Study of Critical Success Factors for Scrum Teams on Delivering IT Projects Success

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Abstract: - Agile frameworks were introduced to tackle the rapid changing speed of technology and to accommodate for the change of demands of customers in IT projects. The most widely used agile framework in the IT industry is Scrum. Even though Scrum was designed to meet the demands of IT projects, data shows that the success rates of projects using Scrum are still low. The paper explores and evaluates the critical success factors that enable Scrum teams to deliver successful IT projects. Various Agile/Scrum success frameworks have been reviewed and extended. The research is through mixed method approach of qualitative and quantitative data from members that are currently working or have previously worked in a Scrum team. The findings show that non-technical factors such as creating a positive team environment are more important than technical factors such as the choice of technology that should be used. The paper also put an emphasis on the role that soft skills may have on the outcome of a project. It was found leadership qualities should be possessed by all individuals to some extent, but it may be more important for some roles compared to others such as the Scrum master.

Key-Words: Critical Success Factors, Scrum Teams, Project Management, IT Projects, Project Success, Agile, Project Factors, Project Management

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1 Introduction

Agile software development is an approach that uses short, iterative, and incremental methods to deliver projects. Agile focusses on finding solutions through the collaboration of self-organising cross functional teams. Agile began to grow in the IT industry with the release of "Agile Software Development with Scrum" by Ken Schwaber & Mike Beedle in 2001.Prior to the introductory of the agile philosophy, IT projects were carried out using the traditional waterfall method. The waterfall method is a more structured approach, which focusses on having a defined scope at the start of the project and following a linear process through the different stages in software development.

Scrum is a framework that utilizes the Agile philosophy and is one of most common practices used today to complete IT projects. Scrum focuses on short iterative cycles referred to as sprints to produce small increments that would be delivered. These sprints can last between a period of 2-4 weeks. A Scrum team comprises of three different roles which include: Product owner, Scrum master and Development team (Schwaber and Sutherland,2001). The research question that will be explored is 'What Critical Success Factors Enable Scrum Teams to Deliver Successful IT Projects?' This research will focus on Scrum teams, exploring various factors that are accountable to delivering successful IT projects. These factors include implementing agile practices, utilising the Scrum artefacts, having effective communication and the importance of soft skills. This research will highlight the importance of leadership qualities, as this is an area where there has been little research carried out and there is an opportunity to extend the literature. The research topic will be approached from several different angles, considering various perspectives of the Scrum team. For example, investigating the most important factors that contribute to delivering successful IT projects to the development team and how it may contrast to the factors for the Scrum master and the Product owner. This will give the opportunity to evaluate which factors may need to be emphasised during the Scrum process, resulting in higher success rates of projects in the IT industry.

2 Literature Review

2.1Background of IT projects

Information Technology projects are the driving force of transformation and business growth. The annual rate of global investment is progressively increasing(Iriarte and Bayona,2020). It is estimated the level of investment in IT will reach 3.79 trillion dollars. The biggest characteristics that define IT

projects is that they tend to produce intangible products such as software. There has been substantial progress in a range of project management practices and methodologies to be implemented within IT projects. Despite this progress, there is still a high ratio of failure within these projects. Different frameworks have contributed to improved project improvement methods that have increased the success rates(Iriarte and Bayona,2020). However, group reports from the Standish Group have found that 31.1% of IT projects are still classified as failures. The results further show 52.7% are completed over budget, late and lack functionality (Gaikema,2019).

2.2 Success Criteria

When it comes to success in IT projects, various authors have suggested different criteria for what makes a successful IT project. For example, many authors agree that projects being on time, within budget and meet user specifications as the success criteria. Powers and Dickson (1973) propose a slight variation of success by having the criteria of: met time, cost, user satisfaction and the impact on computer operations. Powers and Dickson (1973) state it is important for the project to have a positive impact on the current computer operations for it to be successful. Other Authors such as DeLone and McLean(1992) have presented a larger focus on the system in terms of success. For example, they propose six key dimensions as a measure of success for systems which include: net benefits, user satisfaction, use, system quality, information quality and service quality. The user satisfaction criteria have been criticised for using it as a measure of success because it lacks strong theoretical underpinnings. The net benefits criteria hold a big significance as it considers the overall impact of the system.

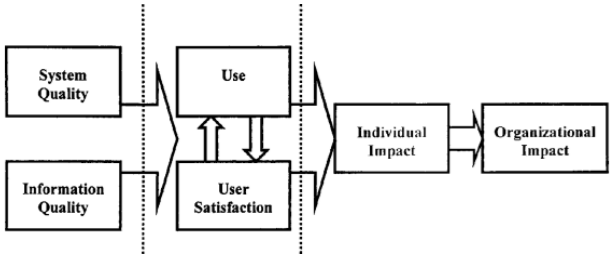

Figure 1 Information system success model, Source (Delone and McLean, 2003)

The following figure 1 represents the model created by Delone and McLean (2003) which depicts an information system success model. The model was constructed by Delone and McLean by reviewing 100 papers containing empirical information systems success measurements. Van der Westhuizen and Fitzgerald (2005) extended this model of success by adding project management specific measures to the framework. For example, the Delone and Mclean model focusses on factors related to the information system only.

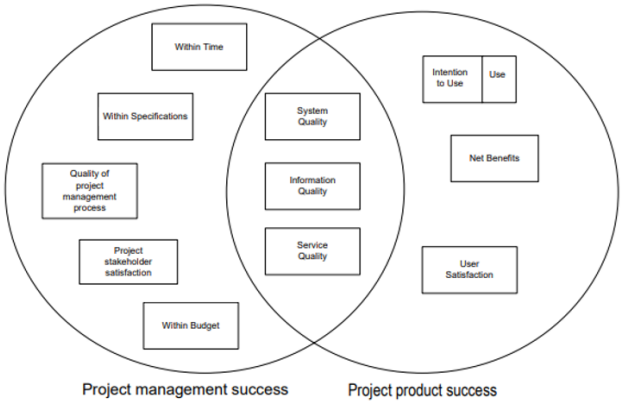

Figure 2. Dimensions of Project Management vs Project Product Success (Van der Westhuizen and Fitzgerald, 2005)

Van der Westhuizen and Fitzgerald (2005) created a Venn diagram which presented various factors that determine success from a project management perspective and a product perspective as shown in figure 2. This led to the creation of Van der Westhuizen and Fitzgerald model which incorporated both aspects.

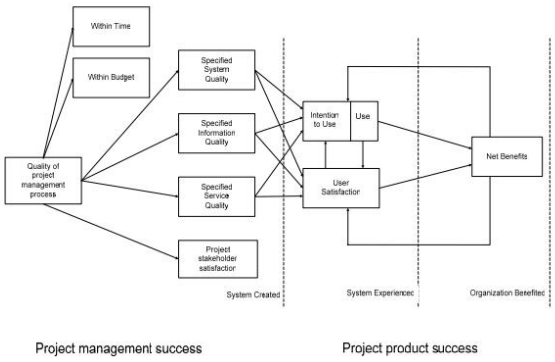

Figure 3. Model of Project Success (Van der Westhuizen and Fitzgerald, 2005)

As seen above the model is an extension of DeLone and McLean's original model and it has been extended with the addition of project management success factors as shown in figure 3. However, it still maintains the core information system success values. Hoang (2013) was able to further extend this

research by creating a simplification of the model proposed by Van der Westhuizen and Fitzgerald shown in figure 4.

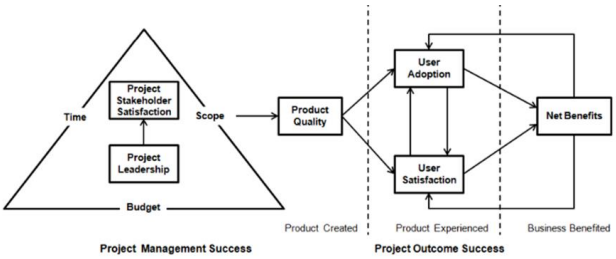

Figure 4. Project Management and Project Outcome Success (Hoang, 2013)

As seen in the model, the basis of Van der Westhuizen and Fitzgerald's model has been kept. For example, the new model still incorporates both project management and product success factor and keeps the same structure of the previous model. The biggest difference is Hoang has simplified the project management success side by replacing the factors with the 'iron triangle' of time, scope, and budget.

However, when it comes to defining project success for this research the most common criteria of being on time, within budget and meeting stakeholder needs will be used. This is because criteria proposed by Powers and Dickson(1973), and DeLone and McLean (1992) put too much emphasis on the system. Although, the models by Van der Westhuizen and Fitzgeraldm, as well as Hoang incorporate both project management and system success factors, using a criterion that looks at the impact the system has on the project is not necessary as this research focusses on the influencing factors of Scrum projects.

2.3Traditional methods

Traditional methods of project management in IT include the waterfall method. The waterfall model used in IT was introduced by Winston Royce in 1970. The waterfall name is derived from the sequential process involved in software development. The waterfall cycle involves progressively moving from one stage to another in a linear order. The waterfall model has five key phases, these stages consist in the following order: *Requirements analysis, Specification, Design, Coding, Testing, and Implementation.* IT projects that have adopted this model spend a large amount of time on each stage of the process, all steps in each stage are refined until all doubts are gone and all requirements are achieved. The core value of the waterfall method is that if a substantial amount of time is dedicated to the design stage of development, it will prevent any bugs and issues occurring later in the process. Once the design stage is over, all coding is taken place during the implementation stage, with no changes being made later. Also, a large amount of documentation is placed on every stage of development (McCormick,2012;Light,2009). Waterfall is an example of a software development cycle. A framework that utilises this method is structured systems analysis and design method (SSADM). SSADM is commonly used for government computing projects and was popularised in the 1980s.

The problem with the waterfall method is it is entirely based on following steps; this can make it difficult to accommodate for any required changes or revision. Any change of requirements, that may occur during the project can result in the work completed at that point in being wasted. Another problem involved with the waterfall method is it places little emphasis on collaborating with clients or the end user. This can be problematic as not including the client during development can result in a difference in expected results when the project is completed. Also, testing is only carried out after the system has been entirely coded. Any significant bugs can cause major delays in the project (Mahalakshmi and Sundararajan,2013). Due to these flaws of the waterfall method, it was clear it wasn't the most appropriate way of completing IT projects.

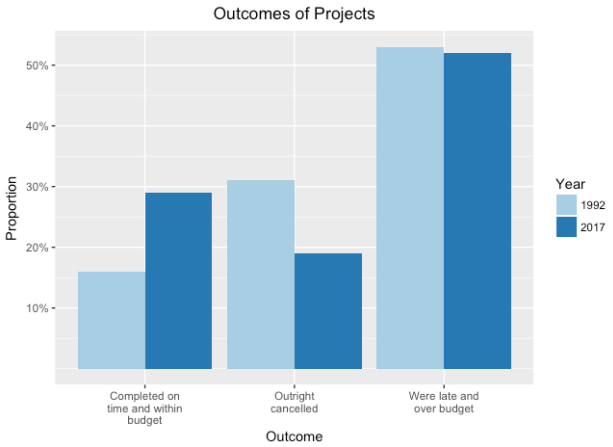

Figure 5 IT project success outcomes (S&F TEAM, 2022)

The figure 5 is derived from a Standish report, it compares IT projects in 1992 and 2017. The projects completed in 1992 would have been using the waterfall method, as seen the success rates of these projects are lower than the projects in 2017.These numbers reinforce the idea that methods of how IT projects should be completed had to be changed. This led to the creation of different agile frameworks.

2.4 Agile Philosophy

Agile frameworks have almost entirely replaced the traditional methods of creating software. Traditional waterfall methods are heavily reliant on documentation and long processes (Ilieva, 2014). The agile development approach was first put in practise in the 1990s with the purpose to increase the delivery speed of the final product (Livari et al, 2004). It had then been further developed with the release of the Agile manifesto. This highlighted the core values of the agile philosophy. These core values are presented below.

Individuals and interactions **Over** Process and tools	Working Software **Over** Comprehensive Documentation
Customer Collaboration **Over** Contract Negotiation	Responding to change **Over** Following a plan

(Highsmith,2002)

The Agile philosophy was best suited for delivering IT projects due to the nature of these projects. For example, IT projects are unique as the requirements tend to frequently change. Therefore, applying the agile philosophy is best suited when delivering projects in this environment (Hoda et al, 2018).New frameworks began to adopt the teachings of the agile philosophy, which helped deliver more successful IT projects. Some of these frameworks include Scrum, Kanban, Lean and XP. These frameworks are adopted by many organisations, the selection of the framework is dependent on the type and culture of the organisation.

2.5 Scrum

Scrum is the most adopted and widely used framework that encompasses the agile philosophy (Fustik,2017). The term was created by the Harvard Business Review study which compared high performing cross functional teams to the rugby Scrum formation. A team utilising Scrum will have specific roles, artefacts and ceremonies derived from the framework. A diagram illustrating the Scrum process can be seen below. A Scrum team includes three main roles: Scrum Master, Product owner and development team. The Product owner is responsible for the business value of the project and communication with the stakeholders involved shown in figure 6. The product owner is also responsible for deciding on what requirements should be worked on next and in what order. The Scrum master is responsible for ensuring the team is productive and they are utilising agile practises during development.

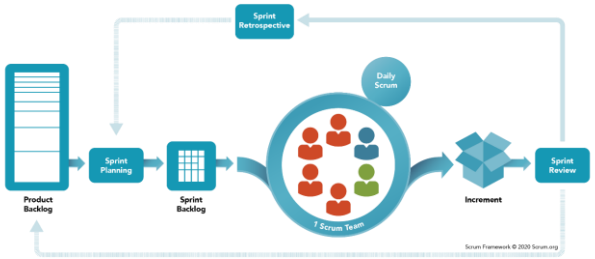

Figure 6 Scrum Framework (Scrum.org, 2022)

Their purpose is to enable cooperation of all roles and functions. Also, to remove any barriers that may impact the team on delivering successfully. It is important to understand that Scrum masters have authority over the practises and processes and not the actual team Itself. The final role in the Scrum framework is the development team. The development team consists of a cross functional team of five to nine members who are responsible in organising themselves to produce the required work for each sprint. A sprint is an increment that lasts from two to four weeks, during this increment a work package is expected to be delivered and reviewed. A Scrum project will have several sprints until the work is completed (Schwalbe, 2012).

Scrum does not put emphasis on extensive documentation, instead it focusses on three main artefacts. A product backlog is a set of requirements and features that is prioritised by the business to create value. It is the work that is required to be completed by the Scrum team. The sprint backlog comprises of the highest priority items derived from the product backlog, that is required to be completed within each sprint. Finally, a burndown chart is used to show the cumulative amount of work which is remaining for each sprint. The chart displays the work on a day-to-day basis (Schwalbe, 2012).

Scrum ceremonies are also a big part of the Scrum framework. The four key ceremonies are facilitated by the Scrum master. Sprint Planning creates the sprint by setting out the work that needs to be completed for the Sprint. This plan is created by the collaboration of the entire Scrum team. The planning addresses the following topics: “Why is the Sprint valuable?”, “What can be done this Sprint” and “How will the chosen work get done?”. Daily Scrum is initiated to track the progress of the sprint goal and make any necessary adjustments to the Sprint backlog. These daily scrums can improve the communication amongst the team and allows opportunities to identify any constraints. The sprint review is carried out at the end of the Sprint and its

purpose is to inspect the outcome of the Sprint. Finally, the Sprint Retrospective is carried out at the end to plan ways to increase the quality and effectiveness. The Scrum team analyses the performance of the Sprint considering the individuals, interactions, processes, and the tools used. The team discusses what went well, the problems encountered and anything that wasn't resolved. Any issues would be added to the backlog for the next Sprint (Schwalbe,2011).

2.6. Other frameworks

The KANBAN framework was created by Taiichi Ohio in the 1940's to help monitor the production amongst norms to achieve Just-in-time producing at Toyota. David J. Anderson applied the KANBAN technique to software development between 2003/2004 when working for Microsoft (Saleh et al,2019). Kanban utilises Lean workflow management method for defining, managing, and improving projects to deliver products/services. Kanban helps teams visualise the work involved in the project, be efficient and help improve continuously. Work is displayed on a Kanban board, allowing teams to optimise work delivery across several teams and control complex projects in a single environment.

Kanban can be broken into two different principles and six practices. The first principle is ***change management***, this is incorporating the already established processes in a non-disruptive method by achieving evolutionary changes and continuous improvement. The second principle is service delivery. This ensures there is an emphasis on customer needs and expectations, regular review of the network of services and to empower people's ability to self-organise around the work. The six practices include: visualise the workflow, limit work in progress, manage flow, make process policies explicit, implement feedback loops and improve collaboratively (Kanbanize, 2022).

Extreme Programming (XP) was introduced by Kent Beck in the late 1990s during his time working on the Chrysler C3 payroll project. XP takes development practices to extreme levels. For example, having frequent inspections by using pair programming. Pair programming is when software is developed by two people using the same machine. The logic behind this method is that two brains and four eyes give the opportunity to continuously review code. Also, automated tests are built before the code is implemented (Bell,2001). The XP framework is built upon practices, principles, and values.

However, due to the characteristics of XP it is only applicable in certain environments. For example, when the software requirements are dynamically changing. There are high risks caused by a fixed time in projects due to using new technology. The project team is small with an extended development team. Finally, the technology being used gives the opportunity to create automated unit and functional tests. Despite there being many agile frameworks, this dissertation will focus on the use of Scrum. This is because as seen in the figure 7, Scrum is the most used agile framework.

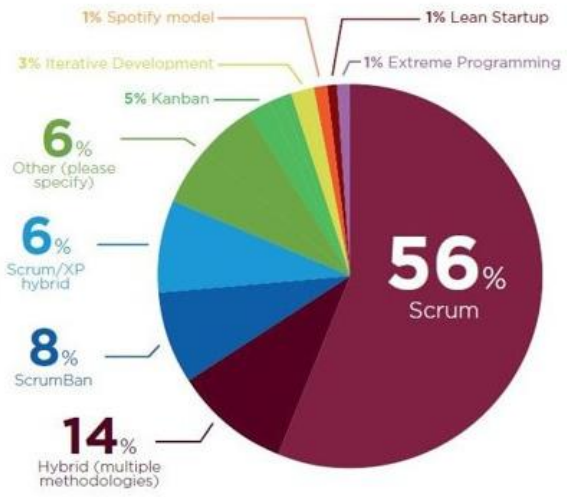

Figure 7. Commonly used Agile Frameworks (Petrova, 2022)

Therefore, it is more valuable to research the critical success factors of Scrum as it is being more widely used across organisations and projects.

Although, agile frameworks were introduced to improve the success rates of IT projects, there is still a large amount of project failure within the IT industry. For example, a Standish group report showed that only 41.62% of Scrum projects are successful. This makes 46.92% late, over budget and not meeting stakeholder needs. Also,11.46% of projects failed to deliver anything at all(Sutherland, 2022). This means that there is an area for research to be conducted to look at what can improve project success rates in Scrum projects. The next section focusses on what influences success in scrum projects and collects a range of factors that can be further investigated.

2.7. Factors influencing success in Scrum projects

This section aims to explore the existing literature around the critical success factors that enable Scrum teams to deliver successful IT Projects. A range of factors will be explored and analysed; the research

found will be used as a framework to conduct primary research on Scrum team members. The first factor explores the importance of having leadership qualities within Scrum teams, especially for roles such as the Scrum master. The soft skills factor is a feature that the Scrum framework does not emphasise, as the framework focusses more on the processes. Therefore, it's important to evaluate the effectiveness of this feature to Scrum projects success.

Table 1. Leadership Mechanisms (Srivastava and Jain, 2017)

Leadership Quality	Definition
Decision making	There were several leadership behaviours that were identified from their study. For example, the ability to make decisions is important for a Scrum master but it must be ensured there is clear communication with the rest of the team members.
Communication	It was found the leader of Scrum teams should encourage communication within and across all team members. Various tools were used by Scrum masters to enhance communication such as web-based conferencing, white board meetings and document sharing.
Commitment to task	The Scrum framework relies on commitment of all team members to deliver the required goal. The Scrum master must be committed throughout the project to the upgradation of tools and methods that are best interest for the team. Further research by Elloy (2005) finds that the super leadership style results to an organised and committed team.
People centric	In a few environments it was found from Srivastava and Jain's research that agile teams need continuous appreciation throughout the project. Failure to do so resulted in teams becoming demotivated which impacted the outcome of the project.
Facilitator	It is crucial for the Scrum master to remove any possible hesitation within the team, redefine any responsibilities and getting the team trained. Scrum teams are expected to be self-organised which means it is the Scrum master's responsibility to remove any impediments in any of the processes and act as a facilitator or coach.
Openness/ transparency	The Scrum master should aim to reduce any barriers to communication and increase the openness and transparency within the team. Openness and transparency increase the confidence of the team and makes them more comfortable in sharing their ideas.

Srivastava and Jain (2017) conducted qualitative research which led them to find leadership mechanisms are required for Scrum masters and the development members in a self-organising team, this plays a part in a project's success shown in table 1. Srivastava and Jain (2017) were able to define leadership methods and behaviours that are directly related for the use of a Scrum Master.

There has also been other research that supports the ideas and framework proposed by Srivastava and Jain (2017). For example, Moe et al (2008) supports the idea that the Scrum master must remove any constraints on the team. This can be achieved by scheduling and organising resources such as hardware, software, training, and licenses. Research by Mundra et al (2013) focused on the implementation of Scrum and agile practices. The paper is derived from the experiences executed in several projects that used the Scrum Framework. It was found by using Scrum principles, multiple companies were able to deliver more successful IT projects by improving quality and productivity.

Chow and Cao (2007) carried out a survey of 109 agile projects which spanned over 25 countries. Chow and Cao used a range of regression techniques and found six success factors that contribute to the success of agile projects. The success factors found are the following: Team Environment, Team Capability, Customer.

França et al (2010) further investigated the factors proposed by Chow and Cao (2007) by conducting a cross-sectional survey which reached out to 62 software engineers that had worked upon over 11 software development Scrum projects. It was found that the criteria listed did contribute to the overall project success. However, it was also found that non agile practices of project management can be influencing project success. Pikkarainen et al (2008) monitored the progress of two different projects and evaluated the impact agile practices had. There were various of positive impacts found from different agile practices. For example, Sprint planning enabled the project to be well managed and made it easy for the Scrum team to be aware of the goals for the next iteration. The use of story/task boards had a positive impact on the team as it gave the opportunity for everyone to see the project status at one glance. Reflection workshops and Scrum retrospectives was an efficient method to deploy and improve agile principles. The practice of continuous integration helped facilitate testing and made it easier for quality engineers to get information on the status of the product.

Pikkarainen et al (2008) also analysed how these agile practices impacted the communication within the project. In project one, the product back log was used to define the features of the product. The use of the Sprint back log gave the team an opportunity to further analyse the requirements and gave them a better understanding. However, as the number of features increased interactions became more complicated. In project 2, planning game meetings was used to define features such as stories on the task board. It was found based on the developers, the stories brought customers a lot closer to the

development and helped understand previously undefined features.

It has also been found by Highsmith (2004) that implementing agile principles within the entire organisation can improve the overall communication. It is suggested that developers and businesspeople must work together daily. Project information is required to be shared through face-to-face communication rather than documentation. It is said when agile principles are implemented at the organisational and project levels it makes it easier to create adaptive products with much less expense. The literature surrounding agile practices is important for this dissertation as agile is core to the Scrum framework. Many of the authors have stated how various practices helped improve projects, this means that it is an important factor to consider during the research for this dissertation.

In addition, Highsmith (2004) considered the viewpoint of developers and how they believed using agile principles played apart into delivering a successful project. Research by Ktata and Lévesque (2010) also centred their research around the development team in the Scrum framework. It was found agile developers are reluctant to adopting non-agile practices. This is because agile methods are designed to avoid traditional engineering practices and focus on delivering software in a quick turnaround. This research is important because it pays attention to the specific needs of a developer in the agile team. As a lot of previous research focuses on the skills and capabilities a Scrum master must have for a Scrum team to be successful.

Lárusdóttir et al (2014) focusses on the communication between stakeholders and the "rapid feedback based on the regular delivery of working software". The biggest contribution of the paper is the overview of the different types of user centred evaluations that are carried out by IT professionals in various Scrum projects.

Wang (2018) investigated the use of scrum artefacts such as the sprint backlog and user stories. Wang looks at the importance off task allocation gained from each user story for every sprint. His findings found poor allocation of tasks can significantly impact a team's performance. He went further to state that the capability and experience of the team members has an impact on the amount of work that can be completed for a sprint.

2.8.Agile/Scrum Success Frameworks

Darwish et al (2015) proposed a framework for the success factors of agile projects. The framework is split into five different dimensions which are: organisational, process, project, people and technical.

1. Organisational factors

Darwish et al (2015) proposed that an organisation has a big impact on the success of a project, as the cultural influence within the organisation can impact various factors in agile software development. The organisation can impact how the user is part of the software development process and creates the environment for the operation of the project.

2. Technical factors

The technical factors of a project relate to the software, technology or hardware used in development and the project. Darwish et al (2015) mentions two key factors in this dimension which are selecting appropriate agile methods and the usage of advanced technology in the project. This means there is the required tools and infrastructure in place for the project and there is a familiarity of the technology that is being used.

3. People Factors

Darwish et al (2015) put a lot of emphasis on the people involved within an agile project that drives the success. This dimension has been divided into two main factors of user involvement and team capability. The sub factors involved under user involvement include dealing with commercial pressure and resolving stakeholder issues. The team capability factor can be broken down into having effective project management skills and using effective communication and feedback. The content of this dimension can be likened to the previously mentioned leadership mechanisms proposed by Srivastava and Jain (2017).

4. Process Factors

This dimension is the tasks, process or the functions of the projects. These factors include risk management, testing and reviewing the software and report the status of the project.

5. Project factors

The final dimension proposed by Darwish et al (2015) is the project factors that relate to the agile principles. These include setting goals and objectives, creating the project schedule, estimating a realistic budget, and defining a clear requirements specification.

Dimension	Main Success Factors	Sub Success Factors
Organizational	Corporate Culture	Support from top management
		Team Environment
People	User involvement	Handling commercial pressures
		Stakeholder politics
	Team Capability	Effective project management skills
		Ability to handle the project's complexity
		Decision time
		Effective communication and feedback
Process	Project management process	Minimum change in requirmeents
		Simplicity in process
		Good reporting of project status
	Project definition process	Risk management
		Time allocation
		Accurate estimates of project resources
	Active testing	Code review
Project	Clear objectives and goals	Project type
		Project nature
	Realistic schedule	
	Realistic budget	Team distribution
		Team size
	Clear requirements and specifications	
Technical	Selecting proper agile method	Configuring the necessary tools and infrastructure
	Using advanced technology	Familiarity with technology

Figure 8. Success Criteria for agile projects (Darwish et al, 2015)

The figure 8 represents a more detailed structure of the framework proposed by Darwish et al (2015). The research presented is useful to the creation of this dissertation because it represents what has previously been used to measure success. Although, the framework presents the success criteria for agile projects, a lot of the criteria can also be applied to Scrum projects.

Critical success factors of software project		Rankings from Table 2
People-related factors (7 critical success factors)	Effective project management skills/methodologies (project manager)	4
	Support from top management	5
	User/client involvement	6
	Skilled and sufficient staffs	9
	Good leadership	17
	Committed and motivated team	22
	Good performance by vendors/contractors/ consultants	25
Process-related factors (16 critical success factors)	Clear requirements and specifications	1
	Clear objective/goal/scope	2
	Realistic schedule	3
	Effective communication and feedback	7
	Realistic budget	8
	Frozen requirement	10
	Proper planning	12
	Appropriate development processes/methodologies (process)	13
	Up-to-date progress reporting	14
	Effective monitoring and control	15
	Adequate resources	16
	Risk management	18
	Effective change and configuration management	20
	Good quality management	23
	Clear assignment of roles and responsibilities	24
	End-user training provision	26
Technical-related factors (3 critical success factors)	Familiar with technology/development methodology	11
	Complexity, project size, duration, number of organisations involved	19
	Supporting tools and good infrastructure	21

Figure 9 Success Criteria, Source (Nasir and Sahibuddin, 2011)

Nasir and Sahibuddin (2011) researched literature from 43 articles from 1990 to 2010 and found 26 critical success factors that were related to project success shown in figure 9. A method of content analysis and frequency analysis was used to analyse the research. From 26 factors identified Nasir and Sahibuddin (2011) split these factors into three sperate categories. These categories consist of people related, process related and technical related critical success factors. In comparison to the success factors proposed by Darwish et al (2015), the project and organisational factors are not considered. However, Nasir and Sahibuddin (2011) were able to take their research further by evaluating the importance of each factor. It was found non-technical factors (94%) dominated over technical factors(6%) when it came to delivering successful software projects. The five most important factors proposed by Nasir and Sahibuddin (2011) are the following: clear and specified requirements, realistic work schedule and budget, alongside a competent project manager are critical to success.

The previous two papers (Darwish et al,2015; Nasir and Sahibuddin,2011) focus on developing success factors surrounding IT and agile projects. Maulana and Raharjo (2021) focus on the success factors in Scrum and analysed the best practices for implementation. From the results of interviews, observations, and analysis of literature studies several obstacles were found in Scrum projects that impact delivering successful projects. The obstacles found are the following:

- Lack of stakeholder knowledge and involvement
- Changes / additional requirements during the development process
- Integrating existing applications (Cross-functionality)
- new team members
- Self-management of developers in carrying out the process

Maulana and Raharjo (2021) were able to develop solutions for these obstacles by mapping them against the success criteria by Ozierańska (2015) and against the research conducted by Atlas which highlights the best Scrum practices. The recommendations made were the following:

- Include stakeholders in understanding the vision and allow them to get a feel for the products being developed from each stage of the project.
- Prioritise each task in development
- Visualise bottleneck factors in the development process
- Emphasis on team building and not being afraid of rotation of existing teams
- Implementation of an appropriate integration paradigm
- Motivating team members which enables them to find methods to complete work more effectively

Overall, there have been a range of literature found of different success factors that enable Scrum teams to be successful. The biggest revelation was the research conducted by Srivastava and Jain (2017) which detailed a leadership mechanism required for

Scrum masters when working with their team, this research was fascinating because the Scrum framework proposed by Schwalbe (2012) put large emphasis on utilising agile practices to be successful. Extending the research of the leadership area is key because it gives an opportunity to add to the Scrum framework by giving a different perspective that organisations may need to take when employing a Scrum master for a project. Despite the leadership factor being important, majority of the research found alluded to effectively implementing agile practices was the biggest success factor when it came to delivering successful IT projects. For example, this is supported by multiple authors that were conducted in the literature review such as Mundra et al, Pikkarainen et al (2008) and Highsmith (2004). The common areas that were proposed by these authors is the use of sprint plannings, user stories and sprint retrospectives. Wang (2018) provided similar research but specifically focussed his research on the artefacts used in Scrum rather than agile principles. Lárusdóttir et al (2014) and Highsmith(2004) provided an insight on how communication can be impacted using the Scrum framework. However, Lárusdóttir et al (2014) focussed on how consistently delivering working software provided rapid feedback from stakeholders and helped to meet expectations. Whereas the research by Highsmith (2004) found implementing agile principles within the organisation can improve communication.

In the next section a framework will be developed derived from the literature found by authors. This framework will be used when conducting primary research and each factor within the framework will be evaluated to find out the critical success factor thar enable Scrum teams to deliver successful IT projects.

3 Methodology

A mixture of qualitative and quantitative methods will be used as the research design. This is because it gives the opportunity to gather information on what people think and why they think so. This is important for this research as it focusses on the opinions of different Scrum team members. Qualitative research asks participants broad and open-ended questions. It is an enquiry approach in which the researcher interprets the meaning of the information presented, drawing on the personal reflections and previous research (Creswell,2002).

3.1 Data Collection

There will be two different forms of data collection for this study, these methods are interviews and questionnaires. Structured interviews will be carried out with different members of the Scrum team such as the Scrum Master and Product Owner. A structured interview is when there is a predetermined set of questions that will be asked to the participants. This method is important because it allows detailed information to be gathered. For example, interviews will give the opportunity to ask Scrum members why they may believe one factor is more important than another in the success of an IT project. The next method used for collecting data will be a mixture of closed and open-ended questions. As there is only a limited number of participants that can be interviewed due to time constraints, questionnaires give the opportunity to collect data from a variety of participants at a quicker rate. It is important of having a combination of the two methods because the interviews will be used as an extension of the questionnaire. For example, the use of interviews gives the opportunity to ask participants to elaborate on questions that may also appear on the questionnaire.

3.2 Sampling

The method of sampling used for this study is convenience sampling. This is when the most easily accessible participants are selected for the study. A benefit of this method is it is quick and cost effective. This is the most suitable method for this research because participants from the software development industry will be interviewed. These members have busy schedules which would mean it would be difficult to use an unbiased sampling method. The snowball method will also be used. This is when the researcher uses the initial group of participants to establish other contacts. For the interviews conducted, after approaching the first few participants, these participants then introduced new Scrum team members that were willing to take part in the study. The responses for the questionnaire were gained by sharing the link to several Linked In groups, which contained individuals that had either worked or are working within a Scrum team. Using this method, a total of 30 responses were gained from a mixture of Scrum masters, Product owners and development team members.

3.3 Analysis of findings

The qualitative data gained from the interviews and questionnaires will be analysed using pattern coding. This means that the initial data will be examined to identify trends, relationships, and patterns. The data will be assigned a label so they can be categorised and put into theme(Kolios,2022). This method is suitable for this research because it would be most effective to group together the common factors

presented by the participants. The quantitative data gained from questionnaires will be presented in visual graphs. This enables the option to make comparisons and identify trends in the data.

3.4 Research question

The research question for research is the following "What Critical Success Factors Enable Scrum Teams to Deliver Successful IT Projects." This was formed by the research conducted in the literature review. The literature review focussed on the influences that impacted the success of Scrum projects. A variety of different factors were found from several different authors. The different factors found provided a basis to further investigate this research and analyse what could influence Scrum project success.

3.5 Theoretical framework

A theoretical framework has been designed from the literature found which will be tested and evaluated. The literature review contained various Agile and Scrum success frameworks which detail a criterion that enables Scrum projects to be successful. After analysing these frameworks, two stood out. The framework proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011). As mentioned in the literature review these frameworks appear to be similar, however, the framework proposed by Darwish et al(2015) has the addition of the 'Organisation' and 'Project' factors. These five factors will be used as part of the theoretical framework to measure their impact on the success of Scrum projects.

As well as these factors, a lot of research in the literature review was conducted around the leadership factor and how important it is for a Scrum master to possess this quality. This is a factor where there haven't been large levels of research in the existing literature. Therefore, it is crucial to measure the impact it may have on the success of Scrum projects. In the literature review research found by Srivastava and Jain (2017) defined a leadership mechanism appropriate for Scrum masters. This included:

- Communication
- Commitment to task
- People centric
- Facilitator
- Openness/transparency

This factor alongside the previous five has been used as a theoretical framework for this research. It will measure the impact these factors have on success, as well as look at any other possibilities that may contribute. The framework designed for the research is shown in table 2.

Table 2 Theoretical Framework

Dimension	Main Success Factor
Organisational	▪ Top management support ▪ Team Environment
People	▪ Handling commercial pressures ▪ Dealing with project complexity ▪ Stakeholder politics ▪ Project management skills ▪ Handling project complexity ▪ Effective communication and feedback
Process	▪ Fixed requirements with little change ▪ Simplicity in process ▪ Frequent reporting of project status ▪ Risk management ▪ Time allocation ▪ Utilisation of project resources ▪ Clear assignment of roles and responsibility
Project	▪ Team size ▪ Team distribution ▪ Project type ▪ Project nature ▪ Code review
Technical	▪ Familiarity with technology ▪ Supporting tools and infrastructure in place
Leadership	▪ Communication ▪ Commitment to task ▪ People centric ▪ Facilitator ▪ Openness/transparency

4 Analysis and Findings

This section analyses all the data gathered from the questionnaires and interviews. The questionnaire collected a total of 30 different results and a total of 7 participants were interviewed.

4.1 Questionnaire Analysis

The first question of the questionnaire asked participants whether they are currently working in a Scrum team. This is important because to be eligible to take part, participants would need to have some experience working in a Scrum team.

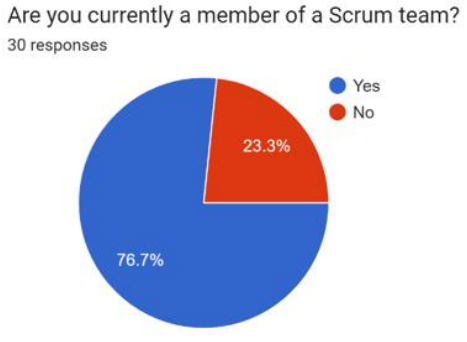

Figure 10. Questionnaire Analysis for Q:1

As displayed in the graph a total of 76.7% of people are currently working in a Scrum team, whereas 23.3% are not as shown in figure 10.

Question 2

As some participants may not be actively working in a Scrum team, the appropriate next question would be to ask was whether they had ever been a member of a Scrum team. As displayed in the graph the results show 100% of the participants had been part of a Scrum team.

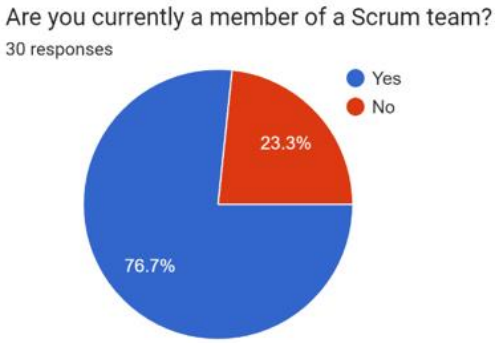

Figure 11. Questionnaire Analysis for Q:2

This is important because this research requires the experience of these participants. If they had never worked with a Scrum team, they would be unable to complete the questionnaire shown in figure 11.

Question 3

The third question asked participants what roles they currently have or have had in the past when working in a Scrum team. As the results show 70% of the respondents were Scrum masters,33% Product owners and 23% were part of the development team as shown in figure 12.

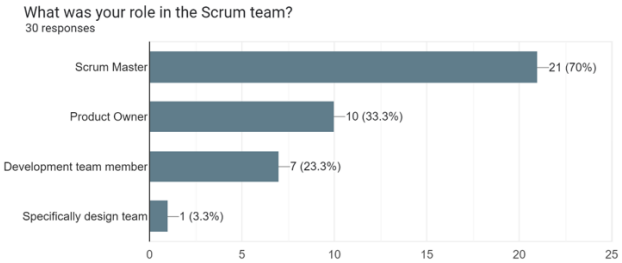

Figure 12. Questionnaire Analysis for Q:3

There was one participant part of the development team but specified they were in a subcategory of the development team known as “design team.” It must be noted in total there are 38 roles answered for this question, but only 20 respondents. This is because there were several respondents that had worked in multiple roles as shown in table 3. Therefore, the table shows the most common respondents were participants that had just worked as Scrum masters with making up a total of 50% of the responses.

Table 3 Combination of roles in questionnaire

Combination of roles	Number
Scrum Master	15
Product Owner	6
Development team member	3
Scrum Master and Product Owner	2
Scrum Master and Development team member	2
Product Owner and Development Team Member	0
All 3 roles	2

Also, just the Product owner role was the second highest number of participants to take part. Whereas there was a similar number of participants that had worked on more than just one role. It is important to identify the different roles that took part in this survey because this research focusses on the success of Scrum projects based on the perspective of team members. This means that this data gives the opportunity to analyse how the responses on project success differs based on the roles each respondent may have worked in.

Question 4

Question 4 asked participants how long they had worked in a Scrum team. The results show that only 10% of respondents had been working in a team for less than a year. 50% had been working in a team between 1-5 years, 26.7% between 5-10 years and only 13.3% had 10+ plus years of experience in a Scrum team as shown in figure 13.

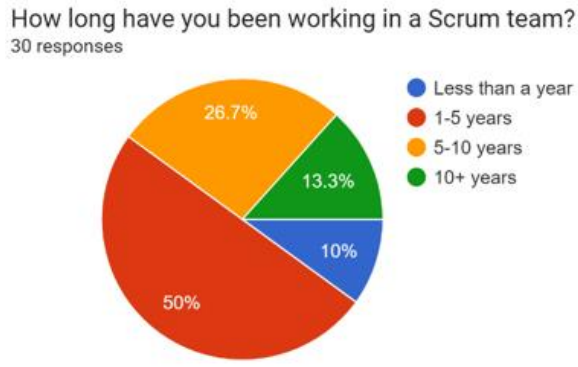

Figure 13. Questionnaire Analysis for Q:4

This data is important because understanding the different experience levels of the participants can influence their opinions and responses.

Question 5

This question specifically focusses on the success rates of the projects the participants had previously worked on. However, it must be noted that the

question is subjective based on the participants perspective of project success as shown in figure 13.

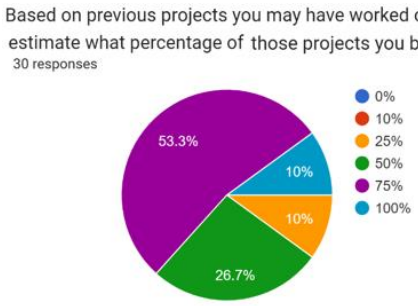

Figure 13. Questionnaire Analysis for Q:5

The results show that a staggering 75% of respondents believed the past projects they had worked on were successful. There were even three respondents(10%) that believed that 100% of projects they had previously worked on were successful. One of these respondents had only been working in a Scrum team less than a year, which means they may have only worked on a small number of projects. However, it was interesting that the other 2 respondents had over 10 years of experience in a Scrum team and believe every project they had worked on was successful.

Question 6

Question 6 is an extension to the last question, but it specifically asks participants their opinion on satisfaction level of their previous stakeholders. The results appear to be like the last question, with 50% of respondents believing at least 75% of their stakeholders were satisfied as shown in figure 14.

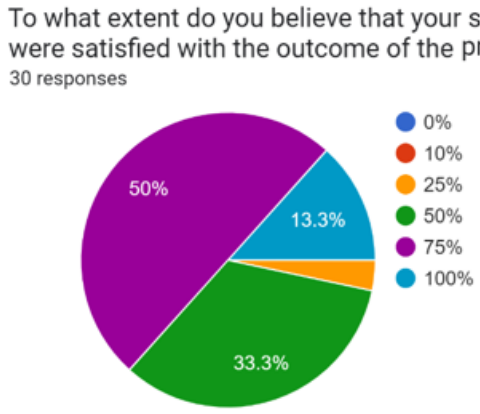

Figure 14. Questionnaire Analysis for Q:6

Just like the last question, the next highest selection was 33.3% believing 50% of all their stakeholders were satisfied. However, for this question there were 4 respondents that believed that 100% of all their stakeholders were satisfied. Conducting further analysis, it was discovered that 2 of the same respondents that believed all their projects were successful also believed 100% of their stakeholders were satisfied.

Question 7

Question 7 was a significant part of the questionnaire as it tested the factors proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011). The participants were given a table displaying all the common factors that influenced success in Agile and Scrum projects as shown in figure 15.

Figure 15. Questionnaire Analysis for Q:7

Participants were then asked to rank each factor on how important they believed it was in delivering success. It was found that the 'People' factor was ranked the most important factor amongst the rest. This is because 15 out of the 30 participants all gave the people factor a 5 when voting on the scale. 'Organisation' was the second most voted factor when all the numbers were added up, it had a total score of 110. The 'Process' factor was a close third as it received a total of 103 points. Finally, the 'Project' factor was valued the least important as it had only received a score of 87 points.

Question 8

The next part of the question was optional and asked participants whether they believed any other factors were important other than the ones proposed in the framework. The question received a total of 14 responses and all responses were coded and categorised together as shown in table 4.

Table 4 Additional Success Factors

Additional Factors	Number of times voted
Customer Focus	1
Emphasis on Product/Solution	2
Appropriate Sprint Length	1
Team building	7
Accountability	2
Knowledge of Agile	1

50% of responses were related to team building factors such as ensuring there is trust amongst the team and there is a positive work environment. This represents how Scrum team members put emphasis on people and interactions with each other, rather than the principles and technicalities of the project. The addition of the emphasis on product/solution factor was mentioned twice and was interesting as it is a factor that would be important in the success of agile projects but was left out of the frameworks proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011).

Question 9

The next section of the questionnaire focused on the leadership factor in Scrum teams and the influence it may have. The participants were asked to rate importance of the leadership factor on a scale between 1-5 with 5 being the most important and 1 being the least as shown in figure 16.

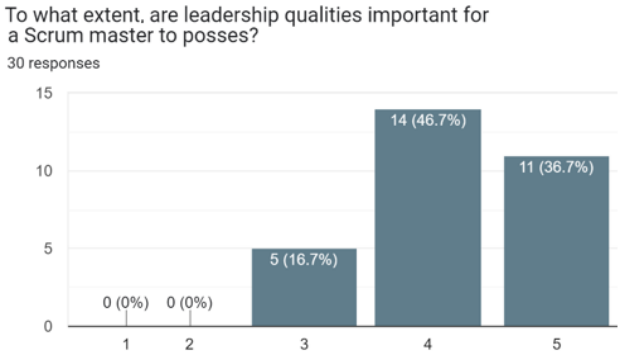

Figure 16. Questionnaire Analysis for Q:9

The results display that 36.7% of participants rated the factor a 5 being the most important and 46.7% rated it a 4. Therefore, 84% of participants voted at the upper end of the scale. It must also be noted no participants voted below three. This means the leadership factor was not dismissed as being an important success factor.

Question 10

Question 10 was an extension of the previous leadership question but focussed on the qualities that a Scrum master may possess. The qualities listed by Srivastava and Jain's (2017) leadership mechanisms were listed as factors(can be seen by the first four options), the rest of the factors were suggestions the participants felt were important to have.

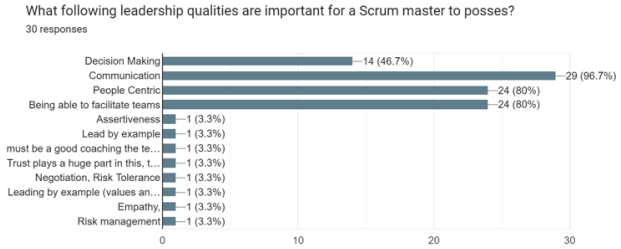

Figure 17. Questionnaire Analysis for Q:10

Communication was the most voted quality by a significant amount. As seen in the graph 96.7% of participants had voted it as an important quality for Scrum masters to have. The next two factors 'People centric' and 'Being able to facilitate teams' were also widely voted at a total of 80%. However, it was unexpected that the decision-making quality had only received a total of 46.7% votes as shown in figure 17.

Question 11

Question 11 was an extension from question 7, but the leadership factor had now been incorporated within the framework. Participants were then asked to rank the factors once again, now that the 'Leadership' factor had been added. The 'People' factor remained to be the highest-ranking factor of them all. 'Leadership' was voted as the second highest ranking factor as shown in figure 18.

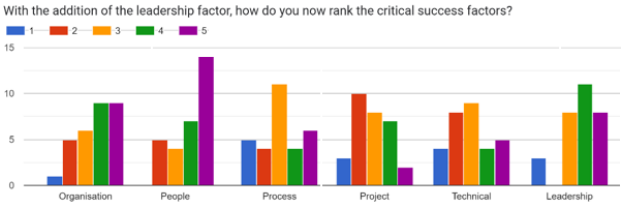

Figure 18. Questionnaire Analysis for Q:11

The rest of the order had remained the same as the results of question 7. This highlights the importance of the factor as once added to the success criteria framework, it had instantly become the second most voted factor.

Question 12

Question 12 was structured like question 10 where a framework found in the literature review was used as a list of options and the participants also had the possibility of adding their own suggestions as shown in figure 19.

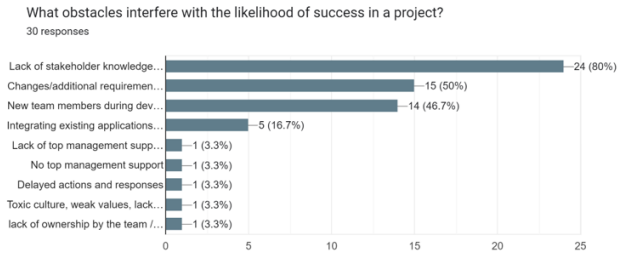

Figure 19. Questionnaire Analysis for Q:12

In this case the framework proposed by Maulana and Raharjo (2021) was incorporated into the question. The results show that lack of stakeholder knowledge and engagement was the most voted factor at 80%.

Question 13

The next question asked participants whether Scrum is their preferred Agile method. As seen from the results 90% of the 30 participants voted "Yes". This data is important because it reflects the popularity of the Scrum framework and justifies the need for more research to be conducted within, the framework as shown in figure 20.

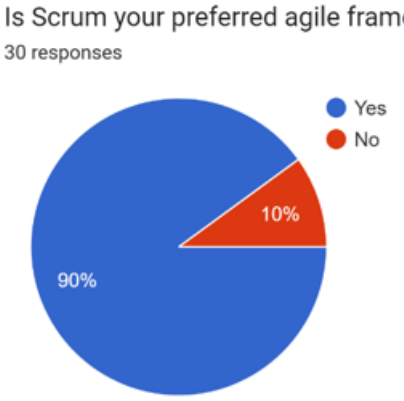

Figure 20. Questionnaire Analysis for Q:13

The next part of the question asked the participants that had selected "No" what their preferred framework is. The results showed that Kanban had three votes and XP had one.

Question 14

The final closed question in the questionnaire asked participants whether they believe Scrum improves the likelihood of success. This is an integral part of the questionnaire because it focusses on the effectiveness of the Scrum framework in project management. The results show that 80% of participants did believe Scrum improves the success rates of projects. The remaining 20% of participants voted "Maybe" and 0 participants voted "No" as shown in figure 21.

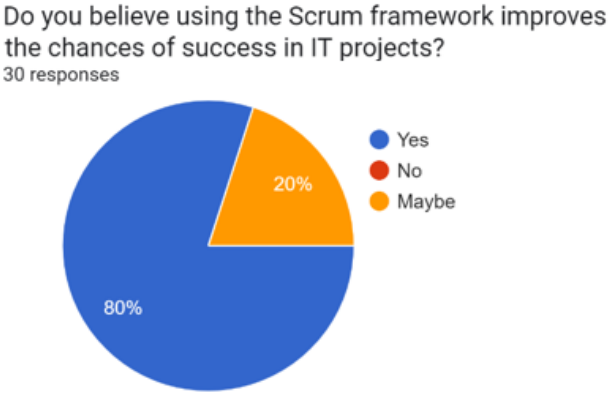

Figure 21. Questionnaire Analysis for Q:14

This means that all participants believe to a certain extent that the Scrum framework improves the chance of project success.

Question 15

The final two questions were open questions and were used to gather the opinions of the participants. The answers from the participants were grouped together and categorised. The number of responses next to each category was tallied. The first question was "*What helps you meet your targets and be successful in a Scrum team?*".

Table 5. Common Success Factors

Common Factors	Number of times voted
Team Environment	4
Realistic use of story points	2
Communication	3
Freedom and independence	1
Collaboration with Stakeholders	6
Deferred Commitment of power options	1
Following the Scrum guide to detail	1
Clear Requirements	1
Product focus	1

The most common factor that helps the participants meet their targets and be successful in Scrum teams is the Collaboration with Stakeholders as shown in table 5. Participants that entered these responses believe their needs to be consistent and effective collaboration with stakeholders. There also needs to be a mutual understanding of the requirements. The next most common category to receive the most responses is team environment. This factor means there needs to be trustworthy and positive team that promotes working in the best way possible. The third top category to receive the most responses was communication this is having effective internal communication with the team and external communication with stakeholders.

Question 16

The final question asked participants on any recommendations they would give Scrum teams. The results can be seen in the following table 6.

Table 6 Team recommendations

Common Factors	Number of times voted
Team environment	6
Appropriate time to work on tasks	1
Product focus	3
Flexibility	2
Sprint duration	1
Effective implementation of agile principles	2
Learn from failure	5
Having a committed dev team	2
Effective communication	3
Clearly defined requirements	2

The results share a similarity with the previous questions. For example, the promotion of a trustworthy team environment was also the most common factor that was suggested by participants. The second highest suggestion was a new factor- the ability to learn from failure. Continuous learning is an agile principle hence why it makes sense why so many participants may have suggested this factor. Other popular factors that also appeared in the previous question include product focus and effective communication.

4.2 Interviews

In total 7 interviews were conducted, with members from all Scrum roles. The purpose of the interviews was to extend the answers received from the questionnaires. Majority of questions in the questionnaire were closed questions, whereas using primarily open questions in the interviews gave the opportunity to receive a wider range of in-depth answers. A brief breakdown of the interviewee participants can be seen in the table 7.

Table 7 Interview Participants

No	Role of participant	Length of experience
1	Scrum Master	1.5 years
2	Product Owner	5 years
3	Developer	2 years
4	Product Owner	2 years
5	Developer	6 months
6	Developer	15 years
7	Scrum Master	10 years

The interviews were conducted after all the responses for the questionnaire had been collected. As mentioned earlier, the developer role had the least number of responses. Therefore, there was more emphasis on getting responses from developers to get a balanced perspective from all roles. The interview responses were analysed using pattern coding, the responses gained from all participants were put into three different categories. These categories are success factors, leadership, and obstacles are further analysed within tables 8-10.

Table 8 Success Factors responses

No.	Success Factors
1	▪ "Most important factor is organisation. It is important to have an environment that promotes working productively and in an "agile" way. ▪ Least important is Project. This is because project nature should not impact the outcome" ▪ "Majority of successful projects that I had worked on were well organised and had a good environment" ▪ "Offering the team emotional support during fast approaching deadlines and stressful periods is important"
2	▪ "The most important factor is people. This is because it is important to form good relationships with team members and stakeholders" ▪ "The process factor is the least important factor as it is more important to focus on the people and the infrastructure available to deliver the project" ▪ "It is easier to deliver the required product when there is a shared understanding with all members on the team"
3	▪ "Technical is one of the most important factors in a project as the required infrastructure is crucial in the development process to achieve the desired outcome of the project" ▪ "Project is the least important factor" ▪ "It has been easier to deliver successful projects when working with the best software and technology." ▪ "High skill level is important when working on a project as it means all teams members are capable of completing the required tasks to the best ability"
4	▪ "People because it is important to have a motivated and trustworthy team that can rely on each other" ▪ "Having team building activities and ice breakers is important when there is a new team working together. It allows the team to be a lot more comfortable with each other" ▪ "Effective sprint management is also an important factor. This is ensuring the length is appropriate and the tasks are prioritised correctly"
5	▪ "Process is the most important. Ensures everything flows in a proper order" ▪ "Seen people having to work twice as hard, due to lack of processes" ▪ "Inadequate understanding of their own role and the team's goal"
6	▪ Project is the most important because it provides a clear objective, realistic schedule, and budget ▪ Enables you reach the objective and be successful ▪ Organisational is least because corporate culture is not important as achieving objectives
7	▪ Organisation is the most important. Corporate culture has an impact on people and processes ▪ Technical is least because if all the other factors are in line the technical side will sort itself out

The responses gained from this category is based on the questions participants were asked around the frameworks proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011). The results in the interviews showed a similar pattern as the results in the questionnaire. This is because the factors 'Organisation', 'People' and 'Process' were the commonly most voted answers amongst participants. In both interviews and questionnaires there were only a few votes for the 'Technical' factor being the most important. It was found all participants that had voted this factor as the most important had experience working on the development team. Whereas the votes for 'Organisation', 'People' and 'Process' were shared across all three roles. In the interviews when asked on any other important factors that may contribute to project success the factors mentioned were Team emotional support, high skill level and effective sprint management. It is important to note that team emotional support/team building significantly was the most suggested answer in the questionnaire.

Table 9 Leadership responses

No.	Leadership
1	▪ "Leadership is crucial because it drives a project team to success" ▪ "These qualities are important because it allows a scrum master to be well rounded and lead a team" ▪ "It is important for all senior members amongst all teams to possess these qualities. For example, the product owner and the senior developers" ▪ "It helps motivate a team during a stressful period and gets the best out of teams"
2	▪ "These factors are important for a scrum master to have as there is no point of having a scrum master that knows all the processes and theory but is unable facilitate and implement these principles into a team" ▪ "These qualities would help a scrum master be a well-suited candidate and help organise a team" ▪ "It would also be important for a product owner to have these qualities, in particular decision making and communication. These are important aspects when it comes to communicating with stakeholders and organising the backlog"
3	▪ "Leadership qualities are important for a Scrum Master, as it helps them to implement agile principles and promotes the team to equip these principles" ▪ "Being able to facilitate teams is the most important quality out of the list, as a scrum master needs to ensure all obstacles are removed that may prevent teams from maximising their productivity and effectiveness" ▪ "These qualities are somewhat important for everyone to possess. However, they are more crucial for senior roles that are leading a team." ▪ "Leadership hasn't made any major significance to the outcome of the project, but it's something that's better to have than not"
	▪ "I would say effective communication is the biggest game breaker, when it comes to the success of a project."
4	▪ "These are important qualities to have because a scrum master should be able to effectively facilitate teams in working together" ▪ "Having these qualities would make a well-rounded scrum master" ▪ "It is important for all members of the team to possess some leadership qualities to an extent" ▪ "Helps meet targets and push the team. Also helps problems that may occur in the team"
5	▪ "All reasons are crucial for a scrum master possess" ▪ "Also having a technical scrum master that understands the dev team" ▪ "The product owner. They must have faith in the product being designed" ▪ "Whoever steps up to the leadership role helps everyone understand why s new feature may be necessary" ▪ "Helps push the company's ethos"
6	▪ "It's important they do and can motivate and rally a team" ▪ "All should contain these qualities" ▪ "Not as important for other roles" ▪ "It has played a part in my projects otherwise the team would be going in circles"
7	▪ "Everyone requires some leadership qualities to be successful but it's not crucial" ▪ "Every role should have leadership qualities in scrum as they should be self-organising" ▪ "Leadership factor has not been a significant factor in previous projects"

The next category gathered all the leadership related responses from the participants. These answers were based on the leadership mechanisms that was proposed by Srivastava and Jain (2017).Participants were asked the importance of the proposed qualities for a Scrum master and whether they believe it is important for any other role in the team to display these qualities. All participants unanimously agreed that Scrum masters should possess the qualities proposed. There was a mixture of responses when it came down to these qualities being needed by any other member. Some participant agreed, whereas others didn't believe it was as important.

Table 10 Obstacles Responses

No.	Obstacles
1	▪ "One of the biggest obstacles that get in the way is a lack of top management support and understanding about the project. It can be frustrating when the management fails to support the vision of the project" ▪ "The biggest challenge of being a Scrum Master, is you are always expected his/her team to be familiar with Agile methods and practices" ▪ "The biggest reasons why Scrum teams fail is due to lack of communication with stakeholders and them having little involvement with the project."

2	▪ "Poor prioritisation of the backlog. This means that more complex or important tasks/features are not focussed on" ▪ "The biggest challenge of being a product owner is stakeholder management; it can be difficult to align several stakeholders to make a decision and converse on a shared single understanding of the product" ▪ "There is a lack of understanding of the sprint goal and what needs to be delivered for each sprint"
3	▪ "New team members joining halfway through the project can slow things down as time is taken to get them up to speed." ▪ "Meeting the sprint deadlines and producing what is required" ▪ "There is a lack of understanding of the Sprint goal, this may cause confusion amongst the team and result in not meeting the expected requirements"
4	▪ "Conflicts within a team can get in the way of delivering a project" ▪ "Also, the addition of new team members" ▪ "Lack of communication, understanding and trust amongst the team"
5	▪ "People leaving during the middle of the project" ▪ "Poor leadership" ▪ "Must ensure whatever I design aligns with the brand guidelines" ▪ "Projects fail due to Lack of trust and issues within the team"
6	▪ "Poor decision making from lead developers, includes decision on technology and methods of completing work" ▪ "Also not having quality control" ▪ "Scrum projects fail due to constant changing of requirements"
7	▪ "Lack of resource management" ▪ "Trying to understand why the team was not delivering, As scrum does not have a metric of measuring individual performance" ▪ "Projects fail due to changing of stakeholders change the direction of the project"

This category gathered responses on the obstacles that may get in the way of a project being successful. It also asked participants why they believed Scrum projects fail. The responses for the obstacles varied between the participants. A lot of the answers given by the interviewees correspond with the results from the questionnaire. There were additional factors listed such as lack of resource management and poor decision making from lead developers.

5 Findings and Conclusions

5.1. Critical Success Factors

In the literature review there were two key frameworks identified, these frameworks were proposed by: Darwish et al (2015) as well as Nasir and Sahibuddin (2011). For example, the findings from Darwish (2015) research presented five key factors that contributed to project success shown in figure 22.

Dimension	Main Success Factors	Sub Success Factors
Organizational	Corporate Culture	Support from top management
		Team Environment
People	User involvement	Handling commercial pressures
		Stakeholder politics
	Team Capability	Effective project management skills
		Ability to handle the project's complexity
		Decision time
		Effective communication and feedback
Process	Project management process	Minimum change in requirmeents
		Simplicity in process
		Good reporting of project status
	Project definition process	Risk management
		Time allocation
		Accurate estimates of project resources
	Active testing	Code review
Project	Clear objectives and goals	Project type
		Project nature
	Realistic schedule	
	Realistic budget	Team distribution
		Team size
	Clear requirements and specifications	
Technical	Selecting proper agile method	Configuring the necessary tools and infrastructure
	Using advanced technology	Familiarity with technology

Figure 22. Success Criteria for agile projects (Darwish et al, 2015)

1. Organisational- explores the cultural impact of the organisation
2. Technical- This is related to the technology, software and hardware involved
3. People- Divided into user involvement of external members of the team and team capability of internal members.
4. Process- Highlights the functions of the project
5. Project- Related to the agile principles and how they are implemented

Similarly, as well as the framework proposed by Darwish et al(2015), research was found by Nasir and Sahibuddin (2011) presented similar factors but excluded the 'Project' and 'Organisational' factors. The findings of both frameworks were used as a template when collecting research data for this research. As seen in Section 4 the frameworks were incorporated into the questionnaire and interviews. Both frameworks present several factors that contribute to project success for agile and Scrum projects. The purpose of this was to determine the significance of the factors presented of these frameworks. As the findings from the literature review already helped contribute to answering the research question of 'What Critical Success Factors Enable Scrum Teams to Deliver Successful IT Projects'. The next step was to extend the literature by determining the most important factors when it comes to delivering projects.

The results from the data analysis of both questionnaires and interviews show that the 'People' factor is the most important when it comes to delivering successful Scrum projects. This is highlighted by respondent 4 stating "people are the most important factor because it is important to have a motivated and trustworthy team that can rely on each other." Respondent 2 also believed people was

the most significant factor because " it is important to form good relationships with team members and stakeholders." Therefore, this reflects how this factor should be emphasised during a project to ensure delivering a successful project. These tasks include:

- Handling commercial pressures
- Stakeholder politics
- Effective communication
- Decision making
- Project management skills (Darwish, et.al, 2015)

Therefore, 'People' is categorised as the most important factor amongst these frameworks, but it is still essential to understand where the other factors rank amongst to each other. 'Organisation' was analysed as being the second most voted factor and 'Process' being third. Respondent 7 believed 'Organisation' was the most important factor as "organisation has an impact on people and processes." This means that the respondent believed organisation is the overarching factor that directly impacts other factors in the framework.

The findings from the data analysis shows that 'Project' factor is the least important factor when it comes to delivering successful IT project with technical just behind it. In the study conducted by Darwish et al (2015) it was found non-technical factors dominated over technical factors. These findings are also supported by the results conducted in this study. As non-technical factors such as 'People' and 'Organisation'. This means that more emphasis needs to be on non-technical factors when aiming to deliver successful project.

5.2 Leadership Findings

The next part of the study was investigating the impact leadership has on the success of a project. The literature review found Srivastava and Jain (2017) defined several leadership mechanisms and behaviours that are necessary for a Scrum master to possess. The following were:

- Decision making
- Communication
- Commitment to task
- People Centric
- Facilitator
- Openness/transparency

This framework was incorporated in both the questionnaires and interviews for this research. The purpose was to identify whether participants believed leadership was important and to highlight the leadership qualities that are needed most. All interviewees agreed that leadership qualities were important for a Scrum master to possess with respondent 1 claiming "leadership is crucial because it drives a project team to success." This is also reinforced by the questionnaire where majority of participants voted the qualities presented are very important for Scrum masters to possess. Therefore, from these findings it can be concluded that it is essential for all Scrum masters to have leadership qualities. When asking participants what qualities from Srivastava and Jain's (2017) mechanism were essential it was found communication was the leading quality with 67.7% of participants selecting it. Interviewee 1,4 and 6 praised the qualities as they believed possessing them would make a well-rounded Scrum master. It was also investigated whether it was important for any other roles to possess leadership qualities. This question was specifically asked to the interviewees, it was found leadership qualities are important for all roles to have to some extent. Only respondent 6 believed these qualities weren't as important for other roles. Respondent 5 believed the Product owner should possess these skills, and the remaining respondents believed it is essential for all senior roles. Therefore, it can be concluded the leadership factor is essential for the Scrum master role, but other roles should possess some leadership qualities.

Once the initial framework proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011) was evaluated, the next step was to incorporate the leadership factor into this framework. The purpose was to judge how participants would evaluate their choices when the leadership factor had been added to the Scrum success framework. The findings show the 'People' factor was still voted as the most important factor when delivering successful IT projects. However, the 'Leadership' factor had been voted as the second highest. This reflects the significance of leadership in Scrum because it beat the remaining four factors proposed by Darwish et al(2015). It must be noted that leadership is also a non-technical factor, this reinforces the findings of non-technical factors being more important than technical. The interviewees were asked whether the leadership factor had made a difference in the success of a project. Respondents 3, 4 and 6 all believed it had played a part in the success of their previous jobs as it helped push the team in the right direction. Only respondent 7 believed it hadn't been a significant factor. This ties into the framework designed earlier which has served as the core foundation of the research.

The above framework was designed based on the various literature found it was inspired by the frameworks proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011). However, the leadership qualities by Srivastava and Jain (2017) has

been incorporated within the framework. During the data analysis each factor had been evaluated by the participants involved in both the questionnaire and the interview. This enabled the results to be analysed and the factors to be compared amongst each other.

Table 11 Theoretical Framework Findings

Dimension	Main Success Factor	Rank
Organisational	Top management support Team Environment	3
People	Handling commercial pressures Dealing with project complexity Stakeholder politics Project management skills Handling project complexity Effective communication and feedback	1
Process	Fixed requirements with little change Simplicity in process Frequent reporting of project status Risk management Time allocation Utilisation of project resources Clear assignment of roles and responsibility	4
Project	Team size Team distribution Project type Project nature Code review	6
Technical	Familiarity with technology Supporting tools and infrastructure in place	5
Leadership	Communication Commitment to task People centric Facilitator Openness/transparency	2

The table 11 presents all the factors that were researched for this in a ranking based on importance when it comes down to delivering successful IT projects. These findings help directly answer the research question and presents critical success factors that enable Scrum teams to deliver successful IT projects. It has also extended the findings of Darwish et al (2015) by ranking how important each factor is in delivering project success. In addition, the literature surrounding leadership has been extended as it was found there was little information around this area when conducting the literature review.

5.3 Obstacles

The literature review also investigated the obstacles that may interfere with the success of a Scrum project. It was found Maulana and Raharjo (2021) identified the following obstacles:

1. Lack of stakeholder knowledge and involvement
2. Changes/additional requirements during the development process
3. Integrating existing applications (Cross-functionality)
4. New team members
5. Self-management of developers in carrying out the process

These obstacles were incorporated into the questionnaire and participants were given the ability to select and identify their own issues. The interview questions only asked participants to identify any potential obstacles without giving the list created by Maulana and Raharjo (2021). The findings show that the biggest obstacles that interferes with project success are:

- Lack of stakeholder knowledge and involvement
- Changes / additional requirements during the development process
- New team members

These obstacles correlate with the findings of Maulana and Raharjo (2021). The findings from the questionnaire and interviews have been able to extend the findings of Maulana and Raharjo (2021) by identifying additional common obstacles identified by the participants involved. The most common obstacles found were:

- Lack of top management support
- Toxic team environment
- Poor decision making

Therefore, the research conducted supports the existing literature of Maulana and Raharjo (2021) and as well as extending the existing factors. This is significant because it highlights to Scrum teams of what needs to be avoided during a project. It is important to understand the key success factors but understanding what may cause the team to fail would help Scrum teams move in the correct direction.

Furthermore, once several obstacles that may get in the way of Scrum teams delivering successful IT projects was understood, this was then extended by investigating why Scrum projects fail from the perspective of team members. This question was asked to the interviewees, and the findings align with the previously identified obstacles. This is because the most common answers fit into the category of:

- Lack of stakeholder knowledge and involvement
- Changes / additional requirements during the development process
- Toxic team environment

These factors were the most common reason why Scrum projects fail based on the responses identified by the interviewees. The fact that these factors were all identified as obstacles indicates an emphasis should be put on controlling these obstacles to ensure they do not interfere with the success of the project.

5.4 Roles

This section focusses on the perspectives of all three scrum roles. The purpose is to develop an in depth understanding on what each role believes on the critical success factors that enable Scrum teams to deliver successful IT projects and how they differ amongst each other.

Scrum Master

The findings show that Scrum masters favour factors such as 'People' and 'Organisation' when delivering a project. All Scrum masters that took part in the questionnaires and interviews had all put an emphasis on leadership qualities. This is supported by respondent 1(Scrum master) claiming having leadership qualities allows a Scrum master to be "well rounded." It was also found large number of Scrum masters suggested the team environment factor as an important success criterion. The findings show that Scrum masters value the non-technical aspects of the project over the technical. This aligns with the role of a Scrum master proposed by Schwalbe (2012) where the key responsibility is ensuring the team is productive and are utilising agile practices. As Scrum masters are less involved with the technical side of the projects, it makes sense they would priorities non-technical factors.

The challenges a Scrum master may face were also investigated. The findings show the biggest issues faced by Scrum masters based on this study is coaching a team when there is a lack of understanding of agile principles. Also, Respondent 7 identified a problem with the Scrum framework that there isn't a metric to understand the individual performances of the team. Scrum measures the problem of the team rather than the individuals. This is problematic because it can make it difficult to identify any liabilities within the team.

Product Owner

The findings for the Product owner role show similarity to the results of the Scrum master. This is because the Product owners involved in the research also believed, 'People' and 'Organisation' were the most important success factors when delivering a Scrum project. There was also a general agreement that leadership qualities are important for Scrum masters to possess. The findings also show that the most common suggestion given by Product owners is having a good team environment is required for a project to be successful. The biggest difference between the findings of the Scrum master and Product owner roles is their view on what obstacles may interfere with the success of the project. For example, 80% of Product owners believed lack of stakeholder engagement was the reason why Scrum projects fail. This is understandable because Product owners are directly involved with the communication with stakeholders. This is supported by Respondent 2 claiming "it can be difficult to align several stakeholders to make decision and converse on a shared single understanding of the product."

Development team

The results for developers show a slight variation to the Scrum master and Product owner roles. This is because the 'Organisation' and 'People' factors were still rated as important, however there was also an emphasis of the 'Process' and 'Technical factors'. Developers are directly involved with the development of the project which makes sense why they may believe technical factors such as the software and hardware used are important in the development of the project. The developers also believed focus on the product/solution and having an appropriate sprint length are important success factors for Scrum projects.

The biggest challenges identified by developers were team members joining and leaving in the middle of the project. It was found this can slow down the development process as it takes time to get new members up to scratch. It was also found one of the factors that can cause a project to fail based on the perspective of developers is the poor decision making by senior developers. This may include decisions on methods of completing work and technology.

5.5 Summary of findings

- After evaluating the findings of the frameworks proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011) it was found the following factors were ranked in the following order from most to least important.
    1. *Organisational*
    2. *Technical*
    3. *People*
    4. *Process*
    5. *Project*
- The leadership qualities presented by Srivastava and Jain (2017) were found to be crucial for a Scrum master to posses
- The communication factor was found to be the most important leadership quality

- When the leadership factor was incorporated into the Darwish et al(2015) framework it became the second most important Scrum success factor
- Maulana and Raharjo (2021) identified several obstacles that may occur in a Scrum project, using their findings as well conducting research found the following obstacles to be the biggest challenges in a Scrum project:
  - ✓ Lack of stakeholder knowledge and involvement
  - ✓ Changes / additional requirements during the development process
  - ✓ Toxic team environment

6. Conclusions and Recommendations

The research question 'What Critical Success Factors Enable Scrum Teams to Deliver Successful IT Projects' has been answered through exploring several different aspects. The first aspect was evaluating the frameworks proposed by Darwish et al (2015) as well as Nasir and Sahibuddin (2011). Each success factors were compared amongst each other, and the literature was extended by ranking how important each factor is when delivering a successful Scrum project. The second aspect explored how leadership may impact the success of a project. This was important because there was little pre-existing information the role soft skills such as leadership may have on Scrum projects. It was found that leadership plays a pivotal role and is essential to have in each Scrum team. The final aspect focused on the obstacles that may interfere with the success of a project. The findings of by Maulana and Raharjo (2021) were reinforced by discovering lack of stakeholder knowledge and involvement was the biggest obstacle when trying to deliver a successful project. Some of the key recommendations for IT sector on the application and implementation to Scrum teams to further enhance the possibility of delivering successful projects is discussed below.

Prioritise Non-Technical Factors over Technical Factors

In the literature review and the data analysis it was found non-technical factors were, more influential in delivering successful projects over technical factors as shown in table 12. It is recommended for Scrum teams to follow the following framework during a project. In orders to achieve the best results the top 3 ranked factors should be prioritised.

Table 12 Theoretical Framework findings

Dimension	Main Success Factor	Rank
Organisational	Top management support Team Environment	3
People	Handling commercial pressures Dealing with project complexity Stakeholder politics Project management skills Handling project complexity Effective communication and feedback	1
Process	Fixed requirements with little change Simplicity in process Frequent reporting of project status Risk management Time allocation Utilisation of project resources Clear assignment of roles and responsibility	4
Project	Team size Team distribution Project type Project nature Code review	6
Technical	Familiarity with technology Supporting tools and infrastructure in place	5
Leadership	Communication Commitment to task People centric Facilitator Openness/transparency	2

These are 'People, 'Leadership' and 'Organisation'. Although these factors should be prioritised, technical factors such as the choice of the hardware and software should not be disregarded. As it was found developers still put an emphasis on technical factors. Therefore, it is recommended to prioritise the leading factors, but it is important to not disregard lower ranked factors such as 'Technical' and 'Project'.

Creating a Positive Team Environment

During the interview and questionnaire process an outstanding number of responses claimed promoting a trustworthy team environment helped deliver successful projects. This means that it is recommended that Scrum teams at the start of a project establish trust amongst the team members. This can be achieved by clearly communicating the expectations of each individual and identifying concerns any member may have. It is also important to provide support for team members if they are struggling or dealing with stress. It may also be necessary to have several ice breakers/activities at the start of the project to help everyone be a lot more comfortable with each other.

Critical for Scrum masters to possess leadership qualities

In the literature review it was found Srivastava and Jain (2017) had identified several leadership mechanisms that were important for a Scrum master to have. This was reinforced during the data collection, all participants involved in the interviews and questionnaires believed that these were essential qualities for a Scrum master to have. Therefore, it is recommended when selecting a Scrum master for a project they must be able to push and motivate a team. This is important because leadership was found to be the second most impactful factor in successful Scrum projects. The table below displays the leadership qualities a Scrum master should possess.

Table 13 Leadership Mechanisms for Scrum masters

Leadership Mechanisms for Scrum masters	
1.	Communication
2.	Commitment to task
3.	People centric
4.	Facilitator
5.	Openness/transparency

Senior Members to Display Leadership Qualities

It is also recommended that all senior members in each team display leadership qualities within their sub team. For example, in the development team senior members should be able to motivate a team and there should be a key figure that can help less experienced members. This relates to creating a positive team environment, having multiple leaders within a team would help create a healthy environment to work in.

Mitigate the number of team members joining and leaving the team

It is recommended to keep the number of members joining and leaving the team to a minimal during the project. This was found to be a key obstacle that interfered with delivering successful projects. As it takes teams a lot of time to adjust to the arrival of new members. New members would need time to get up to track with a project, which was identified as a problem as it could slow down the progress of the project. Also, too many changes within a team would disrupt the established team environment and it would take time to develop a good relationship amongst the new members.

Constant engagement with stakeholders throughout the project

In the research conducted for this research lack of stakeholder engagement was identified as the biggest reasons why Scrum projects fail. Therefore, it is recommended to continuously be communicating with stakeholders throughout the project. This is to ensure the project team and stakeholders share the same vision of the expected product/solution. It was also found the Product owners that took part in this research believed this factor was critical in delivering a successful IT project.

Top management support

The final recommendation is to organisations and how it is important for them to accommodate to the needs of a Scrum team. It was found that Scrum team members thrive when they believe they are appreciated by the organisation and are given the flexibility and freedom to make decisions that helps them work in the best way. An example of this is the development team having a preference of the system they use and the organisation being able to meet these needs.

Limitations of research

The biggest limitation of the methodological approach used for this research; is it may be subject to some biases. This is because a convenience sampling method was being used, and a lot of the questions rely on the opinions and experiences of participants. This was mitigated by ensuring several participants from different Scrum team and organisations were used to take part in the research. In addition, this research could have been improved by also studying a single Scrum team and interviewing the members at different stages of the project. This gives the opportunity to visually see how the success factors may be present or absent in the project.

Another limitation is some responses from participants may suffer from additional biases. This is because they may want to display themselves and the projects they have worked on in the best light. Also, there may be different emphasis on what factors that need to be focused on in different organisations. This is because organisations have different cultures, and these cultures may contrast with each other.

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