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**COMPREHENSIVE ANALYSIS OF PROJECT
MANAGEMENT METHODOLOGIES IN THE
SOFTWARE INDUSTRY**

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Master's Thesis

Supervisor

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The thesis/dissertation titled COMPREHENSIVE ANALYSIS OF PROJECT MANAGEMENT METHODOLOGIES IN THE SOFTWARE INDUSTRY prepared by Tolga MUTLU and submitted on 09/08/2023 has been **accepted unanimously** of Master of Science in Industrial Engineering Department.

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I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

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DEDICATION

First of all, I would like to thank Assoc. Prof. Dr. Yıldız ARIKAN, who always supported me during my thesis writing process. My thesis is dedicated to my wife Melisa Ilgar, my family, my close friends and everyone who supported me in this process. I want to thank them for believing in me and making me see this journey to the fullest.



ÖZET

YAZILIM ENDÜSTRİSİNDE PROJE YÖNETİM METODOLOJİLERİNİN KAPSAMLI ANALİZİ

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Son yıllarda hızla gelişen teknoloji ve artan müşteri talepleri sebebiyle yazılım sektörü oldukça rekabetçi bir ortama sahiptir. Bu ortamda, proje yönetimi yazılım geliştirme için önemli bir rol oynamaktadır. Proje sürecinin yazılım geliştirme, proje yönetimi, planlanması, yürütülmesi, izlenmesi ve kontrolü ile ilgili tüm faaliyetleri içerir. Bu süreçler projenin başarısını etkileyen önemli bir faktördür. Yazılım proje yönetimi sürecinde birçok kararın alınması gerekir. Bunlar, proje için kullanılacak yöntem ve metodolojinin belirlenmesini içerir. Yazılım endüstrisinde birçok proje yönetimi metodolojisi vardır. Bu metodolojiler, farklı gereksinimler ve proje özellikleri için uygundur. Örneğin, Waterfall, Agile, Scrum, Kanban, Extreme Programming, Lean ve Six Sigma gibi farklı metodolojiler mevcuttur. Bu tez, bir literatür taraması ve analitik bir yaklaşım kullanarak yazılım endüstrisindeki proje yönetimi metodolojilerini kapsamlı bir şekilde incelemektedir. İnceleme sürecinde önceden belirlenmiş kriterlere göre seçilen popüler metodolojiler detaylı olarak incelenir. Her metodolojinin temel ilkeleri, özellikleri, kullanım alanları, avantaj ve dezavantajları ele alınacaktır.

Bu tez, yazılım proje yönetimi için kullanılan farklı metodolojileri incelerken proje yöneticileri ve yazılım geliştiriciler için bir rehber görevi görecektir. Proje ekiplerinin mevcut özellikleri ele alındığında kriterlere göre hangi metodolojiyi seçmeleri gerektiğini

öneren bir kılavuz olacaktır. Çalışmanın aynı zamanda yazılım endüstrisinde proje yönetimi konusunda gelecekte yapılacak araştırmalar için önemli bir kaynak olması amaçlanmaktadır.

Anahtar Kelimeler: Proje Yönetimi, Metodolojiler, Scrum, Çevik, Kanban, Şelale.



ABSTRACT

COMPREHENSIVE ANALYSIS OF PROJECT MANAGEMENT METHODOLOGIES IN THE SOFTWARE INDUSTRY

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Due to the rapidly developing technology and increasing customer demands in recent years, the software industry has a very competitive environment. In this environment, project management plays an important role for software development. It includes all activities related to software development, project management, planning, execution, monitoring and control of the project process. This process is an important factor affecting the success of the project. Many decisions need to be made in the software project management process. These include determining the method and methodology to be used for the project. There are many project management methodologies in the software industry. These methodologies are suitable for different requirements and project characteristics. For example, different methodologies are available such as Waterfall, Agile, Scrum, Kanban, Extreme Programming (XP), Lean and Six Sigma. This thesis comprehensively examines project management methodologies in the software industry using a literature review and an analytical approach. During the review process, popular methodologies selected according to predetermined criteria are examined in detail. The basic principles, features, usage areas, advantages and disadvantages of each methodology will be discussed.

This thesis will serve as a guide for project managers and software developers as they examine the different methodologies used for software project management. This study is

also aimed to be an important resource for future research on project management in the software industry.

Keywords: Project Management, Methodology, Scrum, Agile, Kanban, Waterfall.



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1. INTRODUCTION

Successful completion of software projects is of great importance in the modern business world. The complexity and uncertainty of these projects require the use of an effective project management methodology. In recent years, the software sector has a highly competitive environment due to rapidly developing technology and increasing customer demands [1]. In this environment, project management plays an important role for software development. The software development includes all activities related to project management, planning, execution, monitoring and control of the project process. This process is an important factor that affects the success of the project. Many decisions need to be taken in the software project management process. These include determining the method and methodology to be used for the project. There are many project management methodologies in the software industry. These methodologies are suitable for different requirements and project characteristics. For example, different methodologies are available, such as Waterfall, Agile, Scrum, Kanban, Extreme Programming (XP), Lean and Six Sigma. This thesis extensively examines project management methodologies in the software industry using a literature review and an analytical approach. During the review process, popular methodologies selected according to predetermined criteria were examined in detail. The basic principles, features, usage areas, advantages and disadvantages of each methodology will be discussed. The use of project management methodologies in the software industry is of great importance. These methodologies ensure that projects are completed on time, kept costs under control, resources are used effectively and customer expectations are met. It is aimed to determine the most appropriate methodology in software project management by evaluating the characteristics of each methodology and its applications in different sectors [2]. In addition, as a result of this study, a basis for future research on project management in the software industry will be established. At the same time, it is aimed to reach the conclusion that companies are more efficient and more optimal to achieve success, regardless of the number of teams they apply. It also has positive effects on factors such as risk management, communication effectiveness, quality control and change management [3].

This thesis analyses in-depth the existing knowledge in the literature and expands our understanding of project management methodologies in the software industry. In addition, this analysis has the potential to contribute to future research and development. In addition, by identifying some weaknesses of existing methodologies, small, medium and large companies will be addressed and which methodologies to use in their projects of different scales will lead them to the conclusion that it will be the most efficient method in achieving success. In conclusion, this thesis will serve as a guide for project managers and software developers as they examine the different methodologies used for software project management. This study will also be an important resource for future research on project management in the software industry.



2. A REVIEW OF PROJECT MANAGEMENT METHODOLOGIES

In this part of the thesis a review of existing project management methodologies are introduced.

2.1 WATERFALL METHODOLOGY

The Waterfall Methodology is one of the oldest and most widely used methodologies for project management. This methodology is based on the idea of completing the phases of the project in a specific order, and its name is also known as the "water wave" because it is likened to the step-down movement of a drop of water.

The Waterfall Methodology consists of five steps, Requirements:

- a. The objectives, scope and functions of the project are determined.
- b. Analysis: Requirements are examined in detail and design documents are prepared.
- c. Development: Software, coding and testing of the product are carried out.
- d. Test: All features and functions of the product are tested.
- e. Deployment: The product is delivered to the end user.

Because the Waterfall Methodology follows a predetermined and strict sequence, it may have difficulty adapting to changes. For this reason, the Waterfall Methodology is often suitable for large and predetermined projects [4].

A lot of research has been done in the literature on the Waterfall Methodology. Some of this research shows that the tight structure of the Waterfall Methodology gives them better control over project planning, budget, and timing, while others suggest that these structural frustrations are the cause of project failures.

As a result, the Waterfall Methodology remains a popular option for project management, but different methodologies are preferred according to factors such as project requirements, size, and flexibility.

2.2 AGILE METHODOLOGY

The Agile Methodology is a management approach used in the software development process and takes a different approach from the Waterfall Methodology. Agile works with an iterative and computational approach, allowing the software to be adapted quickly by taking feedback from customers and other stakeholders at every stage of the development process. Furthermore, Agile is based on principles such as teamwork, customer collaboration, flexibility, tight communication and continuous improvement.

The Agile Methodology is based on a set of core principles and values. These principles are clearly stated in the so-called Agile Manifesto. These principles are:

- a. Customer Satisfaction: Agile emphasizes that customers' satisfaction is a priority. Understanding customer needs and providing them with appropriate solutions is vital to the success of the project.
- b. Functional Software: Agile believes that software is a working product and, therefore, often emphasizes that functional software must be delivered.
- c. Variability: Agile accepts variability and takes a flexible approach to respond quickly to changing customer needs.
- d. Collaboration: Agile encourages collaboration between the customer and the development team. Good communication and collaboration increase project success.
- e. Motivation: Agile creates a work environment to increase team motivation. Self-managed teams perform better in project development.
- f. Technical Excellence: Agile emphasizes the need for continuous improvement to ensure technical excellence.
- g. Simplicity: Agile advocates the preference for simple solutions that meet customer needs. Instead of complex solutions, functional and easy-to-understand solutions are recommended.
- h. Self-Management: Agile allows team members to manage themselves and make decisions freely.
- i. Continuous Improvement: Agile advocates for continuous improvement. By taking into account feedback and continuously improving, product quality can be improved.

The application of these principles reflects the core philosophy of the Agile Methodology and aims to adopt a customer-focused, flexible, responsive, teamwork-based approach [5].

Although the Agile Methodology has many different types of applications, the three most commonly used varieties are known as Scrum, Kanban, and Extreme Programming (XP). Scrum is a framework in which a development team plans tasks that they can complete within a certain amount of time (usually two weeks). This framework consists of processes called sprints, and at the end of each sprint, the development team meets with customers and other stakeholders to get feedback and update their plans. Kanban is a way for the development team to manage their work by using cards that show the status of tasks on a visual dashboard. The Kanban board shows how many of the tasks have been completed, which ones are in progress, and which ones are on hold. Extreme Programming (XP), on the other hand, performs tasks such as writing, testing, and continuous integration during the software development process frequently, on a small scale, to improve the quality and functionality of the software [6].

The advantages of the Agile Methodology include customer satisfaction, flexibility, fast and tight communication, teamwork and continuous improvement. Advantage such as the ability to quickly adapt the software in accordance with the needs, flexible planning according to customer needs, increasing functionality and quality with customer feedback. However, the Agile Methodology also has some drawbacks. Factors such as frequent changes in requirements, uncertainty, difficulty in constantly communicating with the customer, it is among the problems that may be encountered during the implementation of the Agile Methodology.

Scrum is a framework in which a development team plans tasks that they can complete within a certain amount of time (usually two weeks). This framework consists of processes called sprints, and at the end of each sprint, the development team meets with customers and other stakeholders to get feedback and update their plans. In Scrum, there are three main roles: Product Owner, Scrum Master, and Development Team. A Product Owner is someone who understands customer needs and determines the functional requirements in the development of the product. A Scrum Master is someone who makes sure that Scrum processes are properly implemented and helps remove obstacles. The Development Team,

on the other hand, are the people who develop the product and complete the tasks determined during the sprints.

Kanban is a way for the development team to manage their work by using cards that show the status of tasks on a visual dashboard. The Kanban board shows how many of the tasks have been completed, which ones are in progress, and which ones are on hold. In Kanban, a limit is set for the work to be done, and no more work can be added than this limit. This balances the workload of team members and eliminates problems such as overloading.

Extreme Programming (XP), on the other hand, performs tasks such as writing, testing, and continuous integration during the software development process frequently, on a small scale, to improve the quality and functionality of the software. The core principles of XP include constant communication with the customer, test-driven development, continuous integration, and frequent delivery of small functions. XP also includes many practical techniques, such as dual programming, code reviews, refactoring, and design primacy.

The benefits of the Agile Methodology include customer satisfaction, team motivation, continuous improvement and an increase in product quality. Agile receives customer feedback at all stages of the product development process, allowing the product to be developed to fully meet customer needs. Also, in Agile, team members are constantly communicating and collaborating with each other, which increases team motivation. Agile also works on the principle of continuous improvement, so that it is possible to develop and market the product more quickly. Finally, Agile provides an increase in product quality because continuous feedback is received and necessary improvements are made.

However, the Agile Methodology also has some drawbacks. Agile can sometimes be challenging when customers don't have a clear vision or when requirements change frequently. Also, because feedback is often received in Agile, a number of coordination issues may arise between team members. Because Agile also operates on the principle of continuous improvement, the product may need to be reconfigured frequently, which may require extra time and resources.

Agile Methodology is a preferred management approach, especially when customer satisfaction and product quality need to be increased during the software development

process. Based on the principles of tight communication, flexibility and continuous improvement between customer and team, Agile is an effective method to ensure success in the product development process.

2.2.1 Scrum Methodology

Scrum is a variant of the Agile Methodology and is often used in software development projects. Scrum enables a team to develop quickly and flexibly, collaborating continuously throughout the project. Key features of Scrum include continuous improvement, customer focus, and teamwork.

Scrum is designed as a framework that allows the team to manage and direct the project. The basic building blocks of Scrum are:

- a. **Scrum Team:** Consists of a team of 5-9 people. This team takes part in the software development process and works according to customer needs. Members of the team share responsibilities among themselves and work together for the success of the project.
- b. **Scrum Master:** The Scrum Master is the leader of the team and ensures that the team implements the principles of Scrum. Takes care of the team's problems and takes steps to improve the team's productivity during the development process.
- c. **Product Owner:** The Product Owner represents the needs of the project as a customer or customer representative. The Product Owner follows the team's work and ensures that customer needs are met.

Scrum consists of three main processes:

- a. **Sprint Planning:** Sprint Planning is the process by which the team sets goals for each sprint. A sprint is a time when development work is done over a period of time (usually 2-4 weeks). Sprint Planning is a meeting where the team sets goals and the needs of the product owner.
- b. **Sprint Development:** Sprint Development is the process by which the team works to meet its goals and the needs of the product owner. The team works on software development according to customer needs in this process.

- c. **Sprint Review:** A Sprint Review is a meeting where the team evaluates the work done throughout the sprint to deliver a product that meets customer needs. The team listens to customer feedback and makes the necessary improvements.

Other important components of the Scrum Methodology are:

- a. **Scrum Teams:** In the Scrum methodology, a project team consists of 5 to 9 people. This team is organized by product specifications defined by the product owner to provide a functional feature. The team is self-directed and supported by a Scrum Master.
- b. **Sprint:** In the Scrum methodology, a time period that is performed at a certain time interval and aims to improve the functionality of the product is called a sprint. A sprint usually lasts 2-4 weeks, and the team's goal during a sprint is to complete a predefined set of tasks.
- c. **Product Backlog:** A Product Backlog is the basic document of a Scrum project. The Product Backlog is in the form of a list with all the features, priorities and details of the features. The Product Backlog is prepared by the product owner and allows priorities to be changed.
- d. **Sprint Backlog:** The Sprint Backlog is in the form of a list of tasks that must be completed to achieve the goals specified for each sprint. The Sprint Backlog is created by the Scrum team and updated daily.
- e. **Daily Scrum:** The Daily Scrum is a short meeting held every day. In the meeting, each team member shares the work they have done throughout the sprint, their goals, and any issues they have encountered. The meeting takes place with the participation of each member and usually lasts 15 minutes.
- f. **Sprint Review:** A Sprint Review is a meeting held at the end of a sprint. In this meeting, the members of the team present the work they have done to achieve the goals. The product owner controls the functionality of the product features and changes priorities as needed.
- g. **Sprint Retrospective:** The Sprint Retrospective is a meeting held at the end of the sprint. In this meeting, members of the team discuss the work they have done during the sprint, any issues they have encountered, and how they can improve the sprint process. The Sprint Retrospective is an opportunity for the team to continuously improve itself.

In the Scrum methodology, a project team is led by a leader called the "Scrum Master". The Scrum Master ensures that the team runs smoothly and makes an effort to resolve any obstacles when encountered. It also ensures that each member of the team is productive in their tasks and achieve goals.

In the Scrum methodology, the time allotted for the completion of a particular job is performed in a certain amount of time, which is called a "sprint". The duration of the sprint is usually between one and four weeks and usually lasts three or four weeks. Each sprint is geared toward completing a predetermined set of tasks, and the team is required to accomplish goals throughout the duration of the sprint.

Sprint planning meetings are held before the sprint begins. At this meeting, each member of the team determines the tasks that need to be completed during the sprint and receives an estimated raise for each task. These estimated time frames determine the total amount of work that needs to be completed during the sprint period.

Through daily "scrum meetings," team members share the work they've done throughout the sprint and how close they're to the goals. These meetings help the team identify problems and obstacles and help find solutions.

When the sprint ends, a "sprint evaluation meeting" is held. In this meeting, team members share the work they have completed during the sprint and how close they are to the goals. In addition, it is aimed to evaluate the sprint results and to create a plan for the use of the sprint results. This plan allows the team to work more effectively and efficiently in subsequent sprints.

The Scrum methodology provides flexibility in each sprint process, and improvements can be made at the end of each sprint, considering the successes and problems in previous sprint processes. In this way, it is ensured that the team continuously develops and achieves business goals more effectively.

2.2.2 Kanban Methodology

Kanban is a method that is among the agile methods and is used especially in the production and service sectors. Kanban means "visual card" in Japanese. This method is a system used

to manage a workflow or project and is specifically designed to respond quickly to customer requests [7]. The Kanban method manages workflow through cards or labels that are placed on a board. Each card represents a stage of a job or a component of a service. These cards are placed in a queue on the workflow dashboard and contain additional information about each stage, along with the work to be done.

The Kanban method makes it easy to track jobs by using a visual representation on the workflow dashboard. Jobs can be tracked in real time, providing information on how much time remains in each stage on the dashboard [8]. Managers, team members, and customers can easily see what stage the work is at and how long it will take to complete.

The Kanban method is considered one of the methods of agile software development. This method is especially suitable for ever-changing and rapidly growing businesses. The Kanban method allows for rapid response to customer needs while maintaining the flexibility of projects.

The Kanban method encourages continuous improvement to provide high-quality service. When team members complete a job, they are prepared to be ready to receive pending work at the next stage on the Kanban board [9]. This ensures workload balance among team members and ensures that team members continuously monitor workflow.

The Kanban method is an important tool for project management. This method helps balance the workload between team members by visualizing the workflow. The Kanban method is a popular option among agile software development methods.

2.2.3 Extreme Programming

Extreme Programming (XP) is an agile methodology used for software development. This methodology includes continuous development of software in accordance with customer needs, small and frequent deliveries, a test-oriented development approach, continuous integration, and frequent re-creation of the code[10].

XP aims to work closely with customers, easily accommodate changes and speed up the software development process. To that end, XP is built on five key principles:

- a. Communication: XP recommends finding open channels of communication between customers and developers, and communicating frequently.
- b. Simplicity: XP aims to make the requirements as simple and understandable as possible. Instead of unnecessary features and functions, it focuses on the core features that customers need.
- c. Feedback: XP recommends continuous feedback and frequent checks of the software's compliance with customer requirements.
- d. Courage: XP encourages the ability to accept changes with ease and have the courage to overcome risks.
- e. Collaboration: XP emphasizes the importance of collaboration between developers.

This methodology encourages teamwork and continuous learning.

XP's implementation phases include coding, testing, integration, and getting customer feedback [11]. XP also offers a number of application techniques:

Pair programming: Two developers working together to control and edit each other's code.

Test-driven development (TDD): Write tests to make sure the software works correctly and develop based on the fact that the tests affect the design of the software.

Continuous integration: Enables the software to be continuously checked, tested and integrated.

2.3 LEAN METHODOLOGY

Lean is a method used to improve business processes and increase their efficiency. Its main purpose is to eliminate steps that do not create value by streamlining processes by minimizing waste [12].

Waste is defined as any activity that does not add value to the customer. As an example, elements such as excess stocks, excess process steps, waits, transportation are considered waste.

The Lean approach is based on the principles of continuous flow, fast delivery, customer focus, quality, flexibility, and continuous improvement.

His tools include techniques such as Value Stream Mapping, 5S (Sort, Set in Order, Shine, Standardize, Sustain), Kanban, just-in-time production, and quick change (SMED) [13].

2.4 SIX SIGMA METHODOLOGY

Six Sigma is a method that aims to achieve continuous high-quality results by minimizing errors and variability in business processes. It is data-driven and based on statistical analysis [14] .

It adopts a five-step approach called DMAIC (Define, Measure, Analyse, Improve, Control).

- a. Define (Identification): To determine the objectives and scope of the project, to understand customer expectations.
- b. Measure: Measure existing processes and collect data, identify problems.
- c. Analyse: Analysing data, identifying root causes, and understanding variability in the process.
- d. Improve: Develop and implement solutions to solve problems and improve the process.
- e. Control: Controlling the improvement steps and ensuring the sustainability of the process.

In Six Sigma, methods such as statistical tools, process capability, root cause analysis, control graphs are used [15].

Lean and Six Sigma, though of different origins, are complementary approaches to improving business processes. While Lean focuses on streamlining processes and making them waste-free, Six Sigma aims to control the process by reducing errors and variability. For this reason, organizations often use Lean Six Sigma, a more comprehensive process improvement approach by combining Lean and Six Sigma. This approach involves the use of statistical tools to reduce waste in processes and improve quality.

3. LITERATURE REVIEW

Software project management is a critical discipline that involves the use of methods and techniques that enable software development processes to be effectively planned, managed, and followed. Project management methodologies provide a basic framework for the successful completion of software projects, ensuring customer satisfaction and meeting requirements on time and on budget. This section presents a comprehensive analysis of the existing literature on software project management methodologies [16].

Software project management is an important discipline that enables software development processes to be effectively planned, managed, and followed [17]. There are different methodologies and approaches to the management of these processes. Traditional (waterfall) and agile methodologies are two different approaches commonly used in software project management.

Traditional methodologies adopt an approach in which projects proceed in a linear fashion and stages are completed sequentially. In these methodologies, phases of the project such as requirements analysis, design, development, testing, and deployment are carried out sequentially (Boehm, 1988). In traditional methodologies, a detailed planning and documentation process is required to complete the project. This approach envisages a complete and detailed requirement being identified at the start of the project and limiting changes. The main goal of traditional methodologies is to ensure that the project is completed on time and on budget.

On the other hand, agile methodologies adopt values such as flexibility of the project, fast delivery, collaboration, and continuous customer engagement. In these methodologies, projects are broken down into small, trackable chunks and the goal is to deliver these parts quickly (Beck et al., 2001). In agile methodologies, customer demands and requirements may change as the project progresses. Team members meet frequently to work collaboratively and provide flexibility. This approach brings with it advantages such as customer focus, rapid adaptation to change and continuous improvement.

The study of the differences and comparisons between traditional and agile methodologies is an important research topic in the field of software project management [18]. A meta-

analysis study by Johnson and Ramanathan (2016) found that agile methodologies performed better than traditional methodologies and increased customer satisfaction. On the other hand, there are studies indicating that traditional methodologies are more effective, especially in large and complex projects.

This literature review summarizes findings from studies on the comparison of traditional and agile methodologies. In the studies to be carried out in the following sections, it is necessary to make more detailed analyses about which methodology should be preferred in accordance with the characteristics and requirements of different projects [19].

Scrum is a management and control methodology that is widely used in agile software development processes and emphasizes flexibility, fast delivery, and continuous customer engagement. Scrum aims to achieve success by adopting a customer value-oriented and iterative approach, especially in complex and uncertain projects.

Scrum progresses by dividing projects into small, trackable periods, or "sprints." Each sprint usually covers a time frame of 2-4 weeks and focuses on a specific goal. Throughout the sprint, the team tries to complete the workpieces that provide customer value. Scrum provides transparency and encourages collaboration among team members by using tools such as regular turnaround meetings and visual boards.

The success of Scrum relies primarily on the effective collaboration of three key roles. The product owner sets the vision for the project, defines the requirements, and directs the product development process. The scrum master ensures collaboration between the team, ensures the correct implementation of processes and eliminates obstacles. The development team consists of technical experts who are responsible for the development of the product and complete the workpieces by working through the sprints.

Research on Scrum methodology shows that this approach has many advantages. For example, Scrum has shown positive results, such as fast and frequent delivery, the ability to respond quickly to customer feedback, and increased team motivation. Scrum can also reduce project risks, increase customer satisfaction, and adapt to changing requirements by providing flexibility.

Most of the work on Scrum methodology is based on practical experience. Research on implementation scenarios, case studies, and observations to provide important insights into how Scrum is used in real-world projects and what the consequences are [20]. There are also studies on how Scrum is applied in different sectors and projects, team dynamics, obstacles, and success factors.

Lean and Six Sigma are popular methodologies used for the purposes of continuous improvement and quality management in business processes. Both Lean and Six Sigma focus on goals such as increasing productivity, reducing costs, reducing error rates and increasing customer satisfaction. Both methodologies can be applied separately or used together.

Lean is a management philosophy rooted in the Toyota Production System. Its basic principle is to create an efficient and fluid production process by minimizing waste. Lean adopts an approach that focuses on identifying activities that do not create value, fluidizing business processes, reducing stock quantities and continuous improvement.

Six Sigma is a methodology for quality management and process improvement. It was developed by the Motorola company and aims to reduce errors and variability using statistical tools. Six Sigma follows a five-step process called DMAIC (Define, Measure, Analyse, Improve, Control) and emphasizes data-driven decision-making and problem-solving.

In the literature, there are many studies on the results and success stories obtained by using Lean and Six Sigma methodologies separately and together. Especially in various industries such as manufacturing, service, healthcare, logistics and finance, Lean and Six Sigma applications are remarkable. Research on how it is done, what tools are used and the benefits obtained is remarkable.

In addition, attention is drawn to issues such as difficulties in the implementation of Lean and Six Sigma methodologies, the process of integration into business culture, leadership and training. These studies reveal the factors that must be considered for the successful implementation of Lean and Six Sigma.

Extreme Programming (XP) is a methodology that offers an agile approach to the software development process and emphasizes values such as flexibility, fast delivery, customer

focus, and team collaboration [21]. XP was developed by Kent Beck in the late 1990s and is used to respond quickly to customer demands, improve quality and provide continuous improvement.

XP consists of a set of principles and practices. These principles include customer involvement, continuous feedback, frequent iterations, collaboration, simple design, test-drivenness, and sustainability [22]. The basic principles of XP aim to successfully manage the project, reduce risks and ensure that the project team works effectively.

Many studies have been conducted on the effects and applications of XP in the literature. Research shows that XP helps to achieve positive results in software projects such as fast delivery, high quality, customer satisfaction and cost savings. The effects of XP on customer communication, team collaboration, risk management, and software quality were also examined.

The difficulties and success factors encountered in the application of XP are also discussed in the literature. Research highlights that factors such as leadership, training, communication, process management and team dynamics are important for the successful implementation of XP [23]. In addition, there are studies on the applications of XP in different sectors and the adaptation process.

This literature review aims to comprehensively analyze the principles, practices and implications of XP. In this way, it provides the necessary information to better understand the impact of XP on software projects, optimize their applications and achieve successful results [24].

4. THESIS SURVEY

In order to achieve the aim of this thesis, a survey methodology has been adopted and employed. In the course of the thesis study, a ‘Questionnaire’ has been designed and data has been gathered from many companies and their officials, especially large and corporate companies in the sector, the questions are presented and explained one by one below:

Figure 4.1 shows the name and surname information of the person who will answer the questionnaire, which company and in which department he works in is obtained.

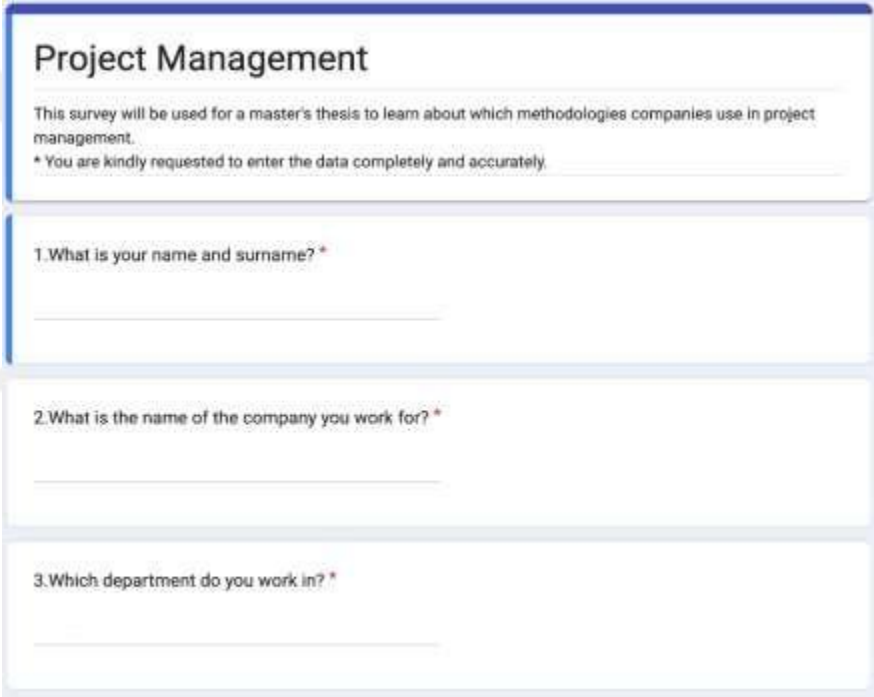
The image shows a digital survey form with a blue border. At the top, the title 'Project Management' is displayed in a bold, black font. Below the title, a paragraph of text states: 'This survey will be used for a master's thesis to learn about which methodologies companies use in project management.' This is followed by a red asterisk and the text: '* You are kindly requested to enter the data completely and accurately.' The form is divided into three sections by horizontal lines. The first section contains the question '1. What is your name and surname? *' with a red asterisk, followed by a single-line text input field. The second section contains the question '2. What is the name of the company you work for? *' with a red asterisk, followed by a single-line text input field. The third section contains the question '3. Which department do you work in? *' with a red asterisk, followed by a single-line text input field. The entire form is set against a light gray background.

Figure 4.1: Personal Information Question-Section.

The second figure (Figure 4.2) shows the information about the project structure in the companies contacted. The number of people in the project team and the scale status of the projects were asked. It was asked whether the companies' work is done in the company office or remote or hybrid.

4.How many people does your project team consist of? *

- ☐ 1-5 people
- ☐ 5-10 people
- ☐ 10-20 people
- ☐ 20+ people

5.How does your company work? *

- ☐ Remote
- ☐ Hybrid
- ☐ Office

6.What is the scale of your project? *

- ☐ Small
- ☐ Medium
- ☐ Big

Figure 4.2: Project Information Question-Section.

The third figure (Figure 4.3) shows the information about which methodologies the project team used before, the impact of the customers on the project and the delivery of the projects were obtained.

7. What methodologies has the team experienced before? *

- ☐ Waterfall
- ☐ Kanban
- ☐ Scrum
- ☐ Extreme Programming
- ☐ Lean
- ☐ Six Sigma
- ☐ Other

8. What is the customer's project participation frequency in your project? *

- ☐ Rarely
- ☐ Sometimes
- ☐ Generally

9. What is your process flexibility in your project? *

- ☐ The process is flexible
- ☐ Planning is strict and process predictable

Figure 4.3: Project and Team Question-Section.

The fourth figure (Figure 4.4) shows the information about the structure of the current projects in the companies was asked. First of all, it was learned who the people working on the project consisted of and the people working in what position. Then, the delivery time of the projects and what kind of projects they produced were asked.

10.Can you give details about the title of the people in the team and how many people they consist of? *

11.How long is the delivery time of your projects? *

- ☐ 0-3 Months
- ☐ 3-6 Months
- ☐ 6-12 Months
- ☐ 12-24 Months
- ☐ 24+ Months

12.What is the job you work for in your department? *

- ☐ Software Product
- ☐ Project Development
- ☐ Software Project
- ☐ Other

Figure 4.4: Project and Team Second Question-Section.

The fifth figure (Figure 4.5) shows a question was asked about which methodology they manage their current projects in the company. With the methodology they used, the success rate of the team in applying the methodology was learned. If they think that they are not fully successful, the reasons for this have been learned.

13.What methodology do you use to manage your projects? *

- ☐ Waterfall
- ☐ Scrum
- ☐ Kanban
- ☐ Extreme Programming
- ☐ Lean
- ☐ Six Sigma
- ☐ Other

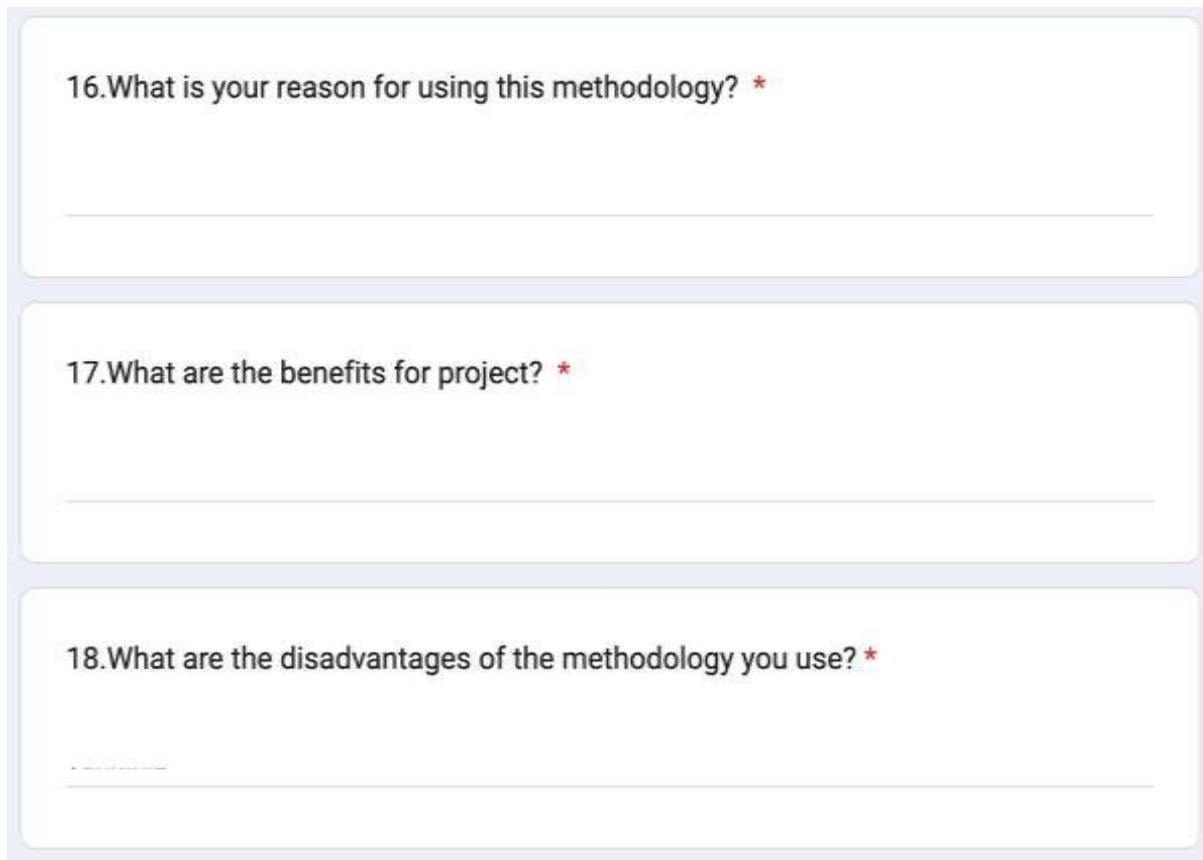
14.To what extent do you successfully perform the rituals of the project management methodologies you use? *

- ☐ %100
- ☐ %75-%99
- ☐ %50-%74
- ☐ %25-%49

15.What is your reason for not applying the methodology exactly? (If you didn't mark 100%, answer this question.) *

Figure 4.5: Project Methodology Section.

The last figure (Figure 4.6) shows the question about why they chose the methodology they used and what kind of wounds the related methodology caused them. If there are areas where the relevant methodology is disadvantageous, it was asked what this information was.



16.What is your reason for using this methodology? *

17.What are the benefits for project? *

18.What are the disadvantages of the methodology you use? *

Figure 4.6: Project Methodology Detail Section.

A total of 17 questions above were conveyed to many companies providing services in Turkey and internationally. Responses were received from approximately 100 different companies and their representatives. In line with the answers, the targeted results were achieved.

5. SURVEY RESULT

The results of the survey are as follows: Graphics and information related to many questions are given in detail. The first, second and third questions in the survey belong to the personal information of the individuals, and the name and surname information was obtained. It has been observed that the representatives of many companies providing services in Turkey and internationally participated in the survey. The second and third questions consist of information about which companies they work in and in which department they work. The majority of the people filling out the questionnaire are from departments in the software industry.

In the fourth question, information about how many groups the project teams consist of was asked. According to the survey results, according to the respondents, the majority of the project teams consist of teams of less than ten people. It has been observed that companies manage projects by dividing their employees into teams. Figure 5.1 below illustrates the findings.

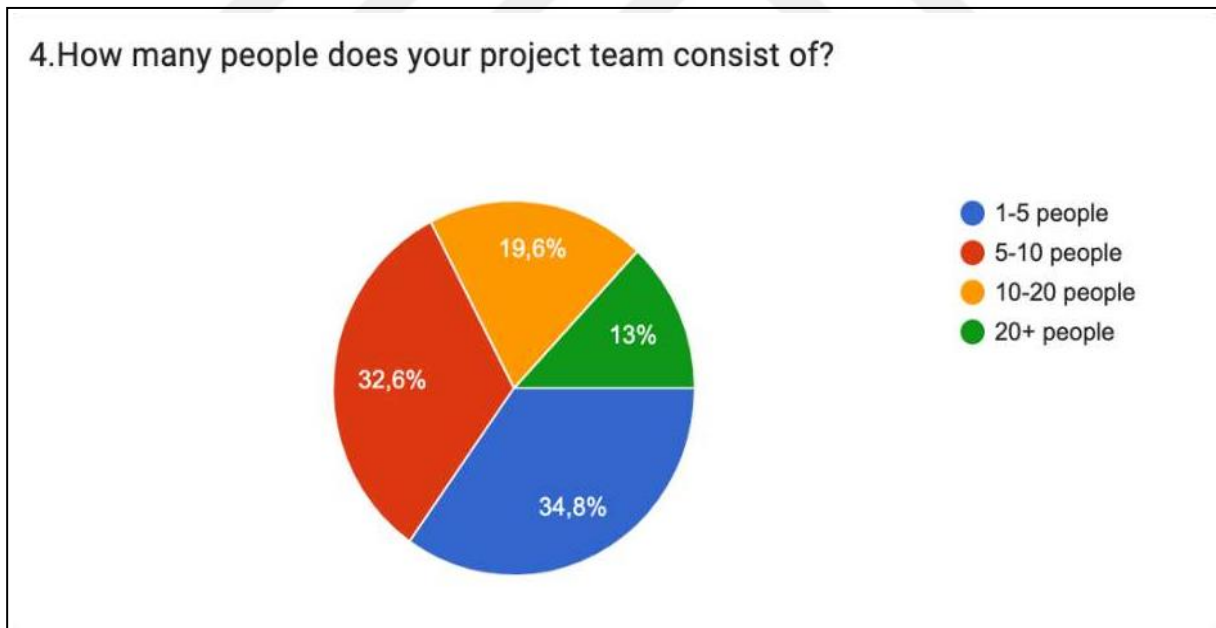


Figure 5.1: Question 4.

The fifth question in the survey was asked whether companies carry out their work from the office, remotely or hybrid. Working styles are very important for the selection and healthy management of methodologies. This can be seen from Figure 5.2 below.

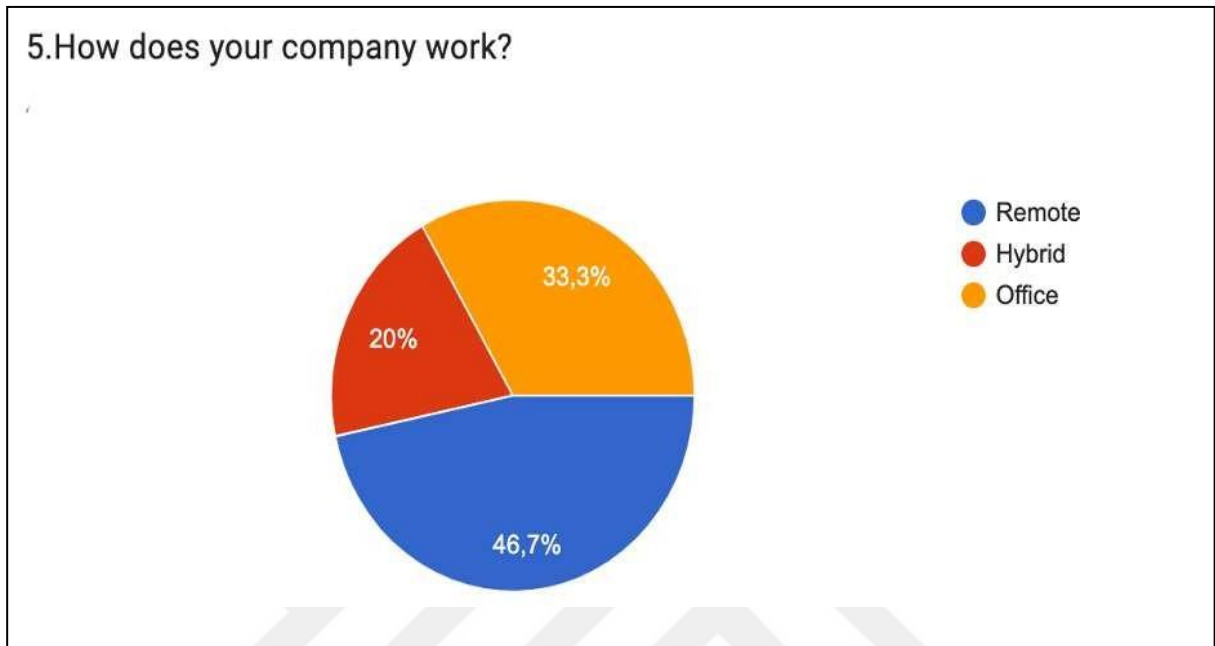


Figure 5.2: Question 5.

Methodologies are selected according to the size of the projects. One of the most important criteria when choosing methodologies is the size of the projects. It has been observed that there are more medium-sized projects in the survey responses, with 54 percent. The results can be seen in Figure 5.3 below.

6.What is the scale of your project?

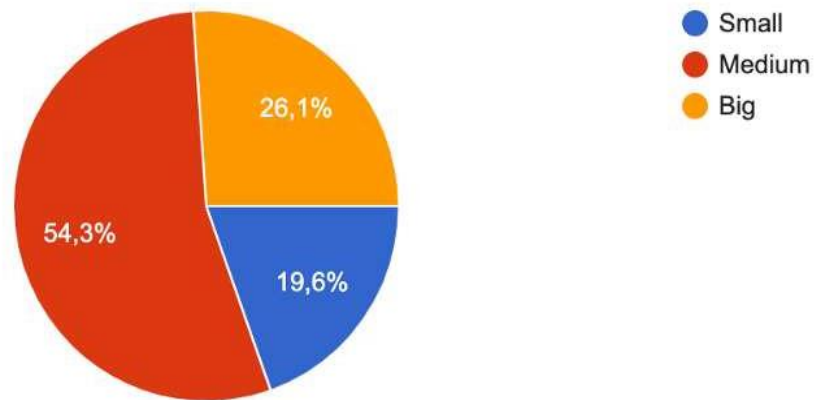


Figure 5.3: Question 6.

In the question, information about the methodologies used by the companies to manage the projects before was obtained. The previous experience of the project teams largely determines the management methodologies of new projects. Project teams often use their previous experience in their new projects. In the projects of the people who participated in the survey, the scrum methodology is mostly used by 52%. 28% of the respondents use the Kanban methodology. Then it uses the Waterfall methodology with a rate of 15%. The fact that they do not use other methodologies is an interesting observation for the survey. The detailed rates can be seen in the Figure 5.4 below.

7. What methodologies has the team experienced before?

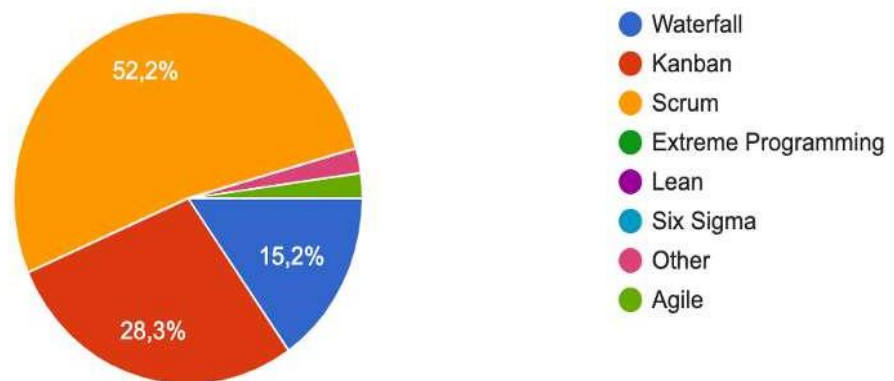


Figure 5.4: Question 7.

The support of the customers to the projects and their interaction within the processes are an important factor in the selection of the methodologies. In Agile methodologies, for example, in scrum methodology, communication and interaction with the customer is at a very high level. But there is very little interaction with the processes in waterfall. The detailed rates are shown in the Figure 5.5 below.

8. What is the customer's project participation frequency in your project?

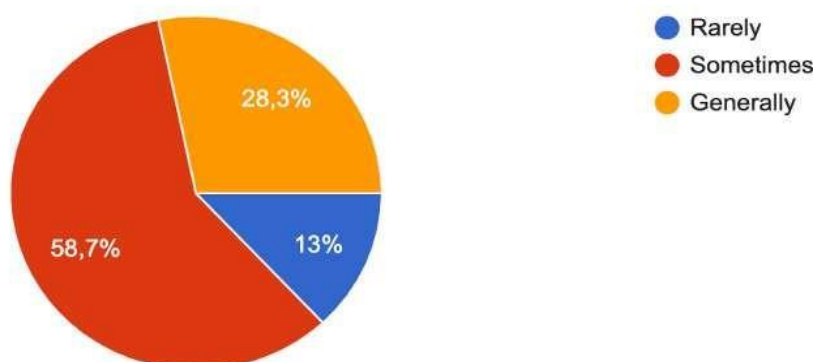


Figure 5.5: Question 8.

Is there flexibility in the delivery processes of the projects or are the processes carried out on difficult and clear dates. These questions have been answered.

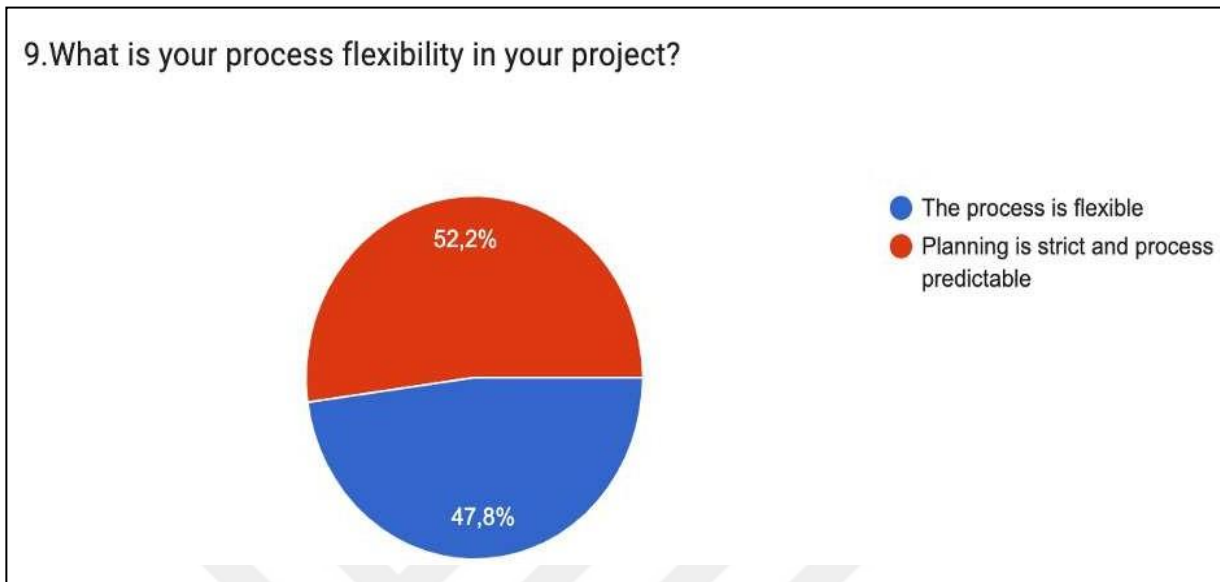


Figure 5.6: Question 9.

In the tenth question in the questionnaire, information about the titles of the people in a team and how many people they consist of was wondered. It has been learned that most of the teams consist of developers and managers who manage them. Such teams generally chose the Kanban methodology. Companies that can include positions such as product owner and scrum master in their teams can use the Scrum methodology. However, due to the requirements of the scrum methodology, some companies do not employ people in the relevant positions even if they use these methodologies. Larger teams generally seem to choose the waterfall methodology. The reason for this is that waterfalls are easier to manage than other methodologies in large companies and organizations. With Waterfall, large projects and organizations can be managed in a more disciplined way.

In the projects, it is seen that projects are made in less than 6 months in general. It was seen that 0-3 month projects were more in the first place with a rate of 32%. Then, projects between 3 and 6 months are carried out with 30% rate.

11.How long is the delivery time of your projects?

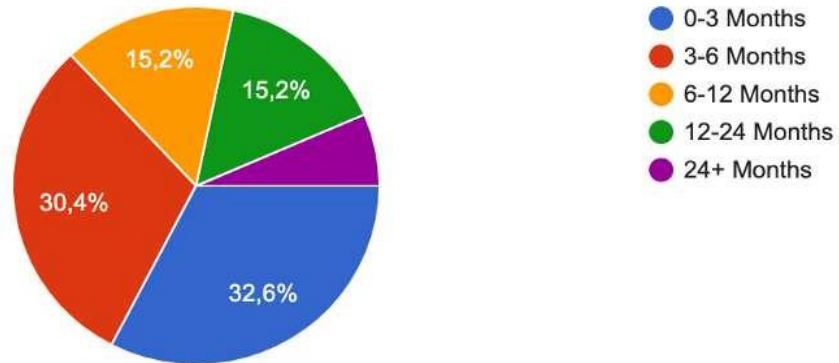


Figure 5.7: Question 11.

Are products or projects made in software processes? These questions have been answered. It has been learned with which methodologies the projects are currently managed. It has been determined that the scrum methodology is used in projects with very high rates. Details are as follows.

12.What is the job you work for in your department?

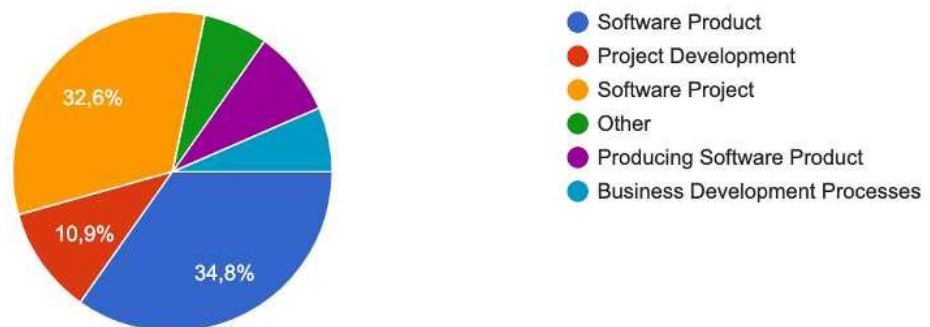


Figure 5.8: Question 12.

It was learned with which methodologies the projects are currently being managed. The most important choice for the teams to complete the projects successfully, in line with the determined budgets and in accordance with all the criteria, considering the risks, is the

methodology in which the projects will be implemented. When the survey responses are analyzed, the majority of the companies have chosen the Scrum methodology with a rate of 52%. The fact that companies choose a scrum does not mean that it is successful for all types of companies and projects. However, in recent years, the Scrum methodology is very popular and used by companies. After the Scrum methodology, the most used methodology is the Kanban methodology with a rate of 30%. Then the Waterfall methodology is used with a rate of 15%.

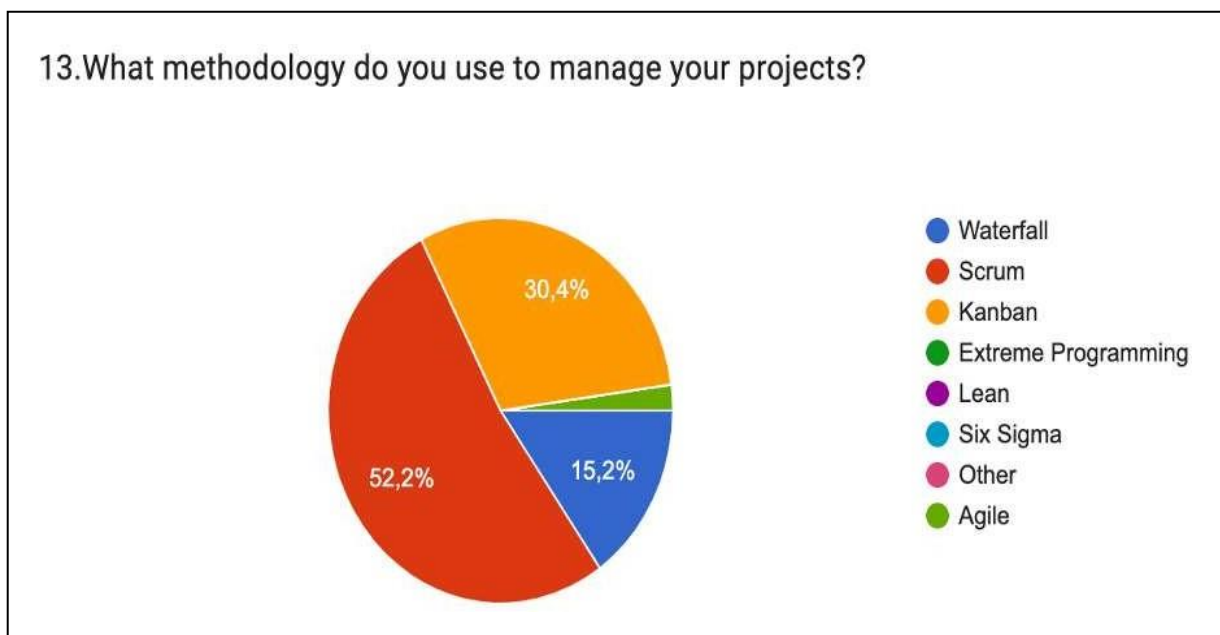


Figure 5.9: Question 12.

Once the project methodologies are selected, each methodology has its own rules. Fulfilling these rules or rituals brings discipline and coping with difficulties for the team. The methodology with the most requirements and rituals is the "Scrum" methodology. It is necessary to establish the appropriate team for this methodology and to add the necessary personnel to the team. It is necessary to complete many rituals completely. As seen in the survey study, many small-scale companies using the Scrum methodology cannot meet these requirements, so their success rates are lower. In corporate and large-scale companies, the success rate is very high in medium and small-scale projects with a team of around ten people. The success rate of the Kanban methodology is very high in small teams. It has been observed that the success rate of Waterfall is much higher in large-scale companies that make

long projects and large-scale projects.

14.To what extent do you successfully perform the rituals of the project management methodologies you use?

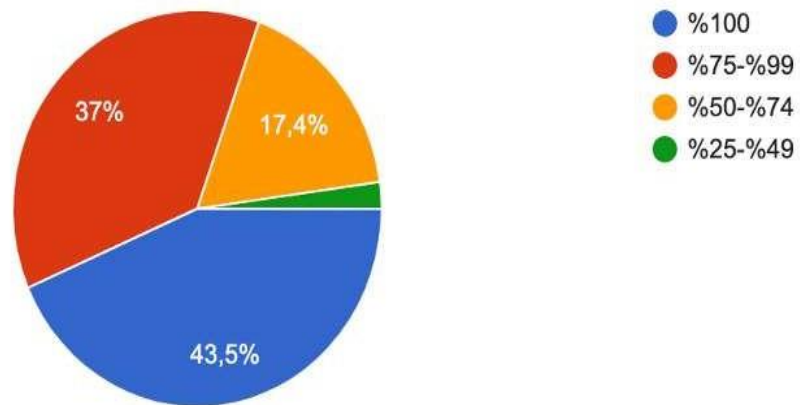


Figure 5.10: Question 14.

What is your reason for not fully applying the methodology in the fifteenth question of the questionnaire? (Answer this question if you did not mark 100%.) The purpose of this question was asked in order to better identify the difficulties faced by the teams. The vast majority of users who chose the Kanban methodology reported that they successfully managed the processes. This can be seen in detail in the table below.

Table 5.1: Question 15-1.

13.What methodology do you use to manage your projects? ▾	14.To what extent do you successfully perform the rituals of the project management methodologies you use? ▾
Kanban	%100
Kanban	%100
Kanban	%100
Kanban	%100
Kanban	%75-%99
Kanban	%100
Kanban	%75-%99
Kanban	%100
Kanban	%75-%99
Kanban	%100
Kanban	%100
Kanban	%100
Kanban	%100
Kanban	%100

The success rate of performing the targeted rituals in projects that choose the Scrum methodology is lower than other methodologies. Companies provide this above a certain rate, but they report that they have difficulties in fulfilling the rituals. The teams reported that they experienced difficulties in rituals, loss of time, and difficulties in fulfilling scrum requirements. You can see the details in the table below.

Table 5.2: Question 15-2.

13.What methodology do you use to manage your projects?	14.To what extent do you successfully perform the rituals of the project management methodologies you use?
Scrum	%75-%99
Scrum	%50-%74
Scrum	%75-%99
Scrum	%100
Scrum	%75-%99
Scrum	%75-%99
Scrum	%100
Scrum	%100
Scrum	%75-%99
Scrum	%75-%99
Scrum	%50-%74
Scrum	%75-%99
Scrum	%75-%99
Scrum	%50-%74
Scrum	%75-%99
Scrum	%50-%74
Scrum	%100
Scrum	%75-%99
Scrum	%50-%74
Scrum	%100
Scrum	%75-%99

It has been determined that large-scale companies generally use Waterfall in large projects and sequential works. It has been observed that success rates are higher in such cases.

Table 5.3: Question 15-3.

13.What methodology do you use to manage your projects?	14.To what extent do you successfully perform the rituals of the project management methodologies you use?
Waterfall	%100
Waterfall	%100
Waterfall	%100
Waterfall	%75-%99
Waterfall	%75-%99
Waterfall	%100
Waterfall	%50-%74

In the sixteenth question, the users participating in the survey were asked why they used the relevant project methodologies. In the criteria of the users when choosing, it was stated that the interaction of the customers with the project, the insufficient number of teams and their

choices were generally decided by the companies. Among the answers, the popularity of the scrum methodology was also frequently mentioned.

In the seventeenth question, what are the contributions of the methodologies chosen by the users to the projects? question has been asked. Users who responded to the survey stated that flexibility in agile methodologies and good contributions in customer relations. It was stated that users who chose the Kanban methodology increased communication with the team.

What are the disadvantages of the methodology you used in the eighteenth question? question has been asked. The answer to this question was the difficulty of performing the rituals. The difficulties of the requirements of the methodologies are also mentioned.



6. DISCUSSIONS AND CONCLUSIONS

As a result of the survey results and analysis, a conclusion was reached in the thesis in line with the information received from many companies in the sector. These results revealed that the success rates of the selected methodologies vary according to the size of the companies, the size of the projects, the targeted durations for the completion of the projects and many differences. More than one inference was obtained by taking this thesis study as a reference. In line with these results, it has been shown that which methodology to choose under which conditions is the most efficient in achieving success. It has been observed that it is much more possible to achieve a high success rate with the methodology to be chosen. While analyzing the results of the survey, previously written theses and articles in this field were examined [25]. Obtained results and inferences are as follows.

If a methodology is chosen based on the number of team members the companies have, according to the survey results; If you have a small team, that is, you manage a team of 1 to 5 people and you carry out your work from the office, choosing the "Kanban" methodology will be the right choice for you to achieve success compared to other methodologies. Because in the survey studies, teams that have a small team and are managed with "Kanban" have much higher success than the others.

If your project team consists of a team of 5 to 20 people at a medium level and you are working remotely or hybrid, the "Scrum" methodology will lead you to success. This methodology has some requirements. If you employ relevant people in certain positions, it is inevitable to achieve success.

If the project team is in a large structure, you can work with both waterfall and scrum. The most important detail here in achieving success is customer demands. If the customer wants flexibility, fast and piecemeal delivery from you, choosing "Scrum" will take you to a much better level in achieving success. However, the most important detail for the customer is the documentation and if he does not interfere with you and wants to get information when the work is done, you can choose the "Waterfall" methodology. Customer preferences in the size of the project vary according to the success rate. Considering the scope of the project and the time periods communicated to you by the customer, the success rates in methodologies are as follows.

If the project scope is small and medium, the success rates of the Kanban methodology are much higher when the customer has little time for the project.

If the project has a medium or large scope and the client keeps the delivery time of the project flexible, the company can choose Scrum or Waterfall. When choosing one of the two, one can make a decision according to the other demands of the customer.

It has been observed that the success rates differ according to the way companies work and when external factors are considered. If the team is working from the office and it is a small team, it will be more appropriate to work with Kanban. Because considering team interactivity project tracking, Kanban will be the most suitable option in this situation.

If the company work remotely and its project have medium scope and duration, "Scrum" will be the most suitable choice.

Waterfall success rates have been found to be much higher if you manage your work from the office and in large-scale businesses.

If the documentation is very important for your client and the project is to be delivered on a turnkey basis, the Waterfall methodology will be the most appropriate one, considering that there are no changes.

If your customer says that flexibility is more important than documentation, fast and piecemeal delivery is very important, if they give importance to communication more than documentation, you should choose Agile methodologies.

You can choose scrum or Kanban if the client has given flexible deadlines for project delivery and time is not critical to success. However, if the customer is not flexible about the duration, waterfall would be a better choice.

The implications of the results of the thesis study has been summarised above. They showed that it is possible to achieve success by choosing different methodologies according to many options and conditions. These recommendations here are according to the results obtained as a result of the survey study and researches. With different companies in different sectors they may be subject to change.

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