Recommendation for Scrum-Based Software Development Process with Scrum at Scale: A Case Study of Software House XYZ

Ahmad Jalaluddin[1*], Eko K. Budiardjo[2], Kodrat Mahatma[3]
[1,2,3]Department of Information Technology, Faculty of Computer Science, Universitas Indonesia, Jakarta, Indonesia
[1]ahmad.jalaluddin11@ui.ac.id, [2]eko@cs.ui.ac.id, [3]kodrat.mahatma12@cs.ui.ac.id

Abstract

Software House XYZ employs Scrum as one of its software development processes. However, the company faces several challenges in the implementation of Scrum, leading to delays in their product releases. Two specific problems are the control of a large-scale Scrum team and the management of team commitments. In addressing these issues, the Scrum at Scale framework has been chosen as a solution. Before implementing Scrum at Scale, an assessment of the current Scrum maturity level at Software House XYZ is deemed necessary. The Scrum Maturity Model, adapted to the Scrum Guide 2020, is selected as the method to evaluate how effectively the company is implementing Scrum. A questionnaire comprising 81 practices was distributed to development teams, with 10 valid responses collected. Based on the assessment using the Scrum Maturity Model, the current Scrum implementation maturity at Software House XYZ is rated at level 1, Initial. A total of 61 practices are proposed for improvement in the Scrum process. Scrum at Scale can be implemented once the suggested Scrum process improvements have been made. These recommendations are structured following the framework outlined in the Scrum at Scale Guide 2022. Validation of the Scrum at Scale recommendations has been conducted by us through interviews with representatives from Software House XYZ. From the validation results, the company expresses interest in trying to implement Scrum at Scale. However, the company agrees to enhance the existing Scrum process within the organization before fully adopting Scrum at Scale.

Keywords: scrum at scale; scrum; scaling agile method; agile; maturity level

1. Introduction

One of the approaches to developing products and services is Scrum [1]. Scrum is also a framework within the Agile methodology. This framework will serve as the foundation for companies to innovate and create products or services. Scrum involves processes starting from Sprint Planning to Sprint Retrospective [2]. This methodology has been widely adopted by numerous companies worldwide.

Software House XYZ is a software development agency founded in 2015. Since 2016 to the present, the company has been offering boot camps with a case study-based learning approach, preparing participants to undertake real project development. Selected bootcamp participants actively contribute to ongoing projects within the company.

The company uses Scrum as its software development process. In each project within the company, there is a dedicated Project Manager involved from the project's initiation to its completion. The company maintains the role of Project Manager even within the Scrum framework they apply. There is a study that surveyed 97 software practitioners from 31 different countries regarding the presence of Project Managers in development teams implementing agile [3]. The research findings indicate that nearly 67% of projects in their respective companies involve Project Managers.

The company also has a specialised team, the Principal Team, comprising selected individuals. In every project, this team is responsible for elaborating the jointly designed product backlog with the Product Owner into a set of tasks within a Sprint. The Principal Team is also accountable for determining the number of story points for each task to be undertaken by the development team. The Principal Team is formed so that the development team can maintain the quality of the company's services.

The development team is expected to complete each task within the designated time set by the Principal Team. However, the reality often deviates from the company's expectations. The story points assigned to each task by the Principal Team are frequently challenging for the development team to adhere to, leading to the necessity of postponing several tasks to subsequent Sprints. While the development team has the option to propose changes to the initially assigned story points, supported by reasons and relevant data, in practice, such requests are infrequently made and considered.

One of the projects at Software House XYZ is the Expedition Application project, which was initially planned to be completed in 5 months. The company initially assigned a Scrum team of 12 individuals to develop this project. However, several issues in the software development process led to a delayed product release. The development team managed to complete the project in 7 months. Additionally, there was an increase in team members by 8 individuals, resulting in a total of 20 members in the Scrum team for the Expedition project. This situation is not in line with the recommended maximum team size by the Scrum Guide 2020.

Based on the data provided by the company to us, similar issues also occurred in other projects at Software House XYZ, such as the logistics application project and the health application project. The task planning devised by the Principal Team cannot be effectively executed by the development team. The company adds members to the development team during ongoing development. However, this does not prevent product release delays; instead, it adversely affects other projects being undertaken by the additional team members. The company desires projects to be completed on time; however, the reality does not align with the company's wishes. The issue is elaborated in Table 1.

Table 1. Problem Definition

Expectation	Realization	Problem
Maintaining the company's development speed standards is crucial to ensuring that the delivery process to clients aligns with the established agreements.	The completion of work commitments does not align with the agreed-upon schedule.	The product release is delayed by 38.33% from the initial planning.

There are other issues present in the company's software development process. We employed a fishbone diagram to analyze these problems [4]. The issues were obtained through interviews with several individuals at Software House XYZ. In the interview, we asked about the factors contributing to product release delays. They are categorized into four domains: people, measurement, management, and method [5]. They are explained in Table 2.

Table 2. Problem Domain

Domain	Problem
People	The technical proficiency of some team members is inadequate.
Measurement	No notification is provided when there are changes in tasks from the client team.
	Changes in task priorities during an ongoing sprint.
	Addition of tasks during an ongoing sprint.
	Difficulty in realizing the determined story points.
	Sudden changes in product requirements.
Management	Control over the commitments that the team needs to achieve in each sprint is insufficient.
	The large size of the Scrum team (approximately 20 people) makes it challenging for the lead to monitor teamwork.
Method	Product requirements are not clearly described by the product owner.

In the Management domain, we have successfully identified two root problems within the company. These two root issues are the inadequate control over commitments that the team needs to achieve in each Sprint and the large size of the Scrum team (approximately 20 people), causing difficulties for the lead in monitoring teamwork. One of the Principals believes that the most frequent hindrance to the development process is the lack of control over work commitments by team members. Not all development teams are proficient in managing their work effectively.

The Pareto principle states that 80% of problems can be generated from only 20% of the total causes [6], [7]. Out of all problem domains, the Management domain only accounts for 22% of the total root causes. However, based on the data collected by us, issues within the Management domain have been identified as the primary problems causing delayed product releases. Therefore, this research will concentrate on resolving issues within the management domain.

Scrum is designed for teams of four to ten individuals [2]. However, teams with a larger number of members can adopt scaling agile methods [8]. Several previous studies have shown that the implementation of scaling agile methods can be applied in various cases across different companies. From the findings of prior research, scaling agile methods assist companies in facilitating information exchange among teams, enhancing trust among teams, and providing a framework capable of adapting to the company's organizational structure [9]. These factors drive many companies to adopt scaling agile methods. AlMutairi's study proposes scaling agile methods to enable companies to distribute large projects [10]. The compatibility of the selected scaling agile method with the company's conditions is a crucial factor for the success of large-scale agile implementation.

Scaling agile methods assist organizations in involving more people in a team and eliminating silos in teamwork [11]. Nevertheless, if a Scrum team is unable

to effectively implement Scrum, they cannot successfully scale Scrum within the organization [12]. Previous research has shown that Scrum maturity can be measured using a maturity model [13]. This model offers recommendations for best practices within Scrum, enabling companies to enhance the maturity of their Scrum implementation. An evaluation of the Scrum process is necessary for a company to ensure its readiness to scale its Scrum processes. With these issues in mind, the research questions posed in this study are as follows:

RQ1: How are the results of the evaluation and recommendations for improving the implementation of Scrum for Software House XYZ?

RQ2: How is the implementation of the Scaling Agile method at Software House XYZ??

2. Research Methods

The approach that can be employed in this research is the explanatory sequential approach. This mixed methods approach begins with the collection of quantitative data. Subsequently, the collected quantitative data will be analysed. The precise quantitative approach is appropriate for research that involves evaluation [14]. The next phase in this approach involves the collection and analysis of qualitative data based on the quantitative data that has been previously analyzed. The collection and analysis of qualitative and quantitative data in this approach are interrelated [15].

There are several methods available to measure the maturity level of a framework. These methods are referred to as maturity models. Maturity models assist organizations in assessing team performance, motivating them to enhance their performance. Additionally, maturity models help bridge the gap between clients and service providers [16].

Hidayati's research compares several Maturity Models such as the Capability Maturity Model Integration for development (CMMI-Dev), Agile Maturity Model (AMM), and Scrum Maturity Model SMM [17]. CMMI-Dev has a very broad assessment scope as it can encompass multiple divisions within an organization. [18]. AMM and SMM have narrower scopes. AMM assists organizations in assessing the maturity processes of teams implementing agile methods in their development processes [19]. Meanwhile, SMM is specifically designed for evaluating the maturity processes of Scrum [16].

We use SMM as the model to assess the maturity of the software development processes at Software House XYZ. This choice is driven by the focus of this study on the implementation of Scrum at Software House XYZ. Data processing in this research will utilize the KPA rating.

The questionnaire in this research is utilized to assess the maturity level of Scrum implementation at Software House XYZ. The questionnaire is structured based on the SMM adapted to the Scrum Guide 2020. Figure 1 is the theoretical framework of this research.
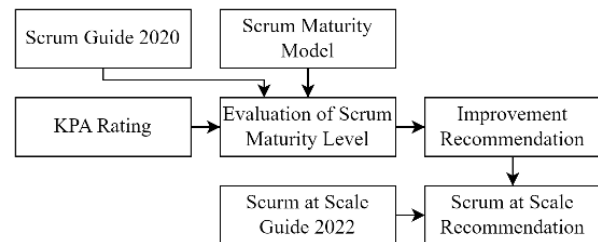

Figure 1. Theoretical Framework

The Scrum teams in Scrum at Scale adhere to the guidelines outlined in the Scrum Guide. Therefore, improvement recommendations from SMM will be utilized for Scrum teams within Scrum at Scale. Scrum at Scale can assist Scrum teams in addressing more complex problems [12].

The SMM comprises three stages: Pre-Appraisal, Appraisal, and Post-Appraisal [16]. The first step is the Pre-Appraisal. In this stage, we will elucidate the ongoing research to the participants through a Google Form. We will explain the formulated problem, the reasons behind conducting this research, and the SMM theory. Subsequently, We will present questions via Google Forms to the participants regarding their expectations regarding the maturity level of Scrum implementation that should exist within their company. The participants are representatives who serve as one of the Leads in the company.

The next stage is the Appraisal stage, which is the primary phase of SMM. We formulate questions to be presented in the questionnaire using Google Forms. This questionnaire consists of 81 questions organized in accordance with the SMM practices adapted to the Scrum Guide 2020. The respondents for this questionnaire are the development team members from Software House XYZ.

The sampling method employed by us is Purposive sampling. Purposive sampling is a technique that relies on our judgment to select research samples [20]. This technique has several types that can be utilized in research, and we opt for the homogeneus sampling type. Homogeneous sampling is a sampling technique that requires selected samples to possess specific similar characteristics. This research gathers data from the year 2023. The selected sample consists of individuals working with Scrum in teams of no more than 10 people.

The questionnaire appraisal respondents consist of Leads, Senior Software Developers, Project Managers, application development teams, and Principals. All these respondents will fill out the same questionnaire,

despite having different roles. Project Managers are required to understand the product to be created by the client. In this company, the Project Manager serves as the internal Product Owner for the company's Scrum team.

Data processing will be conducted using the KPA rating. In KPA rating, respondents can provide four answers to the posed questions: "yes," "no," "partially," and "not applicable." "Yes" is selected when the practice is implemented, while "no" is chosen when the practice is not implemented. "Partially" is the chosen answer when only some aspects of the practice have been successfully applied. "Not applicable" is selected when the queried practice cannot be applied to the team[19]. Subsequently, the research will calculate each goal area using Formula 1.

$$\frac{\Sigma(Yn) + \frac{1}{2}\Sigma(Pn)}{\Sigma(Tn) - \Sigma(NAn)} \times 100\% \tag{1}$$

Yn is a number of "yes" responses, Pn is the number of "partially" responses, Tn is the number of question responses, and NAn is the Total "not applicable" responses. The obtained results will be interpreted into four assessment levels illustrated in Table 3.

Table 3. KPA Rating Assessment Level

Interpretation	Requirement
Fully Achieved	>85% and ≤100
Largely Achieved	>50% and ≤85
Partially Achieved	>15% and ≤50
Not Achieved	≥0% and ≤15

Next, we conduct a post-appraisal. This stage is the final step in the SMM. We provide a questionnaire to the participants to obtain feedback, suggestions, and critiques regarding the Scrum Maturity Model Appraisal results. The outcomes of this stage will serve as recommendations for future research.

Scaling the agile method becomes a solution to meet the organizational needs by aligning multiple teams and facilitating developers to connect with other teams within the company, such as the finance and legal divisions [21]. Furthermore, scaling the agile method helps organizations reach more individuals within the team, eliminate silos in work, and remain competitive in the current market [11]. There are several scaling agile methods available today, including Large-Scale Scrum (LeSS), Disciplined Agile Delivery (DAD), Nexus, Scaled Agile Framework (SAFe), Scrum at Scale, and Spotify [22].

All the scaling agile methods mentioned above have available documentation. In several projects, Software House XYZ assigns around 20 individuals to a team. Nexus, LeSS, DAD, and Scrum at Scale are suitable choices given the company's conditions. These four scaling agile methods can adopt Scrum.

Projects commence with discussions between the customer and the team from Software House XYZ, consisting of the Project Manager and Principal. The purpose of these meetings is to understand the system requirements the customer wants to develop. As the sole team member communicating intensively with the customer, the Project Manager is required to be knowledgeable about the product the customer wants to develop. If the development team has questions about the product requirements, they can inquire with the Project Manager.

Among the scaling agile methods described above, Scrum at Scale is the most suitable framework for implementation at Software House XYZ. In Scrum at Scale, each Scrum team has one Product Owner [12]. In the current framework, the Project Manager can take on the role of Product Owner if Scrum at Scale is implemented. The development team can inquire with the Product Owner in the Scrum team about the product being developed without having to ask the customer directly. This is what led us to recommend the use of Scrum at Scale as the recommended improvement framework for Software House XYZ.

When the improvements to the Scrum process have been formulated, we will recommend the software development process using Scrum at Scale. We have attended Scrum at Scale courses and studied the Scrum at Scale Guide 2022 to gain a thorough understanding of the framework.

3. Results and Discussions

We conducted an interview with the Lead Project Manager as the company representative. From the interview results, the company expressed a desire for Scrum within the organization to reach level 5 - Optimizing. Through this research, we provide recommendations for improving the Scrum process to achieve level 5 Optimizing maturity in Scrum.

3.1 Evaluation of Scrum Process

We distributed the SMM questionnaire to individuals who have previously implemented Scrum while developing software at Software House XYZ. There were 40 individuals with Scrum experience in the company. Out of these 40 individuals, only 10 applied Scrum with a team size of no more than 10 members. The SMM assessment in this study did not collect data from individuals who had experience with Scrum in a larger team size. Ten respondents were provided with the SMM questionnaire prepared by us, and all selected respondents answered the questionnaire.

We assessed the maturity level for each objective within the SMM. Subsequently, we compiled a summary for each goal. The table below presents the summary of the maturity level assessment for the implementation of Scrum at Software House XYZ.

The KPA rating for Basic Scrum goals at level 2 was 73.08% (largely achieved), and the KPA rating for

Requirements Management at level 2 was 75.56% (largely achieved). The recommended practices are those with values not exceeding 85%. Currently, Software House XYZ is at level 1 Initial.

Table 4. Scrum Maturity Level Assessment Results Recapitulation

Level	Goals	Total practices	Interpretation
2	Basic Scrum (BS)	24	Largely Achieved
2	Software Requirements Engineering (SRE)	18	Largely Achieved
3	Customer Relationship Management (CRM)	7	Largely Achieved
3	Iteration Management (IM)	17	Largely Achieved
4	Standardized Projects Management (SPM)	1	Largely Achieved
5	Performance Management (PM)	14	Largely Achieved

Out of the 64 practices that have not yet reached the 'Fully Achieved' status, we propose 61 practices as recommendations for improving the Scrum process at Software House XYZ. However, it is noted that three practices cannot be implemented due to company policies. The following is the number of practices that the company needs to implement to achieve each level of Scrum maturity.

Table 5. Scrum Maturity Level Assessment Results Recapitulation

Level	Number of Improvement recommendations	Cumulative Number of Improvement Recommendations
2	32	32
3	18	50
4	1	51
5	10	61

To achieve level 5, Software House XYZ needs to enhance 61 practices, which is an accumulation of practices at level 2, level 3, level 4, and level 5. Improvement recommendations start with level 2. Level 3 cannot be achieved unless level 2 is attained by the company, level 4 cannot be reached without achieving level 3, and level 5 cannot be attained unless level 4 is accomplished by the company.

Scrum has several crucial elements, namely Scrum roles, Scrum events, Scrum artefacts, and Scrum values [2]. Additionally, Scrum encompasses rules and techniques that constitute best practices within the Scrum maturity model. We present recommended practices grouped into six categories: role, event, artefact, value, rule, and technique. We present recommended practices in Tables 6, 7, 8 and 9. Each table contains recommended practices at Level 2, Level 3, Level 4, and Level 5. The following is a table of recommendations for improving Scrum implementation for SMM level 2:

Table 6. Recommendations for Improving Scrum Implementation for SMM Level 2

Goal	Categories	Practices Recommendation
BS	Role	An individual is serving as the Product Owner, not a Project Manager.
		There is an individual serving as the Scrum Master.
		Providing knowledge about the role of the Team (developers) in Scrum.
	Artifact	There is a clearly outlined Product Backlog.
	Event	Release Planning is conducted at least once.
		Sprint Planning is conducted once every Sprint.
		There is a Daily Scrum.
		Sprint Review is conducted once every Sprint.
		Sprint Review takes place after the development process in one Sprint is completed and before Sprint Retrospective is conducted.
		Sprint Retrospective exists and is conducted once every Sprint.
		A Sprint concludes with Sprint Retrospective.
		There is the appropriate use of Sprint in accordance with Scrum regulations.
	Rule	The Daily Scrum is attended by the development team.
		The Release Burndown is updated according to the progress reported by the Team.
		The Sprint Burndown is updated according to the progress reported by the Team.
		The Product Backlog is updated by the customer or Product Owner.
		Sprint Review is attended by the Scrum team and stakeholders.
	Technique	There is a Release Burndown.
		There is a Sprint Burndown.
SRE	Value	There is a Product Goal in the Product Backlog.
	Rule	The Product Owner has the authority to determine priorities in the Product Backlog.
		The Product Owner can communicate directly with the Team (developers) and Scrum Master.
		The Product Owner communicates directly with stakeholders from the customer side.
		The top Product Backlog Items are determined based on business value.
		Some of the top Product Backlog Items have already been estimated.
		Some of the top Product Backlog Items are small enough to fit into a single Sprint.
		The Product Owner understands the objectives of all Product Backlog Items.
		The Product Owner participates in Sprint Planning.
		The Product Owner presents the latest Product Backlog in each Sprint Planning.
		The entire Scrum team participates in Sprint Planning.
		The entire team is confident that the planned work can be completed entirely within one Sprint.

Goal	Categories	Practices Recommendation
		The Product Owner is satisfied with the priorities to be worked on.

There is no artefact category in Table 6. The artefact or the event category includes practices that state that Scrum Artifacts or Scrum Events are present in the software development process of the company. Meanwhile, rules in the implementation of Scrum Artifacts or Scrum Events will fall into the rule category. Then, the Product Goal is one of the commitments in Scrum. Commitments will fall into the value category.

Table 7. Recommendations for Improving Scrum Implementation for SMM Level 3

Goals	Categories	Practices Recommendation
CRM	Value	The Definition of Done is defined and approved by the entire Scrum team.
	Rule	The Definition of Done is achieved in the increment performed in each iteration.
		Demonstrating a working product at the Sprint Review.
		Stakeholders and the Product Owner provide input or feedback on the conducted demo.
		The maximum duration of the Sprint Review meeting is 4 hours for a Sprint duration of 1 month.
IM	Value	The Sprint Goal is defined in the Sprint Backlog.
	Rule	The Sprint Backlog is updated every day.
		The Sprint Backlog is exclusively owned by the selected Scrum team.
		The Sprint Backlog is broken down into Sprint Backlog Tasks during the Sprint.
		The Sprint ends according to the pre-established schedule.
		Iterations that are failing are immediately stopped.
		The team is not disturbed or controlled by external sources, affecting the team's work.
		The team delivers the product according to the agreed-upon commitment.
		All tasks in the Sprint planning are estimated.
		The Sprint Burndown Chart is visible to all Scrum team members.
		The Sprint Burndown Chart is updated every day.
		Velocity used is only from completed tasks.
	Technique	The Product Owner uses velocity in Release Planning.

The practice of Sprint Goal falls into the value category because the Sprint Goal is a commitment in Scrum. Velocity falls into the technique category because Velocity is used as a performance metric to help the Scrum team understand how much work they can complete in one sprint. Other recommended practices fall into the rule category.

To reach level 4, all practices at levels 3 and 2 must be implemented effectively. Furthermore, all Scrum teams at Software House XYZ must adhere to the same standards in the application of their Scrum practices. The company should monitor the implementation of Scrum regularly

Table 8. Recommendations for Improving Scrum Implementation for SMM Level 4

Goals	Number	Practices Recommendation
SPM	Rule	All projects utilizing Scrum are managed with the same adherence to all goals, objectives, and practices from all the previous levels.

.

Table 9. Recommendations for Improving Scrum Implementation for SMM Level 5

Goals	Number	Practices Recommendation
PM	Rule	The Daily Scrum is conducted every working day, at the same time and place.
		The Product Owner participates in the Daily Scrum several times a week (not necessarily every day).
		The maximum duration of the Daily Scrum is 15 minutes.
		The maximum duration of the Sprint Retrospective is 3 hours for a 1-month Sprint.
		The results of the Sprint Retrospective are formulated as proposals containing concrete improvements.
		At least some improvement proposals from the Sprint Retrospective have been implemented.
		All Scrum team members participate in the Sprint Retrospective.
		Overtime is rare, and if it occurs, it is voluntary.
		There is a constructive criticism discussion within the Scrum team.
		The Scrum team conducts experiments aimed at improving the development process with Scrum.

The successful enhancement of the company's Scrum processes is anticipated to facilitate more effective implementation of the Scrum at Scale processes. Scrum training is also necessary for the development team of the company. Some individuals still do not fully understand how Scrum should be implemented. In addition, the Project Managers of the company need training on how to become effective Product Owners so that the Product Owner role in Scrum can be executed successfully. Furthermore, some Senior Developers or Leads can be provided with training to become Scrum Masters, helping the company ensure that the development team can effectively implement Scrum.

3.2 Scaling Agile Method Recommendation

Currently, scaling agile methods are not only applied in IT companies but also in non-IT companies such as manufacturing firms [9]. The scaling agile method serves as a solution to organizational needs to align multiple teams and assist development teams in connecting with other teams within the company, such as finance and legal divisions [21]. Non-agile teams and agile teams can connect with each other to achieve common goals.

In Scrum at Scale, there is a team that can be filled by representatives from non-IT divisions. This team is called the Executive Action Team and is part of the Scrum Master Cycle in Scrum at Scale. We include the Principal team in this Executive Action Team. According to us, the tasks of the Principals in Software House XYZ will be assigned to this Executive Action Team. By including the Principal team from Software House XYZ in the EAT, you're essentially bringing in high-level decision-makers who can provide valuable insights and strategic direction. The Principals can contribute their expertise in guiding the organization towards its goals and objectives, ensuring that the Scrum implementation aligns with broader business priorities.

Presently, the company employs Scrum methodology for product development, notwithstanding a team size that surpasses the conventional 10-member threshold. The fact is, Scrum is designed for small-sized teams. The ensuing sections outline the existing Scrum process implemented within the company.

Figure 3. The stages of developing the Scrum at Scale design

Figure 2. Scrum in Sofware House XYZ

Figure 2 depicts the current Scrum implemented by the company. We have formulated recommendations for the implementation of Scrum at Scale for Software House XYZ. Fundamentally, the Scrum at Scale process aligns with the Scrum framework. In this research, we made several adjustments to the proposed Scrum at Scale framework to align it with the conditions of this research case study. Figure 3 shows the steps undertaken by us in developing the Scrum at Scale framework for Software House XYZ.

We incorporate Principals into the process outlined in the recommendation for implementing Scrum at Scale for Software House XYZ. Additionally, the Project Manager's role is renamed as the Product Owner. This design is tailored to the specific case study conditions of this research. Therefore, the design recommended by the researcher may not necessarily be applicable to other companies. Figure 4 is the recommendation for Scrum at Scale proposed by us.
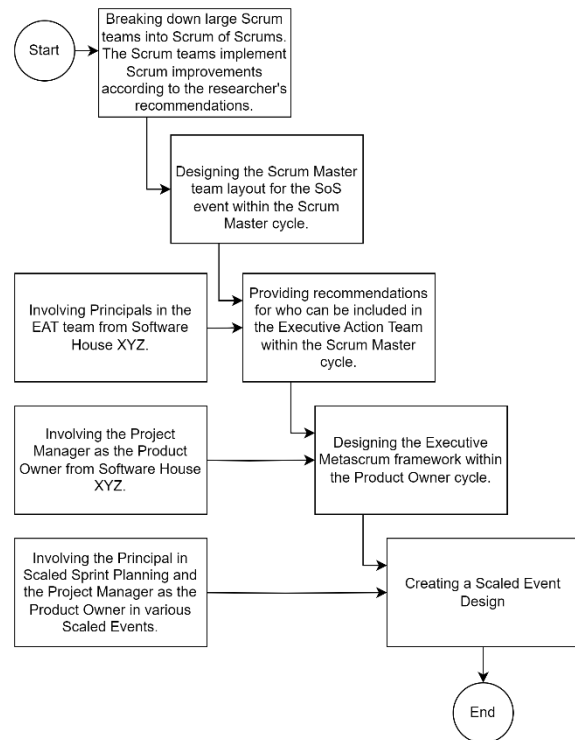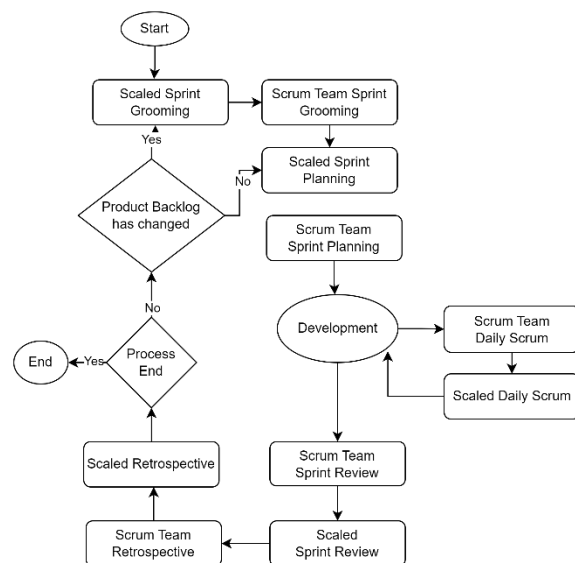

Figure 4. Scrum at Scale Recommendation

In the recommended Scrum at Scale, several additional events are introduced, namely Scaled Sprint Grooming, Scaled Sprint Planning, Scaled Daily Scrum, Scaled Sprint Review, and Scaled Retrospective. These events are collectively referred to as Scaled Events within the Scrum at Scale framework. Meanwhile, other Scrum events remain unchanged.

The effective implementation of Scrum at Scale hinges on the prerequisite of a well-established Scrum foundation within the organization. The applied Scrum should adhere to consistent standards across all Scrum teams within the company. Scrum at Scale serves as a

framework that scales both Scrum teams and Scrum Events. The initial step in designing the implementation of Scrum at Scale involves scaling the Scrum teams. A Scrum team with an expanded scale in the Scrum at Scale framework is denoted as a Scrum of Scrum.

The Scrum of Scrum (SoS) is a mechanism designed to facilitate effective communication and coordination among multiple Scrum teams collaborating on a single project. According to the Scrum Guide 2020, the recommended maximum team size is 10 individuals. However, Harvard research suggests that the optimal team size averages around 4.6 members [23]. Scrum of Scrum functions as a team. Therefore, the recommended size for Scrum of Scrum is 4 or 5 teams.

In Software House XYZ, the Project Manager fulfils the roles of both Product Owner and Scrum Master within the Scrum framework they adopt. In our recommendation, we propose that the Project Manager assume the role of Product Owner. Additionally, we suggest eliminating the Project Manager position in the company and replacing it with a dedicated Product Owner. Therefore, in the recommended Scrum of Scrum setup, there will be no Project Manager role.
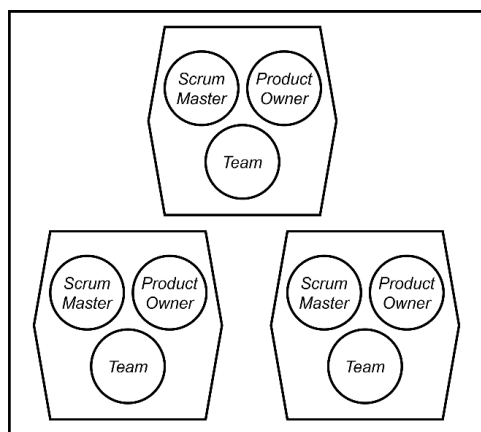
Figure 5. Scrum of Scrum

Figure 5 illustrates a single Scrum of Scrum (SoS). In Scrum at Scale, each Scrum team has its own dedicated Product Owner and Scrum Master. In each team, there will only be one Product Owner and one Scrum Master. The Team is composed of individuals possessing the necessary skills to develop the product. Despite being divided into three teams, they collaborate on the same project and operate within the same Sprint to achieve the agreed-upon Sprint Goal.

Figure 5 features three Product Owners and three Scrum Masters. We recommend that each Product Owner should be assigned to only one team to optimize the outcomes of each team. However, there is no prohibition for a Product Owner to be involved with multiple teams simultaneously. The same principle applies to Scrum Masters. The organization has the flexibility to determine the arrangement of Scrum teams according to their preferences. Certainly, with only one

team to oversee, the Product Owner can devote more focused attention to the tasks and responsibilities of that team.

The Scrum Master for the Scrum of Scrum is referred to as the Scrum of Scrum Master (SoSM) [12] is shown in Figure 6. This role is responsible for ensuring the effective execution of Scaled Scrum events by the plan. The SoSM is appointed from one of the existing Scrum Masters within the Scrum of Scrum.

The SoSM is preferably not replaced during the ongoing project. Scrum of Scrum collaborates with the Chief Product Owner to ensure that increments can be delivered at the end of each Sprint. The SoSM leads the team to foster collaboration and assists in removing team impediments.
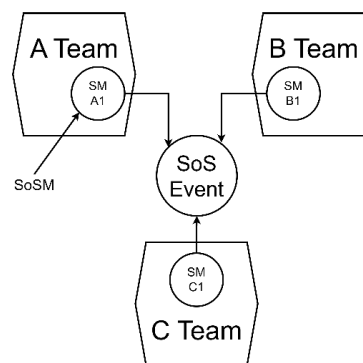
Figure 6. Scrum of Scrum Master

In addition to the Scrum Masters, a crucial role in the Scrum Master Cycle is the Executive Action Team (EAT) as shown in Figure 7. The EAT is a group consisting of executive leaders and high-level business owners responsible for strategic decisions and the implementation of the company's vision. The EAT ensures the continued utilization of the Scrum at Scale framework and provides support to ensure the success of Scrum at Scale implementation. The EAT serves as the liaison for a collection of SoS, SoSoS, or more complex structures.
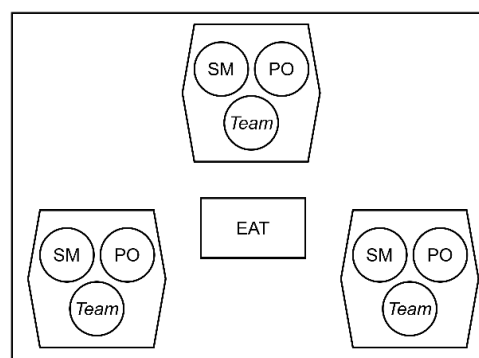
Figure 7. Executive Action Team

The EAT serves as the central hub for the SoS team. EAT members can be drawn from any stakeholder with an interest in the development team. We recommend that EAT members consist of the CTO, Principal,

Engineering Manager, a representative from Project Management, and a representative from Technical Fellow. The company has the flexibility to add or reduce EAT members as deemed necessary. In addition to ensuring the smooth implementation of Scrum at Scale, the responsibilities of the EAT include resolving impediments that cannot be addressed by the SoS team, serving as a liaison between the development team and non-development teams such as finance, HR, and others, ensuring that process improvements in the form of practices from the SMM are implemented by the Scrum team, conducting classes to educate development teams not yet using Scrum on the implementation of Scrum and Scrum at Scale frameworks, supporting various experiments deemed beneficial for the development process, holding periodic meetings among EAT members to refine the development process within the company, ensuring that the delivered product to the client is of tested quality, and maintaining a strong client relationship.

We recommend including Principal members in the EAT. Principals are comprised of experienced individuals responsible for ensuring the smooth progress of projects. Their role is to assist in finding solutions to challenges encountered by the development team. Principals possess qualifications suitable for undertaking various tasks within the EAT.

In the Product Owner Cycle, the Product Owners assemble into a team known as the Executive MetaScrum (EM), led by the Chief Product Owner can be seen in Figure 8. The team is responsible for tasks typically carried out by Product Owners, including creating the Product Backlog, prioritizing the Product Backlog, collaboratively establishing the Definition of Done with the Scrum Master, conducting Release Planning, and other related activities.
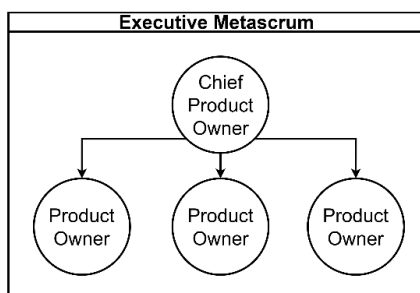

Figure 8. Executive Metascrum

The Chief Product Owner serves as the source of product information for the project and is appointed by the client. The client, being aware of the desired product, fulfils this role. The Project Manager, acting as the Product Owner, collaborates with the Chief Product Owner within the Executive MetaScrum (EM). The Chief Product Owner does not need to be directly involved with any Scrum team; instead, Product Owners from Software House XYZ will be part of the Scrum teams.

The Chief Product Owner is required to comprehend the product vision. Knowledge about the product is conveyed to the Product Owners during EM meetings to discuss the product under development. The Chief Product Owner facilitates EM members for each EM meeting.

Scrum at Scale also introduces Scaled Events tailored for large-sized teams. In the Scaled Events version, there are several adjustments from the typical Scrum Events. The following is an explanation for each Scaled Event.

Scaled Sprint Grooming is an event attended by the EM. Principals may also attend if their expertise is required as seen in Figure 9. The Chief Product Owner presents the product requirements for development.
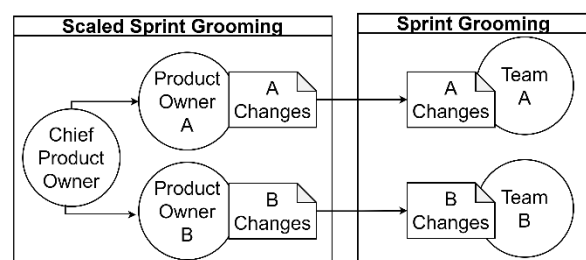

Figure 9. Scaled Sprint Grooming

During this meeting, the Chief Product Owner reassures the quality and prioritization of the top items in the Product Backlog. Any changes communicated by the Chief Product Owner will be relayed by the Product Owners to their respective teams during Sprint Grooming. If there are no changes to the Product Backlog, this event may be skipped.

Scaled Sprint Planning is an event attended by the EM and Scrum Master as seen in Figure 10. Principals may also attend if their expertise is required. The Chief Product Owner is the individual most knowledgeable about the product to be developed.
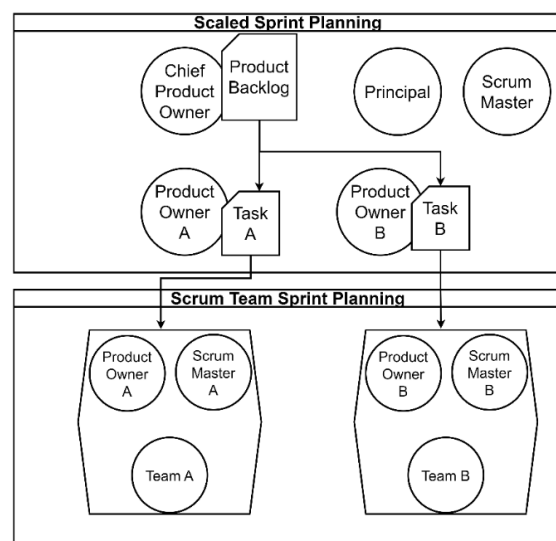

Figure 10. Scaled Sprint Planning

The participants in the meeting will select the Product Backlog Items to be worked on during the ongoing Sprint. Then, the Product Owners will choose tasks for their respective teams. The Scrum Master and Principal have a deep understanding of the team members' capacities within the company. Therefore, the Scrum Master and Principal can assist in this process. Once the Product Owners have determined the tasks for their teams, the meeting concludes. Afterwards, the Product Owners will commence Sprint Planning within their respective teams.

Scrum at Scale facilitates communication and collaboration among Scrum teams in Scrum Events. By scaling Scrum Events, Scrum teams can carry out their work more effectively. Scaled Daily Scrum (SDS) is an activity conducted after the Scrum team's Daily Scrum. In SDS, each Scrum team attending the SDS at the SoS level must send at least one team representative. If there are team members with specific interests in the SDS, those members are also obligated to attend.
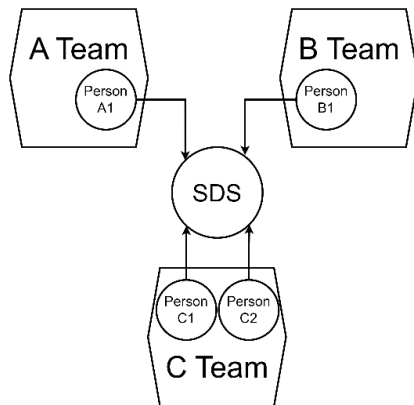

Figure 11. Scaled Daily Sprint

In Figure 11, SDS is attended by 4 individuals from 3 teams. Team C sends 2 representatives because one of them is deemed important to be present at the meeting. We recommend that each team sends the same representative to every SDS to facilitate communication and collaboration among Scrum teams.

SDS takes place after each Scrum team conducts its own Daily Scrum, which has a maximum duration of 15 minutes. We suggest conducting Daily Scrum for all teams simultaneously for time efficiency. After the Scrum team completes their Daily Scrum, representatives from each team will engage in SDS with a maximum duration of 15 minutes.

Scaled Sprint Review is an event attended by the EM and Scrum Master. Scrum teams may send team representatives if needed in the Scaled Sprint Review. Figure 12 is an illustration of the Scaled Sprint Review.

Before the Scaled Sprint Review is conducted, each Scrum team will first hold its own Sprint Review. The outcomes of this Sprint Review will then be revisited by each Product Owner in the Scaled Sprint Review.

Feedback provided by the Chief Product Owner will be documented by the Product Owner and communicated to each team.
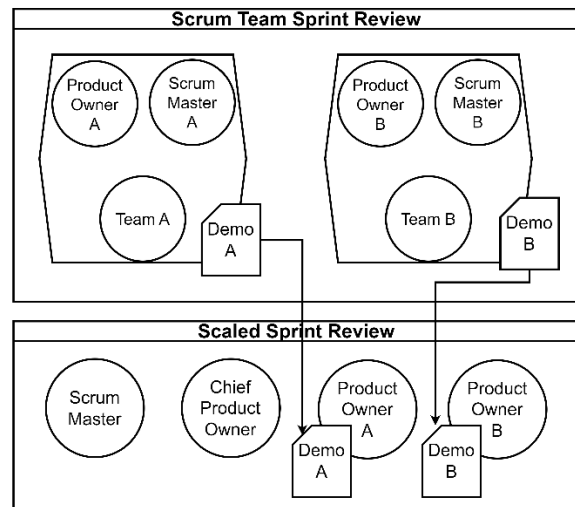

Figure 12. Scaled Sprint Review

Scrum Retrospective is the final event within a Sprint before the Scrum team starts a new Sprint (Rubin, 2012). During the Sprint retrospective, each team member provides insights into the team's work, any arising issues, and potential solutions to address those issues. Improvements gathered from the Sprint retrospective can be applied in the subsequent Sprint.

A scaled Retrospective (SR) is an activity conducted after each Scrum team holds its Scrum Retrospective. This event is attended by the Scrum Master from each team. In this event, participants will discuss the experiments conducted by each team to improve team performance.
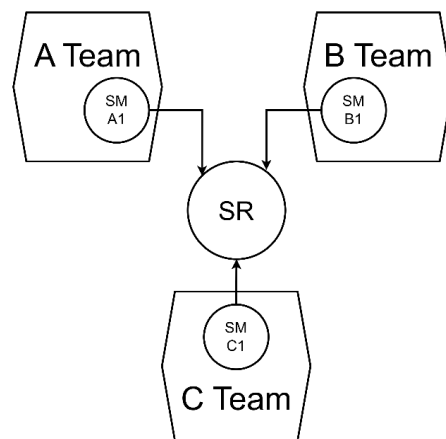

Figure 13. Scaled Retrospective

In Figure 13, all three teams send a Scrum Master as a team representative. The Scaled Retrospective practice follows the best practices outlined in the Scrum Retrospective section of the Scrum Guide 2020. By sharing information about the experiments conducted by each team to enhance the process, other teams can improve their processes if the information is applicable.

Scrum at Scale has two essential components: the Scrum Master Cycle and the Product Owner Cycle. After scaling the Scrum teams, we designed both cycles separately, but these cycles will intersect in the activities of Team Process and Product and Release Feedback. The following will describe both components.

We conducted a validation regarding the recommended Scrum at Scale in Software House XYZ. The validation process involved interviewing the Lead Project Manager as a representative of Software House XYZ. Based on the validation results, we concluded that the proposed Scrum at Scale can address the challenges associated with working with a large Scrum team. The Lead Project Manager expressed the opinion that the current capabilities of the development team in the company are not yet sufficient to fully implement Scrum at Scale. The Lead Project Manager agreed that the development team in the company should first improve its Scrum processes and then consider implementing Scrum at Scale comprehensively. However, the Lead Project Manager mentioned that they might experiment with scaling aspects for Scrum teams, Product Owners, or Scrum Masters. They also expressed the intention to try implementing some Scaled Events when the development team is deemed ready. Positive feedback was obtained from this validation, leading us to decide against making further adjustments to the proposed Scrum at Scale.

4. Conclusions

The aim of this research is to address the challenges of managing large Scrum teams and controlling the team's commitment to work faced by Software House XYZ, both of which contribute to delayed product releases. Based on the analysis conducted, we concluded that the company needs to implement Scrum at Scale for teams exceeding 10 members. However, before adopting Scrum at Scale, the existing Scrum implementation in the company needs to be assessed. The Scrum Maturity Model was chosen as the framework to evaluate how well the company implements Scrum. The Scrum Maturity Model was adjusted according to the Scrum Guide 2020 to align the practices with the latest Scrum guidelines at the time of the research. The evaluation using the Scrum Maturity Model revealed that the current maturity level of Scrum implementation in the company is at level 1, referred to as 'Initial.' The adapted Scrum Maturity Model questionnaire comprised 81 practices, and the KPA rating method was chosen for data processing. All 10 respondents provided answers to the SMM questionnaire. Data processing revealed that many practices at Scrum Maturity Model level 2 were not well-implemented. The KPA rating for Basic Scrum goals at level 2 was 73.08% (largely achieved), and the KPA rating for Requirements Management at level 2 was 75.56% (largely achieved). Goals with KPA ratings below 85% were considered immature. We

interviewed the Lead Project Manager to understand the company's expectations regarding the maturity level that Scrum teams at Software House XYZ should achieve. The company aspires to reach Scrum maturity levels 4 and 5. To attain this, the company must address practices that have not been fully achieved. A total of 61 practices were identified that need improvement for the company to reach level 5 in Scrum maturity. Subsequently, we devised recommendations for implementing Scrum at Scale for Software House XYZ, following the framework outlined in the Scrum at Scale Guide 2022. This step was chosen to resolve issues related to managing large Scrum teams and controlling team commitments. We validated the recommendations through interviews with representatives from Software House XYZ. From the validation results, the company expressed interest in trying Scrum at Scale. However, the company agreed to enhance its existing Scrum processes before fully implementing Scrum at Scale. Scrum at Scale is a framework that does not impose limitations on the size of its teams. As the number of team members increases, Scrum at Scale becomes more complex. Subsequent research could employ case studies with larger teams to derive recommendations for more intricate Scrum at Scale.

References

[1] K. S. Rubin, *Essential Scrum: A Practical Guide to the Most Popular Agile Process*, 1st ed. Addison-Wesley Professional, 2012.

[2] K. Schwaber and J. Sutherland, "The Scrum Guide The Definitive Guide to Scrum: The Rules of the Game," 2020. [Online]. Available: http://www.scrumguides.org/docs/scrumguide/v1/Scrum-Guide-US.pdf.

[3] Y. Shastri, R. Hoda, and R. Amor, "Does the 'Project Manager' Still Exist in Agile Software Development Projects?," Sep. 2016. doi: 10.1109/APSEC.2016.019.

[4] M. Coccia, "The Fishbone diagram to identify, systematize and analyze the sources of general purpose technologies," 2017, doi: 10.1453/jsas.v4i4.1518.

[5] Marchewka, "Information Technology Project Management Providing Measurable Organizational Value - Fifth Edition," 2015.

[6] J. C. Wood and M. C. Wood, *Joseph M. Juran : Critical Evaluations in Business and Management*. Routledge, 2005.

[7] V. Pareto, *Cours d'Economie Politique Professe a l'Universite de Lausanne*, no. v. 1. F. Rouge, 1896.

[8] I. Sommerville, *Software Engineering*, 10th ed. Pearson, 2016.

[9] O. Uludag, M. Kleehaus, N. Dreymann, C. Kabelin, and F. Matthes, "Investigating the Adoption and Application of Large-Scale Scrum at a German Automobile Manufacturer," *Proceedings - 2019 ACM/IEEE 14th International Conference on Global Software Engineering, ICGSE 2019*, pp. 22–29, 2019, doi: 10.1109/ICGSE.2019.00019.

[10] A. M. AlMutairi and M. R. J. Qureshi, "The Proposal of Scaling the Roles in Scrum of Scrums for Distributed Large Projects," *International Journal of Information Technology and Computer Science*, vol. 7, no. 8, pp. 68–74, 2015, doi: 10.5815/ijitcs.2015.08.10.

[11] A. Putta, O. Uludag, S. L. Hong, M. Paasivaara, and C. Lassenius, "Why do organizations adopt agile scaling frameworks?-A Survey of practitioners," in *International Symposium on Empirical Software Engineering and Measurement*, IEEE Computer Society, Oct. 2021. doi: 10.1145/3475716.3475788.

[12] J. Sutherland, "The Scrum At Scale® Guide. The Definitive Guide to the Scrum@Scale Framework: Scaling that Works," 2022, [Online]. Available: https://www.scrumatscale.com/wp-content/uploads/2020/12/official-scrum-at-scale-guide.pdf

[13] K. C. Abimaulana, E. K. Budiardjo, K. Mahatma, and A. Hidayati, "Evaluation of Scrum-Based Software Development Process Maturity using the SMM and AMM: A Case of Education Technology Startup," *2021 International Conference on Advanced Computer Science and Information Systems, ICACSIS 2021*, no. October 2021, 2021, doi: 10.1109/ICACSIS53237.2021.9631308.

[14] P. Leavy, "Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches," 2017.

[15] J. W. Creswell and J. David Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches," 2018.

[16] A. Yin, S. Figueiredo, and M. da Silva, "Scrum Maturity Model," Aug. 2011.

[17] A. Hidayati, E. Budiardjo, B. Purwandari, and H. Edison, "MATURITY MODEL OF SCRUM TEAM'S COMPETENCIES IN GLOBAL SOFTWARE DEVELOPMENT." Sep. 2023. doi: 10.22541/au.168014883.36849555/v1.

[18] M. B. Chrissis, M. Konrad, and S. Shrum, *CMMI for Development: Guidelines for Process Integration and Product Improvement*, 3rd ed. Addison-Wesley Professional, 2011.

[19] C. Patel and M. Ramachandran, "Agile Maturity Model (AMM) Agile Maturity Model (AMM): A Software Process Improvement framework for Agile Software Development Practices," 2009.

[20] P. Salant and D. A. Dillman, "How to conduct your own survey," John Wiley and Sons, 1994.

[21] K. Dikert, M. Paasivaara, and C. Lassenius, "Challenges and success factors for large-scale agile transformations: A systematic literature review," *Journal of Systems and Software*, vol. 119, pp. 87–108, Sep. 2016, doi: 10.1016/j.jss.2016.06.013.

[22] F. Almeida and E. Espinheira, "Large-Scale Agile Frameworks: A Comparative Review," *Journal of Applied Sciences, Management and Engineering Technology*, vol. 2, pp. 16–29, Aug. 2021, doi: 10.31284/j.jasmet.2021.v2i1.1832.

[23] J. R. Hackman, *Leading teams: Setting the stage for great performances*. Harvard Business Press, 2002.