Project Management Selection Criteria

Which Is Better, Traditional Or Agile Method?

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Abstract

The aim of this thesis is to find out whether it is possible to choose between a traditional project management method or an agile project management method with the help of a ready-made procedure. This setting is interesting because agile methods have become common over the last few years. One of the motivations is the importance of the right method for the success of the IT project. If a new project is started quickly without considering the best approach, then a project failure is possible. Since there are numerous methods and their suitability for projects varies a lot, choosing the right project method is important. In this thesis, the issue has been approached through a literature study, augmented with personal reflections from a long career in project management. This kind of research, in which the suitability of methods for a particular project is compared to other methods, has not been extensively documented. Studies based on literature analyses and expert interviews gave the best results, so suitable studies were selected from among them for further comparison. The studies included questionnaires asking for information related to the project. Each question was answered by giving a score. The target of the response was the characteristics of the project, such as scope, quality, risks, time, budget, organization, project team, project team expertise, communication, and responsibilities. The researchers' studies showed that in their own research, they were able to establish a procedure by which the method could be chosen. Their procedure requires deep project management skills before their models are useful to the person making the project management method selection. If a software application according to their method could be created, then choosing the most suitable project method would become easier and more reliable than it is now. This could be a good development proposal for further research.

Keywords: agile project management, traditional project management, decision model, selection model.

Abstrakt

Syftet med denna avhandling pro gradu är att ta reda på om det är möjligt att välja mellan en traditionell projektledningsmetod eller en agil projektledningsmetod med hjälp av en färdig procedur. Denna frågeställning är intressant eftersom agila metoder har blivit vanliga under de senaste åren. En av motivationerna är vikten av rätt metod för ett IT-projektframgång. Om ett nytt projekt startas snabbt utan att överväga det bästa tillvägagångssättet, är ett projektfel möjligt. Eftersom det finns många metoder och deras lämplighet för projekt varierar mycket, är det viktigt att välja rätt projektmetod. I denna avhandling pro gradu har frågan behandlats genom en litteraturstudie, kompletterad med personliga reflektioner från en lång karriär inom projektledning. Denna typ av forskning, där metodernas lämplighet för ett visst projekt jämförs med andra metoder, har inte dokumenterats i stor utsträckning. Studier baserade på litteraturanalyser och expertgranskningar gav de bästa resultaten, så lämpliga studier valdes bland dessa för ytterligare jämförelse. Studierna innehöll frågeformulär som bad om information relaterad till projektet. Varje fråga besvarades genom att ge den en poäng. Målet för svaret var projektets egenskaper, såsom omfattning, kvalitet, risker, tid, budget, organisation, projektgrupp, projektgrupps kompetens, kommunikation och ansvar. Forskarnas studier visade att de i sina egna undersökningar kunde fastställa ett förfarande genom vilket metoden kunde väljas. Deras procedurer kräver djupa projektledningskunskaper innan deras modeller är användbara för den person som gör valet av projektledningsmetod. Om en programvara enligt deras metoder skulle kunna skapas, skulle det bli enklare och mer tillförlitligt att välja den lämpligaste projektmetoden än vad den nu är. Detta kan vara ett fruktbart utvecklingsförslag för vidare forskning.

Nyckelord: agil projektledning, traditionell projektledning, beslutsmodell, urvalsmodell.

Preface

I would like to thank my supervisor Annamari Soini for the good guidance and supportive attitude of my thesis. My thanks also go to Marina Waldén, who made it possible for me to do my thesis. Finally, I want to thank my wife, Outi, who has supported me throughout my studies.

Kai Järvinen

Abbreviations

APM	- The association for project management
APMBOK	- Project management body of knowledge
CCTA	- The central computer and telecommunications agency
CRP	- Critical path method
ENAA	- The engineering advancement association
EVM	- Earned value management
IPMA	- The international project management association
ISO	- International organization for standardization
IT	- Information technology
JIT	- Just in time
PERT	- Program evaluation review technique
PM	- Project manager
PMI	- The project management institute
PMM	- Project management method
PMBOK	- Project management body of knowledge
PRINCE	- Projects in controlled environments
WBS	- Work breakdown structure
WP	- Word package

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1 Introduction

Section 1.1 provides a brief description of the background and what has been the motivation for doing this thesis. Sections 1.2 and 1.3 describe the earlier stages and techniques of project management. Section 1.4 describes the research aim, problems, and issues related to the topic.

1.1 Background and motivation

For one who is about to launch an IT project, the choice of the right tool for a successful job is essential. There are many kinds of project management methods (PMM) that can be used in IT projects. The choice of the right project management model is influenced by experience and the IT project needs. It may be that there is not enough experience, or it is not clear what features are needed of the PMMs. This thesis will present the selection process and show options, operations, and use of different PMMs.

This thesis deals with project management, and its main concerns are IT and data processing in projects. Project management is very wide-ranging, and the focus will be on issues and assumptions that are important for this research.

My interest in these subjects stems from my experience as an IT project manager with a wide variety of projects in industry, banking, administration, and production management, as well as case management. I have been a software supplier and a client. My projects have been mostly international and have had many suppliers. I have seen successful IT projects in my career, but also those IT projects which did not meet the goal. Project management is not just an unnecessary and time-consuming method or tool. Project management helps to better align IT project schedules, costs, and targets with the goals and thus avoid disappointments and failures. The motive behind my research is to gain more appreciation for IT projects and thus, of course, to work on reliability, quality, and cost-effectiveness.

This study is a continuation of my earlier Bachelor´s thesis. The study covered two project management models, but the perspective was very wide-ranging and did not study the contribution of IT to the projects.

I note here that the personal pronoun "he" and possessive pronoun “his” used in this thesis means all genders equally and genders are not treated unequally in any context.

1.2 Earlier studies in relation to the theme

In the following, the project management historical timeline will be presented starting from 1950s into 2000s.

1.2.1 Project management historical timeline

Projects have been made in some form for a long time. According to Duncan Haughey [1], project management can be considered to have started as early as 2570 BC, but the kind of project management that is understood in modern sense began in the 1950. Henry Gantt, familiar to many who worked out project schedules, created in the 1920s the Gantt diagram, which is still used in the project schedules. The Gantt chart is a bar chart showing the phases and completions of a project schedule in relation to time. Dupont developed the Critical Path Method (CRP) in 1957. This method is used to search for a consecutive set of tasks that are executed according to a schedule so that the project does not miss the given schedule. In 1958, the U.S. Navy developed the Program Evaluation Review Technique (PERT) method to analyze the time needed to complete the project tasks. PERT can be used to determine the minimum time to complete a project. The U.S. Department of Defense created the Work Breakdown Structure (WBS) method in 1962. WBS is a hierarchical tree structure with all the tasks that need to be completed to finish a project. IPMA, the world's first international project management association, was founded in Vienna in 1965. The Project Management Institute (PMI) was established in 1969. The purpose of PMI is to promote project management practices, which include certification of project management as an important part. Scrum one of the agile PMMs was created in 1986

in the United States. This method is very widely used. Projects in Controlled Environments (PRINCE) were developed and created in the United Kingdom in 1969. The PRINCE method can be classified as a traditional PMM. In 2001, the Agile Alliance was formed to promote software development in accordance with the twelve core principles of the Agile Manifesto they created [2]. This manifesto is the basis for an agile PMM. See Figure 1.

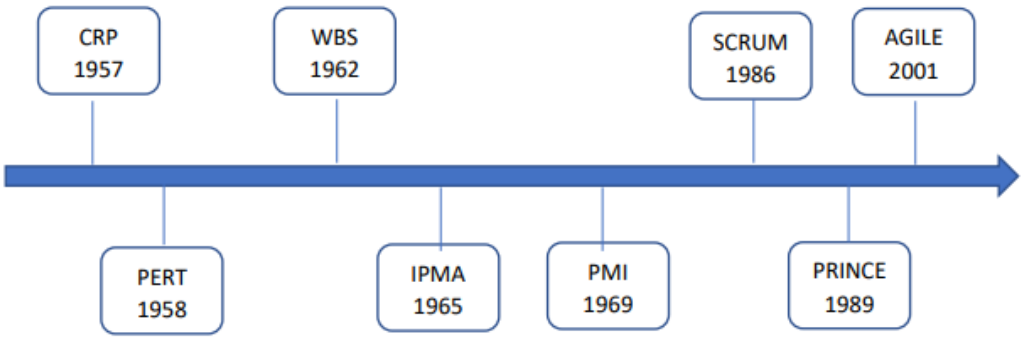

Figure 1: Project Management Timeline.

I will look at and describe what studies of project management models there are, and what kind of results there are, starting from 1980 until the present (2023).

1.3 A historical overview

The following is a brief description of the early methods of project management, which include CRP, PERT, and WBS. Here also are introduced the standardization of project management and the methods of project management in the 1980s.

1.3.1 Critical path method

Project management has developed in such a way that new features have become more common and have started to be combined with other existing methods. This has created traditional project management models and partially agile project management models. As project management developed in the 1950s, there was a need to learn about the duration of the project, the interdependence of different tasks, the risks of the project, and the prioritization of tasks. It was necessary to find the longest path between tasks (critical path) that leads to the realization of the project [3, pp. 65,70]. There are three paths in Figure 2. The critical path is the longest sequence of tasks that must be finished and leads from the beginning (B) to the realization of the project (E). The other two paths in Figure 2 should also be completed and finished in such a way that they do not delay the realization of the entire project.

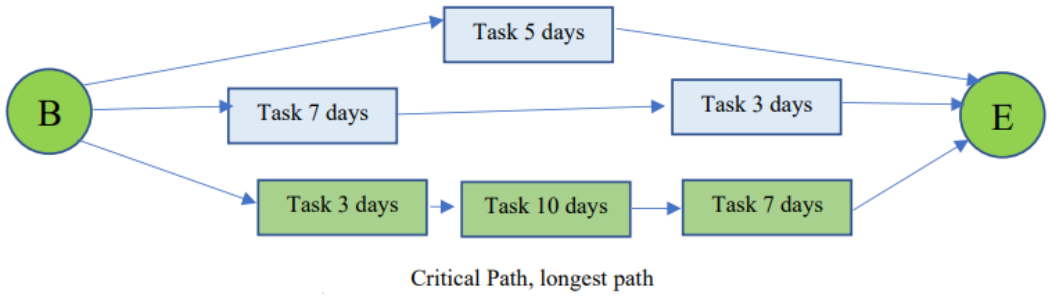

Figure 2: Critical Path.

1.3.2 Program evaluation review technique

Program Evaluation Review Technique, in brief PERT (created in 1958) is a project management planning method of analyzing the associated dependencies between the separate phases of the project [1]. The PERT method is used for high-risk projects. With the help of an algorithm, PERT calculates optimal, pessimistic, and most likely time to perform tasks. To assess the standard active duration of the project, the following formula is used:

te = (a + 4m + b): 6, where **te** is standard active duration, **a** is optimistic time, and **m** is the most likely time, and **b** is pessimistic time. Example: Optimistic value **a** = 38 days, the most likely time **m** = 48 days, and pessimistic value **b** = 70 days. Standard active duration **te** = [38 days + 4(48 days) + 70 days]: 6 = 50 days [4].

The calculation of the algorithm is not further explained in this study. PERT helps to find the critical work phases of the project and to find the right order of the work phases to complete a certain project. PERT helps to find out if the project deadline is scheduled and whether there is leeway in some tasks. Figure 3 shows the principles of the PERT chart.

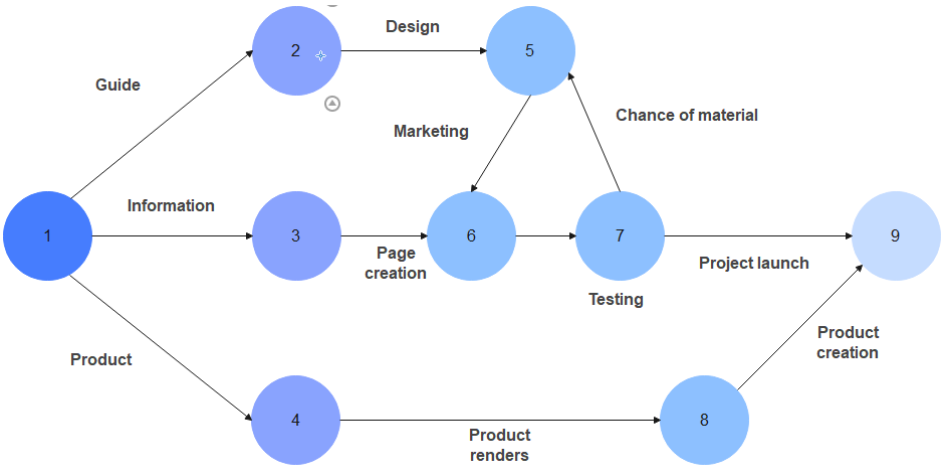

Figure 3: PERT chart.

1.3.3 Work breakdown structure

To clarify all project management structures and what resources are needed for a project, the Work Breakdown Structure (WBS) is needed (created in 1962) [1] [5, pp. 141-143]. WBS aims to divide the work into smaller, more manageable entities. Each work has a beginning and an end. The work is measurable and produces an object. WBS provides working time and labor costs. If necessary, the work can be divided into Work Packages (WP). A WP is a sub-project of a larger project, and it is at a higher level than an activity or task in a project.

The WBS (see Figure 4) begins with the desired final deliverable, which here is 'System development'. The deliverable is divided into as logical and independent entities as possible in the next lower level. The second level is divided into six main project phases, which are: project management, definition, planning, development, implementation, and delivery. Project management is divided into five subprojects: project start, planning, implementation and control, not named project phase, and project end. Planning is divided into eight subprojects: vision and goals, project proposal, specs and requirements, business proposal, budget, resource allocation, create schedule, and communication plan. Project delivery is divided into four subprojects: training, data conversion, implementation, and launch system in production.

Figure 4: Work Breakdown Structure (WBS).

1.3.4 Standardization

Project management needed standards and common operating rules. The International Project Management Association (IPMA) was established in Vienna in 1965 and Project Management Institute (PMI) was established in United States in 1969. Since the 1980s, project management has developed at a fast pace. The Scrum method as it is known today was introduced to the public in 1995. Project Management Manual PMBOK Guide [6] by PMI was published in 1987. This manual can be considered as the original work of traditional project management models. The latest edition of the book was published in 2021. A new feature, Earned Value Management (EVM) to calculate project profitability, schedule, and efficiency was added to the PMBOK® manual in 1989. PMBOK®, which became a methodology [7, pp. 11-15], and finally became the standard for project management in 1998. At the same time, the developers of agile PMMs created The Agile Manifesto [2] in 2001. In 2012, The International Certification Organization published its own project management standard: ISO-21500:2021 Standard [8].

After these significant steps, project management began to take its current form. Developments and new models are appearing, but they are outside the scope of this thesis.

1.3.5 Project management methods of the 1980s

Project management was not new in the 1980s, as Project Management Quarterly reported in 1982. In this publication, Sharad notes that project management and related working methods and techniques are not significantly new in character [9, p. 46]. In the 1980s, it was found that leadership at that time had evolved for 50 years. During that development, there was an understanding of what affects the needs of employees and the operations of management. Autocratic, demanding leadership had suffered a setback due to new, creative, and innovative leadership. For successful management, the concept of "professional management awareness" was added. This had an impact on management philosophies and approaches to things and tasks. At that time, there was a desire to emphasize resourcefulness and judgment in the context of old skills

and tools. The professional management approach helps to see the project staff as trained experts with leadership skills, coordination skills, and the skill of reconciling things and ideas. Sharad notes that when looking at project management literature and learning materials from the 1980s, they found organizational planning, matrix processing, project groups, and the project life cycle, likewise, the contributions of projects, quality, services, and cost accounting. Project baselines had been planned, and functional network models had been developed. This also included budgeting, scheduling, resource management, contract management, and work orders that were already in use at the time. Sharad states that the role of the project manager would become widely known to professionals in the field in the future, with his ability to make a significant contribution to the success of projects. As project expectations increased, project personnel would need to be trained, qualified, and certified for better reliability, competence, and quality [9].

The 1980s were interesting in terms of information technology. IBM's PC, or personal computer, entered the market and revolutionized computing and project management in a significant way. Before that, there had been computers designed for home use in the 1970s, but they did not greatly affect the project management area [10]. As the number of PCs increased all over the world, project management training began to be planned for this new platform. An example is Microsoft Project software, which was launched in 1984 [11]. One example of a Finnish information education provider is Tieturi, which was founded and started, among other things, project management education in the 1980s [12].

1.4 Research aim, problems, and questions

The study deals with the use of project management models in data processing projects and the development of these models. I will present the historical development of project management models from 1980 to today (2023).

One of my important aims is to help those who are about to move into the field of data processing and those who are poorly aware of the PMMs of data processing. I have

chosen the PMMs presented according to their characteristics. There will be two different methods and other PMMs will not be presented in this study.

- Traditional project management methods
- Agile project management methods

The purpose of this study is to provide a sufficient understanding of different project management methods and determine whether the most suitable method can be deduced based on the given situation or whether the optimal method cannot be determined. I will familiarize myself with the literature and studies in the field of project management and analyze the results that I find. The period of study is 1980 - the present day (2023).

2 Basic information and concepts

The most important concepts of this study are presented, such as project management, historical timelines, project phases, standards, certificates, and how ethics and project management are interlinked.

2.1 Project

The definition of a project is "*A temporary endeavor undertaken to create a unique product, service, or result.*" [6, p. 4]. A project is temporary in nature and has a start and an end date. The project may be independent or belong to a larger entity such as a program or a portfolio. The program and portfolio are larger entities or groups coordinated to achieve greater benefits than if projects were to be managed individually [6, p. 4] [8, pp. 2-3]. The project has significant constraints that affect its quality. These are called Triple Constraints (see Figure 5). The first constraint is scope, the customer's requirements for the project; the second constraint is time, which means how much time will be spent on the project to complete it on time, and the third constraint is the cost, which is the total cost of the project. Costs are compared to the budget set at the beginning of the project [5, p. 15]. Constraints control is problematic. Time reduction can increase cost and reduce scope. Cost reduction can increase time and reduce scope. When scope reduces, the time and cost will reduce too. [5, p. 16].

Figure 5: Triple Constraints [13].

2.2 Project management

Project management (PM) can be defined as: "*The application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management refers to guiding the project work to deliver the intended outcomes.*" [6, p. 4]. The outcome of the project is not easy to complete. Success requires a wide range of experts.

2.3 Project phases

The phases of the project management models depend on the type of project management model involved. Traditional linear flow project management model [6, p. 171] phases are initiating, planning, executing (analysis, design, development, testing, deployment), monitoring and controlling, and closing. Project phases in Agile iterative project management models are initiate, plan and estimate, implement, review, retrospect, and release. Other project management models have their own model-specific features that are not presented in this study.

2.4 Project management guides, methods, and standards

Efforts have been made to unify the discipline, execution, and quality of project management by creating consistent policies and standards in the early days of project management. The practice began to develop rapidly when PMBOK® was created and introduced in the United States in 1957 by the Project Management Institute (PMI). In addition to PMI, project management methods and standards have been developed by the Internal Project Management Institute (IPMA), the Central Computer and Telecommunications Agency (CCTA), The Association for Project Management (APM), the Engineering Advancement Association (ENAA), and the Internal Organization for Standardization (ISO). These institutions have created and are now creating standards, guidelines, and policies based on which project management practices and high-quality policies are in place [14, p. 36]. APMBOK or P2M guides are not presented here. See Figure 6.

Two ISO related standards are used in project management.

- ISO 10006:2017, which gives guidelines for project quality management [15]
- ISO 21500:2021, which gives guidelines for project management concepts and processes [8].

Several non-ISO guides are used in project management, such as PMBOK®, IPMA ICB®, APMBOK, and P2M. In addition to these, the PRINCE2 method is also used. See Figure 6.

PMBOK® has been recognized as an accept policy, and its information and guidelines are applicable to most projects. The guide provides clear instructions on how to manage projects and defines project management concepts and components such as the project life cycle and project processes.

The IPMA Individual Competence Baseline (IPMA ICB®) is a general, global guide and a standard by which each participant in a project, program, or portfolio can demonstrate their competence. The goals of IPMA are clear: to improve the competence of individuals and their understanding of their own area.

PRINCE2 ™ Project Management Methodology forms an integrated framework for processes. It tells what is to be done, who should do it, and when to do something. The method is prescriptive and deals only with the roles of the project. It does not take a stand on people who are named for roles [16, pp. 639-654].

Project Management Practices	Type of Classification of Project Management	Organization Issued	Country of Origin	Language Used	First Edition	Latest Edition Available (as 2021)
PMBOK®	Guides	PMI	USA	English	1987	6th edition 2017
ICB	Guides	IPMA	Switzerland	English	1999	4th edition 2015
PRINCE2	Method	CCTA	UK	English	1989	6th edition 2017
APMBOK	Guides	APM	UK	English	1992	7th edition 2019
P2M	Guides	ENAA	Japan	Japanese	2003	3rd edition 2017
ISO10006	Standard	ISO	Switzerland	English	1997	3rd edition 2017

Figure 6: Summary of Classification of Project Management Standards, Guides and Methods [14].

2.5 Project management certifications

The most well-known certifications for project management are Project Management Professional (PMI), IPMA Certificate, and Agile Leader Certificate.

The IT project management certificate is an objective and comparable measure of competence that can be used to examine the competence of a project expert. In all cases, completing the certificate does not necessarily require separate training if the competence is on a very solid foundation, but the training provides assurance to inexperienced project personnel. Finally, efforts have been made to develop the professionalism of project management through the creation of these international certifications. For many jobs, there is even a requirement to complete a certain level of certification [18]. According to a resource, there are already more than 1,200,000 professionals certified by the PMP or Scrum Alliance [17, p. 1].

Certificates are of practical benefit to companies or those who lead projects or otherwise participate in project work. The PMP certificate is based on the Project Management Institute Framework, or PMBOK® Guide. It focuses on the application of best practices and lessons learned. A PMP certificate is a guarantee of a certain level

of project expertise. Completing a PMP is quite demanding because it requires a certain level of work experience and training [5, p. 59].

Researchers from the Spanish consulting firm Lantik S.A.M.P and Universidad Rey Juan Carlos studied the impact of a project management certificate on the success of information management projects. Their research showed that the benefits of certification for a professional guarantee better employment, higher wages, greater self-confidence, and industry respect than for those without PM certification. In addition, it was found that larger companies give the certificate more value than medium-sized or small companies. Certifications are also useful for businesses. According to the study, the performance of the projects improved by up to three times compared to the work of uncertified professionals. The best success was in those companies where the upper management supported the competence and thus also the certification of professionals. The study also found conflicting results for the positive effect. The researchers found that 27% of those with PM certification had no effect on the acceleration of the project or improvement in quality [18, p. 7].

2.6 Ethics and project management

The subject of this study is not philosophy, but I would like to highlight ethical issues. Kliem presents very clearly the value of ethics in project management. “About all professions have a code of ethics, and project management is no exception.” [19, p. 47].

According to Kliem, one of the benefits of ethics is a structure that harmonizes decision-making and provides an opportunity for a common language. Terms used have dissimilar meanings in diverse cultures. Ethics also provides a way to deal with demanding ethical situations, including those for which consideration is required. There is a sense of community among people, regardless of ethnic background and geographical location. Principles, standards, and guidelines highlight known accepted matters and help to determine which are not accepted. Ethical values encourage dialogue over issues and circumstances, which keeps the profession alive. Finally,

ethics enables the transfer of principles and knowledge from one generation to the next generation. There is no need to reinvent everything on one's own [19, pp. 47,48].

Project management has ethical and professional principles, *Code of Ethics and Professional Conduct*, based on accountability, respect, fairness, and honesty. These policies are moral in nature, i.e., they are concepts of right and wrong, good and bad [6, p. 21].

Greater problems in project management arise when working with international projects. Social, political, legal, economic, infrastructural, and geographical dimensions must then be considered [19, pp. 188, 189]. Ethical principles are of excellent value for good project management, but there are some challenges that need to be met and overcome.

3 Project models

In the following we shall take a closer look at different project management methods, starting with the traditional methods and then looking at agile methods.

3.1 Traditional project management methods

Every person in a project is assigned to a role. Several people can share a role, and one person may have several roles. Roles have authority and responsibility. Status in the organization alone is not enough to qualify for a specific role. Appropriate training is also needed for the role. Here are some important roles in traditional PM, from top to bottom of the project [20, p. Chapter 8].

Depending on the project, at least the largest projects have a **Project Sponsor**. The project sponsor represents leadership that is beyond the responsibility of the project management. He supports the project management and provides the project with information about the company's strategy and forms a broad view of the situation for the project management. His or her function is to bring to the project team the company's vision, goal, and expectations, and to support and help the project management reach the desired goal. He keeps the project in line with the business objectives and removes obstacles to the realization of the project. If the sponsor is not involved in the project, the effectiveness of the project may suffer due to longer decision times and possible conflicting priorities [6, pp. 207-208].

The **Steering Committee** is a stakeholder advisory body designed to monitor and steer the project team in the right direction and provide support for decisions that are beyond the project team's competence [6, pp. 180, 250].

Stakeholders can be external or internal groups or individuals who have an impact on the operation or decision-making of the project. The influence of the stakeholders may be directly or indirectly positive or even negative for the outcome of the performance. The functionality of stakeholders depends in a high degree on interpersonal abilities, cooperation, and trust. Through these competencies and skills, the success of the project is more likely than if there were deficiencies in these competencies.

Stakeholders may include, for example, investors, customers, and suppliers. These are determined by the project and the need. Not all projects may have stakeholders [6, pp. 31,33].

The **Program Manager** leads a larger ensemble, where project managers lead projects. The program manager supports the project managers in achieving their goals. The program manager may be responsible for coordinating the activities of the teams, suppliers, and other staff supporting the projects. Program managers often hold regular meetings with project managers, sharing information about the status of the projects and the program, i.e., the program for which the program manager is responsible [21, pp. 14-15].

A portfolio is a collection of projects and programs brought together for more efficient management. The **Portfolio Manager** leads this continuous process of portfolio management [21, p. 15]. Portfolio management is widely used by government agencies and other similar actors, but it is also used by private-sector companies, where the idea originally came into use. Private sector companies can hold comprehensive portfolio management to centralize IT procurement. The use of this is not common in small projects [22, pp. 947-959].

A **Project Manager** is a person appointed by a performing or receiving organization whose main task is to lead a project team that has the responsibility to achieve the project objectives and outcomes [6, p. 4]. A project manager is responsible for project planning, management, delivery development, budget and schedule management, risk management, and much more [23, p. 1231]. A good project manager creates an open discussion by giving people the opportunity to influence the course of things. He also motivates, guides, and advises people on projects [6, p. 41]. There may be several people in project management who have an effective way and ability to lead processes and people. A project manager needs to have that kind of ability. It is good for the project manager to keep the discussion in the project under control and try to avoid conflicts which can arise when too many people try to influence the course and management of the project. The project manager must bring a consensus strategy to the discussion [6, p. 41]. Especially in the planning phase, the project manager should strive to meet the needs and wishes of the stakeholders. In this case, the organization must be ready for the changes. The project manager has a great responsibility to get

everyone to support and understand why the project has been launched and what it aims to achieve. In the planning phase, the project manager must bring in the communication of the vision and the goals brought about by the change at an early stage, so that the necessary matters can be recorded in the project plan [6, pp. 58-59]. The project manager plays a key role in creating and maintaining a good, respectful, and accepting environment for the execution of the project. Such an environment is transparent, honest, respectful, and supportive of others, and one that knows how to enjoy success and achievement [6, pp. 20-21].

The task of the **Project Team Leader** is to lead the project team. The project team leader is either a project manager or a specifically designated expert with expertise in his or her field.

The task of the **Members of the Project Team** is to function as experts in their own group, promoting the project in every feasible way. A project team is a group of people with the necessary knowledge, skills, and experience needed for that project. It is a good idea to have people from different parts of the organization in the project group, if possible, so that the project group can bring different perspectives on the different functions of the organization [6, p. 14].

IT expertise roles in projects are 1) **designers**, who design the programs, and the necessary architecture for delivery. 2**) Programmers** and/or coders who specialize in hardware, software, databases, web environments, and the creation of similar environments. Their work also includes testing and verifying that the work done is in line with the assigned task. 3) **Testers** shall conduct tests in accordance with the test plan to ensure the correct implementation of the new IT programs and/or modifications made.

An IT project requires a variety of **soft and technical skills**. Soft skills are difficult to teach. Soft skills must be inherent in person. Soft skills needed in IT projects are leadership, negotiation, conflict management, communication, and active listening skills. In addition to soft skills, technical skills are also needed, such as software knowledge, understanding of the technology used, and basic business knowledge, cost assessment, and budgeting.

The cooperation between stakeholders and IT personnel is diverse and has a significant impact on the success of the project. The stakeholder can be an individual agent, a group, or a part of a company which operates in expert roles. Stakeholders have a direct impact on the project and its efficiency or inefficiency, as well as the outcome of the project. Stakeholder expertise is needed to assess and communicate the goals, requirements, schedule, costs, risks, quality, and success factors to the project management team, the project manager, and others who need their knowledge. The need for stakeholders is not continuous in terms of project performance, but their expertise can be requested if necessary to meet the needs of the project management. The need for stakeholders can therefore vary a lot at various stages of the project. The success of a project requires effective communication, understanding and commitment between different stakeholders and the project team. The project team and all other project IT groups are also stakeholders, so any interaction and detailed familiarity with matters apply equally to IT personnel and to other project participants [6, pp. 31-33].

Financial risks: Project management decisions are made based on the need for change, competitiveness, or other similar needs, but they are also often based on money. When making plans, all software and hardware needs, as well as design, should be considered [24, pp. 932-940]. Financial risks and decisions should be considered at the pre-planning stage of the project, but at the latest at the planning stage, financial risks should be considered. Risks, including financial ones, should be recorded in a risk analysis in which the likelihood of the risks and their impacts are assessed.

The strengths and weaknesses of traditional PM are that the method of progression is easy to understand and easy to use because it proceeds in a straight line according to a predetermined holistic plan. The method also includes good documentation, which also increases the comprehensibility of the project. The method is therefore predictable because its goal and resources are clear, it has fixed steps, there is no need to guess anything, and one person, the project manager, is responsible for the progress and implementation. All of this requires heavy planning to make everything work. All the work needed for the project is clearly shared, and everyone involved in the project knows what to do and when to do it. There is no overlapping. A major weakness or strength is changing management. Once the project has been completed and approved, no changes will be made. If the project requires changes, then traditional PM is not

the best PM for it. Weakness can also be seen in the fact that the delivery of the project to the client takes place late, after everything has been done. There are indicators for the progress of the project, but reliable monitoring of them is also a weakness of traditional PM [25, p. 216] [26, p. 750].

For the first group I chose traditional PMMs based on the waterfall model. It is typical for them to proceed in predetermined stages from the beginning of the project to its end, considering the design and implementation. For a successful completion of traditional PM, it is important that all sorts of planning be done with care throughout the life cycle of the project. In traditional PM, therefore, the emphasis is on pre-planning, and efforts are made to avoid mid-implementation changes to the original plan. The more that can be planned before the start of the project programming, the greater the benefit for the project implementation. Another benefit of this method is a good documentation of the project. The weakness in traditional PM is making changes to an ongoing project. Any subsequent changes and repairs are expensive to implement and have significant downsides to the schedule and possibly the quality of the project [6]. Traditional PMMs with minimum differences are the Waterfall method, PRINCE2 method, and V-model. This list is not entirely comprehensive but gives an idea of what project management models belong to traditional PM.

3.1.1 Waterfall method

The waterfall method, or so-called traditional project management method, is a sequential process in which project progress is seen as a waterfall that flows downhill through various stages, which are requirements specifications, system design, design implementation, verification and testing, system deployment with maintenance. See Figure 7.

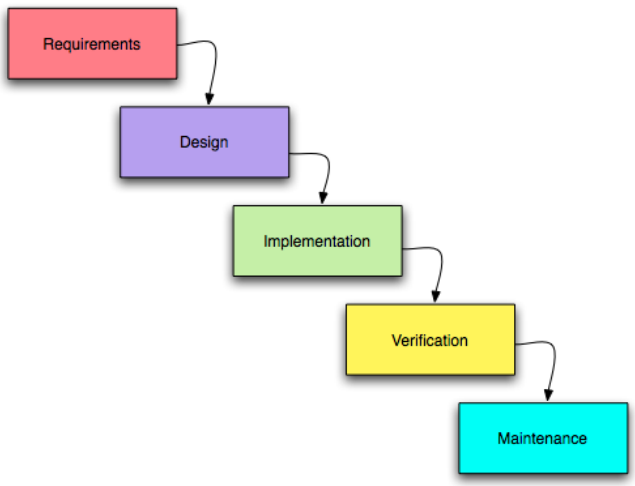

Figure 7: Waterfall model [27].

The first step is the **requirements elicitation.** The purpose of this phase is to produce a high-quality project proposal. At this stage, the client is interviewed, the client's requirements are studied, the roles of the project are defined, and the aim is to clarify as precisely as possible what should be done. The project manager is responsible for the functionality, schedule, cost, and other issues important to the project, which are taken to the next stage for planning [28, pp. 17-24].

The second phase is **system design**. At this point, the project schedule and preliminary project plan are set, and the project has started. The project manager plans and manages the project work according to the assignment received. The project team holds meetings and ensures that everything goes according to plan. A communication plan, responsibility matrix, risk analysis, and schedule, as well as a resource plan and resource assignments, are made for the project. The project plan is complete, and the project is allowed to start the next phase [28, pp. 24-59].

The third stage, design **implementation,** means that all planned tasks and phases are completed and delivered to the customer as agreed. This responsibility falls to the project manager. To see the phase through according to plan, it is monitored by status reports, quality checks, project documentation, risk management, and project schedule updates [28, pp. 60-75].

The next step, the fourth phase, is to perform **verification and testing**. The project manager has overall responsibility for testing. If a test manager has been allocated for testing, then it is his or her responsibility to pass the tests. This does not affect the overall responsibility for testing. Once the test has been passed and approved, no further changes will be made to the project and the installation of the system will be conducted for the customer or end user. In the last step, the launched information system is maintained for making the necessary changes and correcting errors. This step may be part of the project plan if so decided, or maintenance and changes may be separate from the original project [28].

3.1.2 Prince2

PRINCE2 (Projects In Controlled Environments) is a widely used process based PMM suitable for all types of projects, regardless of project size, type, duration, complexity, or scope. PRINCE2 is suitable for managing information technology as well as other projects. PRINCE2 is based on the existence of a particular business case and organized around a plan to generate identified business value. The project must proceed in such a way that it produces the necessary outputs for the top management. It is important that work progresses, changes and risks are managed, schedules and budgets are planned, and quality achieved [29, pp. 30-31].

PRINCE2 contains seven **principles** that guide the entire project work [29, pp. 31-32]. These principles are: 1) The project must have a continuous business justification. 2) The experience gained from the project should be utilized. 3) The roles and responsibilities of the people involved in the project must be defined. 4) The project is progressing and is being led in stages. 5) The project is managed by exceptions. 6) The focus is on products. 7) The method is adapted to suit each project. See Figure 8.

Figure 8: PRINCE2 principles © 2023 www.processexam.com.

PRINCE2 has seven **themes** [29, pp. 32-33], which are: 1) Business justification, i.e., the value the project brings to the business. 2) The roles and responsibilities of the organization should be clear. 3) Quality requirements and measurement methods should be clear and described in terms of how they affect the project. 4) Plans should be described as well as how they affect the project. 5) The potential impacts of risks should be considered. 6) Changes to the plan should be manageable. 7) Progress should be assessable. See Figure 9.

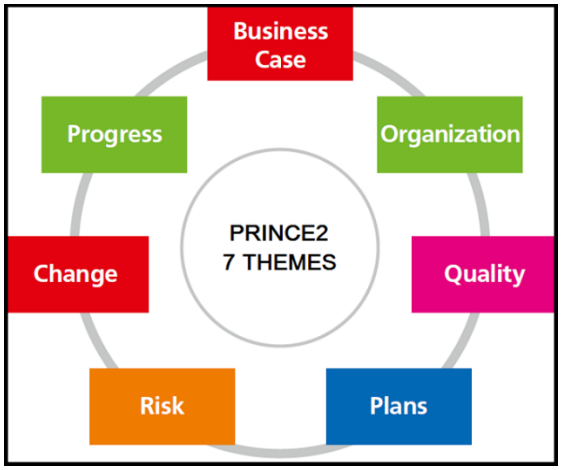

Figure 9: PRINCE2 themes © 2023 www.processexam.com.

PRINCE2 has seven **processes** [29, p. 33], which are: 1) Starting up a project 2) Directing a project 3) Initiating a project 4) Controlling a stage 5) Managing product delivery 6) Managing stage boundaries 7) Closing a project. See Figures 10, 11.

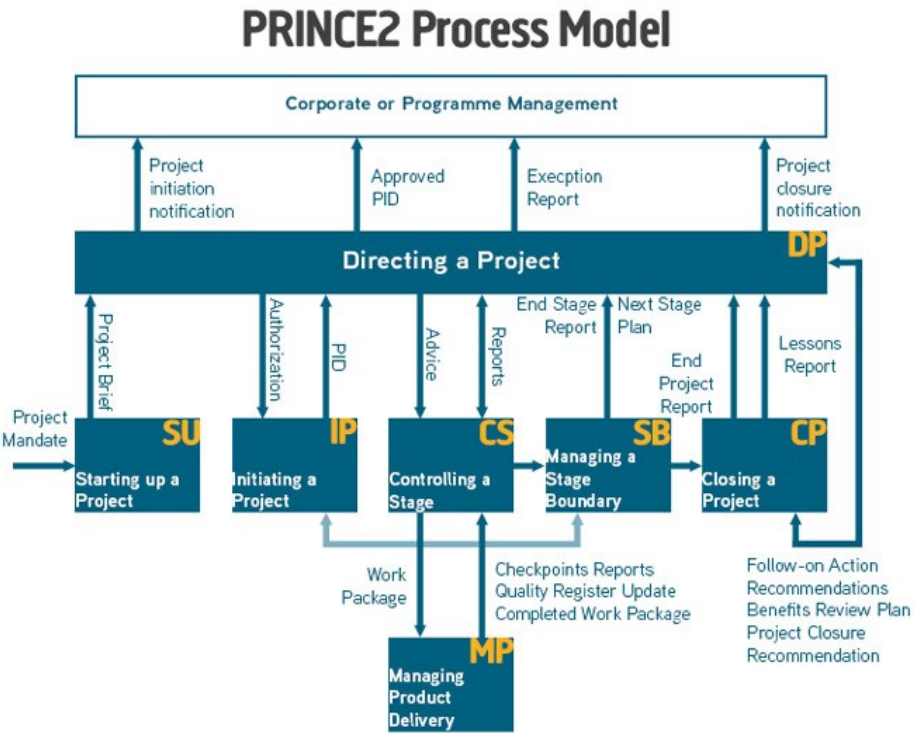

Figure 10: PRINCE2 Process concise Model [30].

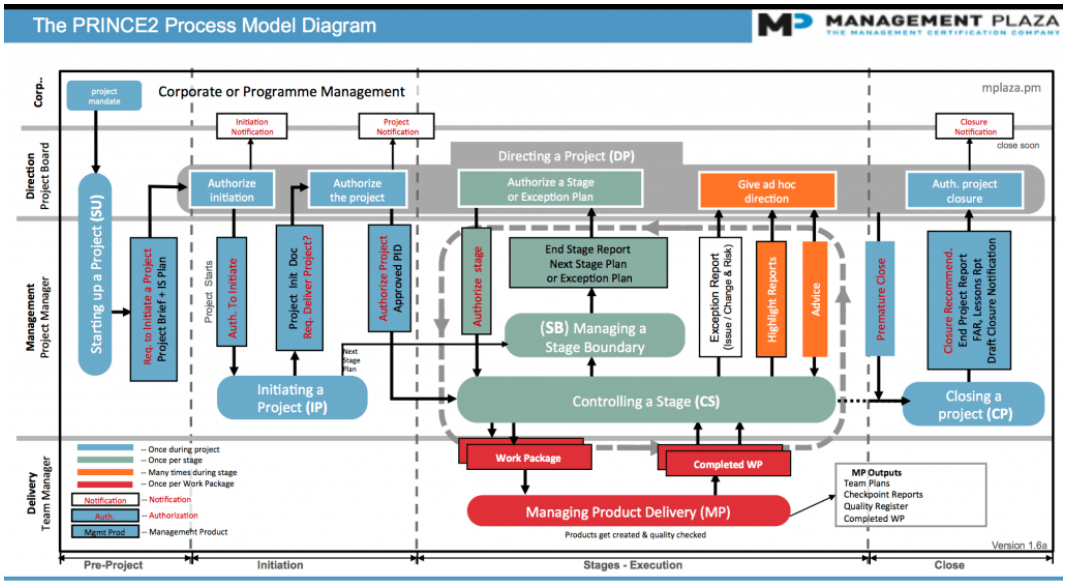

Figure 11: The PRINCE2 Process Model extensive Diagram [31].

The PRINCE2 process begins even before the actual project, as an idea, need, or some other reason triggers the need to start the project. At this point, stakeholders and other contributors will write a preliminary Product Description, which will be presented to the Corporate Management level of the company. If the Corporate Management level gives a mandate to the project, then the first actual phase of the project starts, i.e., starting up a project. *The starting up a project phase* includes naming the project Executive and Project Manager, mapping the project team and naming the members, and selecting the project approach for the initiation phase planning. The starting up a project process delivers plans and proposals to the directing a project process.

Directing a project process approves the proposals and authorizes initiating a project process to continue the project. *The initiating a project process* describes the main activities of the project and ensures and instructs that the project schedule and budget remain within the mandated framework. It is also ensured that the quality of the work done for the client of the project remains excellent.

The following process, *controlling a stage*, describes the core activities of the project manager. The controlling a stage process includes control of budget, schedule, and quality of work. The next process, *managing product delivery*, describes the link between the project manager and the team manager and how the link works. This is

important especially in the case where part of the team operates externally, or they do not have access to PRINCE2. The managing product process includes the project schedule, reporting, and job quality. The managing stage boundary process inspects the tasks under work and plans the next step. At this point, Project Plan and Business Case are being updated. The project manager reports to the Project Board, which approves the plan and gives permission to move on to the next step. The last of the processes is *closing a project*. This stage comes when the project naturally ends up with all tasks completed or if the project is decided to close for some other reason [30].

All PRINCE2 projects have four **management** levels, with a Corporate or Program level at the top. At this level, a project is given a mandate document describing the project in a very general way. The management then appoints the Executive for the project and tells him what tolerances the project has. From now on, the Executive is responsible for the project. The Corporate level then does not interfere with the project, except if the project tolerances have been exceeded. The Corporate management level is a separate level, and it is not part of the project management team. See Figure 12. The Project Management team includes the Project Board, Project Manager, and Team Manager levels. The directing level is the responsibility of the Project Board. All important decisions related to the project are made by the Project Board, such as starting the project, starting each phase, and finally finishing the project.

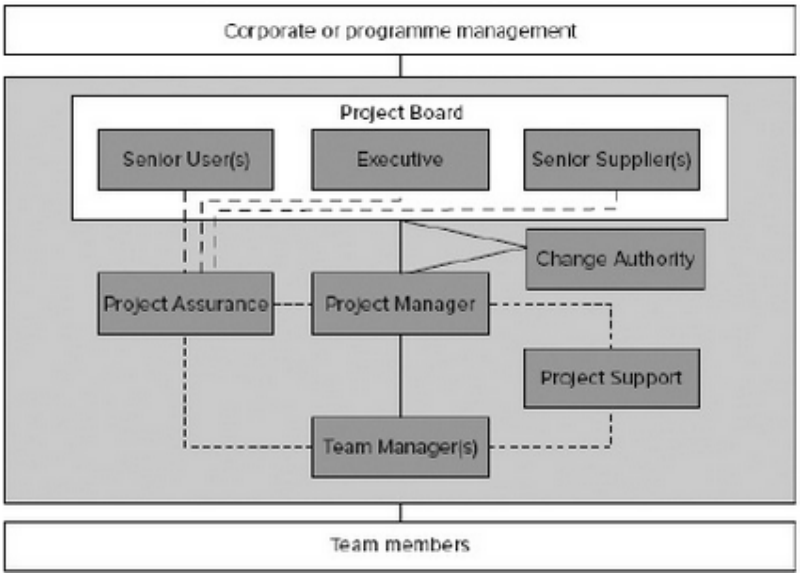

Figure 12: PRINCE2 Project Management Structure [32, p. 6O].

The Project Board usually delegated the day-to-day project management to the Project Manager. The Project Board consists of three roles: the Executive, the Senior User, and the Senior Supplier. The Project Manager is responsible for the day-to-day operation of the project within the tolerances received from the Project Board. He ensures that the required products and services are created for the project. His duties also include informing the management team and external stakeholders about the progress and status of the project. There is only one project manager on the project team. Team managers are responsible for the delivery level. They manage the teams that create the products of the project. If the project is small, the project manager can manage teams in the role of team leader. If there is a team manager, then the project manager delegates the work to them. PRINCE2 needs an effective communication plan so that information is communicated to everyone in the right way and at the right time [32, pp. 6n-6p of 123]. For communication, there is a Communication Management Strategy, which defines how communication is managed within the project team and with those outside the team [32, pp. 3d-3h of 123]. Figure 12 describes the PRINCE2 Project Management Structure and Figures 10 and 11 describes the PRINCE2 Process Model Diagram.

3.1.3 V-model

The V-model is a software development process that is almost like the waterfall model. In the V model, the process steps do not move linearly downwards but turn upwards after the coding phase, resulting in a V-shaped process model. The software development lifecycle (SDLC) consists of steps that application developers consider necessary, such as planning, analysis, design, and implementation. The V model demonstrates the relationships between each stage of the development lifecycle and the associated testing phases. This development process and model is balanced, which means that the output of each stage must be reviewed and approved before it can proceed to the next stage. This model requires close collaboration between the developer and the tester. System-level testing, high-level integration testing, and low-level integration testing are prepared well before testing can begin. Once the programming and coding are completed, all testing is conducted in order. In the V-

model there is a relationship between each stage of development and each stage of testing. The V-model is shown in Figure 13.

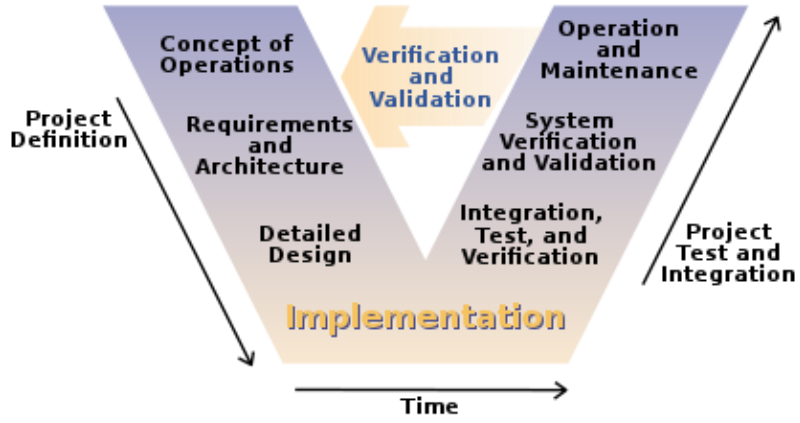

Figure 13: V-Model [33].

Since the V-Model is almost the same as the Waterfall model, its **project management** model is similar and follows the same principles as the Waterfall model. A small difference is the role of the Tester, which is already considered in the requirement phase. Because the V-Model follows the structure of the Waterfall model, it is quite poorly adaptable to changes that occur after the start of the project. If changes are to be made, then the requirement documents and test documents must be updated, and the coding and testing must be done again. The V-Model may not be suitable for small projects with insufficient resources [34].

3.2 Agile project management methods

For agile PM, I have selected later-named project management models that differ from the traditional PM. These are characterized by the functionality of the software, but these models can react quickly and easily to new, necessary changes. Communication is fast, and it reaches everyone instantly. Risks are reduced by rapid iterations. Such iterations last from about a week to two to three weeks. Each iteration is like a miniature project, including all the tasks related to project management, i.e., project planning, requirements analysis, program design, programming, testing, and

documentation. The benefit of this is that after each iteration, software intended for publication is created. The group involved in the implementation of the project is quite small, including only the necessary tasks and roles. Agile PM does not ascribe documentation as much value as traditional PM. Direct, instant communication replaces documentation. In this model, personal chemistry and competence must be present. There is no real project manager at this level. The role of the project manager may come into question when the scope is expanded [35]. Known Agile methods are Scrum, Kanban, and eXtreme programming (XP) [36].

Agile methods are traditionally based on twelve principles, which are as follows: 1) The most important principle is to keep the customer satisfied by providing valuable information as early as possible and continuously. 2) Agile methods allow for changes even at a later stage. 3) Software versions can be brought into production faster than traditional methods. 4) Businesspeople and software development members need to work together daily. 5) All individuals involved in the project need to be motivated.

6) Face-to-face meetings with the development team are important. 7) Functional software is the best measure of the progress of the project. 8) Agile software encourages a sustainable way of working. 9) A good structure of technical quality and software helps with agility. 10) Agile work is simple. 11) Self-directed teams produce the best architectures, specifications, and technical designs. 12) Assessments of one's own work performed at certain intervals ensure the best opportunity to develop one's own work and improve the reliability and quality of delivery [2].

In an agile method, IT personnel are required to have a wide range of platform knowledge and specific skills, including proper methods, techniques, behavior, and engineering. Software development projects contain several values, techniques, roles, and tools. There are differences in roles between different software development projects [37, pp. 157-165].

In agile methods, **IT roles** mainly focus on teams and the work tasks of team members, which include planning, programming, and testing. Tasks and roles may vary within the team according to the specific need and competence. What these agile methods have in common is that teams are very much self-directed and are not managed in the same way as traditional projects under the strong guidance of a project manager.

Teams communicate with the stakeholders, and substance experts to decide what is expected of the team in terms of the project, and what the team should do during the next iteration. The team also participates in testing and acceptance of deliveries with the user and customer organization.

Risk management must be considered and planned for in all tasks so that the project can be successfully completed. Agile PM methods have their own risks, which should be considered when choosing and using the method. Risks to scheduling and requirement specification are the biggest risks that the team needs to be aware of and manage. Financial and security risks should also be well known. All financial matters and terms must be finalized before project initiation. Financial risks for a project can also arise if it is not given an absolute limit that it must not exceed [38, pp. 162-166].

The **strengths and weaknesses** of agile PM are also worth noting. One of the biggest strengths of agile PM is effective and functional communication between team members and increased communication between the team and stakeholders. Project management practice is simple and effective without major formal protocols. The customer provides continuous feedback that allows the team's work and product to be improved quickly and immediately. One of the strengths of the agile method is that it is easy to manage unclear and changing capabilities and changes without major problems. Productivity is also easy to measure with daily meetings and clear iterations. These strengths can easily be obtained, at least in smaller and medium-sized projects. **Weaknesses** in agile PM methods include the fact that project participants do not always have the best and latest knowledge of the project management model in question. Technical skills, coding, and demanding communication may be lacking. The methods may be simple to understand, but they can be remarkably difficult to master. These models do not give much attention to documentation, so it can be difficult to understand and change things later. The architectural design of the systems may be made quickly and therefore not be the best possible. Planning is somewhat behind, and quick task initiation and coding may replace design. The team members' affiliation and collaboration may be unclear in some cases, as they do not always have clear roles [25, pp. 209-219].

3.2.1 Scrum

Scrum is the most widely used Agile project management system in the United States, and its use has also increased in other parts of the world. Although we focus on the processing of information system projects in this study, Scrum is also applicable to other types of projects [39, p. 33]. Scrum is an empirical process based on small teams working intensively and independently. The term "Scrum" comes from the English rugby game, where it is used to restart the game when it is interrupted by an event. This same analogy also applies to the Scrum method. Scrum is a very flexible method, and if there are problems with plans, then new plans can be made to replace the old ones and thus start again. An iterative and incremental approach is used to optimize work and minimize risks [40, p. 3].

Scrum is an easy and lightweight framework that allows teams and organizations to implement easily adaptable solutions to problems and tasks. In short, Scrum is a method in which the Scrum Master takes care of and oversees the development environment in which the Product Owner orders the issue to be resolved and logs it into the Product Backlog. The Scrum team selects and executes the tasks recorded in the product backlog by selecting the tasks to be imported into the **Sprint**, which is the main function of Scrum in which actual development work is done. At the end of the Sprint, the Scrum team reviews the results with stakeholders. The results are recorded in the next Sprint, where new tasks are added from the product backlog to replace the completed tasks. This method is repeated until all tasks in the product backlog have been processed and completed [41]. The Scrum Method process is shown in Figure 14.

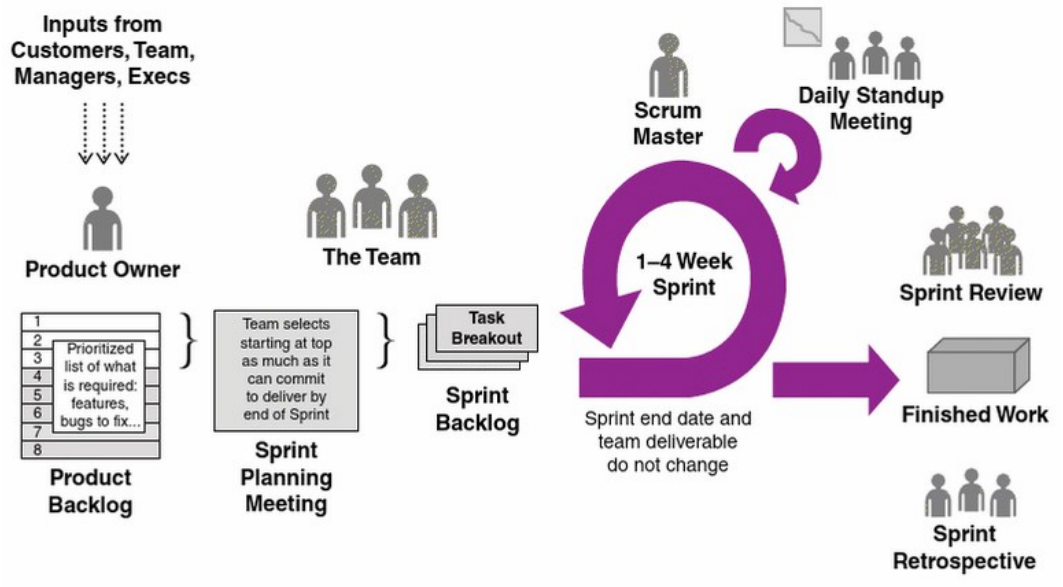

Figure 14: Scrum framework [39, p. 39].

Scrum has Artifacts representing work or value. They are used to maximize the transparency of key information. Each artifact has a commitment to ensure that it provides information by increasing transparency. Artifacts include Product Goal in the Product Backlog, Product Goal in the Sprint Backlog, and for the increase, it is the Definition of Done [41, p. 8]. “The Definition of Done is a formal description of the state of the Increment when it meets the quality measures required for the product. The moment a Product Backlog item meets the Definition of Done, an Increment is born.” [41, p. 12].

In Scrum, a development project can have one to several Scrum teams, each of which has three roles: Project Owner, Scrum Master, and Development Team. The Product Owner is responsible for what tasks are included in the Scrum project and in what order they should be done. His job is to maintain the Product Backlog, bring the necessary information for the Scrum team's work, order tasks for the team, and ensure that the Product Backlog is visible to everyone and that everyone understands the content and importance of the tasks. The product owner represents the project sponsor, plays the role of project decision-maker, and ultimately prioritizes tasks. The role of Product Owner has several elements that project management has, but it is nevertheless quite different. It is the responsibility of the Scrum Master to ensure that the Scrum

used corresponds to the Scrum method and that everyone involved in it understands the Scrum theory and the Scrum method. The Scrum Master also has responsibility for controlling team effectiveness. The two primary responsibilities of the Scrum Master are to ensure the productivity of the Scrum team and to monitor the status of the project throughout its delivery. The Scrum Team is a unified team of professionals that is not hierarchical and does not consist of subgroups, i.e., the team organization is quite simple. All members of the group have the necessary knowledge to increase the value of the Sprint. Since the team does not have a hierarchical structure, they decide internally who does what part of the Sprint. The group is self-directed and does not need outside support to complete the Sprint [39, pp. 33-38] [41].

Sprint ranges in duration from two weeks to four weeks. The duration of the Sprint is fixed, and its length is not changed. Larger and more demanding jobs are broken down to fit the duration of the Sprint so that they can be completed in one Sprint. No more tasks may be included in the Sprint than can be done in a single Sprint. No such changes are made that compromise the Sprint goal. The Development Queue can be specified, and scope can be clarified with the Product Owner. Changing the duration of a Sprint can affect the goal of the Sprint, but it can also be used to learn and thereby utilize it for product development. Each Sprint can be seen as a short project. The Product Owner may cancel the Sprint if the Sprint Goal expires or is incorrect. Otherwise, the Sprint will not be cancelled. Sprint is planned at the Sprint Planning Meeting. Such a meeting lasts from four hours to eight hours, and the meeting is led by the Product Owner. The proposals of the meetings are recorded in the Product Backlog, after which the Scrum Team forms the Sprint Backlog, i.e., the work that is to be done during the next Sprint. The Sprint includes the Daily Standup Meetings, which are held at the same time and in the same place every day. The duration of the meeting is only 15 minutes. Each member of the development team briefly explains what he has done and what he intends to do before the next meeting. The meeting will also report on possible disadvantages and obstacles preventing work. This meeting is attended only by members of the development team [39, pp. 40-43] [41].

Each Sprint is followed by a **Sprint Review** to check the Sprint result and, if necessary, update the Product Backlog. Sprint Review is a working session where the focus is only on the output of the Sprint. It is good for the development team to present the

completed implementations to the Product Owner before the Sprint review so that everyone has sufficient information on the matter. The product owner accepts the finished work at this point, and it is taken off the Product Backlog. The Sprint Review is the second-to-last event of the Sprint, with a duration of four hours for a month-long Sprint. The final stage of the Sprint is the **Sprint Retrospective**, where the product owner goes through the situation with the Scrum Master and the team. They assess whether there is something at work to improve the following Sprints or whether everything is in order [39, pp. 43-44] [41].

3.2.2 Kanban

In addition to Scrum, Kanban is also an effective and much-used Agile method. Kanban includes benefits that help improve the project management process. The concept of kanban was first introduced by Toyota; the term kanban comes from a Japanese word meaning "sign". It is a process management system based on a visual system that can be used to manage information and work using Just-In-Time (JIT) delivery. JIT does not cause extra work for the team because the Kanban method aims at eliminating all unnecessary work and shortening waiting times. As a result, the products can be delivered faster than without the Kanban method. Kanban is an agile method in which delays in the process flow are eliminated or reduced in the development of software projects. According to the Kanban method, a member of the development team may only have one task at a time on which he is working. Once a team member completes his or her task, he can take on a new task to continue working on [42, pp. 2535-2538].

The Agile Kanban method has five **principles**, which are: 1) Workflow Limitation (WIP = work in progress), which is the first core principle. This defines the maximum number of tasks. 2) Workflow visualization, which is another core principle. This is the process of describing mechanisms, interactions, expectations, queues, and delays. 3) Flow measurement and control to measure and express the throughput of tasks. 4) Explicit execution of process practices reflects descriptions of work that needs to be performed and defined particularly well. 5) Using models to identify opportunities for improvement. Kanban adopts a quantitative approach to creating improvements. In

addition to the principles, there are four **practices** which are: 1) Start with what you have, 2) Agree on incremental and evolutionary change, 3) Respect existing roles, processes, and responsibilities, and 4) Encourage leadership throughout the development process [42, pp. 2538-2539].

In the Kanban method, a table is used to visualize the project workflow and track the development process by displaying the actions and keeping the WIP in control of the project. The Kanban **board** makes it possible to focus well on the tasks of the developers. This control can reduce the resources needed and the time spent. Kanban cards are a key part of this method because they can be used to monitor the development process. The Kanban board is divided vertically into columns and steps. Each step is a reference to a task state, and each task is represented by a single card attached to the board representing the current state. Cards are moved from left to right based on status change. There are two types of boards: simple and detailed. It is up to the project manager to decide which card to use. Boards are shown in Figures 15 and 16 [42, pp. 2539-2540].

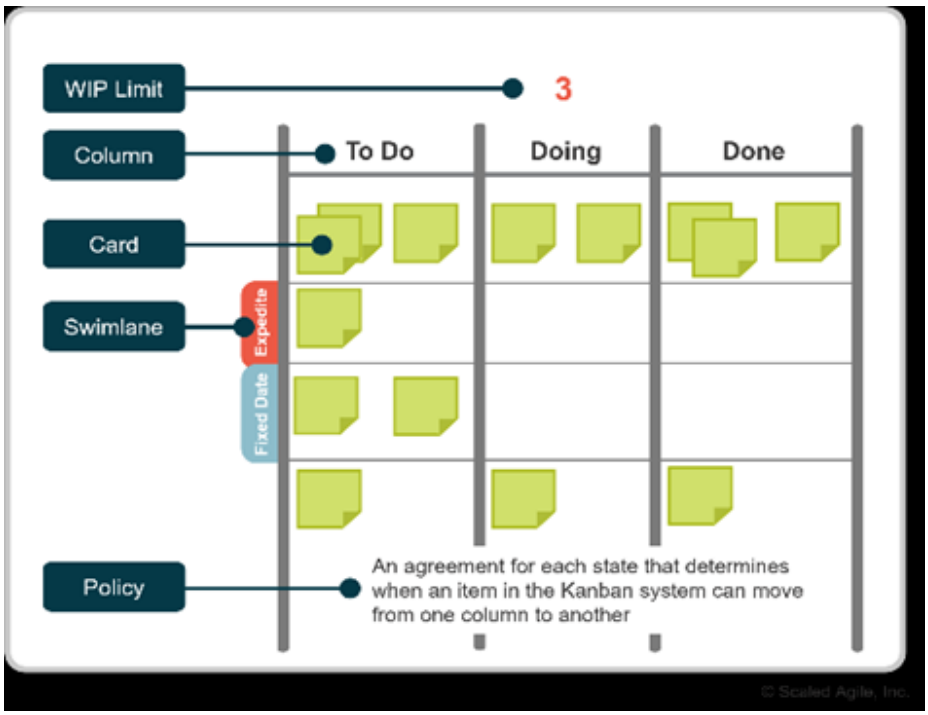

Figure 15: A Simple Board (© Scaled Agile, Inc.).

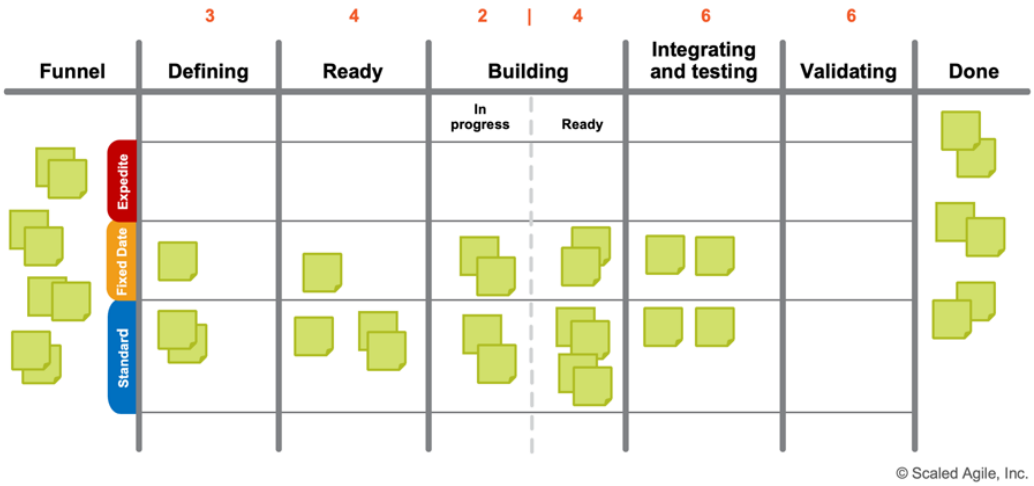

Figure 16: Detailed Board (© Scaled Agile, Inc.).

There are no similar **roles** in Kanban methodology as there are in Scrum, for example. Therefore, it is necessary to ensure among team members that the team has a sufficient understanding of how to proceed in the project and that the team also follows the method as it should. The Kanban process should be understood to make the best possible use of the method. If there is a need to create roles for a project in Kanban, then the team itself must consider whether a certain role is desired for the project. If a new role helps to shorten lead times, then creating a new role in the team will fulfill the principles of Kanban and a new role can be created. Ivan Shamshurin and Jeffrey S. Saltz have studied how to increase the Kanban method expertise, regardless of the lack of designated project staff. They introduced the Kanban Coaching method, where a Kanban Coach ensures that the team understands and follows the Kanban method, and supports and guides the team when needed, improving their understanding of tasks and processes as well as project quality and outcomes [43].

3.2.3 Extreme programming

Extreme programming (XP) was developed by Kent Beck in 1996. This model is best practiced for use by small teams with up to 20 people [44, p. 1] . It is a simple and easily adaptable development method and is suitable for unclear, ambiguous projects or projects where requirements change quickly. This model focuses on user

satisfaction. The best feature of XP is fast responsiveness to changes. This allows the tested, functional software to be delivered to the customer quickly and in small parts. One of the strengths is the close cooperation between the customer and the supplier [45, pp. 80-96].

The Extreme Programming development process consists of six **phases**: 1) Exploration, 2) Planning, 3) Iteration to release phase, 4) Production, 5) Maintenance and 6) Death phase as shown in Figure 17.

Exploration Phase is the first phase of the XP life cycle, exploring and describing the customer's product and its requirements, architecture, tools, and necessary software. At this point, the customer will start writing user stories that do not contain more specific details. The stories on the user cards consist of the order of importance, descriptive short name, and a sentence or two describing the story. User stories must be comprehensive and detailed enough for software developers to understand the task and its system requirements. Once the user stories have been completed, the development team reads them and gives feedback on them. Here are two of the core values of XP: giving and receiving feedback. After feedback, user stories can still be maintained to better match the desired implementation. The exploration phase lasts from a few weeks to a few months, depending on the skills of the developers and whether there are enough user stories for the development phase to start. 2) The **Planning Phase** begins immediately after the exploration phase. This phase begins with a planning meeting to determine which parts can be completed within the deadline and what the strategy for future integration would be. Work is prioritized and user stories are updated. The planning phase is short and only takes a day or two. The release planning goal is to arrange the user stories for the next iteration. This is a continuous procedure that can be changed by updating user stories.

3) **Iterations to Release Phase** is the most significant step in the implementation. At this stage, design, coding, testing and integration are conducted. The duration of iterations varies from one week to four weeks. The very first iteration defines the architecture of the entire system, so those narratives that best meet this need are selected for it. This progresses by having the developers select the tasks to be implemented for this iteration. The work is done as pair programming. In this method there are two programmers working together on the same code. One, the driver, writes

programming code, while another, the navigator, checks all the lines written in the code at the same time as they are written. After the code preparation, functional testing is conducted. If testing does not give the desired result, the task layout will be corrected or changed. Several iterations may be required to complete the development. The development process is monitored, and potential problems are discussed at stand-up meetings. 4) During the **Production Phase**, extreme programming publishes small releases of the software using an incremental process. Continuous publication enables development in iterations. One release cycle can consist of several iterations and each of these iterations can be one to four weeks long. In the production phase, development work is prioritized down to avoid risks in the production phase.

5) The **Maintenance Phase** is important and fundamental for all software. In XP, the correctness of the software is maintained and modified for a certain period. While the existing software is still being used, new functionalities are already being developed. No production-damaging changes will be introduced. 6) The final stage of extreme programming is the **Death Phase**. This stage is reached in two ways. In the first one the software is released and includes all the agreed functions, the customer is satisfied, and there are no more user stories. In the second case, it is evaluated that the development of the software should be discontinued unfinished by some rational and well-motivated decision [45, pp. 80-96]. See Figure 17.

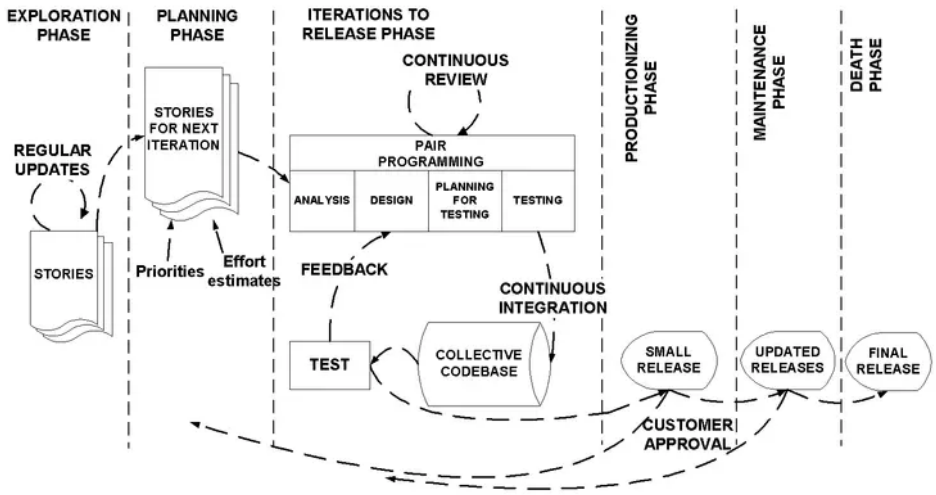

Figure 17: XP life cycle process [46].

XP has some project management **roles**, although efforts are made to keep the development work within the team and communicate as much as possible. In some cases, a group can perform better if its members have their own and clear roles. The roles in a project are divided among the members and one member can act in several roles. XP has seven actual roles. 1) The role of the **programmer** is the principal key role of the entire XP. His main task is coding. The programmer should have a good ability to communicate because the entire project team, including the programmer, communicates with the client. 2) Another key role is played by the **customer**, who defines the requirements of the software using user stories, performs the necessary testing, and verifies the tests. 3) A **coach** is a person with good technical skills and experience in seeing through the XP process. His or her leadership and communication skills help the team members stay on the right path. 4) The task of the **tracker** is to monitor the progress of the project by collecting information about load factors and tests. 5) The t**ester** is responsible for assisting the customers and helping in the design of functional tests. Testers also look at the testing of other team members, because virtually all programmers also conduct testing. 6) The Extreme programming team usually does not have a specialist, but if a team needs technical guidance, a **consultant** can be hired to help the team. The role of consultant is visiting, and he is an outside factor in the project. 7) A leader, **big boss**, can also be called a project manager or coordinator. He is responsible for the decisions and takes care of all the needs of the development team. He monitors the progress of the project and reacts to changes [45].

4 Project management selection

4.1 Basic information

The purpose of this study is to find out how to choose a PMM that suits the topic and needs of the project and what should be considered in the selection. This study combines an exploratory and a descriptive approach. The literature and studies in the field aim to find answers and explanations on how to arrive at a right solution. This study does not predict the future and does not attempt to explain or justify the current situation.

When a new project is being considered, several things need to be understood and clarified before the choice of the actual project model is made. A significant part are the requirements and approaches set for the project. These may change during the project management process, so being prepared for changes must also be considered. The complexity of the project may change during the life cycle of the project, and this should not come as a surprise. A general guideline is that the traditional project management model is well suited for managing structured projects in an environment with clear project requirements, a schedule, a budget, and a defined project scope. However, stakeholders and the project target groups are not always able to define all the necessary factors in the project requirements specification phase. If there are several open-ended questions at this early stage or if one hesitates to choose a traditional project management model, then it is well-motivated to look at other options as well. Alternative to traditional PM methods are agile PM methods. Agile PM project management models are best suited to situations where frequent changes over the entire life cycle can be expected. Agile PM is also suitable for managing unclear projects that lack clear goals and solutions. Such projects are risky and probably involve major changes. The success of a project and the success of project management are different things. Project management can be evaluated throughout the project, from the beginning to the end. In project management, it is important to achieve the goals, stay within the given budget, and guarantee the kind of delivery quality that has been agreed upon. The success of the project will only be known after long-term review and customer reporting [47, pp. 1-5].

In the agile PM approach, a continuous or potential change in the progress of the project is accepted. The more changes are made in the middle of the project, the greater the risks of the project will be, and the goal of the project may also disappear. Change should not be seen as a necessary means of directing the project but rather as an opportunity to influence the outcome and the goal if something important had been overlooked in the beginning. Customer needs have changed in the current market economy, and therefore project solutions also need to be fast to be able to meet the challenge [47, pp. 1-5].

4.2 Traditional project management approach

The traditional PMM is suitable for projects that are well structured, have a clear list of requirements, and have a clear goal. In such projects, the actions targeted at the project are pre-planned and, at the same time, predictable. All the necessary tools, techniques, and measures are clear when planning a project. The entire life cycle of a project must be clear and easy to understand. Traditional project management is characterized by dividing the project into manageable entities, or phases. These projects are characterized by a process-oriented approach that can be applied to an individual project, program, or portfolio in a broader context. All phases of the project must be well defined to avoid subsequent changes to plans and specifications. The traditional PM approach involves the management of successive independent steps, in which no step is repeated more than once. This model guides the project from phase to phase, provided that the previous phase has been completed before moving on to the next phase. Such progress requires very comprehensive planning and definition for all phases of the project. In fact, traditional PM projects are well-designed, well-managed, well-documented, and have an important focus on processes. The input and output of successive phases of the project are clear and easily recognizable. At the beginning and end of the steps, an assessment is performed, which is easy to do based on the specifications. Those checkpoints are called milestones [47, pp. 1-5] . The most notable guide to traditional PM projects is PMI's PMBOK [6]. It broadly defines the concepts of project management.

4.3 Agile project management approach

Agile PM projects are characterized by the fact that not all requirements of the project are known or can be defined at the definition stage at the beginning of the project. As a result, the progress of a project from one stage to another is different from that of a traditional PM project. Agile PM is an alternative PMM to the straight-forward, step-by-step method of traditional PM. The agile PM approach has certain advantages, such as the active involvement of the client and stakeholders in project management and project content. The agile project management model is suitable for projects where it is known what the goal is and what the result should be but where much of what should be defined and solved is still unclear at the start [47, pp. 1-5]. Agile PMMs are commonly used in the context of diverse types of agile PM. These often apply the 2001 Manifesto, which defines the twelve principles and four core values of agile project management (See Agile Project Management Methods). The agile PM project management approach has been able to respond well to questions and actions related to project management today.

4.4 Selection method of the project management

This section explains how data analysis is done and how it responds to the research questions and assumptions. Project management methods in traditional PM and agile PM are of interest according to the starting point of the research. This study also maps out users' interest in choosing a specific project management model. For new IT project managers and others, this study presents selection criteria for choosing a suitable project management model. The selection criteria are indicative and there can be several opinions about their reliability in choosing the right PMM, but these guidelines are nonetheless an indication of what should be considered when choosing a PMM for a project.

This study will determine whether the goal set for it is feasible.

- *The purpose of this study is to provide a sufficient understanding of different project management methods and determine whether the most suitable method can be deduced based on the given situation or whether the optimal method cannot be decided on.*

The management of the company may not know what all PMMs are available and what requirements should be considered for their own project. This kind of information is not always available to the project manager either, so it is good to have tools to facilitate the selection. To start planning a project, it must be known what kind of methodology will be chosen. There are several PMMs, but here we focus on selecting between the traditional and agile PMMs.

4.4.1 Selection method consisting of two stages

Igor Kononenko and his research team presented the PMM selection procedure at an IEEE conference in 2013 [48]. Their solution consists of a two-part selection method. The first part of the selection method is well suited to situations where decision makers do not have sufficient knowledge of which PMM should be chosen. The project manager and other decision makers may have knowledge of a method but not enough knowledge of its suitability or the possible standards to be followed. This is also the kind of situation that a new project manager will face and that he will have to solve. If project method selectors do not have enough time to compare alternative methods or do not have sufficient prerequisites to choose a suitable method, then it is a well-motivated idea to use existing means to choose the most suitable PMM. Kononenko's team of researchers developed a questionnaire for the selection of the project model, which can be used to map the recommended model using different sub-areas. The data in the tables was selected by the research group. The tables give an idea of how the selection has been approached. Alternatively, the research team has chosen the traditional PMM and the Scrum method for agile methods. The PMBok method refers to the traditional method, and SCRUM represents a single agile method here. We can extend SCRUM to generally mean the agile method [48, p. 578].

The survey consists of two parts. The ***first part*** briefly describes what kind of project we are considering (see **Table I**, [48]). Here the selectors give the name of the project, as well as what its scope and type are. The project product section briefly describes product, service, technology, and what the project produces [48, p. 578].

The ***second part*** contains a set of fixed-choice questions (tables II – VI). **Table II** [48, p. 579] explains the customer experience of working with this project team. Possible answers depend on the *customer's experience*. If a client has never collaborated with this team, the score is one. A traditional method is recommended. If he has worked with some of the team members, then the score is two. Even in that case, the traditional method is recommended. If the customer has collaborated with the team leader, then the score is three and one can choose between an agile or traditional method. Lastly, if the client has had one or more projects with the whole project team, then the score is four. In that case, an agile method is proposed [48, p. 578].

TABLE I. BRIEF PROJECT DESCRIPTION

Questions	Answers
Project name	
Project scope	Main strategic project aim. Brief description of innovation/project
Project type	R&D, creation of new product (technology, service), creation of new manufacture
Project product	Brief description of the product, service, technology, innovation created in the project

TABLE II. PROJECT TEAM

Questions	Possible answer	Score	Recommended methodology
Customer's (investor's) experience of working with this project team	Has never worked with this team	1	PMBoK
	Worked with some members of the team	2	PMBoK
	Worked with the project team leader	3	SCRUM, PMBoK
	One or more common projects with the whole project team	4	SCRUM

In **Table III** [48, p. 579], the project manager evaluates the experience of the project team. *The first question evaluates the experience of the project team in the field under consideration.* If experience is limited, the score is one, and the traditional method is recommended. If there is little experience, less than two years, then either of the two methods can be chosen. With more than two years of experience, the preferred method is the agile method.

The second question evaluates the team's ability to adapt and take initiative, as well as an overall understanding of the requirements. If the team does not understand the requirements, constant explanations and constant control are required, the best method is the traditional method, and the score is one. If the definitions are understood, but there is a need for constant control, then the score is two and the method is the traditional method. If the requirements are understood and can be followed and there is no need for continuous monitoring, then the score is three and the preferred method is the traditional method. If the group has a good understanding of the requirements and can work independently and do not require any special follow-up, then the score is four and the method is agile.

The third question is about the cooperation of the project team. If there is no cooperation at all, the score is one and the method is traditional. If there has been cooperation, but in a different field, then the score is two. Either the agile or traditional method can be chosen. If project team has worked together on the creation of one product in a field of interest, then the score is three and the method is agile. If project team has worked together on the creation of several projects in the field of interest, then the score is four and the method is agile.

The fourth question evaluates how well the team manages the tools and methods used. If the tools and methods are not familiar to the team, then the score is one and the method is the traditional method. If the tools and methods are familiar, but the team has not used them, then the score is two and the method is either a traditional method or an agile method. If the tools and methods are familiar and the team has used them, then the score is three or four depending on how widely they have been used. Score three means that there are tools and methods that have been used rarely and score four that usage has been comprehensive. In both cases, an agile method is recommended.

TABLE III. EVALUATION OF THE PROJECT TEAM'S EXPERTISE BY THE PROJECT MANAGER

Questions	Possible answer	Score	Recommended methodology
Work experience in the given field	No work experience.	1	PMBoK
	Experience of working in the field for less than 2 years	2	SCRUM*, PMBoK
	Experience of working in the field from 2 to 5 years	3	SCRUM
	Experience of working in the field for more than 5 years	4	SCRUM
Understanding of requirements, adapting ability, initiative	Almost do not understand the requirements; require frequent explanations and constant control	1	PMBoK
	Understand the requirements, can follow them, but require regular control	2	PMBoK
	Understand the requirements, can follow them, do not require regular control	3	SCRUM
	Have good understanding of the requirements; can follow them without regular control; can suggest better alternatives	4	SCRUM
Experience of cooperation	Have never worked together	1	PMBoK
	Worked together on the creation of a product, but in the different field	2	SCRUM*,PMBoK
	Worked together on the creation of one product in a field of interest.	3	SCRUM
	Worked together on the creation of several projects in the field of interest	4	SCRUM
Knowledge of applied tools and methods	Tools and methods, applied in the given project, have never been used before and are unknown to the team	1	PMBoK
	Tools and methods, applied in the project, are known to the team but have never been used before	2	SCRUM*,PMBoK
	Tools and methods, used in the project, are known to the team, but are rarely used	3	SCRUM
	Tools and methods are known to the team and have been widely used before	4	SCRUM
Learning ability	It is hard for the team to learn new knowledge and technologies, and to adjust to changes	1	PMBoK
	For some members of the team it is hard to learn new information and technologies, but the team can adjust to changes	2	PMBoK
	Easily absorb new knowledge, can adjust to changes	3	SCRUM
	The team can easily absorb information, always tries to learn something new; can well adjust to the changes	4	SCRUM
Team's ability to clearly formulate and openly express ideas	Can't clearly formulate ideas and rarely express them	1	PMBoK
	Can clearly formulate their ideas but rarely express them	2	PMBoK
	Can clearly formulate their ideas and openly express them	3	SCRUM
	Can clearly formulate, openly express and justify their ideas	4	SCRUM
Ability to admit mistakes	Don't admit making mistakes and can't learn from them	1	PMBoK
	Rarely admit their mistakes but try to never make them again	2	PMBoK
	Openly admit making mistakes and try to never make them again	3	SCRUM
	Openly admit making mistakes and always learn from them	4	SCRUM

The next point to evaluate, the fifth question, is how well the team learns new things and how well it can absorb new learned knowledge. If a team has difficulty learning new techniques and things, as well as difficulty absorbing new knowledge, then the score is one and the method is traditional. If only some team members have difficulty learning new techniques and things, but the team can absorb new things, then the score is two and the method is traditional. If the team can easily absorb new things and can well adjust to changes, then the score is three and the method is agile. If the team is doing well in adopting new things, and the team is interested in new things and can well adjust to changes, then the score is four and the method is agile.

The sixth question evaluates the team's ability to formulate things clearly, and openly express current issues and ideas. If the team does not know how to brainstorm well and they do not mention their ideas, then the score is one and the method is traditional. On the other hand, if the team knows how to brainstorm well, but they do not mention their ideas, then the score is two and the method is traditional. If the team can brainstorm well and bring out their own ideas, then the score is three and the method is agile. If the team can brainstorm and bring out the ideas they evaluate well, then the score is four and the method is agile.

The seventh question related to team expertise concerns the handling of mistakes made by the team. If the team does not admit to making mistakes and does not learn from their mistakes, then the score is one and the method is traditional. If a team rarely admits their mistakes but tries to learn from the mistakes they make, then the score is two and the method is traditional. When the team openly brings out their mistakes and tries to avoid making them, the score is three and the method is agile. And lastly, if a team openly admits mistakes made and always learns from mistakes, then the score is four and the method is agile.

The questions in **Table IV** [48, p. 580] aim to find out how communication and reporting affect which project management method would be recommended. *The first question explains what kind of tools are to be used in the project*. If there is a need for written reports and formal record-keeping, then the score is one and the method is traditional. If voice communication (telephone, Internet) is considered more important than the above, then the score is two and the method is agile. If there is a need for on-line communication, then the score is three and the method is agile. If direct communication (meetings, video conferences) is used for communication, then the score is four and the method is agile.

TABLE IV. REPORTING

Questions	Possible answer	Score	Recommended methodology
Means of communi-cation	Written reports. Formal record-keeping	1	PMBoK
	Voice communication (telephone connection, Internet-conference)	2	SCRUM*
	On-line communication (ICQ, E-mail)	3	SCRUM
	Direct communication (meetings, video confe-rences)	4	SCRUM
Frequency of reporting to the Customer	Reports on every opera-tion	1	PMBoK
	Reports on completing the blocks of work	2	SCRUM, PMBoK
	Reports on the readiness of a component of project's product	3	SCRUM
	Reports about project finish	4	SCRUM
Under-standing the scope of works	There is a full list of works; further alternation is impossible	1	PMBoK
	There is a detailed list of works, further alternation is possible	2	PMBoK
	There is an approximate list of project works	3	SCRUM
	The team understands the project goal and several ways for its achievement	4	SCRUM

The second question evaluates the frequency of customer reporting. If every event must be reported, then the score is one and the method is traditional. If, on the other hand, reporting is required after certain larger work packages, then the score is two and either method can be chosen, i.e., the traditional or agile method. When a client wants reports on the readiness of a project for certain products or applications then the score is three and the method is agile. If information about the end of the project or the final report of the project is enough, then the score is four and the method is agile [48].*The third question evaluates the understanding the scope of works*. If there is a full list of works; further alternation is impossible, then the score is one and the method is traditional. If there is a detailed list of works and further alternation is possible, then the score is two and the method is traditional. If there is an approximate list of works, then the score is three and the method is agile. If the team understands the goal of the project and several ways to achieve it then the score is four and the method is agile.

Table V [48, p. 580] goes through the project manager's responsibilities and main requirements for the project. *The very first question takes a position on the consequences of unsatisfactory project outcomes*. The first question approaches the issue with such an important question as whether it is possible that there will be loss of life. If such an option is possible, then the score is one and the traditional PM is chosen as the method. If the project might cause an irreplaceable loss of money, then the score is two. In this case, both methods are selectable, i.e., traditional and agile method. If it is possible to lose a significant amount of money, then the score is three and the method is agile. If there is a loss of comfort at work, then the score is four and the method is agile.

TABLE V. PROJECT MANAGER'S RESPONSIBILITY AND MAIN REQUIREMENTS TO THE PROJECT

Questions	Possible answer	Score	Recommended methodology
Consequences in case of unsatisfactory project outcome	Loss of life	1	PMBoK
	Loss of irreplaceable sum of money	2	SCRUM*, PMBoK
	Loss of insignificant sum of money	3	SCRUM
	Loss of comfort in work	4	SCRUM
Project cost	More than 1 mln. $	1	PMBoK
	From 300 thousand – 1 mln. $	2	SCRUM* PMBoK
	From 100 –300 thousand $	3	SCRUM PMBoK*
	Less than 100 thousand $	4	SCRUM
Requirements to the project quality	Highest international requirements	1	PMBoK
	International requirements	2	SCRUM*, PMBoK
	National requirements	3	SCRUM*
	Local requirements	4	SCRUM
Requirements to the realization period of the project	The period is unlimited	1	PMBoK
	Not very urgent	2	SCRUM*, PMBoK
	Urgent	3	SCRUM
	Very urgent	4	SCRUM

The second question deals with the impact of project costs on PM. The values given here are indicative and set by Kononenko's research team and must be proportionate to the needs of each project. If the cost is more than a certain amount of money (e.g.,

more than one million euros), then the score is one and the traditional method would be the preferred option. In the second option, the cost limit for the project could be some amount estimated to be appropriate (e.g., EUR 300,000 – one million euros). If this option is likely, then the score is two and the method can be either traditional or agile. When the cost threshold is lower (for example, between EUR 100,000 and EUR 300,000), the score is three and the method in this case can be either traditional or agile. In the last case, the cost is lower (for example, less than EUR 100,000), and the score is four and the method is agile.

The third question compares the requirements of the project with the desired quality of the project. If the requirements must meet the highest international standards, then the score is one and the proposed method is traditional. If the standards are lowered to normal international standards, then the score is two and the recommendation for a method is agile or traditional at one's own choice. If the project is satisfied with the requirements at the national level, then the score is three and the method becomes agile. If local level requirements are used, then the score is four and the method is agile.

The last related question deals with the requirements for the project implementation period. If there are no high demands on the implementation time and this is almost unlimited, then the score is one and the method is traditional. If the schedule is more accurate but not urgent, then the score is two and the method can be either, i.e., agile or traditional. When the schedule is urgent, then the score is three and the method is agile. If the schedule is very urgent, then the score is four and the method is agile.

Table VI [48, p. 580] describes the potential risks of a project. *The first question on the probability of risks asks about the possibility of technical, manufacturing, or qualitative risk.* If the risk is found to be most likely (95%), then the score is one and the method is traditional. If the risk is highly likely to occur (75%), then the score is two and the method is traditional. With the potential of success equal (50%), then the score is three and the method is agile. In the last option, the risk is not found to be likely (10%), so the score is four and the method is agile.

TABLE VI. RISKS PROBABILITY

Questions	Possible answer	Score	Recommended methodology
Probability of occurrence of technical, manufacturing or qualitative risks	Risk will most probably occur (95%)	1	PMBoK
	Risk is highly likely to occur (75%)	2	PMBoK
	Probability of risk occurrence is equal (50%)	3	SCRUM*
	Risk is not likely to occur (10%)	4	SCRUM
Probability of occurrence of external risks (disruption of work by contractors, unfavorable political, economic situation in the country, market changes, etc.)	Risk will most probably occur (95%)	1	PMBoK
	Risk is highly likely to occur (75%)	2	PMBoK
	Probability of risk occurrence is equal (50%)	3	SCRUM
	Risk is not likely to occur (10%)	4	SCRUM
Probability of occurrence of organizational risks (disruption of funding, delivery of resources, inaccurate prioritizing, etc.)	Risk will most probably occur (95%)	1	PMBoK
	Risk is highly likely to occur (75%)	2	PMBoK
	Probability of risk occurrence is equal (50%)	3	SCRUM
	Risk is not likely to occur (10%)	4	SCRUM
Probability of occurrence of managerial risks (inefficient planning, controlling, communication problems, etc.)	Risk will most probably occur (95%)	1	PMBoK
	Risk is highly likely to occur (75%)	2	PMBoK
	Probability of risk occurrence is equal (50%)	3	SCRUM
	Risk is not likely to occur (10%)	4	SCRUM
Requirements to the precise compliance with a deadline	The deadline should be strictly met	1	PMBoK
	Insignificant deviation from the deadline is allowed	2	PMBoK
	Considerable deviation from the deadline is allowed	3	SCRUM
	Compliance with the deadline is not strictly required	4	SCRUM

The second question deals with the likelihood of external risks occurring (diversification of contractors' work, unfavorable political situation, economic situation, and market changes, etc.). If the risk is found to be most probable to occur (95%), then the score is one and the method is traditional. If the probability of risk is highly likely to occur (75 %), then the score is two and the method is traditional. With the potential of success equal (50%), the score is three and the method is agile. If the risk is not found to be likely (10%) the score is four and the method is agile.

The third question concerns the probability of risks of the organization such as resources, prioritizing, etc. If the risk is found to be most probable to occur (95%), then the score is one and the method is traditional. If the probability of risk is highly likely to occur (75 %), then the score is two and the method is traditional. With the potential of success equal (50%), the score is three and the method is agile. If the risk is not found to be likely (10%) the score is four and the method is agile [48].

The fourth question concerns the probability of managerial risks. If the risk is found to be most probable to occur (95%), then the score is one and the method is traditional. If the probability of risk is highly likely to occur (75 %), then the score is two and the method is traditional. With the potential of success equal (50%), the score is three and the method is agile. If the risk is not found to be likely (10%) the score is four and the method is agile.

The last question concerns the precise compliance with a deadline. If the deadline should be strictly met, then the score is one and the method is traditional. If an insignificant deviation from the deadline is allowed, then the score is two and the method is traditional. If a considerable deviation from the deadline is allowed, then the score is three and the method is agile. If a compliance with the deadline is not strictly required, then the score is four and the method is agile.

The selection procedure described here helps the project manager and the person or organization responsible for the selection choose the most suitable method. One problem with the selection method can be the conflicting results of different blocks. If the results are contradictory, then one must rely on the recommendations that are more numerous. The choice of the PMM can also be influenced based on one's own preferences. If it is a matter of selecting a project management method of the company, then one needs to think about which option could be chosen as the standard for the company. If the project team has sufficient knowledge of alternative PMMs and has the time and resources to evaluate costs and the necessary human resources, then at this second stage it is also possible to consider what kind of risks the different options involve.

At the ***second stage*** the Kononenko's research presents an algorithm that can be used to estimate the project's work and costs for the desired method. The algorithm used to determine the work content and cost estimate of the method to be evaluated is multi-step:

- First, a methodology analysis is done as to how the project is managed, which processes are important, and how much project team members help lead the project.

- A list of the project manager's work is drawn up for the given method. All processes where a project manager is needed must be considered.
- Next, calculate the number of working hours of the project manager needed to manage the project.
- Identify processes that require the participation of other project team members and what the scope of that work is.
- Calculate the number of hours worked by each team member needed to manage the project.
- In the final stage, the total cost of project management is calculated according to Kononenko's formula as follows. See Figure 18.

$$\tilde{N}_{PM} = PM_{hr} * PM_{mh} + \sum_{i=1}^{m} PMA_{hr_i} * PMA_{mh_i} + \sum_{j=1}^{n} TM_{hr_j} * TM_{mh_j}$$

where:

PM_{hr}– project manager's hourly wage rate;

PM_{mh}–project manager's man-hours;

PMA_{hr_i}–hourly wage rate of an i-th project manager's assistant. An assistant can be represented by a business-consultant or any other professional, involved to managing the project;

PMA_{mh_i}– man-hours of an i-th assistant;

TM_{hr_j}– hourly wage rate of a j-th team member;

TM_{mh_i}– man-hours of a j-th team member.

Figure 18: Work content and cost [48].

Finally, the probability of risks (TABLE VI [48, p. 580]) for both methods is calculated. This gives a calculated reference number for both methods. Comparing these figures provides a recommendation as to which method is more appropriate to choose. The selection process is not easy to complete, especially if the survey results refer to different methods. The project manager must then decide based on the most

popular recommendations and at his own discretion. When optimizing the chosen method, the costs of management processes and their impact on the need for labor are considered.

4.4.2 Decision model for selecting project management method

Theo Thesing and his research team have conducted a study that answers the question, "How can a decision model be set up to select the most appropriate approach to a concrete project?" [26, p. 746]. The research team has developed a technique to assess which PMM is best suited for the chosen project. Their model is based on 15 criteria, which are divided in the following categories: cost, scope, time, organization, and the characteristics of the project team. Expert interviews and user perspectives have ensured a broad view to support the chosen model. They also found that agile PM methods and traditional PM methods can be combined, allowing the traditional, plan-based model to be expanded with agile models. In this way, the benefits of both methods would be exploited. This combination of methods was called a hybrid approach. The goals of Thesing's research team can be summarized as follows: what are the differences, advantages, and disadvantages between agile and traditional project management models, and what kind of decision model can be devised to choose the most suitable project management model? The study was conducted by analyzing six scientific databases from which information was retrieved using a key-word matrix. The criteria used in the database searches were currency, relevance, authority, purpose, and accuracy. Empirical expert interviews sought to ensure the generalizability of the results. There were experts from different fields, from companies of varied sizes, and their age structure was extensive. The experts represented industry, information and communication activities, and finance. Some of them worked as consultants and some in the public sector. The companies of the experts ranged from small companies with fewer than 50 employees to publicly listed large companies. Their age structure was from under 30 to over 60. Professional experience ranged from less than five years of experience to more than ten years of experience [26].

In the first phase the development of the decision model began with the overall modeling process presented in Figure 19.

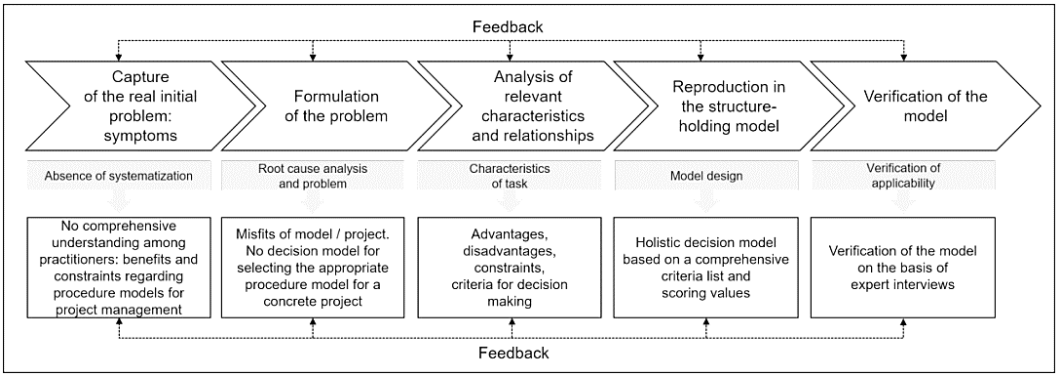

Figure 19: Overall modeling process [26].

In the second phase, a decision model was developed based on research and expert interviews. The decision model must be an appropriate framework for decision-making when choosing a project management model. The model must be of high quality, clear, and consistent. It should represent only those facts that are relevant to the selection of the project management model. Creating a model must not exceed the benefits it brings, and it must be easy to read, understand, and illustrate. The model must satisfy the principle of comparability, i.e., it must be possible to compare models based on methods. The structures of the models to be compared must be consistent according to their organization and processes. The study found some significant differences that need to be considered when choosing a PMM. The main difference between agile and traditional methods is their project planning character. The study found that there is a significant difference in the teams' work structure. In traditional methods, project work is central, while in agile methods, the work process is fast-cycled, open communication based, and flexible, shown in Figure 20.

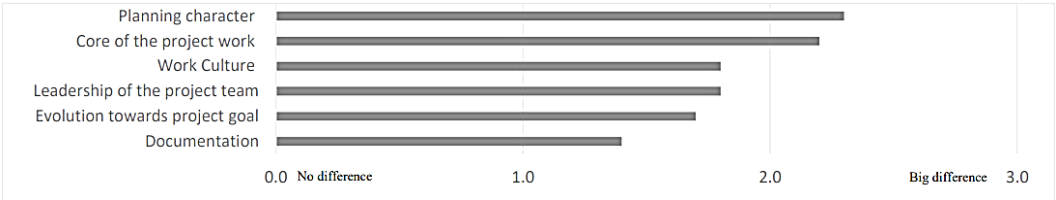

Figure 20: Characteristics of agile versus classical PM [26].

Other differences are not especially important. Both models have important advantages. In traditional models, the key advantages are fixed processes with roles and responsibilities. They are stable, systematic, and have comprehensive documentation. The progress of the project is easy to follow. See Figure 21.

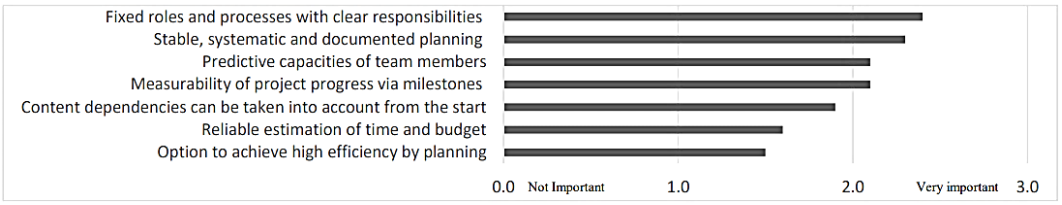

Figure 21: Advantages of classical PM [26].

The biggest advantage of agile models is their ability to react quickly to changed demands, partly due to customer feedback. Agile methods can react quickly and dynamically to customer requirements. See Figure 22 [26].

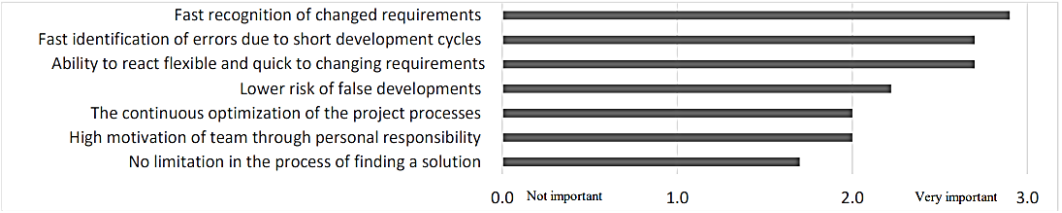

Figure 22: Advantages of agile PM [26].

The study finds that the major disadvantages of the classical PM are errors interpreted in the initial requirements, because of which the design receives incorrect information. See Figure 23.

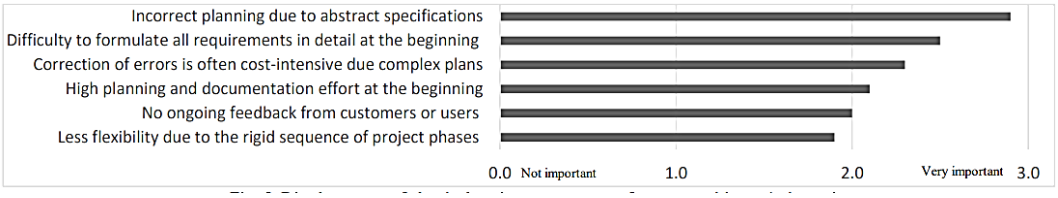

Figure 23: Disadvantages of traditional PM [26].

The major disadvantages of agile PM include cultural differences and terminology that can lead to problems in terms of planning, reporting, and management in general. Much is expected of the team, so there is also a considerable risk. See Figure 24 [26].

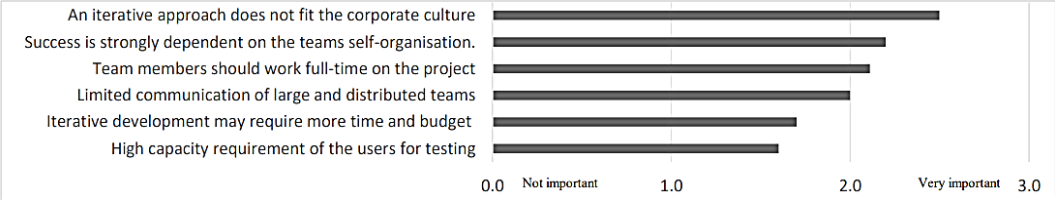

Figure 24: Disadvantages of agile PM [26].

The approach proposed by Thesing's team of researchers is simple due to the structure of the decision-making model. The model is understandable, simple to apply, and has practical relevance. This study uses a similar approach to Boonstra , where projects are divided into four dissimilar project categories, which are 1) design projects, 2) negotiation and competence projects, 3) development projects, and 4) negotiation, competence and development projects [49, pp. 337-342]. This research differs from Boonstra's research in that, instead of four categories, it allows for more accurate and finer customization of the methodology because the results are specific to five important dimensions, which are scope, time, costs, organization, and project team. Decision making is divided into two phases. In the first phase, rough exclusion criteria are used, and in the second phase, more detailed list-based criteria are used to make a more detailed evaluation of the project. This process modifies the model for a specific project and situation to ensure that the project is consistent with the existing processes of the company or project user. Exclusion criteria are the characteristics of projects that prevent agile methodology from being used as a procedural model covering the entire project. The exclusion criteria may be specified due to the nature, organization, or characteristics of the project. If the project has the following features, then it does not fit the agile model: lack of decomposability, frequent changes are not possible, or criticality of the project. Another obstacle may be the nature of the organization or the requirements of the project sponsor, which can be obstacles to the agile method if the management does not understand it or the organization has difficulty delivering incremental updates to the project. See Figure 25 [49].

Step 1: Exclusion criteria	
1.1	**Nature of project** - *Decomposability:* Solution cannot be implemented in increments. The technology used is not suitable for prototyping. - *"One-shot game":* Frequent changes are not possible from a legal/technical perspective or are associated with unacceptable costs. Examples: building a house, transferring a manufacturing plant. - *Criticality of project:* Operation risks prohibit an iterative, agile approach. Examples: process control/real time applications, safety-critical applications. Obligation of proof in the sense of a traceability requirement.
1.2	**Nature of sponsoring organization** - *Sponsor and management* do not support or accept agile philosophy. - *Organization* is not able to accomodate frequent delivery of increments.

Figure 25: Step 1, Exclusion criteria [26, p. 753].

After step one, if even one exclusion criterion is in place, then the success of the agile method is at risk, and it is not worth choosing. Instead of an agile model, a traditional project management model is recommended in this case [49, pp. 337-342]. If the agile model is not excluded, then the model will proceed to the second stage; otherwise, the traditional model has already been chosen.

The second stage has 15 criteria that should be scored. The criteria are grouped into the following groups: scope, quality, risks, critical time-to-market, time, budget, people and culture, organization, and project team. The criteria use the scale: (4) characteristics are fully applicable, (3) characteristics apply to a significant extent, (2) characteristics are partially applicable, (1) characteristics apply only to a limited extent, or (0) characteristics do not apply. When scoring, it can be stated that a high score represents the traditional project management model while a small score represents the agile project management model. See Figure 26.

Step 2: Selection Criteria	
2.1 Project constraints – "magic triangle"	
Average	**2.1.1 Scope, quality and risks**
Score	**Low dynamics and low uncertainty of customer requirements** *Scope and quality requirements* are complete, detailed, stable, and provided at an early stage of the project. *Novelty level/level of innovation* is low. The project does not require very creative work, necessitating frequent changes in scope. Level of customer involvement/engagement needed is low. *Level of complexity* is fully understood by the project team. Risks are fully captured at an early stage of the project.
Score	**High visibility of customer requirements** *Customer and user requirements* are available in a written form and signed at an early stage. *Requirements* can be clearly prioritized by customers, e.g. in categories "must have," "could have," and "will not have." There is *no highly demonstrable user interface* available. *Documentation* of approach and results is important.
Score	**Large size and high complexity of the end product** *High complexity of the end product,* especially with regards to interconnections between sub-projects/parts of the overall solution. *Interdependencies of deliverables:* Against the background of the project contents, each phase can be started only once the preceding phase has been completed. *Solution cannot be implemented by increments* due to the nature of the project. Solution is aimed at *delivering re-usable components. Approved documentation is required.*
Average	**2.1.2 Time**
Score	**Critical time-to-market** needed for a minimum viable product or go-live date. Timescale is fixed: Planned end date must be strictly adhered to.
Score	**Reliable and detailed prediction** of project duration is required.
Score	**Long project duration** or length of release cycle is relatively long.
Average	**2.1.3 Budget**
Score	**Detailed and reliable estimation** of effort and cost are required. Fixed cost estimate is demanded by customer (cost cap).
Score	**Outsourcing of project activities** at fixed prices is planned to reduce the risk of miscalculation.
Score	**Easy estimation of effort/costs**. Potential future changes of scope do not result in high costs.

Average	**2.2.1 Organization**
Score	**Organization type and culture** Characterized by hierarchical, central control (in contrast to a collaborative matrix organization/no central control). *Team* is not empowered by the product owner to make decisions.
Score	**Level of stakeholder involvement** Low level of *stakeholder engagement* as it contrasts with the culture of the organization. Low level of *customer collaboration*, commitment, and domain knowledge: A quick and valid feedback cycle from stakeholders cannot be guaranteed on a constant basis. There is no clear *ownership* of the projects' outcome. *Senior users* are not committed to providing end user involvement. Organization cannot accommodate the frequent delivery of increments.
Score	**Cultural values of the organization** *Focus* on monetary success. *Structure and order* are given a high value of their own. Adherence to milestones and gate reviews are assigned a high significance. *High necessity of documentation* of deliverables. People feel comfortable and empowered by having their roles defined by clear policies and procedures. Subordinate values include *communication, collaboration, self-organization* / many degrees of freedom, feedback, and courage for innovative solutions.
Average	**2.2.2 Project team**
Score	**Personality characteristics** *Low flexibility* towards scope (ability, willingness). Team is not capable of *self-organization*. Low level of collaboration, communication, adaptation, testing, and learning. Not willing to validate their work to the best of their ability and improve their processes. Focus is on *communication via documents* in contrast to direct communication via meetings, working in one room.
Score	**Knowledge and experience** Low average *technical/functional/domain skill and experience level* with regards to project scope. Team members' tenure on the project is short. Low *skill level regarding agile methods*. Non-acceptance and low motivation to apply/learn agile methods.
Score	**Size and geographic distribution** *Size of the team* is large (> 10), and team members work in geographically dispersed locations (across offices, sites, countries, and cultures), thereby resulting in many interfaces and high coordination effort. *Team-internal personal relationships* are weakly developed. Effectiveness of communication is low.

Figure 26: Step 2, Selection criteria [26, pp. 753-754].

For the purposes of the final assessment, the weight of the categories and criteria may be changed for a justified reason. See Figure 27 [49, pp. 337-342]. In Figure 27, the scope of the project is the most major decision category, and the second is the organization. Other criteria are less important. If the scope of the project is clear and all requirements are described in detail, then classic project management has a good opportunity to successfully complete the project. If customer requirements change rapidly, there will be uncertainty in planning, so an agile project management model is a better choice than a traditional PM.

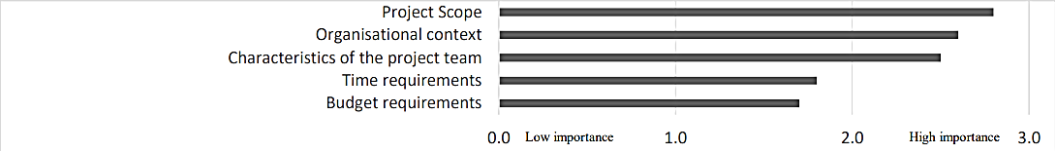

Figure 27: Potential weighing of categories [26, p. 752].

5 Analysis

5.1 Basic information

The purpose of this study is to find out whether it is possible to compare traditional and agile project management methods with each other so that one can choose the right and best method to manage projects. I deal with the selection criteria of project models based also on my own experience because I get then a simple and pragmatic perspective on the analysis. This topic is interesting because with a wrong PMM selection, project failure is possible, costs may rise, schedules may be delayed, and the result of the project may be a completely different outcome from what was desired when the project was set up. Bringing the project to the desired conclusion is rewarding and increases the project organization's self-confidence, competence, and willingness to act in an effective way. The success of the project also affects customer satisfaction. If a new project is being selected, the minimum requirement is that the project manager be familiar with traditional and agile methods with sufficient expertise. Similarly, possible ethical, social, and cultural differences should be identified so that there are no conflicts between the individuals and organizations involved in the project. Everyone should be treated with respect and in accordance with the law. Agreements must be adhered to, and all activities must be transparent and follow clearly defined ethical guidelines. The success of a project must take precedence over one's own success. Project method electors should be aware of whether they have free will, the ability to act outside of external influences when choosing a method, or whether they have a deterministic right with only one choice available. If there are practically no alternatives, then the entire selection process is unnecessary, and the PMM assigned by the management of the company is selected.

According to Gemino, research data shows that projects using the agile method, the traditional method, and even the hybrid method (combining the agile and traditional method) perform equally well in terms of budget, time, and quality [50, pp. 161-175].

5.2 Project management model selection analysis

I have chosen two studies to compare to achieve the goal set for this thesis. These are Kononenko's model, presented in Chapter 5.2.1 and Thesing's model, presented in Chapter 5.2.2.

5.2.1 Kononenko's model

In the first study, the choice of the PMM was approached using questionnaires by Kononenko's research group [48, pp. 578-582]. Their solution has six different questionnaires from different areas of the project. A new project is started by evaluating the kind of project in question. The *project being evaluated* is initially given a brief project description, which includes the name of the project, the scope of the project, i.e., what the main aim of the project being evaluated is, the type of project, and what the product of the project is, i.e., the purpose for which the project is set. When setting up a project, it is useful to consider whether the project has ethical values and legal issues or whether the project information is highly confidential. If there is such information, it should be considered when selecting the PMM and possibly adding suitable questions to the questionnaires. The questionnaire states that only brief information about the project is recorded. I have first-hand experience with projects that have been started quickly without a clear purpose or sufficient description. In such cases, the project sponsor and the project team may have a completely different idea of what is being done. I would like to stress here the importance of accuracy so that the project succeeds well within the agreed frameworks.

The following questionnaires [48, p. 579] specify the *project team's experience* of working together, whether the project field is familiar, and what the project team's under-standing and expertise are in terms of project requirements. Collaboration and expertise in the work of the project promote its success. If the project team is familiar to the customer and common projects have been conducted, then the success of the project is more certain in general because the customer and the team have a common way of working and a language to get things moving. Lack of common background in the team can affect the project schedule and duration of the work and should be

considered when assessing the team's workload and quality. If this is a multinational project, then it is a good idea to agree on how to take cultural, linguistic, and other differences into account in the project. I have been involved in projects where project team members have been located around the world. In such a case, communication plays a key role. Today, social media and working from home or otherwise remotely have increased over the past two or three years. Remote work as one of the options for project team members should be considered when planning a project. Questions such as when to hold meetings are important, too. There are some questions in Table III that I wonder about. If the project team members do not have experience in the area under discussion or do not understand the requirements definitions, then it is questionable whether they are suitable for the new project at all. In my opinion, a composition that does not have enough expertise should not start any project. The questions are still being posed by exploring the scope of cooperation, tools, methods, and learning. If a team member is experiencing major difficulties or does not have any expertise in the aforementioned areas, then I do not think he is suitable as a team member. The questionnaire further explores open, idea-rich thinking on this topic and the recognition of one's own mistakes. Incompetent team members are detrimental to the success of the project. Choosing a project management method cannot be based on the experience or inexperience of a team member. It is the responsibility of the management and project manager of the company to select team members who have the experience needed for the project. Heterogeneous competence is only beneficial to the success of the project.

Next, the questionnaires [48, p. 580] evaluate the *project reporting* methods, the project manager's responsibilities, and the main requirements of a project. Reporting is important for the flow of information, so it is beneficial to agree on the reporting tools, frequency, and scope of work. At the beginning of the project, it is important to assess the consequences of project failure, the budget and quality, and the time limit within which the project should be completed. Table IV is more suitable than previous tables to describe the difference between a traditional and an agile project. The chosen means of communication are well listed but could be put together into a single entity without all the options being treated as separate. Whether or not a phone, the Internet, or emails are used has no bearing on which PMM should be chosen. All the above-mentioned communication tools are used in all projects. The only distinguishing factor

is the amount and accuracy of the written documentation. The traditional method has more extensive documentation than the agile method. The frequency of reporting is also not a significant selection criterion. Kononenko's reporting does not consider how to manage extremely sensitive projects. These include, for example, military information, personal information, confidential information, and business-related information. The storage of this data has precise limitations and rules. Storage media should also be considered at a more specific level.

Table V deals with the *responsibilities* and main tasks of the project manager. The options for project failure have been taken to the extreme. It is not common for people to die when a project fails. In my opinion, this has nothing to do with choosing the method of project management. If people die, it is probably not the fault of the method, but it may be due to the end product of the method. Could a different PMM play a role in this? Perhaps this could be more widely evaluated if such an opportunity is likely .Large losses of money can occur in both methods. There is no way to determine whether the project will be successfully completed with or without big risks. These two questions in the questionnaire are somewhat irrelevant. The following two questions in the questionnaire are dependent on the method. The more rigorous and precise the project requirements, the more likely the traditional method will be chosen. Precise requirements cannot be changed in a traditional method, as in an agile method, but must be followed as agreed. The fast schedule favors the agile method because changes and short incremental additions provide quick-to-test application features for the customer. The traditional method proceeds according to the agreed-upon schedule. I have also had traditional projects conducted on a fast schedule, so I do not consider the fast schedule requirement to be a feature of the agile method alone.

Lastly, the potential *risks of the project* must be assessed, including what these may be and how likely they are. The questionnaires [48, p. 580] provide ready-made answers to each of the sub-areas. Each possible answer has a predetermined score, which can be from 1 to 4. According to Kononenko, the results of the questionnaire responses can be deduced from the fact that the smaller the score of the question, the more controllable and specific elements should be included in the questionnaire. In reporting, smaller scores represent broader, more frequent, and more demanding reporting and understanding. Here, the lower values of 1 and 2 represent the traditional

method, and the higher values of 3 and 4 represent the agile method. In terms of the project manager's responsibilities and main requirements, the lowest value of 1 represents major harm, a greater cost of the project, higher quality, and an agreed schedule, and the higher values of 3 and 4 represent minor harm, a lower cost, lower quality, and a tighter schedule. When assessing project risks, lower values of 1 and 2 represent a higher probability of risk (95% to 75%), and higher values of 3 and 4 represent a moderate probability of risk (50% to 10%). Even in this case, the lower score values support the choice of the traditional method, and the higher score values support the choice of the agile method. From the results of Kononenko's research, it can be generally stated that the lower point values support the choice of the traditional method, and the higher values support the choice of the agile model. In some cases, both methods are recommended on an equal basis, in which case the project manager and decision makers must use their own judgment and consider which method is best suited to the project being evaluated [48]. Kononenko's solution aims to assess risks even during project selection. If there are or will be significant risks in the project, I think the whole project should be questioned, perhaps left undone, or re-evaluated. There is no assurance that significant risk will not occur with the agile method as well. My views apply to all risk-related issues.

Kononenko's method seems quick and easy, but in practice, the selection process does not proceed so smoothly and simply. Before the process of selecting a PMM is completed, it is necessary to carefully determine the customer's needs. The questionnaires give a score, but its interpretation is difficult. The weight of the points given may not be the same in all sections of the survey, and the mutual evaluation of the sections for the project is not obvious. In my opinion, the questionnaires drawn up by Kononenko are indicative and should be specified to suit one's own needs. Kononenko's research creates an algorithm to evaluate the suitability of different methods [48]. See Figure 18. This algorithm is used to calculate benchmarks for both the traditional method and the agile method. The algorithm is given the project management and labor costs, as well as the estimated workloads. Risks and potential impacts are estimated, and the obtained method-specific figures are compared. With the formula, calculations are easy to do. Both methods calculate their own project management costs. Comparing costs and the effects of risks provides a recommendation for the method to be chosen. Finding out the recommended method

seems nevertheless clumsy and difficult to understand. I am not quite sure whether Kononenko's proposal gives the best possible method. Kononenko did not make his own assessments quite directly according to the model. In his own assessment, he used a software application he had made himself to find out the recommended PMM. Kononenko's software application was not used for this thesis, so I cannot evaluate its functionality; instead, I assess the functionality of the solution without the application. His study suggested that the method described can be used to infer the preferred method. I am not entirely convinced of the effectiveness of this method.

5.2.2 Thesing's model

The second model, Thesing's model, explores a procedure or model that makes it possible to choose a traditional or agile PMM. Thesing's research [26, pp. 746-756] is new and is in demand because few similar studies have been conducted. Thesing notes from his research that there is no decision model by which practical operators can choose a suitable project management model, which is why the research is certainly justified, and its result is noteworthy and can help to find a suitable method. I think Thesing and his group are on the edge of time. There is no one right project management model; there is a good method for each different project type. Thesing's motivation for the study was Joslin's research [51, pp. 1377-1392], which sought to determine the relationship between the methodology of the project and the success of the project. Joslin's research found that if the method is ill chosen, the project will suffer from it. Joslin also noted that there is a significant positive relationship between the PMM and the success of the project. Thesing's model is based on 15 criteria that seek information about the cost, scope, time needed for the project, the operational capability and competence of the organization, and the characteristics of the project team. The research was based on six different scientific databases (EBSCO, Emerald Insight, Disco, Google Scholar, Science Direct, and Web of Science), from which information was retrieved using a keyword matrix. 52 relevant sources were found in these databases, based on currency, relevance, authority, accuracy, and purpose. The six databases used in the study represent reliable scientific databases that support the quality of the research. Research based on databases was supplemented with expert interviews. The aim of the expert interviews was to ensure practical relevance to the

subject under study. German project professionals from various fields were used as experts [26].

The empirical survey [26] appears to represent comprehensively different sectors, companies, and age groups. A qualitative analysis of the answers was performed afterwards. Initially, the difference between the traditional method and the agile method was assessed. Based on the answers, the biggest differences between the methods could be found in the design phase. The traditional method was found to follow comprehensive advance planning, which ensures a stable and clear perspective. The agile model was found to follow a step-by-step and, as its name suggests, agile approach. This did not come as a surprise but was in line with research and project methodology expectations regarding the difference between the two methods. The method documentation differs quite substantially, but the difference was not considered a key question. A great similarity was found in the documentation requirements. According to this study, all interviewees agreed that the documentation requirements should be of high quality and relevant to the project [26]. Project documentation is important for later product or service maintenance. The interviewees were aware of this.

Thesing sought to find a model that would make the decision to choose a suitable project management model possible, understandable, simple, and easily applicable in practice. The aim here is not to give one and only one solution, but to help create one's own decisions and to ensure that all critical issues are considered [26]. Such a starting point is beneficial because projects differ in a high degree and no clear-cut selection criteria that would suit them all can be presented.

Thesing's model [26] starts quickly and efficiently. The first stage, which is an *exclusion criterion*, analyzes the nature of the project. The model states that a project cannot be managed by an agile model if even one of the criteria in sections 1.1 and 1.2 of the questionnaires is met. If there are exclusionary criteria, the traditional method can be chosen as the only method for the project. This first step seems like a valid and correct solution. If even one criterion is met in section 1.1 of the questionnaire, then the project is not in line with the essence of the agile method. In section 1.2 of the questionnaire, the project sponsor takes a clear stand on the project method, and it is a

good idea to respect that decision [26]. At this point, there could be a small chance of influencing the decision if there are well-motivated and justified reasons for doing so.

If the evaluation process [26] is continued, i.e., there are no exclusion criteria, 15 selection criteria will be reviewed and evaluated for selection. Each selection criterion is assigned a score value that can be 0 to 4. The value 4 means "features are fully applicable", 3 means "features apply to a significant extension", 2 means "features are partially applicable", 1 means "features only apply to a limited extension", and 0 means "features do not apply". Here lies the possibility of misinterpretation because the giving of values is subjective and different assessors can evaluate the issue differently. If the assessor is more interested in one method than another, it will have a significant impact on the choice. The evaluation should be as objective as possible and aim for a successful outcome [26].

The actual questions [26] that are scored for selection start with the *project constraints* questions, see Figure 26. Initially, the *scope and quality* requirements of the project will be examined. The quality of the project is certainly important to everyone, but we should now be able to assess how creative the work is and what the level of complexity is. This is not easy even for an experienced project manager, and certainly not for someone who is unfamiliar with the topic. There is a great chance of error. In my experience, people tend to judge such problems too positively. The extent and availability of customer and user requirements influence the choice of method. Regardless of the scope of the requirements, it is necessary to determine whether the coverage of the requirements is sufficient, whether the design of the requirements is correct, and whether the requirements are justified for the selection of the PMM. Here, too, expertise helps in the assessment. The choice becomes even more difficult when one begins to evaluate the final product and the interdependencies between deliveries. For example, if the delivery is distributed to several different operators, one must be careful and understand how the cooperation between the operators works. This is not necessarily controlled by small experience, and the possibility of a wrong assessment is high.

Section 2.1.2 of the form deals with the issues to be assessed in relation to the *time and duration* of the project. Here one needs to be able to assess how critical it is to get the product to market quickly and how long it will take for the software to be released into

production. Of course, this is not an IT or project decision; it must be a strong vision from the business management. The *budget* for the project to be evaluated is discussed in section 2.1.3 of the form, see Figure 26. No project can succeed without an adequate budget. To be able to provide these budget estimates, it is necessary to find out with the client what the costs of the project will be. When it comes to budgeting, experience is useful again. If experience is minor, then precise and in-depth negotiations with the customer and one's own organization must be conducted. In some cases, one may end up outsourcing parts of the project or even the whole project. In outsourcing, it is important to agree on exactly what each contractor will do and deliver, and in what time limit the deliveries will take place. In outsourcing, clear contracts, requirements, responsibilities, and the price of outsourcing must be established.

The *organization* plays an important role in the work of the project. Some companies have a hierarchical line organization based on centralized management, and others have a matrix organization where cross-sectional common-use processes have been created for the line organization. A line organization is clearly an organization of senior management, where each activity has a leader to operate under. The line organization should consider the possible slowness of decision making, the cost, and the fact that communication usually takes place from top to bottom, and that information is not easily shared with other departments in the second line. So, a line organization can be, in decisions that require speed and agility, somewhat inflexible. The benefits of a line organization can be seen within one's own team as good cohesion, solidarity, and help. In a matrix organization, a certain competence may be available to everyone, but the challenge may be the division of labor, i.e., which group or part of the organization receives services from a specific process within the matrix organization. If there is a need in a project for a specific process within a matrix organization, then the need should be noted well in advance so that it can be considered when drafting the project plan.

This becomes even more difficult if the cooperating organizations are in different countries or have *different cultures*. One of the most significant cultural differences is the language used in the company and on projects. Other noteworthy differences may be religion and what kind of power structure there is in different countries. I have worked in large international companies where an international language, such as

English, was used as the internal corporate language and as the documentation language. In some cultures, it is typical for customer and supplier staff to communicate only with staff of their own organizational level. This is common in Eastern cultures and even in Europe. I have first-hand experience with the English, where the English senior management mostly discussed with representatives of the Finnish senior management. The more possible cultural limitations the project has, the slower and more difficult the decision-making process becomes. When assessing an organization's impact on a project, it is necessary to carefully estimate the time needed for any additional work and the resulting costs.

The *project team* also has a significant influence on which PMM is best suited. When evaluating a project team, one must consider how flexible, collaborative, self-directed, and competent the team is. The project team should also be critical of communication and the development of the team's own work. If flexibility is lacking, or communication is weak, the choice of an agile method must be carefully assessed. If the team is required to have much documentation expertise and good drafting, then one should be somewhat careful with the agile method. The mutual appreciation, helping, and responsibility of the project team members support a very agile method. Not all project team members have the same expertise and training, but when selecting project team members, it would be a good idea to have a team that is as heterogeneous as possible, so that there would be expertise from several different areas and based on experience. A strong project team is a good place to learn for a team member who is not exactly a top performer. A well-functioning team helps its own members adapt to the team. Knowledge and experience are not in themselves limiting factors for the type of PMM. The shared competence, ability, and desire of the team to influence an ideal outcome of a project through good communication is key to successful project work [45].

Both methods evaluated are clear and understandable in their own way. They allow the project manager to make some kind of assessment of which PMM is worth exploring further. I will consider and present my views in the next chapter on the suitability of the models and whether they meet my goals for this thesis.

6 Discussion and conclusions

I will discuss in section 6.1 the goal of this thesis and why the goal is interesting and important. I present the results I have observed and found in section 6.2. In section 6.3, I will state my own view of the relevance and contribution of the results of this thesis. In section 6.4, I will discuss possible future research.

6.1 Background and study questions

The purpose of this study was to provide a sufficient understanding of different PMMs and determine whether the most suitable method can be deduced based on the given situation or whether the optimal method cannot be inferred in this way. The starting point is interesting because the use of agile methods has become more common and traditional methods have lost their luster as a leading method. Whichever method is chosen, the starting point should be based on knowledge and need, not so much on a feeling that this or that is better than something else.

6.2 Summary of findings

The purpose of this study was to provide a sufficient understanding of traditional and agile PMMs, their functions, the personnel required, and the specific competencies required. I chose these two methods, traditional and agile, because they together form a significant part of all PMMs and have been used for numerous projects. At the beginning of the study, I had the assumption that the process of selecting a suitable project management model is easy and a procedure for the selection can be created. After researching the matter, I did find abundant research and source material on how these two PMMs differ. Both methods are described in detail, but the actual instructions for a selection of the correct method are lacking. In some cases, it was suggested that both methods could be used in parallel or that a hybrid model of these methods could be formed, with the advantages of both methods. I wanted to keep the research clear and focus only on traditional and agile methods. Thesing notes in his own research that the selection procedure of the PMM has not been much studied [26].

Thesing's research also confirmed my own view that choosing a suitable project management model is not as clear an event as one might think. I searched and researched material I found in Google Scholar, dplb computer science bibliography, project management literature, and research articles. I found two studies that I decided to use as a framework for my research and an example of how the selection process can be created and how it can be used to move forward with choosing the right method.

6.2.1 Kononenko's model

The research done by Kononenko [48] and his team of researchers seemed interesting. They published their research at the International IEEE Conference in Berlin in 2013. I was supposed to research as recent studies as possible, preferably from 2020 onwards to the present day (2023). Since there are few similar studies done, I decided to accept that study into my own thesis. The research was clear and had the same aim as I did, i.e., to find out if it is possible to create a procedure to be able to choose the most suitable PMM. When Kononenko surveyed his own research, he found that there were many different project management methods available to choose from. The management of the company may not have sufficient knowledge and understanding of which method suits them best. It must be remembered that companies can have several different projects and all of them can have a different PMM. Kononenko notes that when choosing a PMM, deep expertise is needed in terms of methods, and standards, as well as knowledge of the company's own systems. This view would be slightly opposed to a starting project manager being able to evaluate the most appropriate method.

The questions in Kononenko's questionnaires could be reconsidered to a certain degree. The questions related to the basic information of the project are quite sufficient. The *project team's* previous work with the client can be problematic. It is not usual, at least in the case of software companies, for a customer to always be able to name a familiar project team. I do not think that team members' cooperation with the client will have as much impact as Kononenko recommends. I would consider that the team's expertise in relation to the customer's problem is the main thing, the familiarity between the team and the customer a secondary matter. The experience and

expertise of the team members play a significant role. This applies to all issues related to the expertise of the team [48].

Project *reporting* must be in order in all cases regardless of which PMM is chosen. Here it can be said that in traditional methods reporting and documentation is more comprehensive than in agility, but in my own experience of Scrum Master I would not leave reporting without attention. It is a good idea to write down the progress of one's team, the decisions made, and why these have been made. There may not be a major problem with reporting and documentation if the project is going well or in an excellent matter and the customer is satisfied. This is not always the case, and it is therefore good that protocols have been drawn up on the decisions. In the event of a dispute, it is useful to look at what has been decided, by whom, and why. In my opinion, reporting is not a key factor in choosing a PMM. However, it is important for the PMM's selection decision that all necessary reporting and documentation information is appropriately recorded.

Kononenko discusses the *responsibilities*, main requirements, and potential *risks* in Tables V and VI. Kononenko perhaps goes a little too far with his questions on the questionnaire. People may die because of the project or something else irrevocable may happen, but do these questions affect the choice of PMM? Of course, major risks should be considered when starting a project, but they alone do not affect the choice of the project model. All risks must be assessed and considered in the management of the risks of company level. In general, it can be said that the better things are planned, the better one prepares for everything. After all, there may be deaths in the hospital when the software malfunctions, the electricity may go out, foreign matter may enter the food, a war may break out, of a meteorite may fall to the ground. These are not matters of a single project alone; they need to be dealt with much more broadly. The crucial question here is whether the PMM chosen could have affected these outcomes.

One of the observations is that Kononenko *does not deal with* general ethical problems in his own research. He also ignores the specifics required by religions, different language areas, and time zones. In companies that make software, it is at least possible to face all those problems, and it would be recommendable to take them into account when choosing a PMM. At the very least, it would be useful to consider how to communicate with the project team and how to organize the meetings.

6.2.2 Thesing's model

The research of Thesing [26, pp. 746-756] and his research group is the second of my chosen studies that I am reviewing for my thesis. This research is newer than Kononenko's and has been presented at an authoritative international conference in 2020 and published in the journal Procedia Computer Science in 2021. Their research falls under the topic of project management under the themes of agile and classic project management, decision model, decision support, and the advantages and disadvantages of PPMs [26]. This article is supportive of my own conclusions.

Thesing's approach creates a procedure and model that guide and assist in the decision-making process of PMM selection. Literary analysis as a research method and the use of six scientific databases as data sources seem well motivated to me, especially when the results are compared to expert interviews. Based on the expert interviews, Thesing noted that the main differences between the traditional and agile methods are in the nature of the design methods the project. A traditional method has a focus on holistic design, stability, and long-term design. The nature of the agile method is somewhat the opposite. The expert interviews were in line with studies in the field. I think I would have ended up with the same results as an expert. I consider those findings to be correct and dependable. Thesing went on to ask the experts for their views on the advantages of those two methods.

The *strengths* of the traditional method were found to be fixed roles, stable and systematic reporting, and measurable project progress. The strengths of the agile method were found to be a quick response to changes and identifying errors due to development cycles. These findings are like those I recognize in myself.

The *weaknesses* of traditional methods were possible due to incorrect plans and abstract specifications. Formulating all the requirements at the beginning was also found to be demanding. Correcting errors was even found to be a difficult and costly procedure. Experts found the weaknesses of agile methods: the iterative process can conflict with corporate practice. It was also considered a weakness that the success of the project depends on the team and its methods of operation. Team members should work as full-time as possible on the project. Of these weaknesses I have some experience of my own. Certain experts of the Scrum project were attached to the

project, say with 20% attachment, when the need would have been 80 to 90%. The progress of the project was slowed down because the key person was unable to advance his own contribution. Such a situation can have an impact on other parts of the project and the schedule. I have also noted similar resource shortfalls on the side of traditional methods. Usually, the problem is that the person or resource one needs is not in one's own power: it is someone else who decides how to use him or it. The company's interests in prioritizing a particular project or task have a wide impact on the overall project work. These company management needs are almost impossible to predict. Changes can be very rapid due to, for example, government regulations and critical and extensive system errors, such as the unavailability of a banks' information systems. I have faced these sudden reprioritizations in my own projects.

The questionnaire [26] is divided into two stages. The first step is to clarify *the nature of the project* and the way the company's organization makes decisions. It explains the exclusionary features of the project. Thesing has solved the issue by saying that if any of the following features are realized, then the agile method is excluded from the selections and the traditional method is chosen: 1) It is not possible to implement the solution using increments. 2) It is a one-time, unique project or continuous changes are not possible. 3) The criticality of the project in question requires traditional method. In addition to these points, the support of the sponsor and management for the agile method must be considered. If there is no support, the traditional method will be chosen. I think Thesing has been very attentive to exclusive things, and they are obvious. If something is not possible, it cannot be started or completed. I absolutely agree with Thesing on this point.

The next step [26] is to move on to project content, quality, risk, time management, budget, people and culture, company organization, and project team. At this point, the questions are evaluated according to the evaluator's point of view by giving a score of 0 to 4. Zero means smallest or not significant, and four means especially important. The scoring seems clear, and I think at least an experienced project manager who is familiar with the issues will be able to use this kind of scoring method reliably, but not without sufficient knowledge of the project. The above is not in conflict with the following estimates because I am only focusing on the evaluation of the points. Scoring is a tricky approach in that sense because subjectivity is very much playing a role here.

Some people are more optimistic than others and thus maybe inclined to give higher scores.

The *scope and quality* of the project are greatly influenced by the level of project requirements and whether they are in written form, but measuring the difficulty of the project already requires considerable experience with similar projects. Evaluating the project schedule is difficult. From my experience, I can say that the time schedule is very often rated too short. Project managers tend to promise things finished before they have sufficient reports on the work to be done and what kind of resources are available. A *time-related* score must be accurately evaluated before it is given. The budget is important and should be known before beginning to give any estimates in terms of schedule or quality, see Figure 5 (Triple constraints).

The type of *organization* has quite an impact, as does of the organization or the country in question. Thesing has very well highlighted important points that need to be carefully reviewed and evaluated. The concept of the team itself may, in some contexts, be unknown to companies. It must be remembered that the project manager or team manager is not the manager of the people in the team, at least not always and in all projects. Team competence is the competence of team members and the necessary cooperation with other team members and other external factors. Thus, a team's scoring depends in a high degree on who is in the team and what their skills are. Assessing this requires considerable experience and possibly good knowledge of the way each team member behaves in all situations. If someone's pressure tolerance is low, then he is not suitable for a fast-paced and demanding project. If communication is a problem, or a person does not know the language needed, or there are other personal factors that hinder the work of the project, then such a person should not be selected for a project that requires these features.

The most important categories of the project should be identified, i.e., which factors are most important for the PMM. Thesing [26] clarified this in an expert interview. The most important factors in his research are, see Figure 27 (Potential weighing of categories): 1) Project scope 2) Organizational context, 3) Characteristics of the project team, 4) Time requirements, and 5) Budget requirements. Once the most important categories are clear, the scores given for these categories will be compared. The lowest value is "Low importance", and the highest value is "High importance". The greater

the value, the more weight it has in choosing a method. The selector must be able to determine from that information which PMM is best for his needs. At the end of his research, Thesing states that the characteristics associated with the scope of the project have the greatest impact on the choice of PMM. If the scope of the project is clear, the requirements are described very transparently, and in detail, then the choice of the traditional method PMM is likely and possible. If the above has been done with care, then the responsibilities, different roles, tasks, and processes of the project can be clearly described and documented. In this case, the success of the traditional PMM is possible. The only drawback of the traditional method, according to Thesing, can be considered incomplete design due to false assumptions. However, according to Thesing, this possibility is also marginal. The agile method is the best method to identify changing customer requirements. The best features of agile PMM are quick identification of changing requirements and speedy response to incorrect implementation [26].

In my opinion, Kononenko's research does not give a clear assurance that its model could be used for PMM selection. Kononenko's questionnaire questions were partially irrelevant or not useful for the selection process. If I had received Kononenko's questionnaires, I probably would have hesitated very much before I could have answered them. There will certainly be problems for a new project manager or someone who is unfamiliar with the field through that survey. If this method is to be used, then the questionnaire must be drawn up to fit one's organization.

Thesing's questionnaire was clearer and easier to understand than Kononenko's. Thesing's stage one, or exclusion criterion, is good. It quickly excludes the agile method if it cannot be implemented. The questions in it were easier to understand and better in content for the selection process. I might use Thesing's method, at least tentatively, to consider which PMM I would choose.

- *Using Thesing's method, either agile or traditional PMM can be selected.*

As a constraint, Thesing's model does not suit those unfamiliar with considerable and deep knowledge of project management.

6.3 Relevance and contribution

The thesis manages to give a sufficient overview and explanation of project management and to answer that a model assisting the PMM selection is possible and available. Thesing's model is suitable either on its own or with minor changes, at least to assist the PMM selection process. The model selection procedure is given with the restriction that using the model requires considerable and deep knowledge of project management. The method is not suitable for everyone, so an optimal result has not been achieved in this regard. The main problem with the study was that the chosen topic has not been studied very extensively, and for this reason access to information was somewhat limited. This, of course, gives more relevance to the thesis, as little research has been done on the subject.

In my opinion, the thesis meets the requirements for relevance and contribution to research.

6.4 Future research

The research could go further. The current models could be concretized to the level of a software application, so that the selection procedure would be even more useful than it is now.

Swedish summary – Svensk sammanfattning

Introduktion

Det finns många projektledningsmetoder (PLM) och det är svårt att välja rätt metod. Valet kan basera sig på tidigare uppgifter och erfarenheter eller så är valet av metod en företagsspecifik process. Vid valet av projektmetod är det viktigt att man tar hänsyn till IT-projektets behov och egenskaper, och därför vore det bra om metodväljaren hade ett verktyg som gjorde det möjligt att välja rätt metod. Ett sådant hjälpmedel skulle vara till stor nytta åtminstone för en projektledare vars erfarenhet ännu inte är så omfattande. I denna pro gradu-avhandling presenteras vad projektledning innebär och vilka alternativ som finns. Dessutom presenteras urvalsprocessen samt alternativ till, funktioner och användning av PLM. Denna pro gradu-avhandling handlar om projektledning, med betoning på informationsteknikens roll och perspektiv. Intresset för detta beror på min långa erfarenhet som projektledare för många IT-projekt i ett stort antal industri-, bank-, förvaltnings-, produktionsstyrnings- och ärendehanteringsprojekt. Jag har arbetat som mjukvaruleverantör i IT-företag och i kundens roll för att ta emot de levererade projekten. Många av mina projekt har varit internationella. Dessa projekt har varit framgångsrika, men det har också funnits projekt som inte har nått målen.

Jag har tidigare behandlat detta ämne i en kandidatuppsats, men det handlade bara om två projektledningsmodeller, med fokus på deras egenskaper.

Teoretisk bakgrund

Ett projekt är enligt definition en temporär satsning för att framställa en unik vara eller tjänst [4]. Ett projekt har betydande begränsningar som påverkar dess kvalitet. Detta kallas projekttriangeln (se figur 5). Den första faktorn är omfattning, det vill säga kundens krav på projektet; den andra faktorn är tid, vilket innebär hur mycket tid som kommer att läggas på projektet för att slutföra det i tid, och den tredje faktorn är kostnaden, som innebär den totala kostnaden för projektet. Om en faktor i triangeln påverkas, påverkas även de två andra faktorerna. Projektledning är ett verktyg som

omfattar färdigheter, verktyg och tekniker som gör det möjligt för projektet att möta projektkraven. Projektledning kräver också många andra olika verktyg, såsom guider, metoder och standarder. En av de viktigaste guiderna är PMBOK [4], där man mycket noggrant beskriver vad som ingår i projekthanteringen. Eftersom ämnet för denna pro gradu-avhandling är valet mellan en traditionell och en agil metodik, presenteras här några av de viktigaste metoderna för att klargöra likheterna och skillnaderna mellan dem. Traditionella projektledningsmetoder kännetecknas av att de sträcker sig från början av projektet till slutet av det, med beaktande av planering, testning och genomförande. Då dessa metoder används är det viktigt att all planering görs noggrant i förväg för projektets hela livscykel. Traditionella metoder är tydliga, kräver inga särskilda färdigheter av dem som deltar i projektet och innebär god dokumentation. Som nackdelar med en traditionell metod kan räknas att projektets krav inte får ändras under projektets gång och att kunden inte kan se den färdiga produkten förrän den är klar. Syftet med de agila metoderna är att minimera riskerna för projektledningen genom att dela utvecklingsarbetet i mindre helheter, så kallade iterationer. En iteration varar vanligtvis cirka fyra veckor och omfattar samma steg som ett större projekt har det vill säga projektplanering, analys, programdesign, kodning, testning och produktinstallation. Agila metoder är flexibla, färdiga produkter kan snabbt användas och dessa metoder anpassar sig väl till förändringar i specifikationerna. Nackdelar med de agila metoderna är bristen på förutsägbarhet och resurser samt bristande dokumentation. Traditionella metoder passar bäst för strukturerade projekt med bra kravdefinitioner och ett tydligt projektmål. Agila metoder är bäst lämpade för projekt som inte nödvändigtvis har ett tydligt projektmål, eller där projektets kravdefinitioner ännu inte är färdiga eller där innehållet i dem ännu inte är klart.

Val av projektledningsmetod

I det här avsnittet beskrivs hur dataanalysen har genomförts och hur uppskattningarna svarar på pro gradu-avhandlingens utgångspunkter och forskningsfrågor. I denna pro gradu-avhandling kartläggs vilka frågor som påverkar valet av projektledningsmetoder.

Syftet med denna studie är att ge en tillräcklig förståelse av olika metoder för projektledning och att avgöra om den lämpligaste metoden kan fastställas utifrån en viss situation eller om en optimal metod inte kan påvisas. Två enkäter analyseras, den första gjord av Kononenkos forskargrupp och den andra gjord av Thesings forskargrupp. Kononenkos undersökning omfattar en tvåstegsmetod där projektchefen först fyller i ett frågeformulär för att kartlägga det projekt som ska utvärderas. I formuläret poängsätts de punkter som efterfrågas och slutresultatet är den föreslagna metoden för projektledning. Det förslag som därefter läggs fram kommer att analyseras med hänsyn till kostnader och risker. Det slutliga urvalet görs genom att man bedömer projektet med hjälp av Kononenkos algoritm och genom att jämföra de modellspecifika resultaten med varandra.

Thesings forskning bygger på vetenskapligt källmaterial och expertstudier. Expertundersökningarna genomfördes med hjälp av frågeformulär. Undersökningarna visade vilka egenskaper som beaktades i traditionella och agila projekt och vilka som var styrkorna och svagheterna med respektive metod. Undersökningen var i två steg. I det första steget fastställdes om projektet var sådant att det inte kunde genomföras med en agil metod, då valdes den traditionella metoden. Om båda alternativen var genomförbara fortsatte enkäten med frågor om projektets omfattning, kvalitet, risker, tid, budget och organisation. Svaren poängsattes och resultatet jämfördes med viktningen av de olika aktiviteterna i projektet. Det alternativ vars egenskaper och poängsättning bäst stöder den önskade lösningen väljs som projektledningsmetod.

Analys

Vid analys av resultaten visade det sig att de använda forskningsmetoderna skiljde sig något från varandra. Resultatet av Kononenkos forskning var lite svårare att tolka än motsvarande resultat av Thesing. Enligt min mening borde Kononenkos metod och upplägget av frågorna ha öppnats upp lite för att klargöra saken. Kononenkos metod kräver ganska god erfarenhet av projektledning, och hans metod kan inte rekommenderas för den som inte har tillräcklig förståelse för projektledning. Thesings metod är ganska tydlig och lättförståelig. I hans metod görs ett val som utesluter agila

metoder om projektet inte passar dem. Enkäten är väl utformad och tar även hänsyn till etiska och andra begränsande faktorer, till skillnad från Kononenko-metoden.

Resultat

Denna pro gradu-avhandling ger en bra översikt av projektledning, metoder, riktlinjer och grundläggande begrepp. Det har även tagits ställning till etiska, språkliga och kulturella frågor. De olika metoderna för projektledning beskrivs och skillnaderna mellan traditionella och agila projektledningsmodeller diskuteras. Det kan konstateras att antingen en agil eller en traditionell projektledningsmodell kan väljas med Thesings modell.

Pro gradu-avhandlingen ger en översikt och förklaring av projektledning och bekräftar att valet av PLM är möjligt enligt beskrivningen i denna studie. Thesings modell lämpar sig antingen som den är eller med mindre ändringar, åtminstone som ett hjälpmedel i PLM-valprocessen. Proceduren för val av projektledningsmetod presenteras med den begränsningen att användningen av modellen kräver en mycket djup kunskap om projektledning. Det största problemet i mitt arbete var att det valda ämnet inte har studerats särskilt noggrant och därför finns lite information tillgänglig. Detta ökar naturligtvis vikten av masteruppsatsen, eftersom det inte finns mycket dokumenterad information i ämnet. Jag tycker att uppsatsen uppfyllde kraven på relevans och forskning.

Thesings forskning skulle kunna utökas på så sätt att modellen görs till en applikation som möjliggör val av projektledningsmetod.

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