IMPACT OF SCRUM TAILORING CHOICES ON TECHNICAL DEBT

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ABSTRACT

IMPACT OF SCRUM TAILORING CHOICES ON TECHNICAL DEBT

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Agile software development (ASD) has increased its popularity by proposing solutions to the problems introduced by traditional methods. Among various ASD methods, Scrum is one of the most popular ones. Scrum Guide provides a detailed description of the definitions, rules, and purposes of each Scrum practice (i.e., events, roles, and artifacts). Due to various factors such as team size, team distribution, project domain, technology, and requirement stability levels, organizations prefer to adopt Scrum practices into their contexts and tailor them compared to the original definitions defined in the Scrum Guide. In this thesis study, we explored the tailoring choices made in Scrum practices in software organizations, determined the positive and negative consequences of these choices, and analyzed the impact of these choices from the technical debt perspective. To achieve these objectives, we first conducted a Systematic Literature Review (SLR) to identify existing studies in this field. Following this study, we conducted a survey study with 50 participants and subsequently conducted a follow-up interview study with 10 participants. Based on these studies, we found evidence on tailoring for all Scrum practices. The results
also revealed that tailoring of Scrum practices yields more negative consequences than positive ones in software projects. Specifically, we discovered that specific Scrum tailoring choices lead to issues such as incomplete or incorrect code implementation and tests, lower product quality, and communication problems within Scrum teams, and among Scrum team members and customers.

**Keywords:** Agile Software Development, Scrum, Scrum Tailoring, Technical Debt
ÖZ

SCRUM UYARLAMA TERCIHLERİNİN TEKNİK BORÇ ÜZERİNDEKİ ETKİSİ

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Çevik yazılım geliştirme (ÇYG), geleneksel yöntemler tarafından ortaya çıkan sorunlara çözümler önererek popülerliğini artırmıştır. Çeşitli ÇYG yöntemleri arasında Scrum, en popülerlerinden birisidir. Scrum Kılavuzu, her Scrum pratiğinin (etkinlikler, roller ve eserler) tanımları, kuralları ve amaçlarının ayrıntılı bir açıklamasını sunar. Takım büyüklüğü, takım dağılımı, proje alanı, teknoloji ve gereksinim istikrar seviyeleri gibi çeşitli faktörler nedeniyle, organizasyonlar Scrum pratiklerini kendi bağlamlarına uyarlamayı ve bu pratiklerin Scrum Kılavuzu'nda tanımlanan orijinal tanımlarına kıyasla bazı özelleştirmeler yapmayı tercih ederler. Bu tez çalışmasında, Scrum uygulayan yazılım şirketlerinde Scrum pratiklerinin uyarlanma tercihlerini keşfettik ve bu tercihlerin olumlu ve olumsuz sonuçlarını belirleyerek teknik borç perspektifinden bu tercihlerin etkisini analiz ettilik. Bu hedeflere ulaşmak için, öncelikle bu alandaki mevcut çalışmaları belirlemek için Sistematik Literatür Taraması (SLT) gerçekleştirildik. Bu çalışmanın ardından, 50 kişiyle bir anket çalışması ve sonrasında 10 kişiyle bir mülakat çalışması gerçekleştirildik.
Bu çalışmaların sonucunda, tüm Scrum pratiklerinin uyarlanma biçimlerine dair veriler elde ettik. Sonuçlar ayrıca, bu uyarlama tercihleriyle ilişkili olumsuz sonuçların olumlu sonuçlardan daha fazla olduğunu ortaya çıkardı. Özellikle, belirli uyarlama tercihinin yazılım projelerinde teknik borç neden olabileceği, eksik veya yanlış geliştirmeler ve testlere, ürün kalitesinin azalmasına, Scrum takımı arasında ve Scrum takım üyesi ve müşteri/kullanıcı arasındaki iletişim problemleri gibi sorunlara neden olabildiğini gözlemledik.

**Anahtar Kelimeler:** Çevik Yazılım Geliştirme, Serum, Serum Uyarlamaları, Teknik Borç
This thesis is dedicated to:

My father Bülent ÖZKAN and my mother Nilhan ÖZKAN
&
Seray YALAZ
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LIST OF ABBREVIATIONS

ASD: Agile Software Development
DAD: Disciplined Agile Delivery
DoD: Definition of Done
DV: Dependent Variable
IV: Independent Variable
IWSM: International Workshop on Software Measurement
PO: Product Owner
RQ: Research Question
SB: Sprint Backlog
SLR: Systematic Literature Review
SM: Scrum Master
TD: Technical Debt
TDM: Technical Debt Management
UX: User Experience
CHAPTER 1

INTRODUCTION

The first chapter of this thesis provides background information about the concepts used in this study. Further, in this chapter, the motivation of this study is provided with expressing how this study differs from the other studies in the literature. Considering the similar studies in the literature, the goals of this study are given. Additionally, the research strategy that was followed throughout the thesis is described and research questions of the study are provided. Finally, the overall structure of the thesis is introduced in this chapter.

1.1 Background of the study

The need for developing high-quality products efficiently and managing changes with adaptable and harmless ways led practitioners to adopt new approaches in software development (Ciric et al. 2019). In the past, software development methodologies like Waterfall and V-Model were more popular choices. These approaches introduced additional overhead and problems due to several reasons, such as high emphasis on documentation, and inability to respond to changes quickly and sustainably (Ciric et al. 2019). As a result, software practitioners needed a more flexible approach where it is possible to embrace the change in software projects by rapidly responding to business needs.

Origins of Agile Software Development (ASD) goes back to 1980s. Several methods, contributed to publication of Agile manifesto (Abrahamsson et.al, 2003) such as Crystal family of methodologies (Cockburn, 1998), Extreme Programming (XP) (Beck, 1999), Adaptive Software Development (Highsmith, 2000), Scrum development process (Schwaber, 1995; Schwaber and Beedle, 2001), and Pragmatic Programming (Hunt and Thomas, 2000). In 2001, software practitioners introduced the Agile Manifesto and presented a software development philosophy (Manifesto for Agile Software Development, 2001). Since the declaration of the Agile Manifesto in 2001, ASD has gained significant interest from industry practitioners. Several Agile methods that share its values and principles have been published, including Kanban (Anderson, 2004) and Disciplined Agile Delivery (DAD) (Ambler &
Since then, XP (Beck, 1999) and Scrum (Schwaber, 1995; Schwaber & Beedle, 2001) have started to receive more attention.

Agile Manifesto introduced four core values and twelve principles that illustrate a guide for how ASD should be approached. Details of these core values and principles are provided in Chapter 2.

Among various ASD methods, Scrum is the most widely adopted one (CollabNet VersionOne, 2019). Scrum is an ASD framework that was developed by Ken Schwaber and Jeff Sutherland (Schwaber, 1997; Schwaber & Sutherland, 2017). Scrum puts emphasis on Agile values, principles and practices which are described in Chapter 2. The Scrum Guide clearly describes Scrum events, artifacts, and roles. Therefore, the Scrum guide was preferred as the primary source of guidance in this thesis considering the information about the usage of Scrum practices (Schwaber & Sutherland, 2017).

Due to various project characteristics such as team size, team distribution, project domain, budget and duration, requirement stability, stakeholder availability, legal aspects, and contract types, organizations need to tailor their software processes (Kuhrmann & Kalus, 2013). Tailoring stands for customizing a standardized process to meet the needs of a specific context. It is essential to analyze organizations' motivations behind tailoring software processes. Additionally, discovering the positive and/or negative consequences of these tailoring choices is essential for characterizing various tailoring and understanding under which circumstances it is necessary to tailor software processes.

Scrum practices may not be applied as defined in the Scrum guide for the similar reasons described above for software processes. The Scrum guide that is developed by Ken Schwaber and Jeff Sutherland (Schwaber & Sutherland, 2017) provides a guide for rules and definitions for each Scrum practice. Since these definitions are only limited to providing a basic understanding of Scrum practices and cannot always be used in specific circumstances. Software teams may need to tailor Scrum practices based on their own needs.

Hron and Obwegeser conducted an SLR study to identify factors that motivate teams to tailor Scrum practices. They identified seven main factors based on their analysis of the literature. The first factor is working in distributed settings, which involves having team members from different geographical locations. The second factor is the combination of Scrum with other methodologies, such as XP and Lean development. The third factor is an increased demand for User Experience (UX) and usability, which may require establishing two Scrum teams: one for developers and one for designers. The fourth factor is vertical scaling, which involves embedding Scrum in larger organizational aspects such as strategic planning. The fifth factor is size scaling, which may require alternative frameworks such as
Scrum-of-Scrums or CAFFEA when the number of developers exceeds the recommended number for a single team. The sixth factor is the need for specific tools to deliver a solution. The seventh and final factor is the adoption of Scrum to different contexts, such as modifying Scrum for environments with heavy regulation or adopting Scrum to embedded system development. (Hron & Obwegeser, 2018).

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Ward Cunningham introduced the notion of Technical Debt by stating that the results of decisions taken for short-term benefits without considering the outcomes in the long term (Cunningham, 1992). Just as financial debt, in software projects, if the software teams do not pay the debt early and keep obtaining additional debt, they experience severe consequences, and additional effort would be required to manage the TD in these projects.

Some of the causes of incurring TD in software projects can be stated as: emphasis on quick delivery, architecture and design issues, inadequate test coverage, lack of understanding of system being built/requirements, overlooked and delayed solutions and estimates, less/no/delayed refactoring, code duplicates (Behutiye et al., 2017). Further, when organizations tailor Scrum practices in their context, it is also likely to encounter TD in software projects. In this thesis, we aim to explore the impact of the Scrum tailoring choices of organizations on technical debt in software projects.

1.2 Motivation of the Thesis

Literature in this field can be categorized in four different aspects. The studies in the first category focus on exploring process tailoring criteria for software development projects (Kalus & Kuhrmann, 2013; Hron & Obwegeser, 2018; Campenelli et al., 2015; Jovanovic et al., 2020). The main purpose of these
studies is to be able to understand the tailoring criteria of organizations for software process tailoring.

The studies in the second category focus on challenges and motivations for Agile Tailoring (Kalus & Kuhrrman, 2013; Hron & Obwegeser, 2018; Campenelli et al., 2015). These studies report challenges and motivations that lead to the tailoring of the Scrum method.

One study belongs to the third category, which presents solution strategies for method tailoring (Hron & Obwegeser, 2018). In this study, the primary purpose is to present commonly used solution strategies that are applied to perform Scrum tailoring.

Considering the studies in the fourth category, several studies focus on Scrum practice tailoring. However, further evidence is required about the specific Scrum tailoring choice and its consequences (Fitzgerald et al., 2006; Masood et al., 2020; Eloranta et al.; 2015; Hossain et al., 2011; Mortada et al.; 2020; Diebold et al., 2015; Hassani et al., 2020; Perez et al., 2014).

Considering the research areas of previous studies, most of the studies in the literature only cover tailoring choices of some of the Scrum practices. Additionally, we have found only one study that directly specified the positive impacts of Scrum tailoring (Fitzgerald et al., 2006) and two studies that specified the negative impacts of Scrum tailoring choices (Masood et al., 2020; Mortada et al., 2020). Further, it is required to contribute to the literature by analyzing the impact of Scrum tailoring choices from the technical debt perspective.

Considering the lack of knowledge and examples in the literature regarding the research areas explained above, this thesis aims to fill this gap by developing a research approach with the following goals:

1. Exploring the tailoring choices for each Scrum practice.
2. Specifying the positive and/or negative impact of these choices.
3. Specifying the relation between these tailoring choices and technical debt.

1.3 Research Strategy

This study aims to investigate how Scrum practices are tailored by people across diverse business domains, who implement Scrum as a software development methodology. Further, another purpose of this study is to identify the consequences of these tailoring choices from a technical debt perspective. Regarding these purposes, we detected the following research questions for this thesis study:

**RQ1:** Which practices (events, roles and artifacts) of the Scrum method are tailored in software projects? In what way are they tailored?
RQ2: What are the positive and/or negative evidence for the Scrum tailoring choices?

RQ3: What is the impact of Scrum tailoring choices from the technical debt perspective?

In order to find answers to the research questions that are given above, in this thesis, we adopted a mixed-methods approach to explore the research topic. The first step involved conducting a Systematic Literature Review (SLR) to comprehensively investigate the existing studies in the field. Subsequently, we conducted a survey study among participants working in organizations that apply Scrum as a software development method. To clarify the findings of the survey study, as the last research method, we conducted a follow-up interview study and obtain more comprehensive perspective of the research topic.

As the first step of this research, we conducted an SLR to explore the Scrum practice tailoring choices and their consequences in the literature. We used the IEEE Xplore, ACM, Scopus, and Springer digital libraries as the primary data sources and followed the Kitchenham and Charter’s guideline for conducting the review (Kitchenham et al., 2009). The details of the SLR are described in Chapter 3.

Based on the results of the SLR study, we found examples of Scrum tailoring choices and their positive and/or negative consequences. Yet, additional data was required to explore the impact of Scrum tailoring choices on technical debt. To this end, we decided to conduct a survey study to explore the Scrum tailoring choices from a broader perspective and analyze the impact of Scrum tailoring choices from the technical debt perspective.

The methodology we followed to create the questions for the survey study has three main steps. First, we iteratively developed the hypotheses based on our findings from the SLR results and identified the independent and dependent variables, which will be tested through the survey study. Each hypothesis included an assertion regarding a Scrum practice tailoring and the possible result of that tailoring choice. Secondly, the final version of the hypotheses was used to derive the variables. For each hypothesis, the Dependent Variable (DV) was associated with potential technical debt, while the Independent Variable (IV) was associated with Scrum practice tailoring choice. Finally, we came up with a related survey question for each dependent and independent variable.

To test the clarity and understandability of the survey questions, firstly, we conducted the survey study among four respondents who work for an organization which applies Scrum as a software development method.
Based on the feedback we received from the participants, we updated the survey questions.

As the second stage of the survey study, we conducted a pilot study among 30 participants. Based on the results, we applied a reliability analysis to understand the consistency of the instrument measures.

We used Cronbach’s alpha method for assessing internal consistency for scale questions and decided to remove four questions based on the analysis results.

Finally, we conducted the main survey study among 50 participants to comprehensively understand the Scrum tailoring choices that participants from different fields of business areas experience. Further, based on the survey study results, we specified the relation between these tailoring choices and technical debt.

After collecting the survey results, we conducted a follow-up interview study that employed a semi-structured approach to explore the results further and collect in-depth information about the participants’ experiences. We detected the target sample for the interview study as 10 participants who work for organizations that implement Scrum.

Before starting the interview, each participant was asked for permission to record the interview. Voice recordings have been transcribed to text using the “Sonix.ai”\textsuperscript{1} tool. After transcription, Scrum practice tailoring examples and related technical debts were identified for each interview. We used open coding and coded each tailoring and related technical debt category to identify the themes and patterns in the data.

After applying open coding and retrieving the interview results, we used the “EdrawMind”\textsuperscript{2} tool to create mind map diagrams to visualize the relationship between the Scrum practice tailoring choices and related technical debt resulting from these choices.

Figure 1 below shows each step of the research strategy and the corresponding research methods used in this thesis to answer each research question.

\textsuperscript{1} Sonix.ai. (n.d.). Transcription and audio extraction. Retrieved May 6, 2023, Retrieved from https://sonix.ai/

Figure 1 Steps of the Research Strategy
1.4 Organization of the Thesis

The rest of this thesis is organized as follows: In Chapter 2, the background information about Agile Software Development, Scrum, Technical Debt, definition of Tailoring, and criteria for organizations to tailor software processes are provided.

Chapter 3 of our study presents a detailed overview of the steps followed in conducting a Systematic Literature Review (SLR). This includes outlining the research questions, identifying the academic search engines used, defining inclusion and exclusion criteria, specifying the search query used, reporting the number of papers included after each step of the SLR process, detailing the quality assessment criteria, and describing the snowballing approach. Furthermore, Chapter 3 presents the findings of our SLR study on Scrum tailoring choices, as well as the positive and negative consequences of these choices.

In Chapter 4, the research methodology we followed in this thesis is provided. We outline the connections between our research questions and related research methods that we used to find answers to these questions. Additionally, we provide a comprehensive overview of the research steps, the design of the survey, the structure of the survey, the flow of survey preparation, and the survey hypotheses. The chapter concludes by providing information on the design of our interview study, including details on how the study was conducted.

Chapter 5 presents the data analysis approach and results for the survey study.

Chapter 6 provides information about the data analysis approach and results of interview study.

Chapter 7 discusses the findings of the thesis study from SLR, survey, and interview study points of view and provides a comparative analysis of the results.

Finally, Chapter 8, includes the summary of the findings of this thesis study, contribution of the study for industry, and academia, limitations of the study, and future research suggestions.
CHAPTER 2

BACKGROUND

This chapter presents background information on terminologies frequently used in this thesis including, Agile Software Development, Scrum, Technical Debt, and tailoring Software Processes.

2.1 Agile Software Development

Before development of ASD, software teams were widely using heavy-weight project management methods. These methods were also referred as traditional software development methods (e.g., Waterfall model, V-Model). They include a sequential development process typically as start with analysis, and followed by design, development, and testing stages, where each phase can only start after completing the previous one. Due to several problems with the Waterfall method, such as the required effort for up-front and detailed documentation, inability to respond to rapidly changing requirements, and delayed market releases; most organizations needed a more modern and feasible software development approach.

In reaction to these emerging needs in software development industry, Agile software development method was introduced as an alternative to traditional approaches to overcome certain challenges such as overwhelming documentation, and inability to respond to changes quickly and sustainably (Ciric et al. 2019).

It all started when seventeen software practitioners got together to discuss solutions to problems arising from traditional plan-driven software development approaches. In 2001, they introduced the Agile manifesto and presented a novel software development philosophy (Manifesto for Agile Software Development, 2001). Declaration of Agile manifesto has been a turning point for Agile Software Development with the following four core values:

- “Individuals and interactions over processes and tools”
- “Working software over comprehensive documentation”
- “Customer collaboration over contract negotiation”
- “Responding to change over following a plan”
These values defined in Agile manifesto, further elaborated by twelve principles which are listed below that stand behind these values (Manifesto for Agile Software Development, 2001).

Table 1 Principles Behind the Agile Manifesto

<table>
<thead>
<tr>
<th>No</th>
<th>Principles Behind the Agile Manifesto</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.</td>
</tr>
<tr>
<td>2</td>
<td>Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.</td>
</tr>
<tr>
<td>3</td>
<td>Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.</td>
</tr>
<tr>
<td>4</td>
<td>Business people and developers must work together daily throughout the project.</td>
</tr>
<tr>
<td>5</td>
<td>Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.</td>
</tr>
<tr>
<td>6</td>
<td>The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.</td>
</tr>
<tr>
<td>7</td>
<td>Working software is the primary measure of progress</td>
</tr>
<tr>
<td>8</td>
<td>Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.</td>
</tr>
<tr>
<td>9</td>
<td>Continuous attention to technical excellence and good design enhances agility.</td>
</tr>
<tr>
<td>10</td>
<td>Simplicity--the art of maximizing the amount of work not done--is essential.</td>
</tr>
<tr>
<td>11</td>
<td>The best architectures, requirements, and designs emerge from self-organizing teams.</td>
</tr>
<tr>
<td>12</td>
<td>At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.</td>
</tr>
</tbody>
</table>

Agile values and principles guide the usage of Agile methodology in software teams and construct the foundation of Agile practices by providing a different perspective to the traditional software development approaches in a flexible, iterative, and collaborative manner.

2.2 Scrum

Scrum is a lightweight framework developed by Ken Schwaber and Jeff Sutherland to provide a project management framework for software development by helping people, teams, and organizations generate value through adaptive solutions for complex problems (Schwaber, 1997; Schwaber...
Scrum is based on a set of values, principles, and practices where each practice serves a specific purpose and is adapted based on specific conditions. Scrum is by far the most popular Agile method (CollabNet VersionOne, 2019) and employs an iterative and incremental approach.

2.2.1 Scrum Pillars

As it can be seen from Figure 2, which is adapted from Scrum is based on three fundamental pillars (Schwaber & Sutherland, 2017).

![Figure 2 Three pillars of Scrum](https://www.scrum.org/resources/blog/three-pillars-empiricism-scrum)

**Transparency**
A common standard need to be established to ensure that the emergent process and work is visible to everyone in the Scrum team (Schwaber & Sutherland, 2017).

**Inspection**
The Scrum team needs to constantly inspect how things are going and determine if some aspects of a process deviate from its standards. Inspections should be performed by skilled inspectors (Schwaber & Sutherland, 2017).

**Adaptation**
Immediate actions must be taken when a deviation is detected from inspection, and related adjustments made in the process are expected to minimize further deviation (Schwaber & Sutherland, 2017).

2.2.2 Scrum Values

Successful use of Scrum depends on supporting Scrum pillars with Scrum values. Scrum values build the foundation of Scrum practices and define the

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3 https://www.scrum.org/resources/blog/three-pillars-empiricism-scrum
work ethics in Scrum. As shown in Figure 3, which is adapted from Scrum is based on five values.

![Five values of Scrum](image)

**Figure 3** Five values of Scrum

**Commitment**
Scrum team members must be committed to the Scrum goal and have the authority to meet their commitments (Schwaber & Beedle, 2002).

**Focus**
Every team member needs to focus on meeting the Sprint goal and should not be distracted by any other factor (Schwaber & Beedle, 2002).

**Openness**
Project’s progress and encountered challenges are visible to everyone in the project.

**Respect**
Scrum team members have to respect each other and learn how to accommodate the strengths and weaknesses of each other and compensate for them (Schwaber & Beedle, 2002).

**Courage**
Scrum team members must have the courage to take action and do their best to commit, act, and be open (Schwaber & Beedle, 2002).

**2.2.3 Scrum Events**
Scrum defines a set of events to allow the Scrum team to make process improvements through inspection and adaptation. Scrum has five events, as Daily Scrum, Sprint Planning, Sprint, Sprint Review, and Sprint

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Retrospective which can be seen in the figure below which is adapted from Rubin, (2013):

Figure 4 Sprint Flow

**The Sprint**
Sprints are iterations in Scrum where each iteration is time-boxed to one month or less. The primary purpose of a Sprint is to create a potentially shippable increment at the end of a Sprint. Sprints ensure predictability by allowing the Scrum teams to inspect and adapt progressively during the process (Schwaber & Sutherland, 2017).

**Sprint Rules**
- Sprints are time-boxed to at most one-month duration.
- The sprint backlog cannot be changed during the Sprint.
- The Product Owner has the authority to terminate the Sprint if he/she believes the sprint goal is not viable (Schwaber & Sutherland, 2017; Schwaber, 2004).

**Sprint Planning**
At the beginning of each Sprint, the work that needs to be performed within each Sprint is planned at Sprint Planning meetings. In the figure below, the inputs and outputs for Sprint Planning meeting are provided (Schwaber & Sutherland, 2017).
Sprint Planning Flow

Sprint Planning Rules
- For a one-month Sprint, Sprint planning should take at most 8 hours (Schwaber & Sutherland, 2017).
- Scrum team needs to establish a Sprint goal at the end of the Sprint Planning meeting.
- Scrum Master, development team and Product Owner attend the Sprint Planning activity.

Daily Scrum
Daily Scrum is an event held every day to inspect the team’s progress. The main purpose of the meeting is to improve the team communication and collaboration by answering three questions which are:

- What did I do yesterday?
- What I am planning to do today?
- Are there any impediments that need to be resolved?

Daily Scrum Rules
- Daily Scrum is time-boxed to 15 minutes.
- It is held every day in the same place and time.
- Daily Scrum is a meeting for the Scrum team. In case of attendance from outside, Scrum Master needs to ensure that they do not disrupt the meeting (Schwaber & Sutherland, 2017).

Sprint Review
Sprint Review allows the Scrum team to inspect the current Sprint outputs and adapt to future Sprints. The primary purpose of this meeting is to improve communication between the Scrum team and stakeholders and to get valuable feedback from the stakeholders.

Sprint Review Rules
- Scrum team and stakeholders invited by the Product Owner, attends the meeting (Schwaber & Sutherland, 2017).
- The development team demonstrates the current progress in the Sprint to stakeholders and asks related questions.
• As a result of the meeting, the Product Backlog is adjusted if necessary.

_Sprint Retrospective_
During Sprint Retrospective, the Scrum team inspects the current Sprint and aims to come up with possible improvements as a result of the meeting. The purpose of the meeting is to identify the positive and negative aspects of the current Sprint and create a plan for the future Sprint.

_Sprint Retrospective Rules_
• For one-month Sprints, the meeting is time-boxed to three hours (Schwaber & Sutherland, 2017).
• Only development team, Scrum master and Product Owner attend the sprint retrospective meeting (Schwaber, 2004).

2.2.4 Scrum Roles

**Product Owner**
Product Owner is responsible for Product Backlog management and maximizing the product's value. Product owner expresses the expectations of stakeholders to the Scrum team.

**Product Owner Responsibilities**
• Expressing and prioritizing Product Backlog items based on the goals.
• Making sure that the Product Backlog is transparent and visible to the Scrum Team (Schwaber & Sutherland, 2017).
• Establishing the communication between stakeholders and Scrum team.
• Making sure that development team has a clear idea about the Product Backlog items.

**Scrum Master**
Scrum Master’s primary responsibility is to ensure that the Scrum team understands Scrum values and principles. Scrum Master cooperates with the Product Owner and the development team.

**Scrum Master Responsibilities**
• Expressing the importance of Scrum values and principles to the Scrum team.
• Coordinating the Scrum events and ensuring the attendance of those who need to participate.
• Coaching the Scrum team in the Scrum adoption (Schwaber & Sutherland, 2017).
• Working for removal of any impediments that block the development team’s progress.
• Ensuring that Scrum team is not distracted with external factors (e.g., customers etc.) during the Sprint and focuses only on achieving the Sprint goal.

**Development Team**
Development team is responsible for developing software for creating the potentially shippable increment at the end of a Sprint.

**Development Team Responsibilities**
• Development teams need to involve people from different fields of expertise, such as designers, analysts, developers, testers, etc (Cross-functional).
• Development teams are required to work in a self-organized manner to be able to achieve the Sprint goal.

2.2.5 Scrum Artifacts

**Product Backlog**
Product backlog is a dynamic list of features, requirements, bug fixes and technical spikes. Product Backlog includes the description, size estimate, and order of the items. The Product Owner is responsible for both detailing and prioritizing the Product Backlog items, as well as breaking them down into smaller, more manageable pieces. Product Backlog is always open to change based on technology and business requirements, and market conditions (Schwaber & Sutherland, 2017; Schwaber, 2004).

**Sprint Backlog**
Sprint Backlog is a set of Product Backlog items that need to be implemented to achieve the Sprint goal at the end of a Sprint. Sprint backlog is essential in making the work for particular Sprints visible and monitoring the project's progress.

2.3 Technical Debt
Decisions taken for short-term benefits and sub-optimal actions in software development result in TD. The notion of TD was first introduced by Ward Cunningham as complying with a release deadline by making adaptations that endanger the product's long-term quality and maintainability (Cunningham,1992). Cunningham also drew an analogy between financial debt and technical debt and stated that when the debt is not repaid, it counts as interest on that debt (Cunningham,1992). After Cunningham's definition, several explanations that aim to clarify the TD methodology further have been proposed. Steve McConnell’s definition characterizes TD as intentional and unintentional, considering the source of the debt (McConnell,2008). Unintentional technical debt results from unconscious actions that lead to problematic solutions. On the other hand, intentional technical debt refers to consciously taking shortcuts during different phases of development to meet
deadlines or satisfy customers in the present time by sacrificing the long-term quality and maintainability of a project. According to Nugroho et al., technical debt is the cost associated with enhancing software quality to an optimum level. Nugroho et al. also state that the interest on the debt can be considered as the additional maintenance cost required when the ideal quality level is not achieved. Martin Fowler provides a more detailed categorization of TD by creating a quadrant that assesses the intention of a person who created the debt. Fowler’s quadrant includes two dimensions as reckless/prudent and deliberate/inadvertent (see Figure 6) (Fowler, 2009).

Reckless and Deliberate TD refers to TD that is incurred intentionally. In other words, the Scrum team may purposefully take actions that will result in TD but prioritize other concepts, such as speed over quality, with the expectation that the TD will be paid off in the future. Just as in Reckless and Deliberate TD, in Deliberate and Prudent TD, the team also knows that a decision will likely end with TD. The difference, in this case, is team plans how the TD will be paid off before taking the risks of incurring TD. The third quadrant, Reckless and Inadvertent TD, incurred unintentionally due to reasons such as lack of expertise of team members and time pressure. Finally, Prudent and Inadvertent TD is also unintentionally incurred, but the Scrum team plans to pay the debt soon (Fowler, 2009).

Figure 6 Fowler’s TD Quadrant

Aside from the previous aspects of TD definitions and categorizations, Alves et al. proposed an ontology where the debt’s nature is considered the main criterion to illustrate various types of TD. Based on this ontology, thirteen TD types have been identified and the definition for each TD category is provided below (Alves et al. 2014).
**Architecture Debt**
Architecture debt refers to the type of TD that is encountered in project architecture. One example of Architecture Debt is violation of modularity (Alves et al. 2014).

**Build Debt**
Build debt refers to the problems about build process such as time-consuming build processes (Alves et al. 2014).

**Code Debt**
Code debt refers to problems that can be detected in the source code of the projects resulting from following bad coding practices (Alves et al. 2014).

**Defect Debt**
Defect debt involves the known or unknown defects in software projects. One indicator of defect debt can be stated as uncorrected known defects (Alves et al. 2014).

**Design Debt**
Design debt is incurred when principles of object-oriented design is violated in software projects (Alves et al. 2014).

**Documentation Debt**
Documentation Debt can be detected in project documentations such as missing, or incorrect documentations (Alves et al. 2014).

**Infrastructure Debt**
Infrastructure Debt refers to the type of debt that delays some development activities, such as delaying a release (Alves et al. 2014).

**Process Debt**
Process Debt can be related with not following software development best practices (Alves et al. 2014).

**Requirement Debt**
Requirement debt in software projects refers to the accumulation of incomplete or unclear requirements, as well as requirements that are not correctly implemented (Alves et al. 2014).

**Service Debt**
Service debt refers to the type of debt that is incurred as a result of substitution of web services (Alves et al. 2014).

**Test Automation Debt**
Test automation debt can be related with the problems about automation of the tests of previously developed features (Alves et al. 2014).
**Test Debt**

Test debt includes problems about the test process that might have a negative impact on the product quality such as being unable to test all the cases for a development or testing wrong cases (Alves et al. 2014).

Considering the studies related to Scrum and technical debt in the literature, the main research areas we found are the effect of Scrum practices on technical debt and potential technical debt management strategies by utilizing Scrum practices. In an industry practitioner survey about the effects of agile method use on technical debt management, results revealed that Sprint Reviews / Retrospectives have the strongest positive effect on technical debt management (Holvitie et al., 2017). Similar results can be found in another study where the findings of the study suggest that 31% of the respondents indicated that Sprint Retrospectives as a point of identification of technical debt (Ernst et al., 2015). In another study, a Technical Debt Management (TDM) tool, DebtFlag, is introduced. It is stated that the TD log maintained by the tool can be used in Sprint Planning meetings to define new backlog items to make the TD visible and manageable. In the same study, it is also stated that Scrum’s Definition of Done (DoD) concept within the agile teams significantly contributes to TDM by ensuring a common understanding of TD-related issues (Behutiye et al., 2017).

### 2.4 Tailoring Software Processes

The term “process tailoring” stands for making customizations on software processes’ original definitions and implementing them differently for various reasons. Although several guides and rules exist for software processes generally, organizations can not apply these practices based on their original definitions. Kuhrmann & Kalus, performed an SLR to investigate different types of tailoring criteria. As a result of this study, 49 tailoring criteria, which were the main reasons for companies to make adaptations to original definitions of software processes, were found in the literature (Kuhrmann & Kalus, 2013). Due to various factors such as team size, team distribution, project domain, budget and duration, requirement stability, stakeholder availability, legal aspects, and contract types, organizations have to tailor their processes compared to the original definition of the software development methodologies to achieve business goals (Kuhrmann & Kalus, 2013). Two studies in the literature investigate how tailoring Scrum practices can lead to TD. In the study conducted by Masood et al., it was observed that not having a time limit for Sprints resulted in team members not committing to Sprint goals since they believed the Sprint could be extended at any time. Additionally, not having estimations in Sprints led to unrealistic Sprint goals, which demotivated Scrum team members. The study also presented an example of Scrum tailoring, where not having Sprint Review meetings caused teams to make changes in the late stages of development due to delayed
customer feedback. Finally, the study found that having too short or no retrospectives prevented teams from continuously improving, leading to technical debt. Another study conducted by Mortada et al., found that not having a fixed time for Daily Scrum meetings, led to fatigue among team members and team members lost their focus. Another study conducted by Mortada et al. found that not having a fixed time for Daily Scrum meetings led to fatigue among team members, and team members lost their focus. Additionally, due to having external participants in Sprint Review meetings, developers could not understand client expectations (Mortada et al., 2020).
CHAPTER 3

RELATED WORK

The main goal of this chapter is to provide previous studies that are related to the topic of this thesis and explain the steps and results of the SLR study to further clarify the related work in the field. This chapter demonstrates various key factors of SLR, which includes identifying research questions, selecting academic search engines, defining inclusion and exclusion criteria for paper selection, decision of the search query, quality criteria identification and assessment, and snowballing approach. In 2022, the SLR study was also published in the Joint Conference of International Workshop on Software Measurement (IWSM) and International Conference on Software Process and Product Measurement (MENSURA) with the title of “Tailoring Choices Made in Scrum Projects: A Systematic Literature Review” (Özkan & Özcan-Top, 2022).

3.1 SLR on Scrum Tailoring Choices

3.1.1 Motivation for Conducting the SLR

In this thesis, we are interested in the concept of tailored Scrum practices, such as variations in implementing events, roles, and artifacts, and the consequences of the tailoring choices from the Technical Debt perspective. When we explored the literature, we found three previously published systematic literature review studies (Kuhrmann & Kalus, 2013; Hron & Obwegeser, 2018; Campanelli & Parreiras, 2015) and two systematic mapping studies (Diebold & Dahlem, 2014; Jovanovic et al., 2020) that focus on different perspectives of Scrum tailoring or software process tailoring. We found out that previous literature review studies (Kuhrmann & Kalus, 2013; Hron & Obwegeser, 2018; Campanelli & Parreiras, 2015; Diebold & Dahlem, 2014; Jovanovic et al., 2020) generally focus either on the tailoring criteria for software development projects, or challenges and motivations for Agile tailoring (Kuhrmann & Kalus, 2013; Hron & Obwegeser, 2018; Campanelli & Parreiras, 2015). Hron and Obwegeser (Hron & Obwegeser, 2018), in an SLR study, report the challenges and motivations for companies that want to tailor the Scrum method. In this study, it was stated that considering the 31 relevant studies, seven factors motivating teams to tailor Scrum practices were reported: Working in distributed settings, combination with other
methods, increased requirements for UX and usability, vertical scaling, size scaling, tools, and adoption to a different context. Additionally, six solution strategies for achieving these goals were identified: pre-development, introduction of new procedures/artifacts/roles, providing method guidance, multiplicity of some method elements, and developing specific tools (Hron & Obwegeser, 2018). Kalus and Kuhrmann (2013) performed an SLR in which they presented a collection of 49 tailoring criteria which are later linked to a set of 20 exemplary tailoring actions. Campanelli and Parreiras (2015) conducted another SLR on agile methods tailoring, including the adopted method tailoring approaches and tailoring criteria such as project type, complexity, team size, and technology knowledge. Diebold and Dahlem (2014) conducted a mapping study on agile practices in the industry, which are used in different contexts and circumstances. This study classified practices as fully used, partially used, and not used, which gives an overall understanding of the usage prevalence of specific agile practices. Jovanovic et al., 2020 provide a systematic mapping of available frameworks, issues, and factors to identify different aspects of agile transition.

Considering the studies related to TD and agile software development, Holvitie et al. designed and applied a multi-national survey study among 184 participants who works as software practitioners. This study aims to explore the breadth of practitioners’ knowledge on TD, how TD is manifested across the software process, and the effects of agile software development practices and processes on technical debt. In order to analyze and synthesize the state of the art of TD, its causes, consequences, and management strategies in the context of ASD, Behutiye et al., 2017 conducted an SLR and identified and analyzed 38 primary studies. This study provides an understanding of TD and its management strategies in the context of ASD.

Eight studies contain Scrum event tailoring examples applied in various domains (Masood et al., 2020; Diebold et al., 2015; Hron & Obwegeser, 2018; Fitzgerald et al., 2006; Eloranta et al., 2016; Hossain et al., 2011; Mortada et al., 2020; Hassani et al., 2020). These papers report various Scrum practice tailoring choices of the organizations based on various criteria. Among these eight studies, only one reported positive consequences of tailoring choices (Fitzgerald et al., 2006), whereas two reported negative consequences (Masood et al., 2020; Mortada et al., 2020).

Previous studies mentioned above helped us gain insights into the conditions that arise Scrum tailoring needs, challenges encountered in tailoring Scrum, solution strategies to adopt Scrum in different contexts, the context of TD in ASD, Scrum tailoring examples from various companies operating in different domains and positive and negative consequences of these tailoring choices. In order to find out the details of the findings of each study described above, and to identify the research gaps in the literature for future research
areas, we conducted an SLR study which is described in section 3.2. Based on the results of the SLR, we found that existing studies do not provide Scrum tailoring examples for every Scrum practice. Additionally, we found that focusing on the relationship between tailoring Scrum practices and the TD resulting from these tailoring choices is another research area that needs more concentration. Each step of the SLR process and more detailed information about the results of the studies in the literature are included in Section 3.2.

3.2 Systematic Literature Review Process

In this thesis, the first step of the research process started with an SLR study to collect data from the literature about tailoring choices made in Scrum practices and their consequences from the technical debt perspective. We followed the Kitchenham and Charter’s guideline for conducting the SLR (Kitchenham et al., 2009). The SLR study we performed consists of ten steps which are described below:

3.2.1 Identifying the goal and questions of the SLR

Before starting the research process with the selected data sources, we identified the research questions for the SLR. Considering these research questions, we started to search for similar studies in the literature. The main goal of this SLR study is to determine, analyze and synthesize the scientific papers about the tailoring of Scrum events, roles, and artifacts, and the positive/negative evidence for tailoring choices from the technical debt perspective. The search period starts with 2001, the year in which the Agile Software Development manifesto was published and ends in 2022. To this end, we determined three research questions which are provided below:

1. Which practices (events, roles and artifacts) of the Scrum method are tailored? In what way are they tailored?
2. What are the positive and/or negative evidence for the choices?
3. What is the impact of Scrum tailoring choices from the technical debt perspective?

3.2.2 Identifying main data sources

To search for related studies, we decided to use four online academic search engines: (1) IEEE Explore, (2) ACM Digital Library, (3) Scopus, and (4) Springer.

3.2.3 The search query

To find as many relevant studies as possible, we identified the search keywords with an iterative approach by exploring alternative keyword options and formulated the final query as follows:

(Agile Tailoring OR Agile Practice Tailoring OR Agile Process Tailoring OR Scrum Process Tailoring OR Scrum Adaptation OR Scrum Tailoring)
3.2.4 Identifying the inclusion and exclusion criteria
We identified several inclusion and exclusion criteria to find the most relevant studies in the literature and eliminate the others. These criteria can be listed as below:

**Inclusion Criteria**
Studies that were published between 2001, when the Agile Manifesto was introduced, and 2022 are included. Additionally, papers written in English are included in this study.

**Exclusion Criteria**
Papers with unrelated titles, abstracts, and keywords to our research questions are directly eliminated. In other words, papers that do not provide any information about Scrum tailoring, and technical debt are excluded from the study.

3.2.5 Performing the pilot search
Using the pre-determined search keywords given above, we performed a pilot search in the selected academic search engines. After conducting the search on IEEE Explore, ACM Digital Library, Scopus, and Springer, we found 9506 papers in total. When we got the initial results, we noticed that all of the papers were irrelevant to the research focus of this thesis after some point. Thus, when we realized that the results started to become unrelated to our research topic, we directly eliminated them from consideration and did not apply the same inclusion/exclusion criteria each time.

3.2.6 Performing the first evaluation of the papers
The first step in evaluating the papers was to assess their relevance to the research questions of the SLR study based on the information provided in their titles and abstracts. For the papers that required further clarification after the initial evaluation based on titles and abstracts, we conducted, a full reading and analysis. Following this process, we identified 56 papers that were relevant to our research questions.

3.2.7 Quality Criteria Identification
As the final filtering approach, papers are evaluated based on the quality assessment questions given below:

1. Is the conference where the study was published has at least B ranking? (Conferences that have a ranking of A and B were accepted 5).
2. Are the goals of the research clearly stated?
3. Were the participants of the study appropriately selected?

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4. Is there anything that violates the soundness of the research applied?
5. Are the data collection methods adequately described?
6. Has the context of the study been explained?
7. Is there a valid research design to address the aims of the project?
8. Was the data analysis carried out rigorously?
9. Is there a clear statement of results?
10. Does at least one of the research questions receive their answers?
11. To what extent the paper is related to our topic?

3.2.8 Performing Quality Assessment
Each study is rated on a scale of 3 for each quality criteria question given above (except for the first one), and ones that receive 1 in any of the quality criteria (i.e., 1 corresponds to weak, two corresponds to medium, and three corresponds to good) are eliminated. The number of papers in our paper pool was decreased to 19 after the quality assessment process.

3.2.9 Snowballing
To ensure that we do not miss any relevant studies that can contribute to our research, the snowballing technique is used by browsing through the references section of each paper. Four additional papers were identified and included in our final set of paper pool. In Figure 7 below, steps of our SLR process are provided.

Figure 7 Steps of SLR Process
3.3 SLR Results

In this section, we present the results of the SLR study.

3.3.1 RQ 1 – Tailored Scrum Practices and Tailoring Choices

When we analyzed the SLR data, we specified that the most preferred tailoring approach is either not holding a specific Scrum practice or not properly following the rules defined in the Scrum Guide for that particular practice (Schwaber & Sutherland, 2017). Among 23 papers, eight distinct papers contain Scrum event tailoring examples applied in various domains (Masood et al., 2020; Diebold et al., 2015; Hron & Obwegeser, 2018; Fitzgerald et al., 2006; Eloranta et al., 2016; Hossain et al., 2011; Mortada et al., 2020; Hassani et al., 2020). We specified that the Sprint, Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective are tailored events. Figure 8 shows the distribution of the number of papers per specific tailored Scrum event. It can be deduced that the most reported tailored event is Sprint Review which is followed by the Daily Scrum, Sprint Planning, and Sprint Retrospective.

Figure 8 Tailored Scrum Events

Below, we explain how the Scrum events mentioned above are tailored. Hossain et al., (2011) and Eloranta et al., (2016) state cases where Sprint review (SR) meetings were not held. In some cases, the outcome of sprints is only reviewed by QA teams rather than an overall evaluation of the outcome by the development team and other stakeholders (Hossain et al., 2011). In another company, only Scrum Master, Project Manager, and customers are involved in Sprint Reviews, not development team members, due to one team being too small and the other being too large (Hossain et al., 2011). Although the project management role is more attributed to traditional/plan-driven project management approaches, this study indicates having a project manager role in Scrum projects. Another approach to Sprint Review tailoring is to conduct more than one Sprint Review meeting for each iteration. For example, as stated by Diebold et al., (2015) two companies have a strategy to conduct two review sessions: an internal session with developers to review the results and a second review session to include other stakeholders,
particularly the customer. The reason is that the team can make adjustments based on the first feedback before the customer sees the final result. Figure 9 shows the distribution of the various types of Sprint Review tailoring in multiple papers.

![Figure 9 Type of Sprint Review Tailoring Choices](image)

Additionally, it has been detected that in most examples where the Sprint Review event is tailored, the Sprint Retrospective event is also tailored (Diebold et al., 2015; Eloranta et al., 2016; Hossain et al., 2011). It was stated by Eloranta et al., (2016) that in some companies, no Sprint Retrospective meetings were organized as the teams had insufficient understanding of agile development and Scrum. On the other hand, it was also reported that the Sprint retrospective meetings are scheduled to finish discussions in around 15 minutes. This short-duration preference leads to not being able to run efficient discussions and identify actionable improvement items. There are also cases of not implementing the Sprint Retrospective meetings or rarely implementing them (Diebold et al., 2015; Hossain et al., 2011). Figure 10 shows the distribution of the types of Sprint Retrospective tailoring choices reported in different sources. In this context, keeping the Sprint Retrospective durations short or not organizing any retrospectives may negatively affect the organizations. In other words, these tailoring choices contradict Scrum Guide (Schwaber & Sutherland, 2017) and can be considered false tailoring examples.

![Figure 10 Type of Sprint Retrospectives](image)
Daily Scrum (DS) is the second most commonly tailored Scrum event based on the SLR data. The tailoring choices reported for the Daily Scrum meetings cover the number of meetings companies held in each iteration, the duration of DS meetings, or the participants involved in DS meetings. Hossain et al., (2011) report that onshore and offshore teams held daily scrums separately in distributed projects due to time differences (Hossain et al., 2011). Another frequently made tailoring choice for DS is not to limit the DS meeting duration to 15 minutes (Mortada et al., 2020). Diebold et al., (2015) report that some companies hold the duration of the event for around 30 minutes, which results in conducting the event every two days or only once a week if there is not enough news to share with the team. There are also teams that do not implement the DS event or the ones that include external participants in the DS meetings (Hron&Obwegeser, 2018). The distribution of the Daily scrum tailoring choices reported in different papers is given in Figure 11 below.

![Figure 11 Type of Daily Scrum Tailoring Choices](image)

Sprint Planning (SP) is the third most commonly tailored Scrum event. We specified that the tailoring choices made for the SP event were affected by various factors, such as the number of Sprint Planning meetings held and the preferred backlog items for the current Sprint. For example, Fitzgerald et al., (2006) state that in one team, two sprint planning meetings were preferred instead of one. In distributed teams having pre and post-planning meetings with the onshore teams before the meeting with the offshore teams is another preferred approach. To give an example about the SP tailoring choices from the companies, EnergyInfo held an additional sprint pre-planning meeting to increase the offshore team's domain knowledge (Hossain et al., 2011). CollaborationSoft held weekly Sprint Planning meetings with the project manager and sub-team coordinators. TestSoft held an additional Sprint pre-planning meeting by separating the participants of each meeting (only the
product owner and Scrum master join the first planning meeting) (Hossain et al., 2011). Mortada et al., (2020) reported an example of Sprint Planning tailoring where the team only utilized the Sprint Backlog during the Sprint Planning meeting. Additionally, some cases report a lack of defining a clear Sprint Goal for each Sprint. Figure 12 shows the distribution of the Sprint Planning tailoring choices reported in studies in our paper pool.

Figure 12 Type of Sprint Planning Tailoring Choices

In another two studies, there are also examples of companies that tailor the Sprint structure. For example, Fitzgerald et al., (2006) report that one of the case companies does not use Sprint time boxing. Instead, they continue distributing the tasks until the Sprint is at most 20 working days. Fitzgerald et al., (2006) and Eloranta et al., (2016) report that having sprints longer than one month is another choice regarding the Sprint duration. Figure 13 shows the number of studies that reported tailoring the Sprint timeboxing.

Figure 13 Type of Sprint Tailoring Choices

Figure 14 below shows the distribution of the papers presenting tailored Scrum roles.
Among the 23 studies, the most commonly tailored Scrum role was the Product Owner role, followed by Scrum Master and development team roles. Based on the results, the most common way of tailoring the Product Owner role is assigning other tasks to product owners, such as business analysis and technical management (Masood et al., 2020). The cases reported that customer representatives, business experts, project managers, and Scrum Masters work as POs in Scrum projects (Diebold et al., 2015; Eloranta et al., 2016; Hossani et al., 2020). The second most common way of tailoring the Product Owner role is not having a Product Owner in the team or multiple product owners within the same team. Based on the definition of the Product Owner role in the Scrum Guide, every Scrum team needs to have a Product Owner, and that person cannot have the role of Scrum Master (Schwaber & Sutherland, 2017).

The final approach to tailoring the Product Owner role that was found is assigning a Proxy Product Owner role. This role can be considered as a role that can replace the actual product owner when the PO is not available (Hossani et al., 2020). Figure 15 shows the distribution of the tailoring choices of the Product Owner role reported in the studies in our paper pool.
For the Scrum Master (SM) role, the most reported tailoring choice is not to have an SM role in projects or have other roles (e.g., business analyst) act as SM. Masood et al., (2020) note that some of the Scrum teams do not have an SM role because they consider themselves mature enough and see no reason to have a dedicated SM. In another study, companies fill this role with an existing Project manager, team lead, or developer who acts as Scrum Master. Diebold et al., (2015) report that the reason for having one of the developers as Scrum Master for two companies is because those companies report that they believe developers have better insight into the technicalities of the project. Other examples of Scrum Master tailoring choices include having multiple SMs and replacing SMs with different roles, such as developers or product owners (Hron & Obwegeser, 2018; Hossani et al., 2020). In Figure 16, tailoring choices made for the Scrum Master role reported in studies in our paper pool are shown.

Figure 16 Scrum Master Role Tailoring Choices

The distribution of papers reporting on the tailoring of Scrum artifacts, specifically the Product Backlog and Sprint Backlog, across different domains and companies is provided in Figure 17.

Figure 17 Tailoring Types for Scrum Artifacts
All five studies included in Figure 17 include Product Backlog tailoring, whereas only two papers refer to the Sprint Backlog tailoring choices (Masood et al., 2017; Hron & Obwegeser, 2018). We only observed Sprint and Product Backlog tailoring examples in all the studies we analyzed. However, we did not encounter other tailoring choices, such as burn-down chart tailoring, etc. In one of these papers, the entire team was not always involved in creating the Sprint Backlog, and it was done by a single person, which contradicts the Scrum Guide definition. Additionally, product backlog items arrive from various sources, such as clients, end-users, and the support team (Masood et al., 2017). In another study, 3 of the interviewed teams did not have a product backlog, and seven did not prioritize their product backlog items (Eloranta et al., 2016). Other examples of Sprint and product backlog tailoring choices include introducing both the Sprint and product backlog and using additional artifacts which are not involved in Scrum (Hron & Obwegeser, 2018), using detailed requirement analysis documents instead of a product backlog which against contradicts the Scrum principles (Hossain et al., 2011), defining different concepts such as Feature Pool and Feature Tree to form a product Backlog (Perez et al., 2014). Distribution of the tailoring styles for Sprint and Product backlog can be stated as:

- Having multiple sprint backlogs
- Involving single person in creating the sprint backlog
- Having detailed requirement specification instead of product backlog.
- Not having a prioritized backlog.
- Having multiple product backlogs.
- Not having a product backlog.
- Having multiple backlog item sources.

3.3.2 RQ 2 – Positive and Negative Evidence on the Consequences of Tailoring Choices

The SLR data analysis shows that the aforementioned Scrum practice choices lead to successful or unsuccessful consequences. Despite the lack of evidence on the outcomes of tailoring specific Scrum practices, Fitzgerald et al., (2006) reported that project success can be increased as a result of certain tailoring choices made during Sprint Planning and Sprint. These choices include introducing two planning sessions and simplifying the planning process by eliminating Gantt charts and complex task dependencies. Eloranta et al., (2016) state that tailoring choices were unsuccessful as there is no specific time limit for a sprint, goals were not apparent to the team, and team members were not committed to the sprint goals considering that the Sprint could be extended at any time. Additionally, product backlog tailoring was unsuccessful since the team ended up working on the wrong features that have no value to the customer (Eloranta et al., 2016). Again in the same study, unrealistic sprint goals demotivated the team members as a result of not having estimations in a sprint (Eloranta et al., 2016). As a result of not having
sprint review meetings for some of the teams, teams had to make changes at the late stages of development since they did not receive feedback during sprint review meetings, they only had the chance to get feedback when the customer started using the product (Fitzgerald et al., 2006; Eloranta et al., 2016). Finally, results of sprint retrospective tailoring choices such as having too short retrospectives or not having retrospectives at all can be considered as an ad-hoc development approach that ended up with teams not having a continuous improvement stage. In another study, not having a fixed time for Daily Scrums and exceeding 15 minutes led to fatigue among team members, and members lost their focus (Mortada et al., 2020). Additionally, most of the sprint planning tailoring choices, such as not having a sprint goal, not estimating the stories, and including only sprint backlog as the primary feature source, led to unsuccessful results such as failure to implement important required features, difficulties in defining sprint goals, and unplanned, unorganized sprint planning meetings. Another study stated that external stakeholders were present in sprint review meetings, and the client was not present, leading the developers not to understand client expectations (Hossani et al., 2020). Considering the scrum role tailoring choices, it is stated that the development team had other responsibilities outside of the sprint scope, which resulted in the developers' distraction and eventually resulted in a delay in delivery (Hossani et al., 2020).
CHAPTER 4

RESEARCH METHODOLOGY

In this chapter, the research methodology of the thesis is provided. The purpose of this chapter is to explain the connections between the research questions of this study and related research methods that have been used to find an answer to each research question. In Section 4.1, research steps are provided along with the flow diagram. Each step of the thesis study is given by providing the inputs and outputs of each step. Section 4.2 presents the hypotheses of the survey study, and Section 4.3 presents survey design, including the steps, structure, preparation flow. In Section 4.4, the interview study design and structure are provided. Finally, in Section 4.5, internal and external validity threads for this research and the steps that we followed to construct the validity of the findings are presented.

4.1 Research Strategy

Below, we explain the research strategy associated with the research questions.

As mentioned in Section 1.3, three research questions were specified for this thesis:

- Which practices (events, roles and artifacts) of the Scrum method are tailored in software projects? In what way are they tailored? (RQ1)
- What are the positive and/or negative evidence for the Scrum tailoring choices? (RQ2)
- What is the impact of Scrum tailoring choices from the technical debt perspective? (RQ3)

The first study that is planned to answer RQ1 and RQ2 is an SLR. First, we reviewed the literature to observe the various Scrum tailoring choices from organizations that operate in different business domains and the outcomes of these choices from the technical debt perspective. Each step of SLR study can be found in Section 3.1.

After completing the SLR study, we planned a survey study among individuals who work for an organization that implement Scrum. The purpose
of the survey was to address three research questions: RQ1, RQ2, and RQ3. Survey design and each step of the survey study is outlined in section 4.2.

After collecting the survey study results, we planned a semi-structured interview study to further explore the topic in greater depth and gain more detailed insights from participants. The goal of this interview study was to clarify the relationship between Scrum tailoring choices and technical debt by asking more in-depth questions to participants. We aimed to address RQ1, RQ2, and RQ3 during the interview study. Study design and structure, can be found in Section 4.3.

4.2 Survey Hypotheses

In this section, the hypotheses, and the reasons behind creating each hypothesis are provided. The first step of creating a survey and an interview study in this thesis is creating the related hypotheses which will be tested with related research methods. As the next step, the dependent and independent variables within these hypotheses are identified. For each scrum practice (event, role and artifacts), separate set of hypotheses are created. Related hypotheses and the specific goals for creating these hypotheses are provided in Table 2 below:

Table 2 Hypotheses and the purpose of defining the hypotheses

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Purpose of the Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1.1.1:</strong> Not holding Daily Scrum meetings every day, leads to</td>
<td>The purpose of creating this hypothesis is to test the relationship between the</td>
</tr>
<tr>
<td>communication problems in the Scrum team.</td>
<td>frequency of Daily Scrum meetings and possible communication problems within</td>
</tr>
<tr>
<td></td>
<td>the Scrum teams.</td>
</tr>
<tr>
<td><strong>H1.1.2:</strong> Participation of the stakeholders who do not belong to the</td>
<td>The purpose of creating this hypothesis is to test the relationship between the</td>
</tr>
<tr>
<td>Scrum team in Daily Scrum meetings, results in Daily Scrum meetings to</td>
<td>participation of stakeholders outside the Scrum team and duration of the Daily</td>
</tr>
<tr>
<td>take longer time.</td>
<td>Scrum meeting.</td>
</tr>
<tr>
<td><strong>H1.2.1:</strong> Estimation of backlog item efforts by someone other than</td>
<td>The purpose of creating this hypothesis is to test the relationship between the</td>
</tr>
<tr>
<td>developers, are more likely to lead to inaccurate estimates.</td>
<td>people who estimate the backlog item efforts and accuracy level of the estimates.</td>
</tr>
<tr>
<td><strong>H1.2.2:</strong> Estimation of backlog item efforts by someone other than</td>
<td>The purpose of creating this hypothesis is to test the relationship between the</td>
</tr>
<tr>
<td>developers, leads to decrease in overall quality of intermediate/final</td>
<td>people who estimate the backlog item efforts and quality of intermediate/final products.</td>
</tr>
<tr>
<td>products.</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>H1.2.3: Not holding Sprint planning meetings, leads to complexity and chaos in understanding task definitions</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of Sprint Planning meetings and level of complexity and chaos in understanding task definitions within the Scrum team.</td>
</tr>
<tr>
<td>H1.2.4: Not holding Sprint planning meetings, leads to lack of understanding of team capacity.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of Sprint Planning meetings and level of understanding of the team capacity within the Scrum team.</td>
</tr>
<tr>
<td>H1.2.5: If a Scrum team does not set a Sprint goal in Sprint planning meetings, the ability of the team to deliver working software at the end of the Sprint is weakened.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of setting a Sprint goal in Sprint Planning meetings and frequency of creating potentially deliverable software at the end of a Sprint.</td>
</tr>
<tr>
<td>H1.2.6: The frequency of involving tasks related to previous Sprints instead of new value-added tasks is an indicator of problems in determining the accurate team capacity.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of involving tasks related to previous Sprints and existence of problems in determining the accurate team capacity.</td>
</tr>
<tr>
<td>H1.2.7: The frequency of involving tasks related to previous Sprints instead of new value-added tasks is an indicator of problems in test process.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of involving tasks related to previous Sprints and frequency of entirely completing defined test activities within a Sprint.</td>
</tr>
<tr>
<td>H1.3.1: Using sprints longer than 1 month, results in delayed feedback about the progress from the customer.</td>
<td>The purpose of creating this hypothesis is to test the relationship between duration of Sprints and regularity of receiving feedback from the customer.</td>
</tr>
<tr>
<td>H1.3.2: Using sprints longer than 1 month, leads to late identification of the requirement-related problems.</td>
<td>The purpose of creating this hypothesis is to test the relationship between duration of Sprints and the time when the requirement-related problems are identified.</td>
</tr>
<tr>
<td>H1.3.3: A scrum team which does not use Sprints is unable to frequently deliver an increment.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the existence of Sprints and frequency of creating a potentially deliverable software.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>H1.3.4: Not using the Sprint practice, results in inability to frequently get feedback from the customer.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the existence of Sprints and the frequency of feedbacks received from the customer.</td>
</tr>
<tr>
<td>H1.3.5: Frequent changes in Sprint length, leads to extra effort in planning Scrum events.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the frequency of Sprint length changes and amount of effort in planning Scrum events.</td>
</tr>
<tr>
<td>H1.3.6: Frequent changes in Sprint length, leads to lack of understanding of team capacity.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of Sprint length changes and Scrum team’s level of understanding of team capacity.</td>
</tr>
<tr>
<td>H1.3.7: Changing the Sprint goal during the Sprint, reduces the quality of the intermediate / final products.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of Sprint goal changes during the Sprint and the overall quality of the intermediate / final products.</td>
</tr>
<tr>
<td>H1.3.8: Lack of definition of done criteria for Sprint items, leads to more effort on the similar problems in future Sprints.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the existence of definition of done criteria and required effort on similar problems in future Sprints.</td>
</tr>
<tr>
<td>H1.4.1: Not holding a Sprint Review meeting leads to lack of communication between the Scrum team and stakeholders.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of holding Sprint Review meetings and communication level between Scrum team and stakeholders.</td>
</tr>
<tr>
<td>H1.4.2: Not involving developers in Sprint Review meetings prevents the Scrum team from receiving accurate feedback from the stakeholders.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the attendance of software developers in Sprint Review meetings and the frequency of receiving accurate feedbacks from the stakeholders.</td>
</tr>
<tr>
<td>H1.4.3: Being unable to get useful feedback from customers at Sprint Review meetings, causes important problems to be noticed late.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the frequency of getting useful feedback from customers in Sprint Review meetings and frequency of late identification of problems.</td>
</tr>
</tbody>
</table>
Table 2 cont.

| H1.5.1: | Not holding a Sprint Retrospective meeting, causes the late identification of the problems in each sprint. | The purpose of creating this hypothesis is to test the relationship between frequency of holding Sprint Retrospective meetings and frequency of late identification of problems. |
| H1.5.2: | Keeping Sprint Retrospective meetings too short, results in failure to take necessary decisions for improvement in the subsequent Sprints. | The purpose of creating this hypothesis is to test the relationship between the duration of Sprint Retrospective meetings and the frequency of taking necessary decisions at Sprint Retrospectives. |
| H1.5.3: | Failure to take actions about the decisions made at Sprint Retrospective meetings, causes same/similar process problems to be encountered in future Sprints. | The purpose of creating this hypothesis is to test the relationship between the frequency of taking necessary actions in Sprint Retrospectives and the existence of same/similar problems in future Sprints. |
| H2.1.1: | Having a PO who acts like a traditional Project Manager, decreases team/individual motivation. | The purpose of creating this hypothesis is to test the relationship between behaviour of product owner and team/individual motivation. |
| H2.1.2: | The fact that the Product Owner and the Scrum Master are the same person, causes conflicts in product and process balance. | The purpose of creating this hypothesis is to test the relationship between having the Scrum Master and Product Owner as same person in Scrum team and existence of conflicts in product and process balance. |
| H2.1.3: | Not having a PO in a Scrum team prevents the team from having a well-defined and ordered product backlog. | The purpose of creating this hypothesis is to test the relationship between existence of product owner and frequency of well-defined and ordered product backlog problems in future Sprints. |
| H2.1.4: | Failure of the Product Owner to groom the Product Backlog, leads to rework of the unclear requirements in future Sprints. | The purpose of creating this hypothesis is to test the relationship between the success or failure of Product Backlog grooming and need for rework on requirements. |
| H2.1.5: | If the PO does not fulfill his/her duty in ordering and detailing the requirements, development activities would be incomplete. | The purpose of creating this hypothesis is to test the relationship between the success or failure of product owner in ordering and detailing the requirements and completion of development activities. |
Table 2 cont.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H2.1.6</strong>: If only the Product Owner creates the Sprint Backlog, entire Scrum team is not committed to the Sprint goal.</td>
<td>The purpose of creating this hypothesis is to test the relationship between people who create the Sprint backlog and commitment of Scrum team to the Sprint goal.</td>
</tr>
<tr>
<td><strong>H2.1.7</strong>: If only the Product Owner creates the Sprint Backlog, wrong items are included in the current Sprint.</td>
<td>The purpose of creating this hypothesis is to test the relationship between people who create the Sprint backlog and frequency of including wrong items in the current Sprint.</td>
</tr>
<tr>
<td><strong>H2.2.1</strong>: If SM has other responsibilities other than his/her main duty, Scrum values and principles are not clearly explained to the Scrum team.</td>
<td>The purpose of creating this hypothesis is to test the relationship between existence of other responsibilities of Scrum Master and Scrum team’s level of understanding of Scrum values and principles.</td>
</tr>
<tr>
<td><strong>H2.2.2</strong>: Not having a Scrum Master in a Scrum team, leads to problems about the organization of the Scrum events.</td>
<td>The purpose of creating this hypothesis is to test the relationship between existence of Scrum Master and existence of problems about the organization of Scrum events.</td>
</tr>
<tr>
<td><strong>H2.2.3</strong>: If a Scrum team does not include a role as SM, Scrum team is interrupted a lot with additional requests from the Customer.</td>
<td>The purpose of creating this hypothesis is to test the relationship between existence of Scrum Master and level of interruption of Scrum team by the customer.</td>
</tr>
<tr>
<td><strong>H2.3.1</strong>: If development teams are not cross-functional, there will be poor communication between developers with different specialities.</td>
<td>The purpose of creating this hypothesis is to test the relationship between the cross-functionality of development teams and level of communication between development team members in a Scrum team.</td>
</tr>
<tr>
<td><strong>H2.3.2</strong>: If the development teams are not cross-functional, it is inevitable to have a product with low quality.</td>
<td>The purpose of creating this hypothesis is to test the relationship between cross-functionality of development teams and the product quality.</td>
</tr>
<tr>
<td><strong>H3.1.1</strong>: In the absence of Sprint backlog, the Development Team team loses the transparency in the Sprint.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of creating a Sprint backlog and transparency level of a development team in the Sprint.</td>
</tr>
<tr>
<td><strong>H3.1.2:</strong> In the absence of Sprint backlog, the Development Team team loses the accountability in the Sprint.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of creating a Sprint backlog and development team’s level of accountability in the Sprint.</td>
</tr>
<tr>
<td><strong>H3.1.3:</strong> If a Scrum team does not use Sprint Backlog, the team will have problems with monitoring the project’s progress.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of creating a Sprint backlog and Scrum team’s frequency of encountering problems with monitoring project’s progress.</td>
</tr>
<tr>
<td><strong>H3.2.1:</strong> If a Scrum team does not have a Product Backlog, flow of the work can not be established.</td>
<td>The purpose of creating this hypothesis is to test the relationship between existence of Product Backlog and frequency of encountering problems regarding the flow of the work.</td>
</tr>
<tr>
<td><strong>H3.2.2:</strong> If a Scrum team does not have a Product Backlog, current status is not visible to team members.</td>
<td>The purpose of creating this hypothesis is to test the relationship between existence of Product Backlog and Scrum team’s frequency of encountering problems with monitoring project’s progress.</td>
</tr>
<tr>
<td><strong>H3.2.3:</strong> Having an unordered Product Backlog, leads to delivery of unimportant requirements and failure of the project.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of having an ordered Product Backlog and frequency of delivering the requirements according to customer’s priorities.</td>
</tr>
<tr>
<td><strong>H3.2.4:</strong> If the Product Backlog is not sized right, team fails to test the requirements properly.</td>
<td>The purpose of creating this hypothesis is to test the relationship between frequency of having false product backlog item estimations and frequency of entirely completing defined test activities within a Sprint.</td>
</tr>
<tr>
<td><strong>H3.2.5:</strong> Using requirement analysis document instead of product backlog, leads to extra time to learn about the necessary details for the tasks.</td>
<td>The purpose of creating this hypothesis is to test the relationship between preference of Requirement Analysis documents and level of difficulty in understanding the specific details of the tasks.</td>
</tr>
</tbody>
</table>
Table 2 cont.

| **H3.2.6:** Having a Product Backlog with unclear backlog item definition, leads to failure in development and tests. | The purpose of creating this hypothesis is to test the relationship between frequency of having a product backlog with unclear item definitions and frequency of entirely completing defined test activities within a Sprint. |

### 4.3 Survey Study Design

This section presents the study sample and criteria for selecting target participants for this study to answer RQ1, RQ2, and RQ3. Additionally, the overall structure of the survey, each step of creating the study, and survey questions are provided.

#### 4.3.1 Survey Study Sample

This study includes two independent samples as pilot study and main study sample.

- Sample for Pilot Study: 30 participants
- Sample for Main Study: 50 participants

In both pilot and main study, participants are selected based on the following characteristics:

- Participants who work in a company that applies Scrum as a software development methodology.
- Participants who work as a software practitioner (e.g., software developer, product owner, scrum master, project manager, designer, tester, analyst etc.).

#### 4.3.2 Survey Study Data Collection Instrument

As a quantitative study method, a survey study is used to collect data from participants who apply Scrum as a software development method in their organizations. After creating the hypotheses and related variables, to test these hypotheses, survey questions are created. For each hypothesis described in Table 2 above, there are two variables (IV and DV).

To this end, the independent variable includes a variance in different participants’ Scrum practice adaptation experience, whereas DV includes a variance in the consequence of these adaptations. Thus, to conduct an experiment to test these variables, we separated the questions related to the Scrum adaptation choices of the participants and their consequences.
Before conducting the main study, we conducted a pilot study with 30 individuals who apply Scrum in the organizations they work for. The main purpose of conducting a pilot study prior to the main study is to assess the reliability and consistency of the questions. To assess the internal consistency, we applied reliability analysis on the results. We used Cronbach’s alpha method to assess the internal consistency of the scale questions. We accepted the threshold value for alpha as 0.6 and removed the questions that lower the value below this threshold. As a result, we decided to delete four questions before performing the main study. The reliability analysis stage, deleted scale questions and Cronbach’s alpha values before and after removing the specific scale questions are provided in Section 5.2.1.

4.3.2.1 Survey Structure

The survey consists of 63 questions (Demographic questions are provided in Appendix A and the rest of the survey questions are provided in Appendix B) and is prepared in English. Additionally, for each survey question, corresponding independent and dependent variables are given in Appendix B. To create and distribute the survey, we used Survey Monkey, a cloud-based tool that helps users to create, release and analyze surveys. The survey consists of four types of questions: multiple choice, multiple selections, open-ended, and scale questions. To test each Scrum practice tailoring choice and their results independently, the survey was divided into 12 pages (See Table 3 for different pages of the survey and the number of questions for each question type). Each page, except for the general questions section, aimed to assess the participant's experience in using Scrum practices. The general questions section included questions concerning the potential consequences of Scrum practice tailoring of participants.

Table 3 Type and number of questions in the survey

<table>
<thead>
<tr>
<th>Page</th>
<th>Page Title</th>
<th>Number of questions</th>
<th>Multiple Choice</th>
<th>Open-ended</th>
<th>Multiple Selection</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demographics</td>
<td>12</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Daily Scrum Related Questions</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Sprint Planning Related Questions</td>
<td>6</td>
<td>5</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Related Questions</td>
<td>6</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>---</td>
<td>------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>Sprint Related Questions</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Sprint Review Related Questions</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Sprint Retrospective Related Questions</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Product Owner Related Questions</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Scrum Master Related Questions</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Development Team Related Questions</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Product Backlog Related Questions</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Product Backlog Related Questions</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3 cont.

|   | General Questions | 15 | 9 | - | 3 | 3 |

4.3.2.2 Survey Preparation Flow
Each step of preparation of the survey study is provided in Figure 18.

Figure 18 Steps of Survey Study
4.4 Interview Study Design
To gain a deeper understanding of the technical debt resulting from Scrum tailoring choices and to provide clarity on the findings of the survey study, we conducted a follow-up interview study. This interview study was designed to explore tailoring examples of Scrum practices in greater detail and to broaden our understanding of the associated technical debt. Through this follow-up study, we aimed to answer RQ1, RQ2, and RQ3.

4.4.1 Interview Study Sample
The interview study has only one sample, which consists of 10 participants. As with the survey study, the target audience in the interview study is the same, where each participant is selected among software practitioners who apply Scrum in their organizations. We selected all the interview participants among the survey participants to be able to ask more detailed questions, and gain a deeper understanding of the findings.

4.4.2 Interview Data Collection Instrument
A semi-structured interview technique is employed, where open-ended and closed-ended questions were asked to participants who work for an organization that employs Scrum as a software development method. We choose the semi-structured interview technique due to the following reasons:

- Flexibility to further explore topics that arise during the interview.
- Ability to collect in-depth information about the participants’ experiences.
- Ability to tailor each interview based on the participant’s responses.

To ensure consistency and gain a more detailed understanding of the participants’ responses to the survey, we selected interview study participants among those who had already completed the survey. By doing so, we were able to ask more specific questions to each participant, which allowed us to gain a deeper understanding of their perspectives and experiences regarding Scrum tailoring choices and technical debt.

4.4.2.1 Conduct of the Interview
The interview was conducted among 10 participants, where all participants had previously participated in the survey study. The interviews employed a semi-structured approach with an average duration of 42 minutes. Among the participants, there were 5 Software Developers, 1 Software Tester, 1 Product Designer & Scrum Master, 2 Scrum Masters & Business Analyst, and 1 Business Analyst. All interviews were digitally recorded, and permission was obtained from the interviewees before starting. The questions that have been asked to all participants are as follows:
1. Can you introduce yourself and talk about the responsibilities of the job that you perform every day?

2. Do you experience problems while applying Scrum in your team? Some of the example problems can be considered as communication issues such as misunderstandings, or technical issues such as problems about completing requirements, and tests. If you do, can you talk about the problems that need to be resolved?

3. If you tailor a specific Scrum practice similarly to the results presented in the table for each Scrum Practice tailoring, please specify the exact tailoring preference you have for your project.

4.5 Validity Threads

This section discusses the different methods used to ensure the validity and reliability of the research findings. It aims to demonstrate that the research was conducted in a rigorous and systematic manner, and that the results can be trusted.

4.5.1 Internal Validity

Internal validity in research refers to an experimental condition that makes a difference in the results, such as asking diverse questions to participants and receiving answers in different granularity levels. Regarding this, we found the following internal validity threads for this study:

- Participants may have provided responses that they perceived to be socially desirable, rather than reflecting their true experiences or practices. In order to minimize the negative effects of this, we conducted a follow-up interview study to ask more detailed questions to the participants.

- The use of self-reported measures in the survey study and interview study could introduce bias, as participants may not accurately recall or report their experiences and practices. In order to prevent this, we provided clear and detailed instructions during the survey and interview studies regarding the purpose of the study. Further, during the interview study, we asked follow-up questions to participants to clarify ambiguous responses.

- The length of the survey study may have caused fatigue among participants, leading to lower engagement and potentially affecting their responses. In order to minimize the negative effects of this, we first conducted a pilot study and applied reliability analysis on the results to assess the validity and reliability of the results. As a result of the reliability analysis, we removed 4 question from the survey.
Additionally, we used follow-up interview study to supplement the survey results.

4.5.2 External Validity

External validity refers to the extent to which the findings of the study can be generalized beyond the sample population of the study. Regarding this, we found the following external validity threads for this study:

- The limited number of participants in the survey study may not be representative of the entire population of Scrum practitioners. This could lead to biased results and limit the generalizability of the findings. To address this issue, we distributed the survey to individuals working for different companies which operate in various business domains.
- Participants of the data collection process of this thesis do not represent the entire Agile community. They are only limited to individuals who experienced Scrum tailoring in several projects.
SURVEY DATA ANALYSIS AND RESULTS

This chapter describes the data analysis approach, which includes the preliminary analysis conducted before hypothesis testing and the statistical analysis. It also presents descriptive results about participants’ demographic information, Scrum practice adoption preferences, and potential problems associated with specific Scrum practice tailoring choices. Further, this chapter outlines the statistical analysis methods that are used to test each hypothesis and presents the results of statistical tests.

5.1 Conduct of the Survey

In the survey study, IBM SPSS Statistics Version 26 was used for data analysis. Using SPSS, the following objectives were achieved:

- Conducting Reliability Analysis
- Conducting Normality tests
- Detecting and filling missing values with mean value
- Collecting and organizing descriptive data for Scrum practice adoption preferences
- Conducting Statistical tests for each hypothesis

5.2 Preliminary Analysis

After the pilot study, reliability analysis was conducted on the scale questions to assess the reliability of the questions. Then, before starting the statistical analysis, missing data was detected and handled. Finally, normality analysis was performed on the related variables to decide between the parametric and non-parametric methods.

5.2.1 Reliability Analysis

For each 5-point scale question in the Survey, reliability analysis was conducted to understand the consistency of the instrument measures. We used the Cronbach's alpha method for assessing the internal consistency of the scale questions. First, we included all scale questions in the analysis and assessed the internal consistency. As a second approach, we applied reliability
analysis to each scale question individually and retrieved different Cronbach's alpha values to detect if any question decreased the alpha value and created complexity among the participants. These two approaches are given below.

1. **The reliability analysis results for all scale questions**

   Table 4 Reliability Analysis Results for all scale questions

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.729</td>
<td>46</td>
</tr>
</tbody>
</table>

2. **The reliability analysis results for individual scale questions**

   Table 5 Reliability Analysis Results for individual scale questions

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>Deleted Scale Item</th>
<th>Cronbach's Alpha, after removing the related item</th>
<th>N of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.749</td>
<td>-</td>
<td>0.776</td>
<td>7</td>
</tr>
<tr>
<td>0.743</td>
<td>-</td>
<td>0.824</td>
<td>5</td>
</tr>
<tr>
<td>0.916</td>
<td>-</td>
<td>0.916</td>
<td>5</td>
</tr>
<tr>
<td>0.534</td>
<td>The rate of inexperienced team members is higher than the experienced ones.</td>
<td>0.651</td>
<td>6</td>
</tr>
<tr>
<td>0.576</td>
<td>In our project, there is strong communication between the Scrum team and the other project stakeholders.</td>
<td>0.617</td>
<td>13</td>
</tr>
<tr>
<td>0.386</td>
<td>It takes a long time to allocate the tasks</td>
<td>0.677</td>
<td>6</td>
</tr>
<tr>
<td>0.555</td>
<td>Phases where the bugs are identified - After software is delivered to the customer</td>
<td>0.602</td>
<td>4</td>
</tr>
</tbody>
</table>
In Table 5 above, Cronbach's Alpha values before and after removing a related item are given. The Cronbach's Alpha value in the leftmost column represents the initial results for the reliability analysis of each scale question. The Cronbach's Alpha values in the 2\textsuperscript{nd} column represent the new values when the questions that lower the alpha value are removed. Based on these findings, we deleted one question from 4,5,6,7\textsuperscript{th} scale questions (4 questions in total). Although most resources accept an alpha value greater than 0.7, since there are also resources that indicate that the value between 0.6 and 0.7 is acceptable (Griethuijsen \textit{et al.}, 2014), we decided to accept values that are greater than 0.6.

5.2.2 Handling Missing Data
Prior to conducting statistical analyses on the hypotheses, we analyzed the missing data, which refers to any unanswered questions by participants. Our approach to handling missing data varied depending on the type of the variable and the number of unanswered questions provided by each participant. The steps we took to address missing data can be described as follows:

1. When we extracted the survey results from Survey Monkey, we had the answers of 86 participants. If a participant answered at least 50% of all questions, we kept their data. Otherwise, we deleted the specific rows that reflect the answers for such participants. Following this criterion, we removed the data of 36 participants from our dataset and retained the responses of the remaining 50 participants\textsuperscript{6}. The rows in the table with gray color, indicate the responses of participants that have been excluded from the dataset. The remaining rows without any color represent the responses that we retained.

Responses which are highlighted with green, represent the participants’ data that is removed from the study. Remaining data is retained for further analysis.

2. For continuous variables, we replaced the missing values with mean values before including variables in statistical analysis.

5.2.3 Normality Test
Before deciding between parametric and non-parametric tests, we checked if the related data was normally distributed. To check for normality, in SPSS, we followed the Analyze, Descriptive Statistics, and Explore path, and then

\textsuperscript{6} Our dataset for the survey study can be found in the following link: https://rb.gy/57w6u
from the plots option, we selected the "normality plots with tests" option. We used Kolmogorov-Smirnov statistics results to assess the normality for each variable we wanted to test. A p-value greater than 0.05 is necessary to confirm the normal distribution of a variable (Pallant, 2001). After applying the normality test to each variable, we detected that the p-value was 0 for all variables, which shows that the data was not normally distributed. As a result of the normality test, since the variables were not normally distributed, we decided to choose non-parametric tests for testing our hypotheses. Several factors, such as outliers in the data and limited number of participants in the Survey, might have affected the distribution of the data.

5.3 Survey Study Results

This section presents the outcomes of the survey study, which are divided into three parts. Firstly, demographic information of the survey participants’ is provided. Secondly, descriptive results of Scrum practice adoption choices among survey respondents are presented. Lastly, hypothesis testing results are given.

5.3.1 Demographic Results

This section covers the demographic results of the survey study participants, mainly based on the sector of the organization that the respondents work in, the specialty of the respondents, the origin country of the organizations, and the preferred Agile methodologies perspectives.

5.3.1.1 Sector

![Sector Distribution](image)

Figure 19 Sector Distribution
Figure 19 shows the distribution of the sectors in which survey participants work. The frequency of responses varied across the sectors, with Finance having the highest frequency with 22 responses, followed by E-Commerce and Defense Industry with 6 and 5 replies, respectively. The remaining sectors, including Blockchain, Data Analytics, Gaming, Mobile Ecosystem, Property Technology, IT, Utility Tool, and Health Sector, had only one response for each. The results of the Survey suggest that Finance is the most frequent sector of work among the respondents, followed by the E-Commerce and Defense Industry.

5.3.1.2 Specialty

Figure 20 Specialty Distribution

Figure 20 shows the distribution of specialties among the survey study participants. Out of the listed specialties, Software Engineers received the highest frequency with 39 responses followed by System/Software Testers with 4, Scrum Masters, Business Analysts, Project Managers, and Software Architects with 2, 2, 1, and 1 responses respectively. Most respondents were identified as Software Engineers because Software Engineers are the most common specialty in the software development industry.
5.3.1.3 Origin Country of the Organization

Figure 21 Origin country of the organizations

Figure 21 provides valuable insights into the geographical distribution of organizations where the respondents work for. Turkey and Holland have the highest representation, indicating a higher concentration of organizations in those regions or that the Survey was more accessible to those countries.

5.3.1.4 Preferred Agile Methodologies

Figure 22 Preferred Agile Methodologies
Figure 22 summarizes the results of preferred Agile methodologies among respondents. The most preferred approach is to use Scrum alone with 26 responses. Based on the figure, we can see many examples of Hybrid approaches, such as using Scrum and Kanban together. The figure provides insights into the popularity of different Agile methodologies among survey respondents.

5.3.2 Descriptive Results for Scrum Practice Adoption (RQ1)
In this section, descriptive results of Scrum event, role, and artifacts adoption choices among the Survey study participants are provided in detail.

5.3.2.1 Daily Scrum
In this section, descriptive results of the Daily Scrum frequency, duration and participants among the Survey study participants are provided.

5.3.2.1.1 Daily Scrum Frequency

Figure 23 represents the number of responses from participants of the Survey regarding the frequency of holding a Daily Scrum meeting. The majority of participants, 39 in total, reported having a Daily Scrum once a day. Three participants reported that they hold the Daily Scrum meeting more than once a day. The remaining participants reported that they do not have Daily Scrum meeting every day. These results suggest that holding a Daily Scrum once a
day is the most common frequency among survey participants. Results other than that can be considered as tailoring Daily Scrum frequency (22%). Responses considered as tailoring are indicated with "(T)" in Figure 23.

5.3.2.1.2 Daily Scrum Duration

Figure 24 Daily Scrum Duration

Figure 24 displays the frequency of responses from participants of the Survey regarding the duration of their Daily Scrum event. The duration was recorded in three categories: more than 60 minutes, between 15 and 30 minutes, and 15 minutes or less. Only one participant reported having a Daily Scrum event that lasted more than 60 minutes. 23 of the participants reported having a Daily Scrum event that lasted between 15 and 30 minutes. Additionally, 16 participants reported having a Daily Scrum event that lasted 15 minutes, while 10 participants reported having a Daily Scrum event that lasted less than 15 minutes. These results suggest that the most common duration of Daily Scrum events among survey participants is between 15 and 30 minutes. Holding a Daily Scrum event within this time frame may allow participants to share the necessary information while keeping the meeting efficient and effective. According to Scrum Guide, Daily Scrum is a 15-minute event (Schwaber & Sutherland, 2017). Thus, based on the results, while 32% of the participants could apply this rule, the remaining 68% tailors this practice. Responses considered as tailoring are indicated with "(T)" in Figure 24.
5.3.2.1.3 Daily Scrum Participants

Figure 25 Daily Scrum Participants

Figure 25 displays the participants of the Daily Scrum event among the respondents of the survey study. These results show that most frequently, 12 respondents indicated Development Team, Scrum Master, Product Owner,
and Business analysts as participants of the Daily Scrum. Although rare, based on the results, we can also see that some teams prefer holding Daily Scrum in separate teams (Business analysts team, test team, project managers team, etc.). According to Scrum Guide, Daily Scrum is an event for the Scrum team (development team, Scrum Master and Product Owner). Thus, including participants other than these roles can be considered a tailoring of this practice. Based on the results, it can be suggested that 19 participants reported the attendance of people outside the Scrum team. Results show that 38% of the respondents of the Survey tailors this practice. Responses considered as tailoring are indicated with "(T)" in Figure 25.

### 5.3.2.2 Sprint Planning

This section covers the descriptive results of Sprint Planning usage. Descriptive results of Sprint Planning Frequency, frequency of setting a Sprint goal, and individuals who decide task durations are provided.

#### 5.3.2.1 Sprint Planning Frequency

![Sprint Planning Frequency Distribution](figure26)

Figure 26 Sprint Planning Frequency

Figure 26 represents the frequency of responses from participants of the Survey regarding the frequency of holding the Sprint planning event. Among the participants, the majority of participants, 32, reported that they always have the Sprint Planning event for each Sprint. On the other hand, five reported never holding a Sprint Planning event, while three reported rarely,
four reported sometimes, and six reported often holding it. These results suggest that although most participants value having a Sprint Planning event as a regular part of their Scrum processes, some organizations do not prefer to organize a Sprint planning event each Sprint. According to Scrum Guide, the Sprint should be initiated with Sprint planning (Schwaber & Sutherland, 2017). Considering the results, while 64% of the respondents reported that they always hold Sprint planning, the remaining 36% said that in some Sprints, they do not hold Sprint planning meetings. Thus, based on the results, it can be inferred that 36% of the respondents tailor this practice in varying frequencies. Responses considered as tailoring are indicated with "(T)" in Figure 26.

5.3.2.2 Frequency of Setting a Sprint Goal

![Frequency of Setting a Sprint Goal](image)

Figure 27 Frequency of Setting a Sprint Goal

Figure 27 displays the frequency of responses from participants of the Survey regarding the frequency of setting a Sprint goal at Sprint Planning meetings. Only two participants reported never setting a Sprint goal, while seven reported rarely. In contrast, 6 participants reported sometimes setting a Sprint goal, while 17 participants reported often doing so. Additionally, 17 participants reported always setting a Sprint goal, while 1 participant reported that this was not applicable to them. Scrum Guide suggests that Sprint Goal must be finalized prior to the end of Sprint planning (Schwaber & Sutherland, 2017). As a result, while 34% of the respondents stated that they always set a Sprint goal, 64% were unable to set a Sprint goal in varying frequencies.
Including the 2% of the responses where this practice is not applicable, it can be stated that 66% of the respondents have experienced tailoring of this practice. Responses considered as tailoring are indicated with "(T)" in Figure 27.

5.3.2.3 Individuals who decide task durations

Figure 28 Individuals who decide task durations

Figure 28 represents the individuals who estimate the duration of the tasks. Based on the results, 74% of the respondents reported that team members are involved in deciding the duration of the tasks they are responsible for. On the other hand, it is evident that in some organizations, other people in the project, such as Project Owner, Project Manager, Scrum Master, and team lead, decide the tasks' durations on behalf of other team members. As a result, it can be suggested that 26% of the respondents tailor this practice. Responses considered as tailoring are indicated with "(T)" in Figure 28.
5.3.2.4 Frequency of including tasks from previous Sprints

Figure 29 Frequency of including tasks from previous Sprints

Figure 29 shows five participants reported never including tasks from previous Sprints, while ten reported rarely. In contrast, 19 participants reported sometimes including tasks from previous Sprints, while 12 participants reported often doing so. Only a small percentage of participants, 4, reported always including tasks of earlier Sprints. These results suggest that while many participants include tasks from previous Sprints occasionally, it is not a regular practice for most of the teams.

5.3.2.3 Sprint

This section covers the descriptive results of Sprint usage. Descriptive results of the duration of a Sprint, frequency of changing the Sprint length, Sprint goal, and Sprint Backlog during the Sprint is provided.

5.3.2.3.1 Duration of a Sprint

Figure 30 Duration of a Sprint in Scrum Projects
Figure 30 provides the results of the survey study based on the duration of the Sprint. Almost all participants (47 in total) indicated that their Sprint duration is less than a month. 2 respondents reported that they have Sprints that take longer than one month. One respondent reported that this practice is not applicable in their context. Scrum Guide suggests that Sprints are fixed-length events of one month or less (Schwaber & Sutherland, 2017). These results indicate that while 94% of the participants obey this rule, 4% tailor the duration of a Sprint by exceeding this duration. Finally, the remaining 2%, who say that Sprint practice is not applicable, might indicate not using Scrum.

5.3.2.3.2 Frequency of changing Sprint length

Figure 31 Frequency of changing Sprint length

Figure 31 displays the frequency of responses from the survey study regarding the frequency of changing Sprint length across different Sprints. The highest frequency of responses is recorded as "rarely," with 18 participants indicating that they rarely change the length of their Sprints across different Sprints. As the second highest frequency, 17 participants suggest that they never change the length of their Sprints across different Sprints. This data indicates that while 34% of the participants have not experienced a change in the Sprint length, the remaining 66% have experienced a change at least in some Sprints. The Scrum Guide states that Sprints are fixed-length events (Schwaber & Sutherland, 2017). Thus, this result suggests that 66% of the participants observed tailoring this practice. Responses considered as tailoring are indicated with "(T)" in Figure 31.
5.3.2.3.3 Frequency of changing the Sprint goal

Figure 32 Frequency of changing the Sprint goal

Figure 32 presents the frequency of responses from the survey study regarding changing the Sprint goal during the Sprint. The highest frequency of responses was in the "sometimes" option, with 17 participants indicating that they sometimes changed the Sprint goal during the Sprint. The second highest frequency was recorded as "rarely," with 14 participants suggesting that they rarely change the Sprint goal during the Sprint. The "often" option received eight responses, followed by "never," with six answers. Only 2 participants indicated that they always changed the Sprint goal during the Sprint, while three indicated that the question was "not applicable" to them. Results suggest that only 12% of the participants never observed a change in the Sprint goal, while 82% experienced a change in varying frequencies. The Scrum Guide states that no changes should be made that would endanger the Sprint goal (Schwaber & Sutherland, 2017). Thus, it can be inferred that, including the 6% where this practice is not applicable, 88% of the participants have experienced tailoring of this practice. Responses considered as tailoring are indicated with "(T)" in Figure 32.
5.3.2.3.4 Frequency of changing Sprint Backlog During the Sprint

Figure 33 Frequency of changing Sprint Backlog During the Sprint

Figure 33 displays the frequency of responses from the survey study regarding the frequency of changing the Sprint Backlog during the Sprint. The highest frequency of the responses is recorded as "rarely," with 18 participants. The second highest frequency is sometimes, with 17 participants indicating that they sometimes change the Sprint Backlog during the Sprint. This data suggests that a significant proportion of the participants (36%) rarely change the Sprint Backlog during the Sprint.

5.3.2.4 Sprint Review

This section covers the descriptive results of Sprint Review usage. Descriptive results of the frequency of holding the Sprint Review and participants of the Sprint Review are provided.
5.3.2.4.1 Frequency of holding Sprint Review at the end of a Sprint

Figure 34 Frequency of holding Sprint Review at the end of a Sprint

Figure 34 displays the frequency of responses from the survey study on holding Sprint Review meetings at the end of a Sprint. These results suggest that the majority of respondents reported having Sprint Review meetings at the end of a Sprint "always" (52%), while a smaller number reported doing so "often" (16%) or "sometimes" (16%). Six participants reported that they rarely hold Sprint Review meetings, and only 2 participants reported that they never do so. Sprint Review is an event that should be held at the end of every Sprint. Thus, not holding Sprint Review is a tailoring of this practice. According to the results, 48% of the respondents have observed a tailoring of this practice in their organizations in varying frequencies. Responses considered as tailoring are indicated with "(T)" in Figure 34.
### 5.3.2.4.2 Participants of Sprint Review Meeting

<table>
<thead>
<tr>
<th>Participants of Sprint Review Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable (T)</td>
</tr>
<tr>
<td>Product Owners (T)</td>
</tr>
<tr>
<td>Users (T)</td>
</tr>
<tr>
<td>Business Analysts (T)</td>
</tr>
<tr>
<td>Development Team-Product Owner-Project Manager (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master-Business Analysts (T)</td>
</tr>
<tr>
<td>Development team-Product Owner-Business Analysts-Customer-Users</td>
</tr>
<tr>
<td>Development team-Product Owner-Business Analysts-Customer</td>
</tr>
<tr>
<td>Development team-Scrum Master-Product Owner-Business Analysts-Users</td>
</tr>
<tr>
<td>Development Team-Product Owner-Project Manager - Configuration Manager (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master-Product Owner-Business Analysts-Project Manager (T)</td>
</tr>
<tr>
<td>Scrum Masters (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master-Product Owner (T)</td>
</tr>
<tr>
<td>Development team-Product Owner (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master-Product Owner-Business Analysts-Customer</td>
</tr>
<tr>
<td>Development team-Scrum Master-Product Owner-Business Analysts-Customer-Users</td>
</tr>
<tr>
<td>Development team (T)</td>
</tr>
<tr>
<td>Development team-Scrum Master-Business Analysts (T)</td>
</tr>
<tr>
<td>Development Team-Product Owner-Project Manager (T)</td>
</tr>
<tr>
<td>Business Analysts (T)</td>
</tr>
<tr>
<td>Users (T)</td>
</tr>
<tr>
<td>Product Owners (T)</td>
</tr>
<tr>
<td>Not applicable (T)</td>
</tr>
</tbody>
</table>

Figure 35 displays the results of participants of Sprint Review meetings among the participants of the survey study. Sprint Review is an event where the Scrum team shows the outcome of the Sprint to key stakeholders such as
customers or users. According to the results, the most popular answers for the participants of Sprint Review are the Development team and Scrum Master, Product Owner and Business Analysts with 14 responses and only the development team with six replies. Considering these results, if a Scrum team member or a key stakeholder does not attend the meeting, this practice can be considered tailoring. Thus, it can be suggested that 78% of the participants tailored the participants of the Sprint Review. Responses regarded as tailoring are indicated with "(T)" in Figure 35.

5.3.2.5 Sprint Retrospective Meeting
This section covers the descriptive results of Sprint Retrospective adoption among survey participants. Descriptive results of the frequency of holding Sprint Retrospective meetings, frequency of taking decisions in Sprint Retrospective meetings, and frequency of implementing the decisions taken during Sprint Retrospective meetings are provided.

5.3.2.5.1 Frequency of Holding Sprint Retrospective Meeting

Figure 36 Frequency of Holding Sprint Retrospective

Figure 36 displays the frequency of responses from the survey study about holding Sprint Retrospective meetings at the end of a Sprint. 4 respondents reported that they never hold Sprint Retrospective while the frequency of rarely, sometimes, often, and always is 7, 11, 7, 21 respectively. Sprint Retrospective concludes the Sprint and Scrum team needs to hold this event at the end of every Sprint. Thus, while 42% of the respondents always do so, the remaining 58% tailor this practice in varying frequencies. Responses considered as tailoring are indicated with "(T)" in Figure 36.
5.3.2.5.2 Frequency of Taking Decisions at Sprint Retrospective Meeting

Figure 37 Frequency of Taking Decisions at Sprint Retrospective Meeting

Figure 37 displays the results from the survey study about the frequency of taking decisions at Sprint Retrospective meetings. Two respondents reported that they never take decisions, while five reported rarely and 13 reported sometimes. One of the respondents stated that this question does not apply to them, meaning they do not hold Sprint Retrospectives. Only 12 (24%) participants indicated they always take decisions in the Sprint Retrospectives. Based on the results, 74% of the participants do not always take decisions in their Sprint Retrospectives. Not taking a decision in the Sprint Retrospectives can indicate an ineffective meeting where the aim of the retrospective is not attained.
5.3.2.5.3 Frequency of Implementing Decisions Taken at Sprint Retrospective Meetings

Figure 38 Frequency of Implementing Decisions Taken at Sprint Retrospective Meetings

Figure 38 displays the results from the survey study about the frequency of implementing the decisions taken at the Sprint Retrospective meeting. Twenty people reported that they often implement these decisions, while 13 reported sometimes, and seven reported always. Three of the participants reported that they do not take decisions at Sprint Retrospectives, which is an indicator of inefficient meetings. Additionally, while two people indicated that they never implement these decisions, three said they rarely implement decisions. Based on the results, we can see that only 14% of the overall respondents always implement the decisions, and the remaining 86% either do not take any decisions or do not implement them. Not implementing the decisions taken at the Sprint Retrospectives might lead to similar problems in future Sprints and lower the team members' motivation.

5.3.2.6 Product Owner

This section covers the descriptive results of the Product Owner role. Descriptive results of existence of the Product Owner are provided.
5.3.2.6.1 Existence of Product Owner

Figure 39 Existence of Product Owner in Scrum Projects

Figure 39 presents the Product Owner's existence among the Survey respondents. Based on the results, while the majority of the participants, 44 in total, reported that they have a Product Owner, 6 participants indicated that they do not have a Product Owner in their team. Based on Scrum Guide, every Scrum team needs to include a development team, Product Owner, and Scrum Master. Thus, based on the results, 6 participants (%12) tailored this role. Responses considered as tailoring are indicated with "(T)" in Figure 39.

5.3.2.7 Scrum Master

This section covers the descriptive results of the Scrum Master role. Descriptive results of the existence of the Scrum Master role and additional roles of the Scrum Master are provided.

5.3.2.7.1 Existence of Scrum Master

Figure 40 Existence of Scrum Master in Scrum Projects
Figure 40 presents the existence of Scrum Master among the respondents of the Survey. Based on the results, while 37 participants reported that they have a Scrum Master, 13 participants indicated that they do not have a Scrum Master in their team. Based on Scrum Guide, every Scrum team needs to include a development team, Product Owner, and Scrum Master. Thus, based on the results, 13 participants (%26) tailored this role. Responses considered as tailoring are indicated with "(T)" in Figure 40.

5.3.2.7.2 Additional roles of Scrum Master

Figure 41 shows the additional roles of Scrum Master among different participants are displayed. While only four people stated that their Scrum Master has no other roles, the remaining 46 people stated that either they do not have a Scrum Master in their projects, or their Scrum Master has additional responsibilities. Among these responsibilities, 32% of the respondents indicated that the Scrum Master also works as a Business Analyst in their project. Based on the Scrum Guide, the Scrum Master role has to be a dedicated role (Schwaber & Sutherland, 2017). Thus, most respondents (92%) tailor this role. Responses considered as tailoring are indicated with "(T)" in Figure 41.
5.3.2.8 Development Team
This section covers the descriptive results of the Development team. Descriptive results of the cross-functionality of the development team are provided.

5.3.2.8.1 Cross-functionality of Development Team

Figure 42 Cross-functionality of Development Team

Figure 42 displays the scale of cross-functionality of development teams, which means having team members with different specialties within the same team. Most participants either strongly agree or agree that their development team is cross-functional (40 in total). On the other hand, nine people indicated that they were not entirely sure about this issue by choosing "neutral," but only one strongly disagreed. Based on Scrum Guide, development teams need to be cross-functional (Schwaber & Sutherland, 2017). Thus, considering the only person who chose the strongly disagree option, 2% of the participants did not satisfy this criterion. Responses considered as tailoring are indicated with "(T)" in Figure 42.

5.3.2.9 Sprint Backlog
This section covers the descriptive results of Sprint Backlog. Descriptive results the Scrum team’s frequency of creating a Sprint Backlog, participants of Sprint Backlog creation, frequency of including items that are not ready to be developed to Sprint Backlog are given.
5.3.2.9.1 Frequency of creating Sprint Backlog

Figure 43 Frequency of creating Sprint Backlog

Figure 43 displays the frequency of creating the Sprint Backlog among the survey study participants. While 21 respondents stated that they always create Sprint Backlog, the frequency of often, sometimes, rarely, and never is 12, 9, 1, 5, respectively. Scrum teams need to create a Sprint Backlog as an outcome of their Sprint planning meetings. Thus, not creating Sprint Backlog can be considered as tailoring. Results show that 27 participants (56.2%) experience tailoring this practice in varying frequencies. Responses considered as tailoring are indicated with "(T)" in Figure 43.
5.3.2.9.2 Participants of Sprint Backlog Creation

Figure 44 presents the participants who are involved in creating the Sprint Backlog. Results show that the most common preference is including the development team, Scrum Master, and Product Owner in this process (13 respondents), followed by only the Product Owner with 11 respondents and Scrum Master and Product Owner with 10. Based on the Scrum Guide, Sprint Backlog is a plan by and for the developers, but the entire Scrum team needs to be involved in the process (Development team, Scrum Master, and Product Owner) (Schwaber & Sutherland, 2017). Thus, not including any Scrum member in Sprint Backlog creation or including any other person outside of the Scrum team can be considered as tailoring. Based on the results, only 13 respondents stated that they are creating the backlog with the attendance of the entire Scrum team. The remaining 35 respondents (72.9 %) tailor this practice. Responses considered as tailoring are indicated with "(T)" in Figure 44.
5.3.2.9.3 Frequency of including items that are not ready for development to Sprint Backlog

Figure 45 Frequency of including items that are not ready to be developed

Figure 45 shows the frequency of including items not ready for development to Sprint Backlog. The most common frequency is "sometimes," with 21 responses, followed by "often" and "rarely," with nine answers each. While four people indicated that they always do this, on the other hand, four people reported that they never do so. Based on the results, while only 8.3% of the respondents never experienced this, most participants (89.6%) face this problem in varying frequencies.

5.3.2.10 Product Backlog

This section covers the descriptive results of the Product Backlog. Descriptive results of preference of maintaining requirements, frequency of keeping the Product Backlog up-to-date, and frequency of grooming the Product Backlog are provided.
5.3.2.10.1 Preference of Maintaining Requirements

Figure 46 Preference of Maintaining Requirements

Figure 46 presents the preference for maintaining the requirements among the survey participants. The most common preferences are using Product Backlog and Requirement Analysis Documents and using only Product Backlog, with ten responses each. In Scrum, Scrum teams need to have a Product Backlog. Thus, not using a Product Backlog is a tailoring of this requirement. Based on the results, 16 participants reported not using Product Backlog. Therefore, we can state that 32.8% of overall participants tailor this practice.
5.3.2.10.2 Frequency of keeping Product Backlog up-to-date

In Figure 47 frequency of having an up-to-date Product Backlog is given. The most common answer is "always," with 23 people, followed by often, and, sometimes, with 13 and 10 responses, respectively. Based on the results, we can suggest that the majority of the participants were able to keep their Product Backlog up-to-date frequently.

5.3.2.10.3 Frequency of grooming the Product Backlog

Figure 48 Frequency of grooming the Product Backlog

Figure 48 presents the frequency of grooming the Product Backlog among survey participants. The most common answers are always, sometimes, and
often, with 16, 15, and 14 responses, respectively. Only one person states that they rarely groom their Product Backlog.

5.3.3 Descriptive Findings About Consequences of Scrum Practice Adoption Preferences (RQ2)
In this section, descriptive findings about the consequences of Scrum practice adoption preferences are provided. Frequency and scale of problems are given in Table 6 and Table 7.

5.3.3.1 Frequency of encountering problems in Scrum Projects
Table 6 Frequency of encountering problems in Scrum Projects

<table>
<thead>
<tr>
<th>ID</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>F</td>
<td>P</td>
<td>F</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>F1</td>
<td>2</td>
<td>4.4%</td>
<td>11</td>
<td>24.4%</td>
<td>19</td>
</tr>
<tr>
<td>F2</td>
<td>7</td>
<td>15.6%</td>
<td>19</td>
<td>42.2%</td>
<td>12</td>
</tr>
<tr>
<td>F3</td>
<td>0</td>
<td>0%</td>
<td>5</td>
<td>11.1%</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 6 cont.

| Frequency of noticing significant problems late | F5 | 0 0% | 11 24.4% | 22 48.9% | 7 15.6% | 5 | 11.1% |
| Frequency of encountering requirements-related issues | F6 | 1 2.2% | 15 33.3% | 16 35.6% | 7 15.6% | 6 | 13.3% |
| Frequency of having trouble with knowing requirements (backlog priorities) | F7 | 4 8.9% | 20 44.4% | 13 28.9% | 6 13.3% | 2 | 4.4% |
| Frequency of encountering problems with monitoring the project’s progress | F8 | 6 13.3% | 18 40% | 13 28.9% | 6 13.3% | 2 | 4.4% |
| Frequency of delivering requirements according to customer’s priorities | F9 | 0 0% | 6 13.3% | 7 15.6% | 26 57.8% | 6 | 13.3% |

The frequency of problems that participants of the survey study encountered is provided in Table 6 above. Answers that need to be stressed out for each problem are labeled in grey. In the first column of the table, the ID for each
problem is provided (F1-F9). Based on Table 6, the frequency of the common problems in Scrum teams can be summarized as follows:

**F1:** Based on the results, it can be observed that individuals are experiencing concentration problems due to too many meetings with varying frequencies. While only two individuals indicated that they had never experienced this problem, the remaining participants indicated that they experienced this problem with different frequencies. While 19 respondents indicated that they occasionally encounter this problem, eight indicated "often," and five indicated "always," which shows that 28.9% of the participants experience this problem very frequently.

**F2:** Results indicate that communication problems exist within the team, with varying degrees of frequency. Out of the total number of respondents, seven reported that they never experienced communication problems, while 19 stated that they rarely have such problems. On the other hand, 12 individuals indicated that they sometimes experience communication problems within the team. In comparison, only four individuals reported experiencing these problems often and three always, which shows that 15.6% of the participants experienced this problem very frequently.

**F3:** Out of the total number of respondents, none of the individuals reported never creating a potentially deliverable version, while only five individuals stated that they rarely do so. On the other hand, 17 individuals indicated that they often create a potentially deliverable version in each Sprint, while 15 individuals reported that they sometimes do that. The data shows that five individuals who reported "rarely" and 15 individuals who reported "sometimes" have some problems with frequently being able to create a potentially deliverable version in each Sprint. Creating a potentially deliverable version in each Sprint is an essential Agile practice that ensures continuous delivery of working software and can lead to increased customer satisfaction.

**F4:** The results show that most respondents (24) completed defined test activities "often" during a Sprint. Meanwhile, a smaller percentage of respondents reported completing these activities "sometimes" (9), "always" (7), "rarely" (5), and "never" (0).

**F5:** The results indicate that most respondents (22) reported noticing significant problems "sometimes" late. A smaller percentage of respondents reported noticing these problems "rarely" (11), "often" (7), and "always" (5), while none of the respondents reported never noticing significant problems late.
F6: The data indicates that most respondents (16) reported encountering requirements-related issues "sometimes." A smaller percentage of respondents reported experiencing these issues "rarely" (15), "often" (7), and "always" (6). Only one respondent reported never encountering requirements-related issues.

F7: The data indicates that the majority of respondents (20) reported having trouble with knowing requirement (backlog) priorities "rarely." A smaller percentage of respondents reported having trouble "sometimes" (13) or "often" (6), while only two respondents reported having trouble "always." However, four respondents reported never having trouble with knowing requirement priorities. These findings suggest that while some respondents struggle with knowing requirement priorities, the majority do not encounter this issue regularly.

F8: The data shows that most respondents (18) reported encountering problems with monitoring project progress "rarely." A smaller percentage of respondents reported experiencing these problems "sometimes" (13) or "often" (6), while only two respondents reported encountering problems "always." However, six respondents reported never encountering problems with monitoring project progress. These findings suggest that while some respondents encounter issues with monitoring project progress, the majority do not experience these problems frequently.

F9: The data shows that most respondents (26) reported delivering requirements according to customer priorities "often." A smaller percentage of respondents reported "sometimes" (7) or "always" (6), while only six respondents reported "rarely." None of the respondents reported delivering requirements according to customers' priorities. These findings suggest that most respondents deliver requirements according to customers' priorities, which indicates a positive alignment between project objectives and customer needs.
### 5.3.3.2 Scale of potential problems in Scrum Projects

Table 7 Scale of potential problems in Scrum Projects

<table>
<thead>
<tr>
<th>ID</th>
<th>Problem Description</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Variances between estimated size and actual size for the backlog items are high</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>30</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>S2</td>
<td>Intermediate/final products developed in the project are of good quality</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>S3</td>
<td>I struggle to comprehend the specific details of the tasks</td>
<td>6</td>
<td>12</td>
<td>10</td>
<td>20</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>S4</td>
<td>In each Sprint, we encounter similar problems</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>18</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>S5</td>
<td>Our customer satisfaction for each Sprint is high</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>
The scale of potential problems that participants of the survey study encountered is provided in Table 7 above. Answers that need to be stressed out for each problem are labeled in grey. In the first column of the table, the ID for each problem is provided (S1-S7). Based on Table 7, the scale of potential problems in Scrum teams can be summarized as follows:

**S1**: The data shows that the majority of respondents (16) were neutral about the statement, while a smaller percentage of respondents agreed (12) or strongly disagreed (1) with the statement. Only a few respondents strongly agreed (5) or found the statement not applicable (1) to their experience.

**S2**: The data shows that the majority of respondents (28) agreed with the statement, while a smaller percentage of respondents strongly agreed (13) or were neutral (6) about it. Only a few respondents disagreed (2) or strongly disagreed (0) with the statement, and one respondent found the statement not applicable to their experience. These findings suggest that most respondents perceive the intermediate and final products developed in the project to be of good quality, indicating a positive outcome for the project.

**S3**: The data shows that the majority of respondents (16) were neutral about the statement, while a smaller percentage of respondents agreed (11) or disagreed (10) with the statement. The remaining respondents strongly disagreed (6) or strongly agreed (6) with the statement, and one respondent found the statement not applicable to their experience. Overall, based on the results, it can be stated that 17 participants (34% of all participants) stated that they have trouble comprehending specific task details.
S4: Based on the results, most respondents (20) were neutral about the statement, while 12 people agreed and eight strongly agreed that they encounter similar problems each Sprint. Thus, it can be stated that 20 people (40% of all participants) have a problem of encountering similar problems each Sprint in their organizations.

S5: Results suggest that only a few people indicated that customer satisfaction in the company they work for is not high. While 12 people stated they neither disagreed nor agreed with this statement, most respondents agreed (21) or strongly agreed (10).

S6: Based on the results, most respondents either agreed (26) or strongly agreed (8) that they always have a clear idea of the tasks that need to be completed within a Sprint. Only seven people (14% of all participants) reported having problems with having a clear idea of the tasks that needed to be completed.

S7: Based on the results, while 33 people (66% of all participants) either agreed or strongly agreed that the team/individual motivation in the project was high, 15 people (30%) were neutral about this statement. Only two people (4%) opposed this idea by disagreeing with this statement.

5.3.4 Hypothesis Testing (RQ3)

In this thesis study, 44 hypotheses were defined to test the correlation between independent and dependent variables. These hypotheses and the goal of creating each are presented in Chapter 4.5. Related statistical methods have been identified to test each hypothesis based on the types of independent and dependent variables. These variables can be categorized as categorical variables, continuous variables, and discrete variables. Since the distribution of most of the variables was not normal, we decided to use non-parametric versions for each parametric test. We conducted hypothesis testing on a total of 44 hypotheses, using a significance level of $\alpha = 0.05$. The results of each statistical test revealed that significant values were detected for only 5 of the hypotheses. As a result, we could accept 5 of these hypotheses, which are presented below in Table 8. The remaining 39 hypotheses were not accepted, and all 44 of the hypotheses and related statistical methods that we used to test each hypothesis are shown in Appendix C. Statistical test results with a p-value less than 0.05 showed a significant correlation between IV and DV. Thus, we accepted the related hypotheses that satisfies this criterion and not accepted the remaining ones. The results of the statistical tests are also provided in Appendix C.
Table 8 Accepted Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Test</th>
<th>P-Value</th>
<th>Accepted / Not accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1.5.3:</strong> Keeping Sprint Retrospective meetings too short, results in failure to take necessary decisions for improvement in the subsequent Sprints</td>
<td>Chi-Square</td>
<td>.003</td>
<td>Accept</td>
</tr>
<tr>
<td><strong>H2.1.8:</strong> If only the Product Owner creates the Sprint Backlog, wrong items are included in the current Sprint.</td>
<td>Chi-Square</td>
<td>.000</td>
<td>Accept</td>
</tr>
<tr>
<td><strong>H2.2.2:</strong> Not having a Scrum Master in a Scrum team, leads to problems about the organization of the Scrum events.</td>
<td>Mann-Whitney U</td>
<td>.002</td>
<td>Accept</td>
</tr>
<tr>
<td><strong>H3.2.4:</strong> If the Product Backlog is not sized right, team fails to test the requirements properly</td>
<td>Logistic Regression</td>
<td>.030</td>
<td>Accept</td>
</tr>
<tr>
<td><strong>H3.2.5:</strong> Using requirement analysis document instead of product backlog, leads to extra time to learn about the necessary details for the tasks.</td>
<td>Mann-Whitney U</td>
<td>.014</td>
<td>Accept</td>
</tr>
</tbody>
</table>
CHAPTER 6

INTERVIEW DATA ANALYSIS AND RESULTS

In this chapter, first of all, the data analysis approach of the interview study is provided. The interview data collection process, tools used to transcribe the recordings, and analysis of the study results are presented. Section 6.2 provides demographic results of the interview study participants, descriptive results of Scrum practice adoption examples, and results of the tailoring choices among participants. In section 6.3, technical debt that arises from these tailoring choices is provided by categorizing each technical debt instance.

6.1 Data Analysis Approach

In this interview study, 10 participants who apply Scrum in their organization have been interviewed. The demographic information about the participants’ roles, industry and size of the organizations can be seen in Table 9 below. Interview study design, study sample, and details about how we conducted the interview can be found in section 4.3. Before starting the interview, each participant was asked for permission to record the interview. 10 voice recordings have been transcribed to text using the “Sonix.ai” tool. We followed a semi-structured approach to explore the topics in detail, ask follow-up questions when necessary, and customize the questions based on the responses from the participants. After transcribing the recordings, Scrum practice tailoring examples and associated TD instances have been noted to a separate Word file for each participant. Open coding (Strauss & Corbin, 1990) has been used to analyze the qualitative data to examine the results and identify tailoring and technical debt categories that emerged from the responses. After applying open coding (Strauss & Corbin, 1990), key themes and patterns in the data have been identified to develop a more comprehensive

understanding of the phenomenon. Finally, the “EdrowMind”\textsuperscript{8} tool has been used to generate mind maps that clearly show the connection between each tailoring choice and related technical debt due to this choice.

Table 9 Interviewee Profile

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Company Name</th>
<th>Company Industry</th>
<th>Company Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Software Developer</td>
<td>Company 1</td>
<td>Finance</td>
<td>Medium</td>
</tr>
<tr>
<td>B</td>
<td>Software Developer</td>
<td>Company 2</td>
<td>E-Commerce</td>
<td>Large</td>
</tr>
<tr>
<td>C</td>
<td>Product Designer</td>
<td>Company 3</td>
<td>Retail</td>
<td>Medium</td>
</tr>
<tr>
<td>D</td>
<td>Test &amp; Verification Specialist</td>
<td>Company 4</td>
<td>Finance</td>
<td>Medium</td>
</tr>
<tr>
<td>E</td>
<td>Software Developer</td>
<td>Company 5</td>
<td>E-Commerce</td>
<td>Small</td>
</tr>
<tr>
<td>F</td>
<td>Software Developer</td>
<td>Company 4</td>
<td>Finance</td>
<td>Medium</td>
</tr>
<tr>
<td>G</td>
<td>Senior Business Analyst &amp; Scrum Master</td>
<td>Company 6</td>
<td>Finance</td>
<td>Large</td>
</tr>
<tr>
<td>H</td>
<td>Software Developer</td>
<td>Company 7</td>
<td>Telecommunication</td>
<td>Large</td>
</tr>
<tr>
<td>I</td>
<td>Software Developer</td>
<td>Company 8</td>
<td>Finance</td>
<td>Large</td>
</tr>
<tr>
<td>J</td>
<td>Senior Business Analyst &amp; Scrum Master</td>
<td>Company 8</td>
<td>Finance</td>
<td>Large</td>
</tr>
</tbody>
</table>

6.2 Interview Study Results

In this section, the results of the interview study are presented. Demographic results, descriptive results, and the results of Scrum tailoring choices from the technical debt perspective are presented. The correlation between each result and the related research question of the thesis is shown in parentheses for each sub-heading.

6.2.1 Demographic Results

In this section, demographic results related to the participants' sector, specialty, and Scrum experience are presented.

6.2.1.1 Sector

![Sector Distribution Chart]

Figure 49 Sector Distribution of Interview Study Participants

As seen in Figure 49 in this interview study of 10 participants, the majority of the participants (60%) work in the finance industry. Out of the ten participants in the study, two (20%) reported working in the e-commerce industry, one (10%) reported working in the telecommunication industry, and another (10%) reported working in the retail industry.
6.2.1.2 Speciality

Figure 50 Distribution of Interview Study Participants

In this interview study of 10 participants, the majority of the participants (5) work as software developers. Three participants work in a hybrid role, performing the job duties of both business analysts and Scrum Masters. One participant works exclusively as a business analyst, and another participant works as a software tester.

6.2.1.3 Scrum Experience

Figure 51 Scrum Experience of Interview Study Participants

Figure 51 presents the Scrum experience of the participants in the organizations they worked for. Based on the results, the majority of the participants (6) either have 1.5 years or two years of experience in Scrum. Two participants reported having three years of experience, while the
remaining two reported having 4 and 5 years of experience with Scrum, respectively.

6.2.2 Descriptive Results for Scrum Practice Adoption (RQ1)
In this section, descriptive results for each specific Scrum practice (event, role, and artifact) are presented.

6.2.2.1 Daily Scrum
In this section, descriptive results of the Daily Scrum practice adoption among interview study participants are given.

6.2.2.1.1 Daily Scrum Frequency

![Daily Scrum Frequency](image)

Figure 52 Daily Scrum Frequency among interview participants

In Figure 52, Daily Scrum frequency among 10 interview participants is presented. Based on the results, while the majority of the participants (8) prefer to hold only one Daily Scrum meeting per day, 2 participants reported that they have more than one Daily Scrum meeting every day. Based on the results, 2 participants who prefer to hold more than one Daily Scrum meeting per day, experience a tailoring of this practice in their Scrum teams.
6.2.2.1.2 Daily Scrum Duration

Figure 53 Daily Scrum Duration among interview participants

Based on Figure 53, majority of the participants (6) stated that their Daily Scrum takes between 15 and 30 minutes. While three participants stated that their Daily Scrum meetings take exactly 15 minutes, one participant stated that their Daily Scrum meeting takes less than 15 minutes. Based on these findings, while only 30% of the participants use this practice as suggested in Scrum Guide and keep the Daily Scrum duration at 15 minutes, the remaining 70% tailor this practice.
6.2.2.1.3 Daily Scrum Participants

According to Figure 54, while seven interviewees experienced a tailoring of Daily Scrum participants, only three reported attendance of the participants as suggested in Scrum Guide. Two participants reported that the Development team, Product Owner, Scrum Master, Business Analysts, and test team were the Daily Scrum participants. One participant reported that Development team, Scrum Master, and Product Owner attend the Daily Scrum meetings.

6.2.2.2 Sprint Planning

This section covers the results of the interview study in Sprint Planning adoption preferences of the participants.
6.2.2.1 Sprint Planning Frequency

Figure 55 Sprint Planning Frequency among interview respondents

Figure 55 presents the frequency of Sprint Planning meetings among interview participants. Based on the results, every respondent who participated in this study stated that they hold Sprint planning every Sprint. Results show that none of the participants tailors this practice and prefer to adopt it as suggested in the Scrum Guide.

6.2.2.2 Frequency of Setting a Sprint Goal

Figure 56 Frequency of Setting a Sprint Goal among interview respondents

Figure 56 shows that 60% of participants (6) always set a Sprint goal during Sprint planning. The remaining 40% (4) reported setting a Sprint goal frequently. Based on the results, four participants rarely tailor this practice by not setting a Sprint goal during the planning meetings.
6.2.2.3 Individuals who decide task durations

![Graph showing individuals who decide task durations](image)

Figure 57 Individuals who decide task durations among interview respondents

Based on Figure 57, every participant in the interview study stated that the team members individually decided the task durations, which is also the suggested approach based on the Scrum Guide. Thus, none of the participants of the interview study tailor this practice.

6.2.2.4 Frequency of including tasks from previous Sprints

![Graph showing frequency of including tasks from previous Sprints](image)

Figure 58 Frequency of involving tasks from previous Sprints among interview respondents

Based on Figure 58, being unable to finish the given tasks in one Sprint is common. While six people indicated that they encounter this problem often, four participants stated that they sometimes need to face this issue. An underestimation of the related task durations or inability to decompose the tasks small enough to finish in one Sprint might be a reason for this problem.
6.2.2.3 Sprint

6.2.2.3.1 Duration of a Sprint

Based on Figure 59, the most common Sprint duration among interview participants is two weeks with seven responses. While two people reported that they prefer 1-week Sprints in their organizations, only one stated that their Sprint takes one month. Scrum Guide suggests that Sprints are fixed-length events of one month or less (Schwaber & Sutherland, 2017). Thus, all of the participants abide by this rule and use this practice as suggested.

6.2.2.3.2 Frequency of changing Sprint length

Figure 60 presents the frequency of changing the Sprint length among Survey participants. Based on the results, six participants stated that they always adhere to the Sprint length suggested in the Scrum Guide without any
changes. However, two participants reported sometimes making changes, and the remaining two reported rarely making changes to the Sprint length. Based on the results, four people (40%) of the interview participants tailored this practice and changed the Sprint length in varying frequencies.

6.2.2.3.3 Frequency of changing the Sprint Backlog During the Sprint

Based on Figure 61, the most frequent response regarding changing the Sprint backlog during the Sprint is "rarely," with four participants choosing this option. The remaining choices are never, and sometimes, with three answers each. As a result, 70% of the respondents (7) experienced a change in their Sprint backlog during the Sprint in varying frequencies. Additional requests from the customer or inability to prioritize tasks in the correct order might have caused this need.

6.2.2.3.4 Frequency of changing the Sprint Goal During the Sprint

Based on Figure 62, the most frequent response regarding changing the Sprint goal during the Sprint is "rarely," with four participants choosing this option. The remaining choices are never, and sometimes, with three answers each. As a result, 70% of the respondents (7) experienced a change in their Sprint goal during the Sprint in varying frequencies. Additional requests from the customer or inability to prioritize tasks in the correct order might have caused this need.
Based on Figure 62, the most frequent response among the interview participants regarding the frequency of changing the Sprint goal during the Sprint is “rarely” with four participants choosing this option. Three participants stated that they sometimes change the Sprint goal during the Sprint, and three participants stated that they never do so. Since changing the Sprint goal during the Sprint is considered as a tailoring in Scrum, it can be concluded that seven participants have tailored this practice from time to time. This means that 70% of all the interview participants have experienced tailoring of this practice.

6.2.2.4 Sprint Review
6.2.2.4.1 Frequency of holding Sprint Review at the end of a Sprint

![Frequency of holding Sprint Review at the end of a Sprint](image)

Figure 63 Frequency of holding Sprint Review among interview respondents

In Figure 63, we can see that only four people stated that they always hold Sprint Review. Not holding Sprint Review meetings is a tailoring choice for this practice. Thus, the remaining 6 participants tailor this practice in varying frequencies.
Based on Figure 64, two participants reported that this question does not apply to them, meaning they do not hold Sprint Review meetings. Considering the remaining answers, only 2 participants experienced usage of this practice that is suggested by the Scrum Guide and included both the Scrum team and customers in the meeting. If any Scrum team member or customers/users do not participate in Sprint Review, it is considered as tailoring Sprint Review participants. Additionally, if any participant outside the Scrum team participates in Sprint Review, it is also considered tailoring. Based on the results, 8 participants reported tailoring choices for this practice which are indicated with “(T)” in Figure 64.
6.2.2.5 Sprint Retrospective

6.2.2.5.1 Frequency of holding Sprint Retrospective

Figure 65 Frequency of holding Sprint Retrospective among interview respondents

Based on the results, the majority of the participants (7) reported that they always hold Sprint Retrospective meetings. The remaining 3 participants reported often, rarely, or never holding the meeting. One participant stated that instead of Sprint Retrospective meetings, they prefer to have a different meeting called “Lessons Learned”, which is similar to a Sprint Retrospective. Based on the results, 3 participants tailored this practice in varying frequencies.

6.2.2.5.2 Frequency of Taking Decisions at Sprint Retrospective

Figure 66 Frequency of taking decisions at Sprint Retrospective meetings among interview respondents
In Figure 66, we can see that while half of the participants reported always taking decisions at Sprint Retrospective meetings, the remaining half reported often doing so. Based on the results, participants who reported that they often take decisions at Sprint Retrospective meetings, rarely experience tailoring of this practice.

6.2.5.3 Frequency of Implementing Decisions Taken at Sprint Retrospective meetings

Figure 67 Frequency of implementing decisions taken at Sprint Retrospective meetings among interview respondents

Based on Figure 67, five participants (half of the total participants) often implement the decisions taken at the meeting for improvements in consecutive Sprints. Three individuals reported "sometimes", while one participant reported "never," and another participant reported "always" implementing the decisions taken at Sprint Retrospective meetings. Based on the results, only one person reported that they always implement the decisions taken at Sprint Retrospective meetings. Based on these findings, the remaining 9 participants (90%) tailor this practice in different frequencies.
6.2.2.6 Product Owner

6.2.2.6.1 Existence of Product Owner

Figure 68 Existence of a Product Owner within the Scrum teams

Based on the findings in Figure 68, it can be observed that 80% of all participants reported the existence of a Product Owner in their Scrum team, while the remaining 20% (2 participants) reported not having a Product Owner in their team. Among these two individuals, one reported that Project Manager works as a Product Owner in their team, and the other participant reported that the Development team deals with the tasks that normally should be handled by a Product Owner. Based on the results, two individuals experienced tailoring of this practice by not having a Product Owner in their Scrum teams.

6.2.2.7 Scrum Master

6.2.2.7.1 Existence of Scrum Master

Figure 69 Existence of a Scrum Master within the Scrum teams

Figure 69 shows that while half of the participants (5) have a Scrum Master in their Scrum teams, the remaining half do not prefer to have such a role. Among these five individuals who reported the absence of the Scrum Master in their teams, Product Owner, Project Manager, Engineering Manager,
Development team member, or Scrum Coach replaced this role. Scrum Master is a necessary role that every Scrum team needs to include. Thus, based on the results, 50% of the participants tailor this practice by not including this role.

**6.2.2.7.2 Additional Roles of the Scrum Master**

![Additional Roles of the Scrum Master](image)

Figure 70 Additional roles of Scrum Master among interview respondents

In Figure 70, additional roles of the Scrum master are presented. Based on the results, we can see that all participants who reported having a Scrum Master in their Scrum teams also reported that the Scrum Master role is not a dedicated role in their context. The most common answer, N/A, with 50% of all responses, means that there is no Scrum Master in half of the participants’ Scrum teams. Three participants reported that the Scrum Master in their teams also works as a Business Analyst. The remaining participants reported Product Owner and Product Designer as additional roles of SM. Based on the Scrum Guide, the Scrum Master role has to be a dedicated role (Schwaber & Sutherland, 2017). Thus, we can state that all of the participants experience tailoring of this practice.
6.2.2.8 Development Team

6.2.2.8.1 Cross-functionality of Development Team

Figure 71 Cross-functionality of development teams among interview respondents

Based on Figure 71, the most common response is “Strongly Agree” with 3 participants. On the other hand, two of the participants strongly disagree, and one disagrees with the idea of having a cross-functional development team. Not having a cross-functional development team can be considered a tailoring of this practice. Thus, it can be stated that 30% (3) of the respondents experience tailoring of this practice.

6.2.2.9 Sprint Backlog

6.2.2.9.1 Frequency of Creating Sprint Backlog

Figure 72 Frequency of creating Sprint Backlog among interview respondents
Based on the results in Figure 72, we can see that all participants reported that they created a Sprint Backlog as an output of Sprint Planning. Thus, none of the respondents experience tailoring of this practice.

6.2.2.9.2 Participants of Sprint Backlog Creation

![Participants of Sprint Backlog Creation](image)

Figure 73 Participants of Sprint Backlog creation among interview respondents

In Figure 73, participants who are involved in Sprint Backlog creation are presented. The entire Scrum team must be involved in this process, and including anyone who is not involved in the Scrum team is also considered as tailoring. Based on the results, 60% of the participants tailor this practice.

6.2.2.9.3 Frequency of Including items that are not ready for development to Sprint Backlog

![Frequency of including items that are not ready for development](image)

Figure 74 Frequency of including items that are not ready for development among interview respondents
In Figure 74, we can see that all participants reported that tasks that are not ready for development are involved in their Sprint backlog. The most common frequency is “sometimes,” with five responses, followed by rarely with 3, and often with two responses.

6.2.2.10 Product Backlog
6.2.2.10.1 Preference of Maintaining Requirements

Based on Figure 75, the most common choice of maintaining requirements among interview study participants is using Product Backlog & Requirement Analysis Documents together with four responses (40%). Other preferences are reported as using Product Backlog & Use Case Diagrams together and only using Product Backlog, with three responses each. Since all of the respondents reported that they use Product Backlog, none of the participants experienced tailoring.

6.2.2.10.2 Frequency of keeping Product Backlog up-to Date

Figure 75 Preference of maintaining requirements among interview respondents

Figure 76 Frequency of keeping Product Backlog up-to date among interview respondents
Based on the results in Figure 76, while 50% (5) of the participants reported that they always keep their product backlog up-to-date, the remaining half stated as they often do so. Thus, all participants could frequently keep their product backlog updated in their Scrum teams.

**6.2.2.10.3 Frequency of grooming the Product Backlog**

![Frequency of Grooming the Product Backlog](image)

Figure 77 Frequency of grooming the Product Backlog among interview respondents

Figure 77 presents the frequency of grooming the Product Backlog among interview respondents. Results suggest that 60% (6) of the participants reported always grooming their Product Backlog, and the remaining 40% (4) reported that they often do so. Based on the results, all of the respondents frequently were able to groom their Product Backlog in their Scrum teams.

**6.2.3 Impact of Tailoring Choices from Technical Debt Perspective (RQ2 & RQ3)**

This section presents the tailoring choices among participants of the interview study and the results of these choices from the technical debt perspective. The study presents the instances of technical debt associated with each Scrum practice tailoring choice, along with the type of technical debt related to these choices. Additionally, the number of occurrences of each technical debt among interview participants is presented. To present this information and show the connection between the tailoring choices and related technical debt, mind map diagrams are provided for each tailoring choice.

The example notation that is used for mind map diagrams is provided below in Figure 78. Green rectangles with rounded corners represent the main topic. Main topics in the mind map diagrams, represent the tailoring choices of the Scrum practices among interview participants. The title of the main topics starts with T, followed by a number that represents the sequence of the tailoring, such as “T1”. After the sequence number, information about the
context of where the tailoring happened is provided. White rectangles represent the subtopics where each subtopic is a technical debt example resulting from different tailoring choices. The explanations that are given as subtopics are derived from the answers of the interview participants’ responses. The number of occurrences is provided underneath each subtopic. The number of occurrences represents the number of times the participants encountered a technical debt due to a tailoring choice. For example, if the number of occurrences is provided as three, it means that three out of ten interview participants experienced that specific technical debt in their projects. Finally, the green rectangles on the rightmost of the figure indicate the category of technical debt associated with each technical debt instance mentioned by interviewees.

We considered different TD categories based on an SLR study about the organization of different TD types that have been identified in the literature (Alves et al., 2014). Based on the results of this SLR study, thirteen TD types have been identified as architecture debt, build debt, code debt, defect debt, design debt, documentation debt, infrastructure debt, process debt, requirement debt, service debt, test automation debt, and test debt (Alves et al., 2014). To understand which category the relevant technical debt example belongs to, we first identified the keywords in the technical debt descriptions by conducting open coding technique (Strauss & Corbin, 1990) on interview results. Following this, we mapped the identified keywords to the technical debt categories mentioned by Alves et al., 2014. For instance, if we identified a keyword as a communication problem, we mapped it to People Debt, or if we identified a keyword as incomplete or incorrect requirements, we mapped it to Requirement Debt.

Technical debt categories, definitions of each category, and the indicators that we used to map each TD example to a specific TD category are adapted from Alves et al., (2014) and Martini et al., 2020 and provided in Table 10 below.

Table 10 Definition and Indicators of each Technical Debt Category

<table>
<thead>
<tr>
<th>Technical Debt Type</th>
<th>Definition</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement Debt</td>
<td>Accumulation of incomplete or unclear requirements, as well as requirements that are not correctly implemented</td>
<td>Size of the requirement backlog list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incomplete or inaccurate requirement definitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ambiguous requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partially implemented requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constantly changing requirements</td>
</tr>
<tr>
<td>Type of DEBT</td>
<td>Description</td>
<td>Example Problems</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Code Debt</td>
<td>Problems that can be detected in the source code of the projects resulting from following bad coding practices</td>
<td>Code outside of standards, Duplicated Code, Slow algorithms, Unused or dead code</td>
</tr>
<tr>
<td>Architecture Debt</td>
<td>Type of TD that is encountered in project architecture</td>
<td>Violation of Modularity, Issues in Software Architecture, Structural Dependencies</td>
</tr>
<tr>
<td>Design Debt</td>
<td>Use of practices in source code which violates the principles of good object-oriented design</td>
<td>Code smells, Duplicated Code, God classes, Intensive Coupling, Issues in Software Design</td>
</tr>
<tr>
<td>Process Debt</td>
<td>Type of TD that is encountered as a result of having inefficiencies in software development processes.</td>
<td>Not following software development best practices, Lack of process standardization, Lack of process documentation, Delays in the process, Lack of Prioritization, Lack of a clear explanation of stakeholders on the value of the process.</td>
</tr>
</tbody>
</table>
Table 10 cont.

<table>
<thead>
<tr>
<th>Team/People Debt</th>
<th>Refers to issues resulting from the people in a team which can delay some of the development activities.</th>
<th>Communication problems between Scrum team and customers/users</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expertise concentrated in too few people</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Morale and motivation problems of the employees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Satisfaction level of the stakeholders</td>
</tr>
<tr>
<td>Test Debt</td>
<td>Type of TD that refers to problems that are encountered during the testing activities.</td>
<td>Incomplete or insufficient tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low coverage</td>
</tr>
<tr>
<td>Defect Debt</td>
<td>This type of TD results from postponing the fix of the known defects that are identified during the testing activities.</td>
<td>Uncorrected known defects</td>
</tr>
</tbody>
</table>

Figure 78 Notation of the Mind Map Diagram

6.2.3.1 Estimation of Product Backlog Items’ (PBI) Efforts
This section covers examples of both under-estimation and over-estimation of PBI efforts and related technical debts that interview participants experience.
6.2.3.1 Under-estimation of PBI Efforts

Figure 79 Results of under-estimation of PBI Efforts

6.2.3.2 Over-estimation of PBI Efforts

Figure 80 Results of over-estimation of PBI Efforts

6.2.3.2 Participants of Sprint Backlog Creation

Figure 81 Participants of Sprint Backlog Creation Tailoring Results
6.2.3.3 Involving Tasks that are not ready to be developed to Sprint Backlog

Figure 82 Results of involving items that are not ready to be developed to Sprint Backlog

6.2.3.4 Product Backlog Refinement

Figure 83 Results of Product Backlog Refinement Tailoring
6.2.3.5 Experience Level of Development Team Members

Figure 84 Results of experience level of development team members

6.2.3.6 Prioritization of the Items

Figure 85 Results of problems about prioritization of the items
6.2.3.7 Involving Items From Previous Sprints

Figure 86 Results of involving items from previous Sprints

6.2.3.8 Scrum Master

This section covers the tailoring choices and their results regarding the Scrum Master role among the interview study participants. Two main categories of tailoring choices are not having a Scrum Master or having additional roles to the Scrum Master role. The results of these tailoring choices are presented from the technical debt perspective in Figure 87 and Figure 88.

6.2.3.8.1 Not having a Scrum Master

Figure 87 Results of not having a Scrum Master
6.2.3.8.2 Scrum Master’s additional roles

Figure 88 Results of having additional roles of Scrum Master

6.2.3.9 Daily Scrum

This section covers the tailoring choices and their results about the Daily Scrum event among the interview study participants. Two main categories of tailoring choices are participants and content of Daily Scrum. The results of these tailoring choices are presented from the technical debt perspective in Figure 89 and Figure 90.

6.2.3.9.1 Participants of Daily Scrum

Figure 89 Participants of Daily Scrum Results
6.2.3.9.2 Daily Scrum Content

Figure 90 Daily Scrum Content

6.2.3.10 Determining the team capacity

Figure 91 Results of problems about determining the team capacity

6.2.3.11 Sprint Review

This section covers the tailoring choices and their results about the Sprint Review event among the interview study participants. Two main categories of tailoring choices are participants of Sprint Review and not holding a Sprint Review meeting. The results of these tailoring choices are presented from a technical debt perspective in Figure 91 and Figure 92.
6.2.3.11.1 Participants of Sprint Review

Figure 92 Tailoring the Participants of Sprint Review Results

6.2.3.11.2 Not holding Sprint Review

Figure 93 Results of not holding a Sprint Review meeting
6.2.3.12 Not having a cross-functional development team

Figure 94 Results of not having a cross-functional development team

6.2.3.13 Changing the Sprint Goal During the Sprint

Figure 95 Results of changing the Sprint Goal During the Sprint
6.2.3.14 Team members working for several Scrum teams

Figure 96 Results of having team members who work for several Scrum teams

6.2.3.15 Not implementing the decisions taken at Sprint Retrospectives

Figure 97 Results of not implementing the decisions taken at Sprint Retrospectives

6.2.3.16 Product Owner

This section covers the tailoring choices and their results regarding the Product Owner role among the interview study participants. Two main categories of tailoring choices are detailing the Product Backlog items and not having a Product Owner within the Scrum team. The results of these tailoring choices are presented from the technical debt perspective in Figure 98 and Figure 99.
6.2.3.16.1 Detailing the Product Backlog Items

Figure 98 Results of not detailing the Product Backlog items enough

6.2.3.16.2 Not having a Product Owner

Figure 99 Results of not having a Product Owner within the Scrum team
CHAPTER 7

DISCUSSION

This study aims to investigate the tailoring choices of Scrum practices and their impact on technical debt. The first research question explored the ways where Scrum practices (events, roles, and artifacts) are tailored. The second research question investigated the positive and/or negative evidence of the tailoring choices. Finally, the third research question examined the impact of tailoring choices adapted in Scrum from a technical debt perspective.

In the literature, many studies have explored the topic of Scrum practice tailoring (Masood et al., 2020; Diebold et al., 2015; Hron & Obwegeser, 2018; Fitzgerald et al., 2006; Eloranta et al., 2016; Hossain et al., 2011; Mortada et al., 2020; Hassani et al., 2020; Perez et al., 2014). However, we explored a gap in the research when it comes to examining the impact of these tailoring choices from a technical debt perspective. Although three studies indicated positive and negative consequences of these tailoring choices (Eloranta et al., 2016; Fitzgerald et al., 2006; Mortada et al., 2020), we have not found a study that explicitly makes a connection with the technical debt that might have occurred as a result of the specific Scrum practice tailoring choice. Moreover, in the literature, studies have presented only some of the Scrum practice tailoring results. This study differs from the existing studies by providing tailoring results for every Scrum practice and making a connection between the related Scrum practice tailoring choice and technical debt.

To achieve the objectives of this study, this thesis employed a mixed-method study which includes both qualitative and quantitative data collection and analysis methods to have a more comprehensive understanding of the research questions. First, we conducted a survey study among participants who apply Scrum as a software development methodology in their company. The survey questions were carefully prepared to cover all possible Scrum practice tailoring choices and their corresponding results. Through this survey, we were able to collect valuable data on the frequency and nature of
Scrum practice tailoring choices among the participants, as well as their perceptions of the positive and negative impacts of these tailoring choices. Following the survey, we conducted an interview study with 10 participants to obtain more detailed information about the results from the survey, with a particular focus on the technical debt perspective of these tailoring choices.

The tailoring of Scrum practices is an essential aspect of Agile software development that can have a significant impact on technical debt. The Systematic Literature Review, survey, and interview study findings provide insight into commonly encountered tailoring practices. The SLR study and survey study found that the most frequent tailoring choice for Daily Scrum meetings was holding the meeting longer than 15 minutes (Mortada et al., 2020; Diebold et al., 2015). However, the interview results suggest tailoring the Daily Scrum participants is more common. Additionally, the SLR results suggest that external participants were sometimes involved in Daily Scrum meetings (Hron&Obwegeser, 2018). In addition to these findings, the survey and interview studies revealed that some Scrum team members do not attend the meeting such as development team members or Product Owner, or some teams prefer to hold separate Daily Scrums for the development and testing teams. It is also essential to explain the results of Daily Scrum tailoring choices from the technical debt perspective. According to the interview results, the Product Owner's absence from Daily Scrum meetings causes communication problems between the Scrum team and the Product Owner. In addition, separate Daily Scrum meetings for the development and testing teams lead to communication problems between the two teams, resulting in missing test cases, incomplete tests, and software that does not fully meet requirements.

Based on the survey and interview studies, it appears that not setting a Sprint goal is a common tailoring practice in Sprint Planning meetings. In fact, survey results indicate that 66% of participants do not set a Sprint goal from time to time, which is supported by interview study results where 40% of participants reported the same. The most frequent tailoring practice for Sprint Planning meetings in the SLR was holding more than one Sprint Planning meeting for each Sprint, which was not specified in the survey or interview studies (Fitzgerald et al., 2006; Hossain et al., 2011). Additionally, while the SLR results have not identified any studies on tailoring the participants who decide task durations during Sprint Planning, the survey and interview studies identified this as a common practice. Considering the impact of these tailoring choices, as a result of the interview study, we found that not involving every Scrum team member in Product Backlog grooming where the task complexities are estimated leads to a false estimation of the tasks and incomplete or incorrect developments at the end of the Sprint. On the other
hand, based on the SLR study results, in one of the organizations, introducing two Sprint Planning sessions increased the overall project success (Fitzgerald et al., 2006).

Based on the SLR study, the most common Sprint practice tailoring choice is not having time-boxing for Sprints (Fitzgerald et al., 2006; Masood et al., 2020). This means that the Sprint is finished when all the tasks included in the Sprint are completed. However, survey and interview study results indicate that the most frequent Sprint tailoring choice among participants is changing the Sprint goal during the Sprint. Specifically, 88% of participants reported this in the survey, and 70% reported it in the interview study. Interestingly, the literature review results have not identified any studies on tailoring choices related to the frequency of changing the Sprint length and goal. However, the survey and interview studies detected and presented these tailoring preferences. These findings demonstrate that teams can make a wide range of tailoring choices while executing the Sprint and that these choices can vary depending on the needs and context of each team. It is essential to be aware of these tailoring choices and their potential impact on technical debt to make informed decisions about how to tailor the Sprint for each project. In this regard, based on the interview study results, changing the Sprint goal during the Sprint leads to incomplete developments by changing the priorities of the requirements. Additionally, changing the Sprint goal during the Sprint has a negative impact on the development team’s motivation, leading to a rushed process and negatively affecting the quality of development and testing processes. Considering the SLR results, as a result of not having time-boxed Sprints, team members were not committed to the Sprint goal (Masood et al., 2020).

Based on the SLR results, the most common Sprint Review tailoring choice is not holding a Sprint Review at the end of the Sprints (Hossain et al., 2011; Eloranta et al., 2016). Although survey and interview study results also include examples of not having a Sprint Review meeting among the participants, the most frequent Sprint Review tailoring choice in these studies is tailoring the participants of Sprint Review meeting by not including the customer or users, or not involving the entire Scrum team in the meeting. Additionally, while the SLR study found an example of tailoring where some organizations prefer to hold more than one Sprint Review for a single Sprint (Diebold et al., 2015), in the survey, and interview studies, we have not detected the exact tailoring. Considering the results of these tailoring choices, based on the interview results, not holding the Sprint Review meeting after every Sprint leads to a lack of understanding of the customer’s priorities and expectations from the Scrum team, resulting in a decrease in product quality due to the inability to receive necessary feedback. SLR study results also
suggest that due to not having Sprint Review meetings, teams had to make changes at the late stages of development (Masood et al., 2020). On the other hand, interview results report that not having customers or users in Sprint Review meetings leads to communication breakdown, constantly changing requirements, and additional meetings for getting useful customer or user feedback.

While the SLR study found that the most frequent Sprint Retrospective tailoring is not holding the retrospectives (Diebold et al., 2015; Hossain et al., 2011; Eloranta et al., 2016), in the survey and interview study, we detected that not implementing the decisions taken at the Sprint Retrospective meetings is more common among the participants. Additionally, in the literature, we have not seen any study that presents an example tailoring about the frequency of taking decisions in Sprint Retrospectives and implementing these decisions. As a part of the survey and interview study, we also detected and presented these tailoring choices. Considering the impact of these tailoring choices, based on the results of the SLR study, it is stated that not having retrospectives prevented teams from having a continuous improvement stage (Masood et al., 2020). In the interview study, we found that not implementing the decisions taken during the retrospectives results in the continuation of the same problems, delays in work, communication problems within the Scrum team, and decreased team motivation.

In the SLR study, the most frequent tailoring for the Product Owner role is having additional Product Owner roles (Diebold et al., 2015; Eloranta et al., 2016; Hossani et al., 2020; Masood et al., 2020). In both the survey and interview study, the only tailoring we have found is not having a Product Owner role in some teams. While SLR results include tailoring examples such as having a Proxy PO multiple PO in a Scrum team and having additional roles of PO, we have not seen any of these tailorings in the survey and interview results. Interview study results suggest that when a Scrum team does not have a PO, it leads to communication problems between developers and customers, additional work effort for software developers such as detailing PBIs, and reaching the customer problems directly to the developer, negatively affecting their morale and motivation.

The lack of a dedicated Scrum Master in Scrum teams is a significant finding from the literature, survey, and interview studies. It is important to note that the absence of a dedicated Scrum Master may result in a team's lack of guidance, especially for new teams that may not yet understand Scrum principles and practices. On the other hand, not having a dedicated Scrum Master may also decrease the team's sense of ownership and responsibility for their work. It should be kept in mind that a Scrum Master is an essential
role in Scrum, and without it, teams may face challenges in implementing Scrum practices effectively. The finding that a majority of survey and interview participants do not have a dedicated Scrum Master role raises the question of whether Scrum is being implemented effectively in these teams and the potential impact on the quality of the product delivered. From the technical debt perspective, statistical analysis conducted on the survey study suggests that not having a Scrum Master in a Scrum team leads to problems with the organization of the Scrum events. Additionally, interview results provide further detail about the technical debt resulting from the Scrum Master tailoring choices. Based on the interview results, not having a Scrum Master leads the Scrum team to be unable to get the necessary feedback for Scrum process improvement, which leads to problems in the organization of the Scrum events. Additionally, not having an SM, causes extra work effort for another person who needs to deal with the SMs' responsibilities. Further, interview results suggest that due to the lack of an SM in the Scrum team, the team has trouble being interrupted by external stakeholders such as customers. This situation decreases the motivation and quality of the team's output. Finally, interview results show that when Scrum Master also works as a Business Analyst, analysis documents created by the SM are not detailed enough, leading to incomplete developments and tests.

For all the research studies, the common development team tailoring is not having a cross-functional development team. Survey study results, studies in the literature, and interview study results show that it is common in Scrum teams not to have a cross-functional development team. Based on the interview results, not having a cross-functional development team leads to communication problems between developers with different specialties. Additionally, not having a cross-functional development team results in team members engaging in additional tasks outside their job descriptions. Finally, two interview study participants stated that not having the Software testers and developers in the same Scrum team leads to incomplete, incorrect developments and incomplete testing of the requirements.

Regarding the Sprint Backlog, in the literature, we found tailoring choices such as a single person creating the Sprint Backlog and having multiple Sprint Backlogs (Masood et al., 2017; Hron & Obwegeser, 2018). On the other hand, both in the survey and interview results, the most common tailoring choice is including items to Sprint Backlog that are not ready to be developed in the particular Sprint. Although we found examples of Sprint Backlog tailoring related to not creating a Sprint backlog in the SLR, and survey study, on the contrary, in the interview study, none of the participants reported such tailoring. Additionally, it is essential to note that while in the survey and interview studies, we found examples of not having an SB and including
items that are not ready to be developed to SB, we did not detect the same tailoring examples in the literature. Regarding the technical debt resulting from SB tailoring, based on the SLR findings, it is stated that as a result of not estimating Sprint Backlog items, unrealistic Sprint goals demotivated the team members (Masood et al., 2020). Survey results report that if only the Product Owner creates the Sprint Backlog, wrong items are included in the current Sprint. This situation shows us that Sprint Backlog creation should be a collective activity in which the entire Scrum team participates. Additionally, interview results suggest that creating the Sprint Backlog without or only with the development team leads to involving tasks in Sprint that are not ready to be developed. Based on the interview results, including items to Sprint Backlog that are not ready to be developed negatively impacts the morale and motivation of the ones responsible for these tasks. Additionally, it also risks other tasks in the Sprint by requiring extra effort for clarifying task details and ends up with being unable to finish development and testing activities within the Sprint.

While in both SLR and survey studies, we found examples of not having a Product Backlog (Eloranta et al., 2016); we did not detect the same situation in the interview study. In SLR, survey, and interview studies, we found examples of problems with prioritizing the Product Backlog. In the survey and interview studies, we found that some teams do not groom the product backlog from time to time, which is related to detailing and estimating the PBIs. Considering these tailoring choices from the technical debt perspective, SLR results suggest that teams ended up working on the wrong features due to not having a product backlog or not prioritizing the backlog (Eloranta et al., 2016). Survey results report that the team fails to test the requirements properly if the Product Backlog is not sized right. Survey results also show that using requirement analysis documents instead of the product backlog leads to extra time to learn the necessary details for the tasks. Based on the interview results, prioritizing tasks in the wrong order leads to being unable to finish the tasks on time. Additionally, prioritization problems also cause communication problems with the customer, which leads to difficulties in determining the tasks with higher priority.

It is also essential to discuss the reasons behind organizations' tailoring choices. A follow-up semi-structured interview study contributed to this thesis by enabling us to ask follow-up questions and receive detailed responses from the participants. Based on the answers from the participants, the most common reasons behind these tailoring choices were noted as the time pressure imposed by the customer, domain constraints, resource shortages, and the perceived lack of necessity for certain Scrum practices or roles by the organizations.
In the statistical analysis conducted on the survey results, only 5 out of 44 hypotheses were accepted. If we discuss potential reasons for not being able to validate the majority of the hypotheses, the 64-question survey study may have taken longer than expected for some of the participants. This situation may have caused attention deficits, resulting in incomplete or incorrect answers from participants. In addition, the fact that all survey questions were in English may have caused some participants to misunderstand some questions and provide incorrect answers. Furthermore, we asked questions in the final section of the survey that aimed to measure potential technical debts that could arise from tailoring Scrum practices. When participants reached the end of the survey, their attention may have been divided, and they may have been fatigued, which could have negatively affected the quality of their responses in this section. Finally, the number of participants we could include in the survey analysis was limited to 50. When the survey was shared with participants, difficulties were encountered in continuing to share the survey with participants and receiving feedback from them due to the earthquake disaster that occurred in Turkey. As a result of these challenges, we obtained a smaller sample size which might have decreased the power of statistical tests, making it more difficult to detect significant differences or relationships among variables.
CHAPTER 8

CONCLUSION

Existing studies in the literature tend to concentrate on providing tailoring examples of various Scrum practices adopted by organizations. The main objective of this thesis is to comprehensively examine the tailoring decisions made for each Scrum event, role, and artifact, and to evaluate the potential implications of such tailoring choices from the perspective of technical debt. Through this research, the study aims to contribute to a deeper understanding of the impact of tailoring on technical debt and provide insights for organizations looking to tailor their Scrum practices to meet their unique needs. Our research methodology involved several steps to examine the tailoring choices for Scrum practices and their impact on technical debt. Firstly, we conducted a comprehensive review of the literature to learn about the existing studies related to tailoring examples of Scrum practices. The SLR study is published and presented in IWSM Mensura Conference (Özkan & Özcan-Top, 2022). Secondly, we conducted a survey study among participants who apply Scrum as a software development methodology in the organization they work for. The survey study focused on identifying the tailoring choices made for every Scrum practice and their potential impact on technical debt. Lastly, to gain a more in-depth understanding of the survey results, we conducted a follow-up interview study.

We started our research process by conducting an SLR study to explore the existing studies in the literature, which are about the Scrum practices that are tailored among various organizations operating in different business domains, and to have a detailed understanding of the positive and negative consequences of these tailoring choices. After thorough evaluation, we identified a final set of 23 papers for our study literature. As a result of the SLR study, we found examples of tailoring choices for every Scrum practice in the literature. Details about how we designed and conducted the SLR and tailoring choices for each Scrum practice can be found in section 3.2 and 3.3.1 respectively. Our study also examined the positive and negative consequences
of the identified tailoring choices for Scrum practices. In the literature, we found that only one instance of Scrum practice tailoring resulted in a positive outcome. The positive and negative consequences of Scrum practice tailoring choices in the literature can be found in section 3.3.2. Upon reviewing the SLR results, we realized the need for further studies that provide tailoring examples for each Scrum practice and explicitly make a connection with the technical debt that might have occurred resulting from each of these tailoring choices.

After conducting an SLR study, we conducted a survey study among individuals working in companies that uses Scrum, with the aim of learning about the ways in which each Scrum practice is tailored and understanding the relationship between these tailoring choices and technical debt. Main survey study included 63 questions in total, and we used Survey Monkey, a cloud-based tool to create and distribute the survey. Once we obtained the results from the participants, we transferred the data from Survey Monkey to SPSS for preliminary analysis and applying statistical tests for testing our hypotheses.

According to the survey results, we identified various tailoring choices for each Scrum practice among 50 participants from 11 different sectors. Based on the results we found that the most frequently tailored Scrum event, role, and artifact are Sprint Retrospective, Scrum Master, and Sprint Backlog respectively. Detailed information about the tailoring results can be found in section 5.3.2. Survey study also aimed to discover the technical debt examples resulting from the tailoring choices described above. Among the 44 hypotheses that we identified, based on the statistical tests that we applied, we were able to validate 5 hypotheses. Regarding these results, tailoring choices and resulting technical debt examples can be stated as follows:

1. Keeping Sprint Retrospective meetings too short, results in failure to take necessary decisions for improvement in the subsequent Sprints.
2. If only the Product Owner creates the Sprint Backlog, wrong items are included in the current Sprint.
3. Not having a Scrum Master in a Scrum team, leads to problems about the organization of the Scrum events.
4. If the Product Backlog is not sized right, team fails to test the requirements properly.
5. Using requirement analysis document instead of product backlog, leads to extra time to learn about the necessary details for the tasks.
To further detail the data obtained from the survey, and to better understand and reveal the impact of Scrum practice tailoring preferences on technical debt, we conducted a follow-up interview study. The study involved interviewing 10 participants who have experience with Scrum implementation in their organizations. The participants were asked questions related to their usage of Scrum practices within their teams, as well as the positive and negative effects of their choices. The interview study followed a semi-structured approach, which allowed for detailed exploration of the topics, as well as the ability to ask follow-up questions when necessary and customize the questions based on the participants’ responses. Open coding was used to analyze the data obtained from the interview study and identify key themes and patterns related to Scrum practice tailoring and its impact on technical debt.

Based on the results of the interview study among 10 individuals from 8 different companies operating in 4 different sectors, the most frequently encountered tailoring choices for Scrum events, roles, and artifacts are Sprint Review, Scrum Master, and Sprint Backlog respectively. The semi-structured interview study enabled us to delve into the consequences of these tailoring choices more deeply and gain a comprehensive understanding of their impact on technical debt in software projects. Regarding these consequences, based on the interview results, some of the most frequently encountered technical debt examples resulting from the tailoring choices among the interviewees can be stated as follows:

- As a result of under-estimation of the tasks, tasks are not completed in the current Sprint, and transferred to the next Sprint (Requirement Debt & Process Debt).
- Involving tasks that are not ready to be developed to Sprint Backlog, risks other tasks in the Sprint by requiring extra effort for clarifying task details (Requirement Debt & Process Debt).
- Not holding the Sprint Review meeting after every Sprint, leads to a lack of understanding of the customer’s priorities and expectations (People Debt).
- Being unable to detail the Product Backlog items enough, leads to incorrect or incomplete developments, and tests (Requirement Debt & Test Debt).

The complete list of tailoring choices for each Scrum practice and technical debt resulting from Scrum practice tailoring choices can be found in section 6.2.2 and 6.2.3 of the study.
8.1 Implications of the Research
This section, discusses the potential practical and theoretical implications of the research findings.

8.1.1 Implications for Practice
- Findings of this thesis study highlights the need for practitioners to be aware of the different ways in which Scrum can be adapted to suit the needs of their organization and teams.
- Practitioners can use the findings to make informed decisions when tailoring Scrum practices, considering the potential risks and benefits of different tailoring choices.
- Practitioners can apply the insights gained from the technical debt examples resulting from Scrum practice tailoring choices to recognize possible causes of technical debt that may have arisen from their Scrum practice preferences. This understanding can help practitioners to identify the potential sources of technical debt and take appropriate measures for technical debt management.

8.1.2 Implications for Theory
- Findings of the thesis can inform future research on the tailoring of Scrum practices including the reasons behind tailoring choices in organizations, and positive and negative consequences of these choices.
- Findings of the thesis can contribute to the development of frameworks or guidelines for the tailoring of Scrum practices.
- Results of the study, contributes to the understanding of the impact of tailoring Scrum practices on technical debt, which can inform future research on the topic.
- Findings of the study can contribute to the development of best practices or guidelines for minimizing technical debt in Scrum Projects.

8.2 Future Research
We identified following future research topics that can contribute to the field:
- A potential future research topic might be to conduct a comparative study to explore how Scrum practices are tailored in different industries or domains, such as finance, healthcare, education, and e-commerce, to gain a better understanding of how contextual factors impact Scrum practice tailoring.
Future studies may focus on other Agile methodologies such as Extreme Programming (XP), Kanban, or Lean, and investigate the extent to which their practices are tailored and the resulting impact on project outcomes.

Future studies may focus on an exploration of the relationship between Scrum practices and different types of technical debt, such as design debt, code debt, testing debt, and infrastructure debt in detail.

Future studies may extend this study by having a comparative analysis of the effectiveness of different technical debt management strategies in Scrum projects, such as refactoring, testing, and automation.

Future studies may concentrate on conducting a similar survey study in a broader scale to eliminate the limitations that are encountered in this study.
REFERENCES


## Appendix A: Demographic Questions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P2.1:</strong> How old are you? (Multiple Choice)</td>
<td>A. 18-24</td>
</tr>
<tr>
<td></td>
<td>B. 25-34</td>
</tr>
<tr>
<td></td>
<td>C. 35-44</td>
</tr>
<tr>
<td></td>
<td>D. 45-54</td>
</tr>
<tr>
<td></td>
<td>E. 55-64</td>
</tr>
<tr>
<td></td>
<td>F. 65 or above</td>
</tr>
<tr>
<td><strong>P2.2:</strong> What is your gender identity? (Multiple Choice)</td>
<td>A. Female</td>
</tr>
<tr>
<td></td>
<td>B. Male</td>
</tr>
<tr>
<td></td>
<td>C. Prefer not to answer</td>
</tr>
<tr>
<td><strong>P2.3:</strong> Which of the following sector do you work in? (Multiple Choice)</td>
<td>A. E-Commerce</td>
</tr>
<tr>
<td></td>
<td>B. Defense Industry</td>
</tr>
<tr>
<td></td>
<td>C. Health Sector</td>
</tr>
<tr>
<td></td>
<td>D. Finance</td>
</tr>
<tr>
<td></td>
<td>E. Other</td>
</tr>
<tr>
<td><strong>P2.4:</strong> What is the name of the company you work for (Open-ended)</td>
<td>-</td>
</tr>
<tr>
<td><strong>P2.5:</strong> What is your position in the company you work for? (Multiple Choice)</td>
<td>A. Software Engineer</td>
</tr>
<tr>
<td></td>
<td>B. Product Owner</td>
</tr>
<tr>
<td></td>
<td>C. Scrum Master</td>
</tr>
<tr>
<td></td>
<td>D. Project Manager</td>
</tr>
<tr>
<td></td>
<td>E. UI/UX Designer</td>
</tr>
<tr>
<td></td>
<td>F. Architect</td>
</tr>
<tr>
<td></td>
<td>G. System / Software Tester</td>
</tr>
<tr>
<td></td>
<td>H. Business Analyst</td>
</tr>
<tr>
<td></td>
<td>I. Other</td>
</tr>
<tr>
<td><strong>P2.6:</strong> Which country do you live in? (Open-ended)</td>
<td>-</td>
</tr>
<tr>
<td><strong>P2.7:</strong> What is the origin country of your organization? (Open-ended)</td>
<td>-</td>
</tr>
<tr>
<td><strong>P2.8:</strong> How many years of experience do you have in Scrum projects? (Open-ended)</td>
<td>-</td>
</tr>
</tbody>
</table>
| **P2.9:** Which of the following Agile methodologies are you using in your project? If you’re applying a hybrid approach, you can select more than one option. (Multiple Selection) | ▪ Scrum  
▪ Extreme Programming(XP)  
▪ Lean Software Development  
▪ Crystal  
▪ Kanban  
▪ Feature-Driven development  
▪ None  
▪ Other |
|---|---|
| **P2.10:** Below, 7 items were listed to understand the complexity level of your project. Please rate the following items considering your project. (1 - the lowest, 5 - the highest) (Matrix) | **P2.10.1:** The number of features or functionalities included in your project  
**P2.10.2:** The number of dependencies on external systems  
**P2.10.3:** The amount of legacy code that needs to be integrated or migrated  
**P2.10.4:** The level of the technical difficulty of your projects, such as the need to use advanced algorithms or cutting-edge technologies  
**P2.10.5:** The degree of uncertainty or risk associated with the project, such as a tight deadline or a lack of clear specifications  
**P2.10.6:** The level of integration with other systems or platforms  
**P2.10.7:** The level of customization required for the project |
| **P2.11:** How many years of experience do you have in your current position? (Open-ended) | - |
| **P2.12:** Approximately how many people are involved in the project you are currently working on? (Open-ended) | - |
### Appendix B: Questions of the Survey and Variables of the Research

<table>
<thead>
<tr>
<th>Page</th>
<th>Page Title</th>
<th>Questions</th>
<th>Options</th>
<th>Independent Variable (IV)</th>
<th>Dependent Variable (DV)</th>
</tr>
</thead>
</table>
| 2    | Daily Scrum Related Questions | P3.1: How often do you hold your Daily Scrum meetings? (Multiple Choice) | A. Once a day  
B. More than once a day  
C. Three times in a week  
D. Two times in a week  
E. Never  
F. Other | IV1.1.1: Frequency of Daily Scrum meetings | -                                                                          |
|      |                             | P3.2: How long do your Daily Scrum meetings take on average? (Multiple Choice) | A. Less than 15 minutes  
B. 15 minutes  
C. 15-30 minutes  
D. 30-60 minutes  
E. More than 60 minutes  
F. Not applicable | - | DV1.1.3: Duration of Daily Scrum meetings |
|      |                             | P3.3: Which of the following roles attend Daily Scrum meetings in your project? (Multiple Selection) | ▪ Development Team  
▪ Product Owner  
▪ Scrum Master  
▪ Business Analyst | IV1.1.2: Participants of Daily Scrum meeting | -                                                                                  |
| P3.4: Which of the following statement do you agree? (Multiple Choice) | A. The participation of people outside the Scrum team in Daily Scrum meetings causes the meeting to go beyond its purpose. |
| | B. The participation of people outside the Scrum team in Daily Scrum meetings has no negative impact on the purpose of the meeting. |
| | C. Other |
| | D. Not applicable |

**IV1.1.2:** Participants of Daily Scrum meeting
| 3 | Sprint Planning Related Questions | **P4.1**: How often do you hold Sprint planning meetings?(Multiple Choice) | A. We never hold Sprint Planning meetings  
B. We rarely hold Sprint planning meetings  
C. We sometimes hold Sprint planning meetings  
D. We often hold Sprint planning meetings  
E. We always hold Sprint planning meetings | **IV1.2.2**: Frequency of Sprint planning meetings |
|---|---|---|---|---|
| **P4.2**: How frequently do you set a Sprint goal for your Sprints?(Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **IV1.2.3**: Frequency of setting a Sprint goal |
| **P4.3**: Who decides how long each task would take during Sprint Planning(Multiple Selection)? | Team members  
Product Owner  
Scrum Master  
Project Manager | **IV1.2.1**: Person who estimates backlog item efforts |
|   | **P4.4:** While planning the sprint, how often a particular part of the sprint capacity is allocated to activities such as refactoring, training etc.? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **IV1.2.4:** Frequency of allocating certain capacity of sprint to refactoring |
|---|---|---|---|
|   | **P4.5:** While planning the Sprint, how often works of previous iterations are included in the Sprint rather than setting new value-added tasks? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **IV1.2.5:** The frequency of involving tasks related to previous Sprints |
|   | **P4.6:** How often do you, as the whole Scrum team, agree on the Sprint goal and the planned work before a Sprint begins? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **DV2.1.7:** Commitment of Scrum team to the Sprint goal |
| 4 | Sprint Related Questions | **P5.1:** Do you run your projects in an iterative manner? (Multiple Choice) | A. Yes  
B. No | **IV1.3.2:** Existence of Sprint | - |
| **P5.2:** What is the planned duration of a Sprint in your project? (Multiple Choice) | A. Less than a week  
B. One week  
C. Two weeks  
D. Three weeks  
E. One month  
F. Longer than 1 month  
G. Until all the work is completed  
H. Not applicable | - |
| **P5.3:** How often does the Sprint duration vary between different Sprints? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | - |
| **P5.4:** How often do you observe that the Sprint goal is changed while running the Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | - |
| **P5.5:** How often does your workload increase due to adding new items to your Sprint backlog after a sprint is initiated? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **IV1.3.4:** Frequency of Sprint goal changes | - |
| **P5.6:** Do you ensure that the Definition of Done (DoD) criteria is satisfied before a Sprint ends? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. No DoD criteria exist in the project  
G. Not applicable | **IV1.3.5:** Existence of definition of done criteria | - |
| **P6.1:** How often do you hold a Sprint Review meeting at the end of a Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always | **IV1.4.1:** Frequency of holding Sprint Review meetings | - |
| **P6.2:** Which of the following roles attend to Sprint Review meetings? (Multiple Selection) | - Development Team  
- Product Owner  
- Scrum Master  
- Business Analyst  
- Customer  
- Users | **IV1.4.2:** Attendance of developers in Sprint Review meetings | - |
| 6 | Sprint Retrospective Related Questions | **P6.3:** How often do you get useful feedback from customers at Sprint Review meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Customers/users do not participate in the Sprint Review meetings  
G. Not applicable | **IV1.4.3:** Frequency of getting useful feedback from customers |
| 6 | Sprint Retrospective Related Questions | **P7.1:** How often do you hold a Sprint Retrospective meeting in each Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  |
| 6 | Sprint Retrospective Related Questions | **P7.2:** How frequently do you take decisions in the Sprint Retrospective meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.3:** How often could the Scrum team members express their opinions openly and constructively | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.4:** How often do you hold a Sprint Retrospective meeting in each Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  |
| 6 | Sprint Retrospective Related Questions | **P7.5:** How frequently do you take decisions in the Sprint Retrospective meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.6:** How often could the Scrum team members express their opinions openly and constructively | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | **IV1.5.1:** Frequency of holding Sprint Retrospective meetings |
| 6 | Sprint Retrospective Related Questions | **P7.7:** How often do you hold a Sprint Retrospective meeting in each Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  |
| 6 | Sprint Retrospective Related Questions | **P7.8:** How frequently do you take decisions in the Sprint Retrospective meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.9:** How often could the Scrum team members express their opinions openly and constructively | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.10:** How often do you hold a Sprint Retrospective meeting in each Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  |
| 6 | Sprint Retrospective Related Questions | **P7.11:** How frequently do you take decisions in the Sprint Retrospective meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.12:** How often could the Scrum team members express their opinions openly and constructively | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.13:** How often do you hold a Sprint Retrospective meeting in each Sprint? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  |
| 6 | Sprint Retrospective Related Questions | **P7.14:** How frequently do you take decisions in the Sprint Retrospective meetings? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |
| 6 | Sprint Retrospective Related Questions | **P7.15:** How often could the Scrum team members express their opinions openly and constructively | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |

**IV1.5.1:** Frequency of holding Sprint Retrospective meetings

**DV1.5.3:** Frequency of taking necessary decisions at Sprint Retrospectives

**DV1.5.1:** Transparency among the Scrum team members
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
<th>Answers</th>
</tr>
</thead>
</table>
| P7.4: How long do your Sprint Retrospective meetings take on average?   | A. Less than 15 minutes  
B. 15-30 minutes  
C. 30-45 minutes  
D. 1 hour  
E. Not applicable  
F. Other                   |         |
| IV1.5.2: Duration of Sprint Retrospectives                               |                                                         |         |
| P7.5: If you take decisions at Sprint Retrospective meetings, how often do you implement those decisions and take the necessary actions? | A. We do not make any decisions in Sprint Retrospective meetings  
B. Never  
C. Rarely  
D. Sometimes  
E. Often  
F. Always  
G. Not applicable       |         |
| IV1.5.3: Frequency of taking necessary actions in Sprint Retrospectives |                                                         |         |
| Product Owner Related Questions                                          | P8.1: Is there a Product Owner working in your project (Multiple Choice) | A. Yes  
B. No                       | IV2.1.2: Existence of PO |
<p>| P8.2: To what extent do you agree with the following statements         |                                                         |         |
| <strong>P8.2.1:</strong> | Product Owner clearly communicates customer expectations to the Scrum team, acting as a bridge between stakeholders and the Scrum team. | 1 (Strongly Disagree) to 5 (Strongly agree) or Not applicable | <strong>DV2.1.2:</strong> Communication level between the team and stakeholders |
| <strong>P8.2.2:</strong> | Product Owner takes an active role in prioritizing and detailing the Product Backlog items. | - | <strong>IV2.1.4:</strong> Success or Failure of Product Backlog grooming, <strong>IV2.1.5:</strong> Success or Failure of Product Owner in ordering and detailing the requirements |
| <strong>P8.2.3:</strong> | Product Owner contributes to the Sprint Planning meeting by making sure that the Scrum team chooses the right tasks for the Sprint Backlog | - | - |</p>
<table>
<thead>
<tr>
<th>P8.2.4: Product Owner determines the Acceptance Criteria and ensures that these criteria are met</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>P8.2.5: Our project's Product Owner is acting like a traditional manager</td>
<td>IV2.1.1: Attitude of PO</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Scrum Master Related Questions</td>
<td>A. Yes B. No</td>
</tr>
<tr>
<td>P9.1: Is there a Scrum Master working in your project? (Multiple Choice)</td>
<td>▪ Software Developer ▪ Product Owner ▪ Business Analyst ▪ Project Manager ▪ None of them ▪ Other ▪ Not applicable</td>
<td>IV2.1.1: Existence of other responsibilities of SM</td>
</tr>
<tr>
<td>P9.2: Which of the following roles does the Scrum Master perform in addition to the Scrum Master role in your project? (Multiple Selection)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P9.3: To what extent do you agree with the</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Following statements about the Scrum Master in your project? (Matrix)</td>
<td>1 (Strongly Disagree) to 5 (Strongly agree) or Not applicable</td>
<td>DV2.2.1: Scrum team’s level of understanding of Scrum values and principles</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>P9.3.1:</strong> Our Scrum Master helps the whole Scrum team to understand the Scrum values and principles</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>P9.3.2:</strong> Our Scrum Master successfully organizes Scrum events</td>
<td>-</td>
<td>DV2.2.2: Existence of problems about the organization of Scrum events</td>
</tr>
<tr>
<td><strong>P9.3.3:</strong> Our Scrum Master contributes to eliminating the impediments that inhibit team’s productivity</td>
<td>1 (Strongly Disagree) to 5 (Strongly agree) or Not applicable</td>
<td>-</td>
</tr>
<tr>
<td><strong>P9.3.4:</strong> Our Scrum Master enables the team to focus on the Sprint goal during the Sprint by protecting the Scrum team against external factors</td>
<td>-</td>
<td>DV2.2.3: Level of interruption of Scrum team by the customer</td>
</tr>
<tr>
<td>Development Team Related Questions</td>
<td>P9.3.5: Our Scrum master establishes strong communication with the product owner, helping the product owner to directly drive development</td>
<td>-</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>P10.1: To what extent do you agree with the following statements about the development teams in your project? (Matrix)</td>
<td>1(Strongly Disagree) to 5(Strongly agree)</td>
<td>-</td>
</tr>
<tr>
<td>P10.1.1: People from different fields of expertise (analysts, architects, designers, developers, ...</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IV2.3.1: Cross-functionality of development teams</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Testers, etc.,) are involved in the same team</td>
<td><strong>P10.1.2:</strong> In our project, software teams successfully manage the process of achieving the sprint goal by organizing themselves</td>
<td><strong>IV2.3.2:</strong> Existence of self-organized development team</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>P10.1.3:</strong> Each development team member, participates in each daily scrum and shares the progress</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P10.1.4:</strong> Development team assists the Product Owner to create, refine, estimate and prioritize product backlog items</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P10.1.5:</strong> Development team, participates in Sprint Planning and helps the team to establish the Sprint goal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P10.1.6:</strong> The rate of inexperienced</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly agree</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Strongly Disagree) to 5 (Strongly agree)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 10 | Sprint Backlog Related Questions | **P11.1**: How often do you create a Sprint Backlog for Sprints in your project? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always | IV3.1.1: Frequency of creating a Sprint Backlog |
|    |                                | ▪ Development Team  
▪ Scrum Master  
▪ Product Owner  
▪ Other  
▪ Not applicable |    |
|    |                                | **P11.3**: How often tasks which are not ready to be developed are included in your Sprint Backlog? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable |    |
|    |                                | ▪ Product Backlog  
▪ Requirement Analysis Documents |    |
| 11 | Product Backlog Related Questions | **P12.1**: Which documentation approaches do you prefer to write and maintain the requirements? | ▪ Product Backlog  
▪ Requirement Analysis Documents | IV3.2.1: Existence of |
|    |                                |    |    |    |

**Team members** are higher than the experienced ones (+8 years) in our project.

d/less experienced team members

---

**Sprint Backlog Related Questions**

**P11.1**: How often do you create a Sprint Backlog for Sprints in your project? (Multiple Choice)

A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always

**Development Team**  
**Scrum Master**  
**Product Owner**  
**Not applicable**

**P11.3**: How often tasks which are not ready to be developed are included in your Sprint Backlog? (Multiple Choice)

A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable

**Product Backlog**  
**Requirement Analysis Documents**

**Product Backlog**  
**Requirement Analysis Documents**

**Existence of**
| P12.2: How often do you keep your product backlog up-to-date? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | IV3.2.2: Frequency of having an ordered Product Backlog |
|---|---|---|
| P12.3: How often do you detail the items on your product backlog, calculate their duration and complexity, and prioritize them? (Multiple Choice) | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always  
F. Not applicable | IV3.2.2: Frequency of having an ordered Product Backlog, IV3.2.6: Frequency of having a product backlog with unclear item definitions |
| 12 General Questions | P13.1: How often do you have problems concentrating on your work because of having too many meetings? | A. Never  
B. Rarely  
C. Sometimes  
D. Often  
E. Always | DV2.1.4: Frequency of having well-defined and ordered product backlog |
| (Multiple Choice) | P13.2: How often do you experience communication problems within the team?(Multiple Choice) | A. Never  
B. Rarely  
C. Sometime  
D. Often  
E. Always | DV1.1.1: Frequency of communication problems in the Scrum team |
|-----------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------------------------|
| P13.3: Which of the following do you experience due to communication problems?(Multiple Selection) | ▪ We do not have any problems  
▪ We have coordination problems  
▪ Information about the changes in the project, such as changes on requirements or sprint goals, are received later than expected  
▪ Problems in the project are |DV1.1.1: Frequency of communication problems in the Scrum team,  
DV1.3.2: The time when the requirement-related problems are identified,  
DV1.5.2: Frequency of late identification of problems |
<table>
<thead>
<tr>
<th>P13.4: Please rate the following items regarding your current project? (Matrix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>being detected later than expected</td>
</tr>
<tr>
<td>• Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P13.4.1: In our project, variances between estimated size and actual size for the backlog items are high</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Strongly Disagree) to 5 (Strongly agree) or Not applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P13.4.2: Intermediate / final products developed in the project are of good quality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P13.4.3: I struggle to comprehend the specific details of the</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DV1.2.1: Accuracy of the estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DV1.2.2: Quality of intermediate / final products</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DV1.2.3: Level of complexity and chaos in</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
</tr>
<tr>
<td>tasks assigned to me.</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td><strong>P13.4.4:</strong> Team capacity is determined accurately and realistically for each Sprint.</td>
</tr>
<tr>
<td><strong>P13.4.5:</strong> Work is evenly distributed among team members.</td>
</tr>
<tr>
<td><strong>P13.4.6:</strong> Intermediate/final deliverables in the project do not meet all of the defined requirements.</td>
</tr>
<tr>
<td><strong>P13.4.7:</strong> The participation of people outside the Scrum team in Daily Scrum meetings causes the meeting to go beyond its purpose in our project.</td>
</tr>
<tr>
<td><strong>P13.4.8:</strong> In each Sprint, we encounter problems that had to be resolved in 1(Strongly Disagree) to 5(Strongly agree) or Not applicable</td>
</tr>
</tbody>
</table>

158
<table>
<thead>
<tr>
<th>Previous Sprints.</th>
<th>Future Sprints</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P13.4.9:</strong> In our project, there is strong communication between the Scrum team and the other project stakeholders (Customers, key decision-makers in the organisation, users etc.).</td>
<td></td>
</tr>
<tr>
<td><strong>P13.4.10:</strong> Our customer satisfaction for each Sprint is high.</td>
<td></td>
</tr>
<tr>
<td><strong>P13.4.11:</strong> In our project, we are experiencing problems with ensuring the balance between the execution of the Scrum process (planning the events, etc.) and maximizing the value of the product.</td>
<td>1 (Strongly Disagree) to 5 (Strongly agree) or Not applicable</td>
</tr>
<tr>
<td><strong>P13.4.12:</strong> We always receive feedback from the customer at regular intervals.</td>
<td></td>
</tr>
<tr>
<td>P13.4.13:</td>
<td>During the project, we encounter problems related with software design such as the need to redesign the software architecture.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>P13.5:</td>
<td>How often do you create a potentially deliverable version of your product in each Sprint?(Multiple Choice)</td>
</tr>
<tr>
<td>P13.6:</td>
<td>How often are the defined test activities entirely completed within a Sprint?(Multiple Choice)</td>
</tr>
<tr>
<td>P13.7:</td>
<td>How often do you notice significant problems late in your project?(Multiple Choice)</td>
</tr>
<tr>
<td>P13.8:</td>
<td>Which of the following problems do we do not have any</td>
</tr>
</tbody>
</table>
### P13.9: How often do you encounter requirements-related issues such as frequent requirement changes, ambiguous requirements etc.) (Multiple Choice)

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Never</td>
<td></td>
</tr>
<tr>
<td>B. Rarely</td>
<td></td>
</tr>
<tr>
<td>C. Sometimes</td>
<td></td>
</tr>
<tr>
<td>D. Often</td>
<td></td>
</tr>
<tr>
<td>E. Always</td>
<td></td>
</tr>
</tbody>
</table>

**DV2.2.2:** Existence of problems about the organization of Scrum events

### P13.10: Please rate the

**DV1.3.2:** Frequency of encountering requirements-related issues
following items regarding your current project. (Matrix)

<p>| P.13.10.1: It takes a long time to allocate the tasks to team members. | - | DV2.3.3: Required effort in project planning and task allocation |
| P.13.10.2: Development team members take responsibility for achieving the Sprint goal, based on their expertise. | 1 (Strongly Disagree) to 5 (Strongly agree) | |
| P.13.10.3: I always have a clear idea of the tasks that need to be completed in the Sprint. | - | DV3.1.2: Level of accountability in the Sprint |
| P.13.10.4: Responsibility of the work to be carried out in a Sprint belongs to the team members. | - | DV1.5.1: Transparency among the Scrum team members |
| P.13.10.5: The relationship between the requirements and related software units | - | - |</p>
<table>
<thead>
<tr>
<th><strong>P.13.10.6:</strong> Team/individual motivation in the project is high.</th>
<th></th>
<th><strong>DV2.1.1:</strong> Team/Individual motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P.13.11:</strong> How often, as a Scrum team, do you have trouble with knowing requirement (backlog) priorities within the team? (Multiple Choice)</td>
<td>A. Never</td>
<td><strong>DV3.2.3:</strong> Frequency of delivering the requirements according to customer’s priorities</td>
</tr>
<tr>
<td></td>
<td>B. Rarely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Sometimes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Often</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E. Always</td>
<td></td>
</tr>
<tr>
<td><strong>P.13.12:</strong> How often do you encounter problems with monitoring your project's progress? (Multiple Choice)</td>
<td>A. Never</td>
<td><strong>DV3.1.3:</strong> Frequency of encountering problems with monitoring project’s progress</td>
</tr>
<tr>
<td></td>
<td>B. Rarely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Sometimes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Often</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E. Always</td>
<td></td>
</tr>
<tr>
<td><strong>P.13.13:</strong> How often do you deliver the requirements according to your customers' priorities? (Multiple Choice)</td>
<td>A. Never</td>
<td><strong>DV3.2.3:</strong> Frequency of delivering the requirements according to customer’s priorities</td>
</tr>
<tr>
<td></td>
<td>B. Rarely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Sometimes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Often</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E. Always</td>
<td></td>
</tr>
<tr>
<td><strong>P.13.14:</strong> Which of the following problems about the software</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Violation of modular architecture</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design do you encounter in your current project? (Multiple Selection)</td>
<td>Highly coupled classes or subsytems</td>
<td>Duplicated code</td>
</tr>
<tr>
<td>---</td>
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</tr>
</tbody>
</table>

**P.13.15:** Please rate the following items regarding the frequency of the phases where you identify the bugs in your project. (Matrix)

<table>
<thead>
<tr>
<th></th>
<th>1 (Very Low) to 5 (Very High)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P.13.15.1:</strong> During software development</td>
<td>-</td>
</tr>
<tr>
<td><strong>P.13.15.2:</strong> During functional tests</td>
<td>-</td>
</tr>
<tr>
<td><strong>P.13.15.3:</strong> During regression tests</td>
<td>-</td>
</tr>
<tr>
<td><strong>P.13.15.4:</strong> After related software unit(s) are delivered to the customer</td>
<td>-</td>
</tr>
</tbody>
</table>
## Appendix C: Hypotheses and Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Test</th>
<th>P-Value</th>
<th>Accepted / Not accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1.1.1</td>
<td>Chi-Square</td>
<td>.074</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.1.2</td>
<td>Chi-Square</td>
<td>.246</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.2.1</td>
<td>Kruskal-Wallis H-test</td>
<td>.727</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.2.2</td>
<td>Kruskal-Wallis H-test</td>
<td>.667</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.2.3</td>
<td>Kruskal-Wallis H-test</td>
<td>.358</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.2.4</td>
<td>Kruskal-Wallis H-test</td>
<td>.656</td>
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</tr>
<tr>
<td>H1.2.5</td>
<td>Chi-Square</td>
<td>.096</td>
<td>Not accepted</td>
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<tr>
<td>H1.2.6</td>
<td>Kruskal-Wallis H-test</td>
<td>.220</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.2.7</td>
<td>Chi-Square</td>
<td>.913</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.3.1</td>
<td>Mann-Whitney U</td>
<td>.875</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H1.3.2</td>
<td>Chi-Square</td>
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<tr>
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<td>Chi-Square</td>
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<td>Not accepted</td>
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<tr>
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<td>Mann-Whitney U</td>
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<tr>
<td>H1.3.7</td>
<td>Kruskal-Wallis H-test</td>
<td>.073</td>
<td>Not accepted</td>
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<tr>
<td>H1.3.8</td>
<td>Kruskal-Wallis H-test</td>
<td>.903</td>
<td>Not accepted</td>
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<tr>
<td>H1.4.1</td>
<td>Kruskal-Wallis H-test</td>
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<td>Not accepted</td>
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<tr>
<td></td>
<td>Test Type</td>
<td>Value</td>
<td>Result</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------</td>
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<td>--------</td>
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<tr>
<td>H1.4.2</td>
<td>Chi-Square</td>
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<td>H1.5.1</td>
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<td>Chi-Square</td>
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<td>H2.1.1</td>
<td>Spearman Correlation</td>
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<tr>
<td>H2.1.5</td>
<td>Spearman Correlation</td>
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<tr>
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<td>Chi-Square</td>
<td>.000</td>
<td>Accepted</td>
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<td>H2.2.1</td>
<td>Kruskal-Wallis H-test</td>
<td>.386</td>
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<td>H2.2.2</td>
<td>Mann-Whitney U</td>
<td>.002</td>
<td>Accepted</td>
</tr>
<tr>
<td>H2.2.3</td>
<td>Chi-Square</td>
<td>.651</td>
<td>Not accepted</td>
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<td>H2.3.1</td>
<td>Logistic Regression</td>
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<td>H2.3.2</td>
<td>Spearman Correlation</td>
<td>.155</td>
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<td>H3.1.1</td>
<td>Kruskal-Wallis H-test</td>
<td>.871</td>
<td>Not accepted</td>
</tr>
<tr>
<td>H3.1.2</td>
<td>Kruskal-Wallis H-test</td>
<td>.666</td>
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<tr>
<td>H3.1.3</td>
<td>Chi-Square</td>
<td>.535</td>
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<td>H3.2.1</td>
<td>Chi-Square</td>
<td>.803</td>
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<td>H3.2.2</td>
<td>Chi-Square</td>
<td>.083</td>
<td>Not accepted</td>
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<tr>
<td>H3.2.3</td>
<td>Chi-Square</td>
<td>.080</td>
<td>Not accepted</td>
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<tr>
<td>H3.2.4</td>
<td>Logistic Regression</td>
<td>.030</td>
<td>Accepted</td>
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<td>H3.2.5</td>
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<td>Chi-Square</td>
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