3 Inferential Analysis

Inferential statistics is concerned in making predictions about a population from observations and from analysis of a sample. That is, it allows to take the results of an analysis using a sample and can generalize it to the larger population that the sample represents. This study analysed the sample data using Pearson correlation and linear regression. Below sections describe the results of the analysis.

4.3.1 Analysis based on Pearson Correlation

This section describes about the finding of hypothesis testing based on correlation. Correlation is a technique used for investigation of the relationship between two quantitative and continuous variables. Multiple hypotheses defined are tested for reject

H0 in favour of Ha or to accept H0 using bivariate correlation analysis in SPSS tool. This analysis uses Person correlation value (r) and signed (two tailed) values to accept H0 or Ha. Pearson's correlation coefficient (r) is a measure of strength of the association between the two variables. Table 4.3 shows the coefficient r value ranges, which are used to consider the strength of the relationship.

Table 4.3: Strength of relationship based on Pearson Correlation value.

Pearson Correlation Coefficient (r)	**Strength of Association**
+.70 or higher	Very strong positive relationship
+.40 to +.69	Strong positive relationship
+.30 to +.39	Moderate positive relationship
+.20 to +.29	weak positive relationship
+.01 to +.19	No or negligible relationship
0	No relationship
-.01 to -.19	No or negligible relationship
-.20 to -.29	weak negative relationship
-.30 to -.39	Moderate negative relationship
-.40 to -.69	Strong negative relationship
-.70 or higher	Very strong negative relationship

Pearson’s r is close to 1

This means that there is a strong relationship between two variables. Changes in one variable are strongly correlated with the changes in the second variable. If the number is very near to 1, It is considered as a strong relationship between the two variables. However, it’s not possible to make further interpretations about the relationship, based on this factor.

Pearson’s r is close to 0

This means that there is a weak relationship between two variables. Changes in one variable are not correlated with changes in the second variable. If Pearson’s r is 0.01, It is considered as weekly correlated.

Pearson's r is positive (+)

This means that as one variable increases in value, the second variable also increase in value. Similarly, as one variable decreases in value, the second variable also decreases in value. This is named as positive correlation.

In addition to Pearson correlation value (r), the signed two tailed value further can be used to show if there is a statistically significant correlation between two variables.

If the Sig (2-Tailed) value is greater than 0.05

There is no statistically significant correlation between the two variables. That means, increment or decrement in one variable do not significantly relate to increases or decreases in second variable.

If the Sig (2-Tailed) value is less than or equal to 0.05

There is a statistically significant correlation between two variables. That means, increment or decrement in one of the variables has a significant relationship for the increment or decrement of the other variable.

4.3.2 Testing Hypothesis

This section discusses finding of the hypothesis testing based on Pearson's correlation. Five hypotheses defined in section 3.1 are tested and results are below explained in section.

4.3.2.1 Testing hypothesis 01

H0: There is no significant relationship between communication factors and the success of the Scrum project.

Ha: There is a significant relationship between communication factors and the success of the Scrum project.

A two tailed Pearson correlation test was performed to find the relationship between communication factor and success of the Scrum project. The test results are available in table 4.4.

Results:

Table 4.4: Pearson's correlation values between communication factor and project success

Correlations

		Project Success	Communication
Project Success	Pearson Correlation (r)	1	.308**
	Sig. (2-tailed)		.001
	N	117	117
Communication	Pearson Correlation	.308**	1
	Sig. (2-tailed)	.001	
	N	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion:

From the Correlations Table 4.4, it can be seen that the correlation coefficient (r) equals 0.308, indicating a relationship with positive moderate strength. The value of p is less than 0.05. Therefore, there is a statically significant relationship between communication factor and success of the project.

Based on the results we can state below.

- Scrum project success and communication factor have a statistically significant linear relationship ($p < .05$).
- The direction of the relationship is positive (i.e., Scrum project success and communication factor are positively correlated), meaning that these variables tend to increase together (i.e., greater success of the project is associated with greater communication).
- The magnitude, or strength, of the association is moderate ($0.30 < r < 0.39$).

Therefore, H0 can be eliminated while accepting Ha.

4.3.2.2 Testing hypothesis 02

H0: There is no significant relationship between technology factors and the success of the Scrum project.

Ha: There is a significant relationship between technology factors and the success of the Scrum project.

A two tailed Pearson correlation test was performed to find the relationship between technology factor and success of the Scrum project. The test results are available in table 4.5.

Results:

Table 4.5: Pearson correlation values between technology factor and project success

Correlations

		Project Success	Technology
Project Success	Pearson Correlation(r)	1	.393**
	Sig. (2-tailed)		.000
	N	117	117
Technology	Pearson Correlation	.393**	1
	Sig. (2-tailed)	.000	
	N	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion:

From the Correlations Table 4.5, it can be seen that the correlation coefficient (r) equals 0.393, indicating a relationship with positive moderate strength. The value of p is less than 0.05. Therefore, there is a statically significant relationship between technology factor and success of the project.

Based on the results we can state below.

- Scrum project success and technology factor have a statistically significant linear relationship ($p < 0.05$).
- The direction of the relationship is positive (i.e., Scrum project success and technology factor are positively correlated)
- The magnitude, or strength, of the association is moderate ($0.30 < r < 0.39$).

Therefore, H0 can be eliminated while accepting Ha.

4.3.2.3 Testing hypothesis 03

H0: There is no significant relationship between process factors and the success of the Scrum project.

Ha: There is a significant relationship between process factors and the success of the Scrum project.

A two tailed Pearson correlation test was performed to find the relationship between process factor and success of the Scrum project. The test results are available in Table 4.6.

Result:

Table 4.6: Pearson correlation values between process factor and project success

Correlations

		Project Success	Process
Project Success	Pearson Correlation(r)	1	.340**
	Sig. (2-tailed)		.000
	N	117	117
Process	Pearson Correlation	.340**	1
	Sig. (2-tailed)	.000	
	N	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion:

From the Correlations Table 4.6, it can be seen that the correlation coefficient (r) equals 0.340, indicating a relationship with positive moderate strength. The value of p is less than 0.05. Therefore, there is a statically significant relationship between process factor and success of the project.

Based on the results we can state below.

- Scrum project success and process factor have a statistically significant linear relationship ($p < 0.05$).
- The direction of the relationship is positive (i.e., Scrum project success and process factor are positively correlated)
- The magnitude, or strength, of the association is moderate ($0.30 < r < 0.39$).

Therefore, H0 can be eliminated while accepting Ha.

4.3.2.4 Testing hypothesis 04

H0: There is no significant relationship between people factors and the success of the Scrum project.

Ha: There is a significant relationship between people factors and the success of the Scrum project.

A two tailed Pearson correlation test was performed to find the relationship between people factor and success of the Scrum project. The test results are available in Table 4.7 given below.

Result:

Table 4.7: Pearson correlation values between people factor and project success

Correlations

		Project Success	People
Project Success	Pearson Correlation(r)	1	.380**
	Sig. (2-tailed)		.000
	N	117	117
People	Pearson Correlation	.380**	1
	Sig. (2-tailed)	.000	
	N	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion:

From the Correlations Table 4.7, it can be seen that the correlation coefficient (r) equals 0.380, indicating a relationship with positive moderate strength. The value of p is less than 0.05. Therefore, there is a statically significant relationship between people factor and success of the project.

Based on the results we can state below.

- Scrum project success and people factor have a statistically significant linear relationship ($p < 0.05$).
- The direction of the relationship is positive (i.e., Scrum project success and people factor are positively correlated)
- The magnitude, or strength, of the association is moderate ($0.30 < r < 0.39$).

Therefore, H0 can be eliminated while accepting Ha.

4.3.2.5 Testing hypothesis 05

H0: There is no significant relationship between organizational cultural factors and the success of the Scrum project.

Ha: There is a significant relationship between organizational cultural factors and the success of the Scrum project.

A two tailed Pearson correlation test was performed to find the relationship between organizational cultural factor and success of the Scrum project. The test results are available in Table 4.8 given below.

Result:

Table 4.8: Pearson correlation values between organization culture factor and project success

Correlations

		Project Success	Organization Culture
Project Success	Pearson Correlation(r)	1	.323**
	Sig. (2-tailed)		.000
	N	117	117
Organization Culture	Pearson Correlation	.323**	1
	Sig. (2-tailed)	.000	
	N	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion:

From the Correlations Table 4.8, it can be seen that the correlation coefficient (r) equals 0.323, indicating a relationship with positive moderate strength. The value of p is less than 0.05. Therefore, there is a statically significant relationship between organization culture factor and success of the project.

Based on the results we can state below.

- Scrum project success and organization culture factor have a statistically significant linear relationship ($p < 0.05$).
- The direction of the relationship is positive (i.e., Scrum project success and organization culture factor are positively correlated)
- The magnitude, or strength, of the association is moderate ($0.30 < r < 0.39$).

Therefore, H0 can be eliminated while accepting Ha.

4.3.2.6 Summary of hypothesis results

This research consists of five hypotheses. As per correlation results all of these have been accepted. Following Table 4.9 shows the summary of hypothesis test results.

Table 4.9: Summary of hypotheses results

Hypothesis	Correlation	Accepted hypothesis
H1: Communication factor	Moderate	Ha
H2: Technology factor	Moderate	Ha
H3: Process factor	Moderate	Ha
H4: People factor	Moderate	Ha
H5: Organization culture	Moderate	Ha

According to the hypothesis test factors such as communication, technology used in projects, process of the organization, people skills and organizational culture positively effect on the success of the Scrum project development.

4.3.2 Analysis based on Linear Regression

Linear regression is a common statistical data analysis technique. It is used to determine the extent of the linear relationship between a dependent variable and one or more independent variables. Linear regression is performed using the SPSS tool. Based on this analysis relationship between each dependent variable to each independent variable can be displayed. The first table shows the variables in the analysis. Table 4.10 indicates communication, technology, people, process and organization culture are used to predict the success of the Scrum based project.

Table 4.10: Details of variables used in linear regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Communication, Technology, Organization Culture, Process, People[b]	.	Enter

a. Dependent Variable: Project Success

b. All requested variables entered.

Table 4.11 shows the multiple linear regression model summary and overall fit statistics. It is figured that the adjusted R^2 of our model is 0.241 with the $R^2 = 0.274$. This means that the linear regression explains 27.4% of the variance in the data. According to the R square it can be stated 28% of the success of the project is explained by communication, technology, people and process factors.

Table 4.11: Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.524[a]	.274	.241	.40918

a. Predictors: (Constant), Communication, Technology, Organization Culture, Process, People

Table 4.12 shows the results of F test to determine whether the model is a good fit for the data. The model fitness for the data increases when the p value decreases. According to this p-value that is close to 0, which indicates model is a good fit for the data.

Table 4.12: F test results

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.019	5	1.404	8.385	.000[b]
	Residual	18.584	111	.167		
	Total	25.604	116			

a. Dependent Variable: Project Success

b. Predictors: (Constant), Communication, Technology, Organization Culture, Process, People

Table 4.13 shows the beta coefficients. The Coefficients part of the output gives the values that are required in order to write the regression equation. The regression equation has given below:

Predicted variable (dependent variable) = intercept + (slope * independent variable)

The equation for the regression line stated below can be computed referring to the Table 4.13 given below. This equation shows the relative importance of each factor towards success of the Scrum software development process.

Project Success =
1.159 + 0.057 (Organization culture) + 0.099 (People) + 0.065 (Process) + 0.275 (Technology) + 0.229 (Communication)

Therefore, each identified factors affect the success of the project with below percentages:

People = 10%,

Process = 7%,

Technology = 28%,

Communication = 23%,

Organization culture = 6%

The coefficient values can be further explained as follows:

People = The coefficient for people is 0.099. So for every unit increase in people, a 0.09 unit increase in project success is predicted, holding all other variables constant.

Process = The coefficient for process is 0.065. So for every unit increase in process, a 0.065 unit increase in project success is predicted, holding all other variables constant.

Technology = The coefficient for technology is 0.275. So for every unit increase in technology, a 0.275 unit increase in project success is predicted, holding all other variables constant.

Communication = The coefficient for communication is 0.229. So for every unit increase in communication, a 0.229 unit increase in project success is predicted, holding all other variables constant.

Organization = The coefficient for organization is 0.057. So for every unit increase in organization, a 0.057unit increase in project success is predicted, holding all other variables constant.

Std. Error shows the standard error values associate with each coefficient.

Table 4.13: Coefficient values

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.159	.448		2.587	.011
	Organization Culture	.057	.077	.076	.740	.461
	People	.099	.084	.127	1.181	.240
	Process	.065	.079	.083	.821	.413
	Technology	.275	.105	.257	2.624	.010
	Communication	.229	.082	.236	2.795	.006

a. Dependent Variable: Project Success

According to above table 4.13 the intercept value is 1.159. Therefore, we can say communication and technology factors have higher percentage effect on the successful adaption of Scrum in software development process.

4.4 Summary

This chapter describes the results of statistical analysis using three sections. Those sections are Cronbach alpha calculation, descriptive analysis and inferential analysis. The questionnaire created based on the theoretical framework. After creating questionnaire conducted pilot survey to validate it based on Cronbach alpha calculation. The research eliminated five questions to increase the Cronbach alpha value. After that collected data based on online questionnaire. This chapter explains the results of descriptive analysis and inferential analysis results. Inferential analysis is done using person correlation and linear regression. Pearson correlations show positive significant relationship between success factors and the Scrum methodology adoption. Next chapter explains the conclusion of the study.

CHAPTER 5: CONCLUSION

In this chapter the main findings of previous chapters are brought together within the framework of the research questions and the general objective set in the introduction. Main objective of the research is to identify and provide insight into success factors of Scrum variant that help software development projects in Sri Lanka to complete the development process with more accomplishment and identifying the relative importance of each factor when compared with each other.

5.1 Research Outcome

This study has done descriptive analysis and inferential analysis. The important role of descriptive analysis is visualizing raw data. It describes, shows or summarizes data in a meaningful way. Inferential analysis is concerned with making predictions about a population from observations and analyses of a sample. That is, it helps to use the results of an analysis using a sample and can generalize it to the larger population that the sample represents. The inferential analysis is based on Pearson correlation and linear regression. Pearson correlation helped to prove the hypothesis and liner regression helped to identify the percentage importance of each factor towards the success of the Scrum project.

The results of the descriptive analysis show that males represent more than females in the IT workforce as the sample represent only 32% of females. Most IT workface contains B.Sc. degree and that is like their minimum qualification. Most of the participants have more than one-year experience in Scrum practicing and most of the teams contain five to ten members. Also the daily stand up meeting duration is 15 to 20 minutes. This shows most organizations follow theoretical aspects of the Scrum.

The below section explains about the summary of project objectives achieved through literature survey, descriptive and inferential analysis.

Objective 1: Identify the factors towards the successful adoption of Scrum software development processes.

One main objective of the research is to identify and provide insight into success factors of Scrum in Sri Lanka. Success of Scrum project is defined as the dependent variable and five other success factors are identified as independent variables from literature survey. These independent and dependent variables are used in the theoretical framework. The online questionnaire created for data capture contains questions to collect demographics data, independent and dependent variable related questions. The data is collected from employees in selected software developing companies in Sri Lanka. Inferential analysis is done based on survey data to test hypothesis statically. As per the hypothesis test, identified factors have positive relationship with the success of the Scrum project. Below section summarizes the result of each hypothesis test.

In first hypothesis, communication factor has been identified as significantly moderately and positively related to success of Scrum project. That means frequency of Scrum meetings, visibility of requirements and opportunity to raise ideas has positive impact on success of the Scrum project.

In second hypothesis, technology factor has been identified as significantly moderately and positively related to success of Scrum project. Pearson correlation results gave ‘r’ value as 0.393 for the relationship between technology and project success according to hypothesis 2. It also demonstrates a moderate and positive relationship between those two factors. The Scrum process is very dynamic and expects quick outputs. That means training and learning ability and technology used in the project have positive impact on success of the Scrum project.

In third hypothesis, process factor has been identified as significantly moderately and positively related to success of Scrum project. Strength of the relationship is moderate. That means management style, delivery strategy, decision making, customer commitment, customer awareness used in the project have positive impact on success of the Scrum project.

In fourth hypothesis, people factor has been identified as significantly moderately and positively related to success of Scrum project. Strength of the relationship is moderate. That means people skills, team capability, team distribution, customer satisfaction, customer collaboration, leadership and guidance/support used in the project have positive impact on success of the Scrum project.

In fifth hypothesis, organization culture factor has been identified as significantly moderately and positively related to success of Scrum project. Strength of the relationship is moderate. That means team location; team structure and reward systems used in the project have positive impact on success of the Scrum project.

According to hypothesis testing results factors: technology, people, process, organization culture and communication show positive relationship with the project success.

Objective 2: Relative effect of different categories on the success of the project

Next objective of the study was to identify the relative importance of each factor when compared with each other. The study performed the linear regression to achieve this objective. It is a common statistical data analysis technique which is used to determine the extent to which there is a linear relationship between a dependent variable and one or more independent variables. 'F' test results show the 'p' value is very close to 0. Therefore, it indicates model is a good fit for the data. The coefficients part of the output gives the values to write below regression equation. This equation shows the relative importance of each factor towards success of the Scrum software development process.

Project Success =

1.159 + 0.057 (Organization culture) + 0.099 (People) + 0.065 (Process)

+ 0.275 (Technology) + 0.229 (Communication)

According to the regression equation the coefficient for people is 0.099. Therefore, for every unit increase in people, a 0.09 unit increase in project success is predicted, holding all other variables constant.

Similarly, for every unit increase in process, a 0.065 unit increase in project success, every unit increase in technology, a 0.275 unit increase in project success, every unit increase in communication, a 0.229 unit increase in project success, every unit increase in organization, a 0.057 unit increase in project success.

Therefore, above mentioned results indicate the success of the Scrum project mainly depends on the technology used in the project and then on the communication facilities available among the team.

5.2 Policy Level Implications

Hypothesis test in the study have identified positive relationship between communication, people, process, technology, organizational culture and the success of the Scrum project. Therefore, proper application of above factors will lead to success of the Scrum projects. According to the online survey data, following actions will increase the ability of achieving success in Scrum project. Most of the participants of the survey have good adherence to Scrum. Therefore, their answers indicate, they normally follow daily Scrum meetings, Scrum team size and best practices in Scrum. So it is very important to follow the best practices to gain success in Scrum adoption. Based on responses following improvements has been identified.

- Make arrangements to make daily stand up meeting and have timely communication.
- Encourage necessary documentation and practice appropriate knowledge transfer methodology. This will help to improve people skills and improve the process of decision making and customer awareness.
- Use Scrum features such as product backlog, product demos, burnt down charts to improve the visibility of the product to the team.
- Involve product owner in Scrum team meetings. This will help to do proper sprint planning and review progress.
- Build trust. Survey data also shows strong customer relationship is very important to make project successful.
- Use appropriate coding standards and automated integration and automated testing which help to improve the iterations.
- Use defined standards and process to manage code changes and other modifications. Use proper change management system. This is very important to maintain rapid changes in Scrum development process.

5.3 Research Limitations

Below mentioned research limitations were identified during the execution of the research and during the survey data collection through online questionnaire.

The research was performed within limited time frame. Therefore, research objectives were defined to meet the defined time frame and most achievable research objectives are selected for the research. In addition, due to the time constraint when deciding sample size consider margin of error as 9% and confidence level as 95%.

The demographic data gathered through the online survey represented below properties.

Gender: Male (Majority participant)
Level of education: Bachelor's and master's degree
Number of employees: 41-100,101-500

This can be due to the nature of software development industry in Sri Lanka. These limitations can be considered in future studies.

Online questions were designed incorporating simple and easy to understand properties. The questions didn't fully explain the context of the questions. Since the questionnaire was filled online there was no proper mechanism to check the uncertainty of questions and answers. Therefore, there can be some instances where responses are not 100% accurate.

5.4 Future Work

There are number of Agile variants developed based on Agile framework. Scrum is currently the most popular representative of Agile family. It is very often combined with other Agile practices. Sole knowledge of Scrum restrained the researchers from relating the findings to these variants. Therefore, it is very important to study Scrum with other Agile methodologies.

In this research these success factors are identified based only on theory. Therefore, should use the results obtained in this study in actual projects and test the degree of usefulness of the results in practice.

This research only considers about internal software development teams in Sri Lanka. Therefore, the success factors may differ for other development structures such as offshore models. This research can further improve by considering offshore software development model as well.

Scrum process has advantages as well as disadvantages. Therefore, as a future research can do identification of ways to overcome the few weaknesses of Scrum. As an example how to be used in larger projects, with larger teams, and which would offer better and scientifically sound planning tools. During the literature review most of the previous research mentioned about the size of the Scrum team. Scrum is a structured framework to support complex product development. However, Scrum methodology faces the challenge of managing large teams. They mentioned size of the Scrum team should be small to be successful. Therefore, it's good to do more research to face this challenge. It would be very beneficial if we can come up with a new method that accommodates the strengths while suppressing the weaknesses of both methods.

Furthermore, it is good to see where Scrum is heading. The adaptation of Scrum principles is moving into retail, marketing, manufacturing and government industries. This is because, these principals are highly transferrable and are based on a strong focus on customer service. Therefore, it is also beneficial to do research on finding success factors in adapting Scrum in other areas in addition to software industry.

5.5 Summary

This section describes the conclusion of the study using four sections. Those sections are research outcome, policy level implication, research limitations and future work. The study has presented a theoretical framework illustrating five dimensions of success factors of Scrum projects and the sub success factors under each factor to reach for understand ability and applicability. The inferential analysis shows positive correlation for all the identified success factors identified using literature survey. It indicates communication, process; people, organization culture and technology positively correlate with the adoption of Scrum successfully. The inferential analysis achieves the main two objectives of the project successfully. The main limitation of the research is the time constraint. Also the data collection is only based on online questionnaire. Future work section describes about ideas to improve the research future to gain more benefits in Scrum methodology.

REFERENCES

1. Abbas, N., Gravell, A. M., & Wills, G. B. (2008). Historical roots of Agile methods: where did "Agile thinking" come from?. In Agile Processes in Software Engineering and Extreme Programming (pp. 94-103). Springer Berlin Heidelberg.

2. Bassil, Y. (2012). A Simulation Model for the Waterfall Software Development Life Cycle. International Journal of Engineering & Technology (Ijet), 2(5).

3. Chandra Misra, S., Kumar, V., & Kumar, U. (2010). Identifying some critical changes required in adopting Agile practices in traditional software development projects. International Journal of Quality & Reliability Management, 27(4), 451-474.

4. Chow, T., & Cao, D. B. (2008). A survey study of critical success factors in Agile software projects. Journal of Systems and Software, 81(6), 961-971.

5. Cronbach's Alpha | Real Statistics Using Excel. (n.d.). Retrieved from http://www.real-statistics.com/reliability/cronbachs-alpha/

6. Cohen, D., Lindvall, M., & Costa, P. (2004). An introduction to Agile methods. Advances in computers, 62, 1-66.

7. Dingsøyr, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of Agile methodologies: Towards explaining Agile software development. Journal of Systems and Software, 85(6), 1213-1221.

8. Duncan Haughey. (2011, December 19). Understanding the Project Management Triple Constraint. Retrieved November 26,2015, from

https://www.projectsmart.co.uk/understanding-the-project-management-triple-constraint.php

9. França, A. C. C., da Silva, F. Q. B., & de Sousa Mariz, L. M. R. (2010). An Empirical Study on the Relationship Between the Use of Agile Practices and the Success of Scrum Projects. In Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement (pp. 37:1–37:4). New York, NY, USA: ACM. http://doi.org/10.1145/1852786.1852835

10. Huo, M., Verner, J., Zhu, L., & Babar, M. A. (2004, September). Software quality and Agile methods. In Computer Software and Applications Conference, 2004. COMPSAC 2004. Proceedings of the 28th Annual International (pp. 520-525). IEEE.

11. Jiang, L., & Eberlein, A. (2009, October). An analysis of the history of classical software development and Agile development. In Systems, Man and Cybernetics, 2009. SMC 2009. IEEE International Conference on (pp. 3733-3738). IEEE.

12. Larman, C., & Basili, V. R. (2003). Iterative and Incremental Development: A Brief History. Computer, 36(6), 47–56.

13. Lindstrom, L., & Jeffries, R. (2004). Extreme programming and Agile software development methodologies. Information systems management, 21(3), 41-52.

14. Hajjdiab, H., & Taleb, A. (2011). Adopting Agile software development: Issues and challenges. International Journal of Managing Value and Supply Chains (IJMVSC), 2(3), 1-10.

15. Green, P. (2012, August). Adobe Premiere Pro Scrum Adoption: How an Agile Approach Enabled Success in a Hyper-competitive Landscape. In 2012 Agile Conference (pp. 172-178). IEEE.

16. El-Emam, K., Goldenson, D., McCurley, J., & Herbsleb, J. (2001). Modelling the likelihood of software process improvement: An exploratory study. Empirical Software Engineering, 6(3), 207-229.

17. Larman, C., & Basili, V. R. (2003). Iterative and incremental development: A brief history. Computer, 36(6), 47-56.

18. Lindvall, M., Basili, V., Boehm, B., Costa, P., Dangle, K., Shull, F., …Zelkowitz, M. (2002). Empirical Findings in Agile Methods. In Extreme Programming and Agile Methods — XP/Agile Universe 2002 (Vol. 2418, pp. 197–207). Berlin, Heidelberg: Springer Berlin Heidelberg. Retrieved from http://link.springer.com/10.1007/3-540-45672-4_19

19. Misra, S. C., Kumar, V., & Kumar, U. (2009). Identifying some important success factors in adopting Agile software development practices. Journal of Systems and Software, 82(11), 1869-1890.

20. Kruchten, P. (2004). The Rational Unified Process: An Introduction (3rd ed.). Addison-Wesley Professional.

21. Qumer, A., & Henderson-Sellers, B. (2008). An evaluation of the degree of agility in six Agile methods and its applicability for method engineering. Information and software technology, 50(4), 280-295.

22. Raosoft.com, (2016). Sample Size Calculator by Raosoft, Inc.. Retrieved January 26, 2016, from http://www.raosoft.com/samplesize.html

23. Rational Unified Process: Best Practices for Software Development Teams. (2016). Rational Software White Paper.

24. ReQtest, (2015). How Spotify does Agile - A look at the Spotify engineering culture | ReQtest. Retrieved January 15, 2016, from http://reqtest.com/blog/how-spotify-does-Agile-a-look-at-the-spotify-engineering-culture/

25. Shrnhur, A. J., Levy, O., & Dvir, D. (1997). Mapping the dimensions of project success. Project management journal, 28(2), 5-13.

26. Singh, S., & Chana, I. (2013). Introducing agility in cloud based software development through ASD. Int. J. u-and e-Service, Sci. Technol, 6(5), 191-202.

27. Strickland, J. (2011). Simulation Conceptual Modeling. Lulu.com. Retrieved 26 November 26,2015, from https://books.google.com.au/books?hl=en&lr=&id=WsmEAwAAQBAJ&oi=fnd&pg=PR1&dq=Simulation+Conceptual+Modeling&ots=sJWozJbT1Q&sig=HhKL_8k-F_bjHMBOPZ0Orl5C8sY#v=onepage&q=Simulation%20Conceptual%20Modeling&f=false

28. The 8th Annual "State of Agile" Survey. (2014) (1st ed.). Retrieved May 13,2015, from https://www.versionone.com/pdf/2013-state-of-Agile-survey.pdf

29. Turk, D., France, R., & Rumpe, B. (2014). Limitations of Agile Software Processes. Third International Conference On Extreme Programming And Flexible Processes In Software Engineering, 1409.6600, 43-46.

30. Van Kelle, E., van der Wijst, P., Plaat, A., & Visser, J. (2015, May). An empirical study into social success factors for Agile software development. In

Cooperative and Human Aspects of Software Engineering (CHASE), 2015 IEEE/ACM 8th International Workshop on (pp. 77-80). IEEE.

31. Voigt, B. J., Glinz, M., & Seybold, D. I. C. (2004). Dynamic system development method. Department of Information Technology, University of Zurich, Zurich20 January. 29.

APPENDIX A: QUESTIONNAIRE

Demographics

1. What kind of Agile method are you using?
    - Scrum
    - Others (Extreme Programming, Crystal Methodologies, Feature Driven Development)

2. The number of employees in the organization
    - 10–20
    - 21–40
    - 41–100
    - 101–500
    - 501–1000
    - Greater than 1000

3. Your role in the team?
    - Product owner
    - Scrum master
    - Team member
    - Project manager
    - Other

4. How many years you have been practicing Scrum?
    - Less than 1 year
    - 1-3 years
    - 3-5 years
    - Greater than 5

5. How many years you have been working with a software development team?
    - 1-5
    - 6-10
    - 11-15
    - 16-20
    - More than 20

6. What is your highest education qualification?
    - High school
    - Diploma
    - Bachelor's degree
    - Masters' degree
    - Doctorate degree
    - Professional Certification
    - Other

7. What is your gender?
    - Male
    - Female

Factor based questions

Organizational culture:

1. Our organization management empowers the development team to do its work using the Scrum method successfully
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

2. Organization infrastructure is compatible with Scrum style work environment
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

3. Organization reward system helps to make Scrum process successful
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

4. Organization face to face communication helps to improve the communication and negotiation in Scrum environment
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

5. Our projects have mechanisms that enable employees to communicate and negotiate quickly and effectively.
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

People:

1. The number of employees in your team is
    - Less than 5
    - 5–10
    - 11–20
    - 21–40
    - Greater than 40

2. Are you comfortable in working in Scrum process without help?
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

3. Our team generally consists of technically competent and experienced people who help to deliver product on time.
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree

- Strongly disagree

4. Organization managers have knowledge about Scrum system which help to reduce cost
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

5. Team member's good customer relationship helps to manage the deliverable quality and scope
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

6. Highly motivated team members complete the tasks with good quality
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

7. Coherent, self-organizing teamwork help provide quality deliverables using Scrum
    - Strongly Agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

Process:

1. We strive to make important project decisions rapidly
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

2. Our management support the decisions of the developers which help to improve the quality of deliverable
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

3. Organization Scrum based requirement management process successfully manage the scope of project
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

4. Organization follow Scrum oriented project management process to manage time and cost
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

5. Organization follow Scrum based configuration management process to achieve success
    - Strongly Disagree
    - Somewhat Disagree

- Neither Disagree nor Agree
- Somewhat Agree
- Strongly Agree

6. Organization track progress of the project continuously which helps to monitor the scope.
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

7. Customer's full authority over the process helps to manage scope
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

8. Our customers are committed to the project, They are motivated, active, and consider themselves to be responsible elements of the project which is a key factor of the success of project
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

Technology:

1. Our team members are in general always willing to continuously learn from one another and train them through training programs to improve quality of deliverable
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

2. We use latest technologies and tools in our projects to reduce time
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

3. Project has rigorous refactoring activities to maintain scope and quality of project
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

4. Organization has appropriate training team for technical people to improve the quality of work
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

5. Quality of deliverables are gained by good coding standards
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

6. Project delivers most important features first to maintain customer relationship
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

7. The project has clearly stated and measurable goals and objectives
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

Communication:

1. We have daily Scrum meeting in our project
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

2. Daily Scrum duration is
    - 15 min
    - 20 min
    - 30 min
    - 45 min
    - More than 45

3. All team members can participate in sprint alignment
    a. Strongly Disagree
    b. Somewhat Disagree
    c. Neither Disagree nor Agree
    d. Somewhat Agree
    e. Strongly Agree

4. All team members have the visibility to Scrum process
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

5. Projects have right amount of documentation to improve the project visibility
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

Project success

1. Less number of high/medium severity defects in sprint plan delivery shows successful adaption of Scrum
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

2. Efficient use of time improves the product delivery
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

3. Scope monitoring improves the customer relationship
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

4. Project manages always completes the project within allocated budget to achieve successful project
    - Strongly Disagree
    - Somewhat Disagree

- Neither Disagree nor Agree
- Somewhat Agree
- Strongly Agree

5. Strong customer commitment, relationship is very important for a successful project
    - Strongly Disagree
    - Somewhat Disagree
    - Neither Disagree nor Agree
    - Somewhat Agree
    - Strongly Agree

1. Please specify any other factors that you think very important for successful adaption of Scrum (Optional):

APPENDIX B: CRONBACH ALPHA ANALYSIS

B.1 Communication Factor:

B.1.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. List wise deletion based on all variables in the procedure.

B.1.2: Reliability Statistics

Cronbach's Alpha	N of Items
.710	5

B.1.3: Item Statistics

	Mean	Std. Deviation	N
[We have daily Scrum meeting in our project]	4.10	.726	42
Daily Scrum duration is	4.64	.618	42
[All team members can participate in sprint alignment]	3.83	.794	42
[All team members have the visibility to Scrum process]	3.93	.601	42
[Projects have right amount of documentation to improve the project visibility]	3.79	.682	42

B.1.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[We have daily Scrum meeting in our project]	16.19	4.012	.323	.723
Daily Scrum duration is	15.64	3.845	.516	.646
[All team members can participate in sprint alignment]	16.45	3.522	.445	.677
[All team members have the visibility to Scrum process]	16.36	3.503	.718	.571
[Projects have right amount of documentation to improve the project visibility]	16.50	3.915	.407	.686

B.1.5: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
20.29	5.477	2.340	5

B.2: Organization Culture:

B.2.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. List wise deletion based on all variables in the procedure.

B.2.2: Reliability Statistics

Cronbach's Alpha	N of Items
.662	5

B.2.3: Item Statistics

	Mean	Std. Deviation	N
[Our organization management empowers the development team to do its work using the Scrum method successfully]	3.98	.715	42
[Organization infrastructure is compatible with Scrum style work environment]	3.83	.621	42
[Organization reward system helps to make Scrum process successful]	3.26	.828	42
[Face to face communication helps to improve the communication and negotiation in Scrum environment]	3.71	.970	42
[Our projects have mechanisms that enable employees to communicate and negotiate quickly and effectively.]	3.64	.958	42

B.2.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[Our organization management empowers the development team to do its work using the Scrum method successfully]	14.45	5.132	.519	.572
[Organization infrastructure is compatible with Scrum style work environment]	14.60	6.296	.206	.686
[Organization reward system helps to make Scrum process successful]	15.17	5.215	.376	.629
[Face to face communication helps to improve the communication and negotiation in Scrum environment]	14.71	4.111	.578	.522
[Our projects have mechanisms that enable employees to communicate and negotiate quickly and effectively.]	14.79	4.660	.422	.611

B.2.5: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
18.43	7.324	2.706	5

B.3: People Factor:

B.3.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. List wise deletion based on all variables in the procedure.

B.3.2: Reliability Statistics

Cronbach's Alpha	N of Items
.674	6

B.3.3: Item Statistics

	Mean	Std. Deviation	N
[Are you comfortable in working in Scrum process without help]	3.71	.835	42
[Our team generally consists of technically competent and experienced people who help to deliver product on time.]	3.98	.517	42
[Organization managers have knowledge about Scrum system which help to reduce cost]	3.52	.862	42
[Team members have good customer relationship]	3.62	.962	42
[Highly motivated team members complete the tasks with good quality]	3.79	1.048	42
[Coherent, self-organizing teamwork help provide quality deliverables using Scrum]	3.79	1.048	42

B.3.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[Are you comfortable in working in Scrum process without help]	18.69	9.487	.164	.705
[Our team generally consists of technically competent and experienced people who help to deliver product on time.]	18.43	10.007	.230	.680
[Organization managers have knowledge about Scrum system which help to reduce cost]	18.88	8.888	.272	.675
[Team members have good customer relationship]	18.79	6.953	.621	.548
[Highly motivated team members complete the tasks with good quality]	18.62	6.827	.566	.567
[Coherent, self-organizing teamwork help provide quality deliverables using Scrum]	18.62	6.778	.577	.562

B.3.5: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
22.40	11.027	3.321	6

B.4: Process Factor:

B.4.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. Listwise deletion based on all variables in the procedure.

B.4.2: Reliability Statistics

Cronbach's Alpha	N of Items
.663	8

B.4.3: Item Statistics

	Mean	Std. Deviation	N
[We strive to make important project decisions rapidly]	3.62	.764	42
[Our management support the decisions of the developers which help to improve the quality of deliverable]	3.43	.831	42
[Organization Scrum based requirement management process successfully manage the scope of project]	3.69	.563	42
[Organization follow Scrum oriented project management process to manage time and cost]	3.45	.803	42
[Organization follow Scrum based configuration management process to achieve success]	3.60	.665	42
[Organization track progress of the project continuously which helps to monitor the scope.]	3.93	.921	42
[Customer's full authority over the process helps to manage scope]	3.07	1.113	42
[Our customers are committed to the project, They are motivated, active, and consider themselves to be responsible elements of the project which is a key factor of the success of project]	3.52	.994	42

B.4.5 Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[We strive to make important project decisions rapidly]	24.69	11.487	.311	.642
[Our management support the decisions of the developers which help to improve the quality of deliverable]	24.88	11.376	.289	.648
[Organization Scrum based requirement management process successfully manage the scope of project]	24.62	12.095	.325	.643
[Organization follow Scrum oriented project management process to manage time and cost]	24.86	11.491	.284	.648
[Organization follow Scrum based configuration management process to achieve success]	24.71	11.136	.474	.611
[Organization track progress of the project continuously which helps to monitor the scope.]	24.38	11.266	.254	.659
[Customer's full authority over the process helps to manage scope]	25.24	9.015	.513	.583
[Our customers are committed to the project, They are motivated, active, and consider themselves to be responsible elements of the project which is a key factor of the success of project]	24.79	9.977	.433	.610

B.4.6: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
28.31	13.682	3.699	8

B.5: Technology Factor:

B.5.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. Listwise deletion based on all variables in the procedure.

B.5.2: Reliability Statistics

Cronbach's Alpha	N of Items
.657	7

B.5.3: Item Statistics

	Mean	Std. Deviation	N
[Our team members are in general always willing to continuously learn from one another and train them through training programs to improve quality of deliverable]	3.81	.969	42
[We use latest technologies and tools in our projects to reduce time]	3.52	.862	42
[Project has rigorous refactoring activities to maintain scope and quality of project]	3.74	.798	42
[Organization has appropriate training team for technical people to improve the quality of work]	3.21	1.001	42
[Quality of deliverables are gained by good coding standards]	3.45	1.173	42
[Project delivers most important features first to maintain customer relationship]	3.62	.731	42
[The project has clearly stated and measurable goals and objectives]	3.62	.936	42

B.5.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[Our team members are in general always willing to continuously learn from one another and train them through training programs to improve quality of deliverable]	21.17	9.801	.533	.567
[We use latest technologies and tools in our projects to reduce time]	21.45	12.351	.145	.679
[Project has rigorous refactoring activities to maintain scope and quality of project]	21.24	11.161	.408	.612
[Organization has appropriate training team for technical people to improve the quality of work]	21.76	10.625	.360	.623
[Quality of deliverables are gained by good coding standards]	21.52	11.036	.201	.686
[Project delivers most important features first to maintain customer relationship]	21.36	11.064	.489	.596
[The project has clearly stated and measurable goals and objectives]	21.36	9.943	.535	.569

B.5.5.: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
24.98	13.975	3.738	7

B.6: Project Success:

B.6.1: Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

a. Listwise deletion based on all variables in the procedure.

B.6.2: Reliability Statistics

Cronbach's Alpha	N of Items
.703	5

B.6.3: Item Statistics

	Mean	Std. Deviation	N
[Less number of high/medium severity defects in sprint plan delivery shows successful adaption of Scrum]	3.79	.898	42
[Efficient use of time improves the product delivery]	3.79	.682	42
[Scope monitoring improves the customer relationship]	3.83	.696	42
[Successful projects complete with in allocated budget]	4.02	.604	42
[Strong customer commitment, relationship is very important for a successful project]	4.19	.455	42

B.6.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
[Less number of high/medium severity defects in sprint plan delivery shows successful adaption of Scrum]	15.83	2.923	.516	.640
[Efficient use of time improves the product delivery]	15.83	3.313	.619	.584
[Scope monitoring improves the customer relationship]	15.79	3.538	.494	.639
[Successful projects complete with in allocated budget]	15.60	4.344	.240	.731
[Strong customer commitment, relationship is very important for a successful project]	15.43	4.153	.515	.652

B.6.5: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
19.62	5.315	2.305	5