Master Thesis

Tools for selecting optimal project management methodology in the information technology domain.

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Thesis Supervisors: Ing. Athanasios Podaras, Ph.D.
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Master Thesis Assignment Form

Tools for selecting optimal project management methodology in the information technology domain.

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- PROJECT MANAGEMENT INSTITUTE, 2021. *A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Seventh Edition and The Standard for Project Management (ENGLISH)*. California: Project Management Institute, ISBN: 1628256648.
- JOSLIN, Robert, 2019.*Project Management Methodologies, Governance, and Success: Insight from Traditional and Transformative Research*. New Jersey: Auerbach Publishers. ISBN:1466577711.
- GADISH, David , 2021. *The 6-Step Approach to Embracing Project Management For Increased Personal, Professional, and Business Success*. US: Amazon Digital Services LLC – KDP. ISBN: 1954713061.
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Anotace

Hlavním cílem tohoto výzkumu je vytvořit nástroj, který pomůže projektovým manažerům v oblasti informačních technologií optimalizovat výběr nejvhodnější metodiky projektového řízení pro jejich projekty. Výzkum bude probíhat ve dvou částech: teoretické a praktické. V teoretické části bude proveden přehled různých teoretických odkazů za účelem hlubšího porozumění typům a charakteristikám metodik projektového řízení. Na základě tohoto přehledu bude identifikována řada parametrů, které ovlivňují volbu metodiky. Výzkum také ukáže vztah mezi úspěchem projektu a metodologií, aby bylo možné identifikovat další faktory, které by měly být zváženy.

V praktické části výzkumu budou zaslány dotazníky projektovým manažerům v oblasti informačních technologií. Cílem těchto dotazníků je ověřit parametry identifikované v literární rešerši a určit jejich význam při výběru metodiky projektového řízení. Výsledky dotazníků budou použity k vývoji modelu, který dokáže optimalizovat proces výběru mezi agilními a tradičními vodopádovými metodikami.

Celkově má tento výzkum potenciál poskytnout cenné poznatky o faktorech, které ovlivňují volbu metodiky projektového řízení a vztahu mezi metodikou a úspěchem projektu. Výsledný nástroj by mohl být cenným zdrojem pro projektové manažery v oblasti informačních technologií, který jim pomůže činit informovanější rozhodnutí a zlepšit celkový úspěch jejich projektů.

Klíčová slova

Annotation

The main goal of this research is to create a tool that can help project managers in the Information technology domain to optimise the selection of the most suitable project management methodology for their projects. The research will be conducted in two parts: theoretical and practical. In the theoretical part, a review of various theoretical references will be done to gain a deeper understanding of the types and characteristics of project management methodologies. Based on this review, a number of parameters that influence the choice of methodology will be identified. The research will also show the relationship between project success and methodology to identify additional factors that should be considered.

In the practical part of the research, questionnaires to project managers in the Information technology domain will be sent. The goal of these questionnaires is to validate the parameters identified in the literature review and to determine their importance in choosing a project management methodology. The results of the questionnaires will be used to develop a model that can optimise the process of choosing between agile and traditional waterfall methodologies.

Overall, this research has the potential to provide valuable insights into the factors that influence the choice of project management methodology and the relationship between methodology and project success. The resulting tool could be a valuable resource for project managers in the Information technology domain, helping them to make more informed decisions and improve the overall success of their projects.

Keywords

Project management methodologies, Agile and waterfall methodologies, Information Technology domain, critical success factors

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List of Abbreviations

PMM   Project management methodology

IT   Information Technology

PMI   Project management Institute

ERP   Enterprise resource planning

CRM   customer relationship management

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Introduction

In order to accomplish corporate goals and strategic objectives, organisations turn opportunities into projects. All organisations may have the project success as their ultimate objective. Organisations employ a variety of tools and approaches that can help them move closer to attaining their ultimate goals in order to make projects successful. This is where the necessity for project management comes into play, allowing businesses to manage the project methodically and effectively(HAZEM, ,2019).

The usage of project management techniques has been growing gradually as a lot of industries have incorporated project management techniques in their processes and approaches. Major use of these techniques have been done in the **Information and Technology domain**. However there lies a huge problem in the way it is dealt with as the success rate of these projects are less. A study done by Standish group in the Information & technology domain showed that only 29 % reported project success, 52 % of projects faced delays and 19% projects were failed (TERESO, 2018). Analysing these types of situations in the domain, it can be understood that there is a lot of room for innovation and new models to be implemented.

One of these is about choosing a suitable project management methodology for the projects. According to a study conducted, project management methodologies help projects to succeed by over 22.3% (JOSLIN, 2019). By following project management methodologies (PMM), organisations can benefit from lower risk and cost as well as higher success rates. A team's approach to managing stakeholders, project phases, client demands, change management, and other factors can be determined by the project management methodology. The project can adhere to the goals that must be completed without deviating from them by using project management methodology, which offers structure and flexibility. Therefore, the focus of this research is on the significance of project management methodologies and the key variables that must be taken into account when making a methodology selection in the Information technology domain.

Goals & Research Description

The goal of the research is to create a tool which can optimise the selection of a suitable methodology for a project in the Information technology domain. And also give the readers a more detailed comparison of agile and traditional methodologies. In order to achieve the goal, it is important to find the parameters that influence the choice of methodology and also find the relationship between the methodologies and project success.

The research is divided into two parts namely theoretical and practical work. The theoretical part consists of gaining a deeper understanding about types and characteristics of project management methodologies through various theoretical references. Based on these theoretical references a certain number of parameters which influence the choice of methodology is considered. The theoretical factors can also be found by understanding its relation between project success and methodology. The practical part consists of sending questionnaires to project managers in the Information technology domain in order to validate the parameters considered in the literature review and to find the importance of the parameters while choosing the project management methodologies by the practitioners in the real world. Further these parameters will be considered in the model which can optimise the process of choosing a project management methodology.

Research Objectives:

- Understanding the relationship between project management methodology and project success.

- Identify the parameters that impact the choosing of the project management methodology.

- Rank the parameters according their importance in choosing the project management methodology

- Creation of a conceptual model which optimises the decision making for the selection of project management methodology.

1. Project Management Overview

According to the Project Management Institute(PMI), project management can be defined *"as the use of specific knowledge, skills, tools and techniques to deliver something of value to people"* (PMI, 2017). It consists of budgeting, stakeholder communication , scoping , strategy creation, meeting deadlines and many more.

There are two main models which are considered to be most important which are Waterfall model and Agile model. One gives a more linear approach towards the project and the other is iterative and incremental in nature. The project life cycle consists of four major stages: starting the project, organisation and preparation, carrying out the work and lastly ending the project.

Every stage can be further divided into 5 process groups –

- Initiating process

- Planning process

- Executing process

- Monitoring & controlling process

- Closing process

And all these process groups consist of 10 knowledge areas which are very essential for a project to be run successfully. These topics will be explained in detail in further sections (PMI, 2017).

1.1 Project Management Life Cycle

According to PMI, project management life cycle can be defined as "*the series of phases that a project passes through from its start to its completion"* (PMI, 2017). It can be viewed as the value delivered to the client across multiple project phases by a group of individuals working under the direction of a leader. In order to effectively complete the project, the project manager is regarded as the primary accountable job and must be well-versed in communication, comprehension, and leadership.

According to the PMI Talent Triangle, which was developed by the project management institute, a project manager should possess three key characteristics. Technical expertise that enables him to communicate with his technical staff and handle some technical difficulties in a difficult situation. He has business and strategic understanding that allows him to comprehend the needs of the sponsor and the client and formulate plans accordingly. leadership abilities that allow him to inspire and make sure his team works well together (PMI, 2017).

The some of the main key concepts and terms of project management are :

- Project

- Methodology

- Project manager

- Stakeholders

- Value delivery

- Scope

- Budget

- Process groups

Project is a temporary undertaking to achieve a goal which has to be delivered to the customer within a specific timeline and under the budgetary constraints. This means a project has a start and an end to it within which the project team works to achieve the goal according to the customer requirement. Methodology is the approach towards a project which can define how the whole project can be structured. Project manager is a person who is responsible for taking a project towards success by coordination with stakeholders and other important activities. Stakeholders are people who are involved or related to the project namely, project team, customers and investors (PMI, 2017).

The Characteristics of a project are :

- **Temporariness:** The projects are temporary in nature that means it has a definite start and an end.

- **Uniqueness :** Projects have specific goal which align with requirements of the customer therefore every project is unique and requires careful planning

- **Interdependence:** projects have multiple stakeholder from from different departments, therefore it is interdependent and requires efficient communication plan

- **Uncertainty**: projects involves risks and uncertainty which has to be mitigated accordingly

- **Constraints:** Projects have many constraints that have to be taken care of like budget, time quality etc.

(PMI, 2017)

Budget is the finance allotted for the completion of the project. There is a very big importance for this as there have been previous studies showing that a lot of projects in various industries go over budget which has resulted in even the closure of companies therefore budget is considered as one of the most important factors for project success (PACE, 2019).

Process groups are described as stages or phases in which the project moves in order to achieve the objectives and goals.

The process groups are

- **Initiating process** - processes which involve the thorough authorization and signing of the project charter to start the project.

- **Planning process** - this process involves scoping , creation of plans regarding schedule, communication with stakeholders, budget usage, risk planning etc

- **Executing process** - process involves carrying out the tasks designed in the project plan in order to fulfil the project requirements.

- **Monitoring & controlling process** - process involves in tracking the progress of the project and also keeping it on track by not letting it go out of scope.

- **Closing process** - process involves handing over the project deliverables to the customer and also formally authorising the completion of project.

 (PMI, 2017)
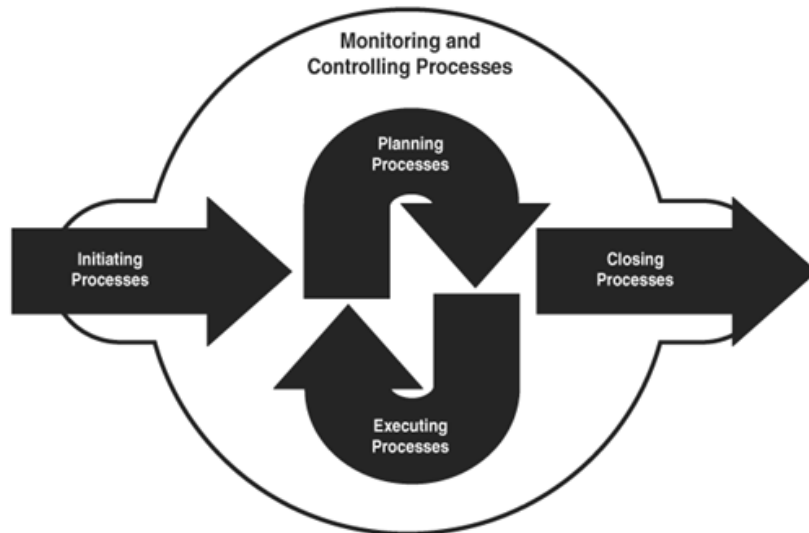
Figure 1- Process groups

Source: (PMI, 2017)

Knowledge areas can be said as the identified area which can add value to the project by providing inputs, contents etc.

There 10 knowledge areas in project management which are :

- **Project Integration management** - Project integration management deals with coordination between the various process groups where the people involved will be determined to integrate and coordinate various processes.

- **Project schedule management** - Project schedule management deals with making sure that the creation of schedule for the project takes place and deadlines are tracked and met.

- **Project cost management** - Project cost management deals with determining the operational costs involved during the course of the project. It also is the management of planning and allocating budgets so that the budget doesn't go over the board.

- **Project scope management** - Project scope management deals with scoping the project with the factors that are only necessary for the project and rejecting the ones which are not.

- **Project communication management**- It is the management of communicating with stakeholders and finding suitable ways to provide information to the stakeholders.

- **Project Quality management** - It deals with making sure that the goals are achieved with utmost quality and value so that it increases the customer satisfaction

- **Project resource management** - It deals with management of the resources like people , budget, supplies which are required for the execution of the project.

- **Project risk management** - It deals with understanding the risks which have the potential to impact the project and planning to tackle it. Usually risk management involves planning , impact analysis, response planning etc.

- **Project procurement management** - It deals with obtaining the supplies or inventory needed for the execution of projects outside the project team.

- **Project stakeholder management** - Project stakeholder management deals with the management of stakeholders by showing them the updates regarding the progress and getting feedback or also changes regarding the project.

(PMI, 2017)
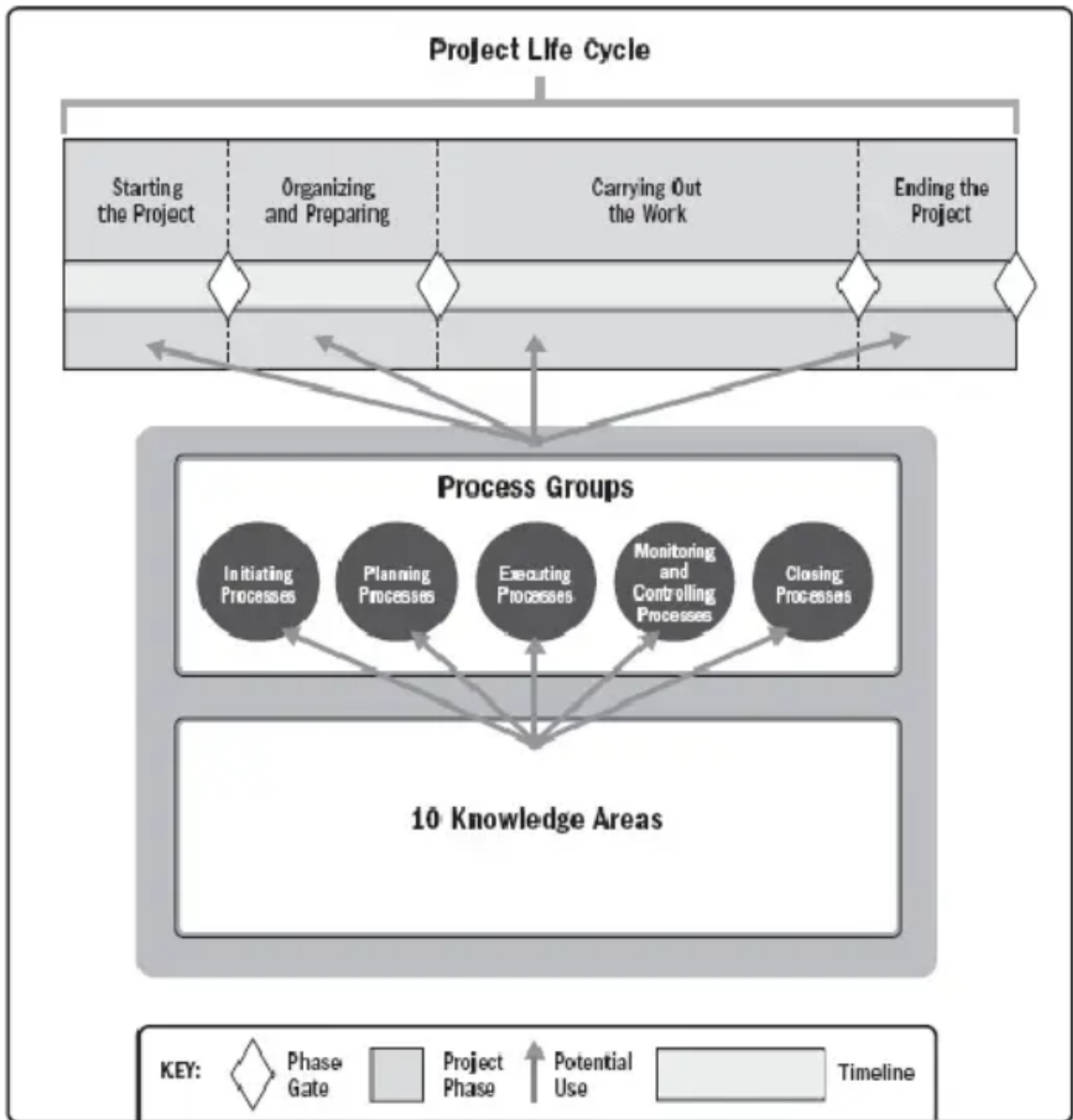
Figure 2. Interrelationship of key components in projects

Source: (PMI, 2017)

1.2 Impact Of Organisational Structure on Project

Organisational structure is critical to project progress because it governs resource allocation, work separation, and process implementation. The organisational structure determines who is in control and how the project is centralised. It establishes a command hierarchy, which will be critical for the projects. It also defines the ability of the project manager to control the resources for the project. Smaller firms are less likely to adopt this because it has little impact on them. However, as the company expands and enters new regional markets, a deliberate strategy is required to eliminate the complexities and confusions that might lead to project failure. The corporation employs several organisational structures in order to achieve project success. Choosing an organisational structure for the project also proves to be very important as it has to be aligned with the strategic objectives of the company (GEORGE, 2020).

Organisational Structure	Project Manager's Authority	Resource Availability
Simple	Little or none	Little or none
Functional	Little or none	Little or none
Multi-Divisional	Little or none	Little or none
Matrix -Strong	Moderate to high	Moderate to high
Matrix - weak	Little or none	Low
Matrix - Balanced	Little or moderate	Low to moderate
Project Oriented	High to almost total	High to almost total
Virtual	Little or moderate	Low to moderate
Hybrid	mixed	mixed
Project management Office	High to almost total	High to almost total

Table 1. types of organisational structure
Source: (PMI, 2017)

1.3. Role of Uncertainty and complexity in a Project

According to PMI, the definition of uncertainty with respect to a project can be "*A lack of understanding and awareness of issues, events, paths to follow, or solutions to pursue*" . It is a state of unpredictability where the operating conditions of the project environment is not known completely (PMI, 2021). Inorder to successfully navigate through this aspects of environment that contribute to project uncertainty can be listed below :

- Economic factors such as prices instability, inflation/deflation and resource availability.
- Technical factors like emerging technology , new complexities related to systems
- physical environment as it pertains to safety and working conditions
- political influences, internal or external of the organisation.

(PROJECT MANAGEMENT INSTITUTE, 2021)

According to PMI, *"Complexity can be a characteristic of a program, project or its environment which is difficult to manage due to human behaviour, system behaviour or ambiguity"*. complexity usually exists where there are a lot of interconnected and interdependent factors which can influence the project in various ways. In complex environments, a lot of individual variables cumulatively can lead to unintended outcomes. Understanding and mitigating these factors can be crucial in the IT projects as the conditions like new emerging technologies, market conditions and many more factors can have an impact on project progress (PROJECT MANAGEMENT INSTITUTE, 2021).

2. Project Management Methodologies

Project management methodology (PMM) is the framework or structure that enables the project to be planned and carried out in a methodical way. Methods and project management methodologies can differ slightly from one another. Methodology is the framework developed for the entire project cycle, whereas method is the short-term use of certain instruments. Simply put, the project management technique provides a degree of flexibility within which the project can be properly carried out. Although there are many different methodologies, the traditional waterfall methodology and agile methodology typically encompass the majority of them (HAZEM, 2019).
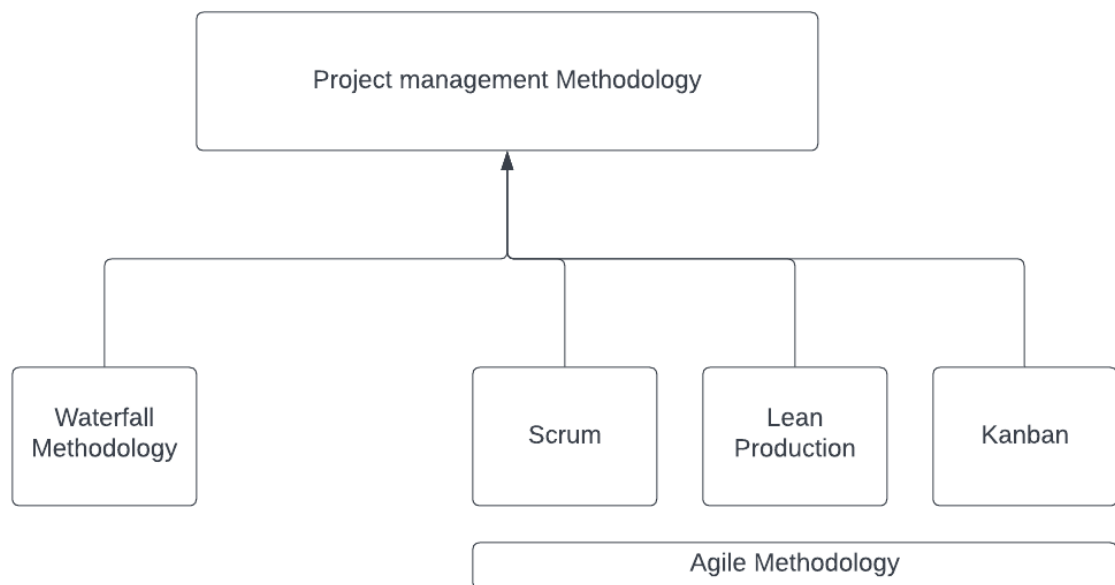
Figure.3. Project management methodologies
Source: Own contribution

Every project has its own set of specifications and uniqueness through requirements of the customer. Depending on the domain and the nature of work a project management methodology can be assigned to it enhancing the chances of project success. The intention of the project management methodology is to increase the chance of project success by providing a suitable framework for the operation (PACE, 2019).

A lot can go wrong if the chosen methodology for a project is wrong, it usually results in overspending, overschedule or no coordination between the stakeholders which results in project failure. For example, In the production of Electronic chips, it is difficult to use an agile methodology (iterative approach) because if the manufacturer shows the user a half made chip the user will not know what to give feedback to, which can just result in wasting time. Instead of that if they adopt a waterfall methodology, they will be able to complete the full chip and show it to the consumer which makes it eligible for the feedback. This example proves the importance of choosing the right project management methodology which has the certain amount of potential to impact the project success.

Even though methodology gives a framework for the project , many recent studies have shown that the managers usually like to customise it according to their knowledge and intuition. They use their tactical knowledge to customise the methodology to their own specification and are also found to be satisfied with these kinds of approaches towards it (HAZEM, 2019).

The most used methodologies are :

- Traditional waterfall method

- Agile Methodologies

2.1 Traditional Waterfall Methodology

The traditional waterfall methodology originated in the 1970 by Winston Royce revised the Idea from Herbert D. Benington who proposed it for the software development processes in 1950 . The waterfall methodology is linear in nature which means that the whole project is divided into different stages according to the work to be done and is validated at the end of every stage before moving to the next stage. Until today the waterfall methodology has been one of the most widely used methods in Europe and North America. But nowadays due to the rapid trends in changing technology, agile has also been one of the most widely used methodology (ARORAL,2021).

The waterfall methodology is a linear project management approach where each phase of the project is completed in sequence, and the project moves on to the next phase only after the previous phase is completed. The waterfall model has distinct phases such as requirements gathering, design, implementation, testing, deployment, and maintenance. The goal of the waterfall methodology is to ensure that each phase is completed thoroughly before moving on to the next, resulting in a well-documented and predictable development process.The figure below shows the different phases in the waterfall methodology (KPI, 2018).
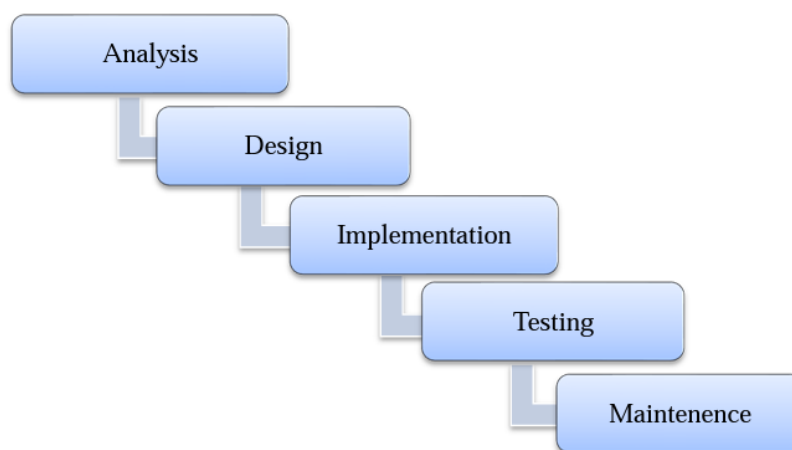
Figure 4. Waterfall Approach

Source:(ARORAL,2021)

A software project's stages can be broken down into phases for analysis, design, implementation, testing, deployment, and maintenance. The analysis phase comprises taking into account the requirements for the software project, which includes comprehending the requirements and expectations of stakeholders. Following the completion of the analytical phase, the project enters the design phase, where the software architecture and system design are produced. The actual labour is done during the implementation phase, which also involves coding. The software is then evaluated to see if it lives up to user expectations.Any bugs will be addressed and relocated upon deployment. The program is regularly maintained after deployment, and any required changes are made regularly (ARORAL,2021).

2.1.1 Advantages of Traditional waterfall methodology

The traditional waterfall method gives a very good structure to the project due to its sequential nature and can be very useful where the requirements are well defined and the customer knows exactly what they want. It provides a very clear and simple way for new joinees to understand the project. Also another point about the traditional waterfall method is that it supports very well documented files which makes it easier for the newcomers to understand. Good documentation can be very helpful in the maintenance phase for change requests or any processes. Documentation can also be used as a reference for future projects. After every phase, monitoring is done which will give clarity for the team members while moving to the next phase of the project. Further explanation of the advantages and the disadvantages is also done in the comparison of methodologies section (ARORAL,2021).

2.1.2 Disadvantages of Traditional waterfall methodology

As the many parameters are defined in the initial phases the methodology doesn't really provide much flexibility for the customers to change their requirements.The change management in traditional waterfall can be rigid as a fixed process has to be followed and has to be approved by the sponsor. Last minute changes in the project can negatively affect the project. This is the reason why waterfall is usually preferred in small projects where the requirements are well defined and the product is well defined. (ARORAL,2021).

2.1.3 Waterfall methodology Usage

The waterfall methodology can be recommend when the following conditions can be met :

- Well defined scope and clear picture of the end product

- Well defined requirements and does not change over a period of time

- Less risks and uncertainties better for the project

(ARORAL,2021)

2.2 Agile Methodologies

Agile techniques adaptability and effectiveness have been the primary drivers behind their widespread application internationally. One of the most popular choices in the software development process is to implement agile approaches. Out of the approximately 20 agile approaches, scrum, kanban, Lean and extreme programming are the ones that are most frequently employed (RASNACIS, 2017).

Before getting into the detailed explanation of agile methodologies it will be important for the readers to learn about the iterative and incremental project life cycles. According to the PMI , In iterative life cycles the project scope is determined first in the initial phase and then changes as they go through the project. In incremental life cycles, the product functionalities are changed as they go through the iterative cycles within a determined time constraint (PMI, 2017).

Agile methodologies are also known as adaptive life cycles which are iterative and incremental in nature. It is more of a dynamic approach taken towards the creation of a product deliverable. In the Information and technology domain, the project scope is determined in the initial phase and during the iterations it can be changed and also functionalities can be increased, but time and cost will be fixed (KPI, 2018). This methodology is customer centric as customer participation is mandatory. The customer is involved in every iteration as to give feedback about the product which inturn is used to change the functionalities according to the customer requirements. The agile methodologies are also flexible in nature (PMI, 2017).
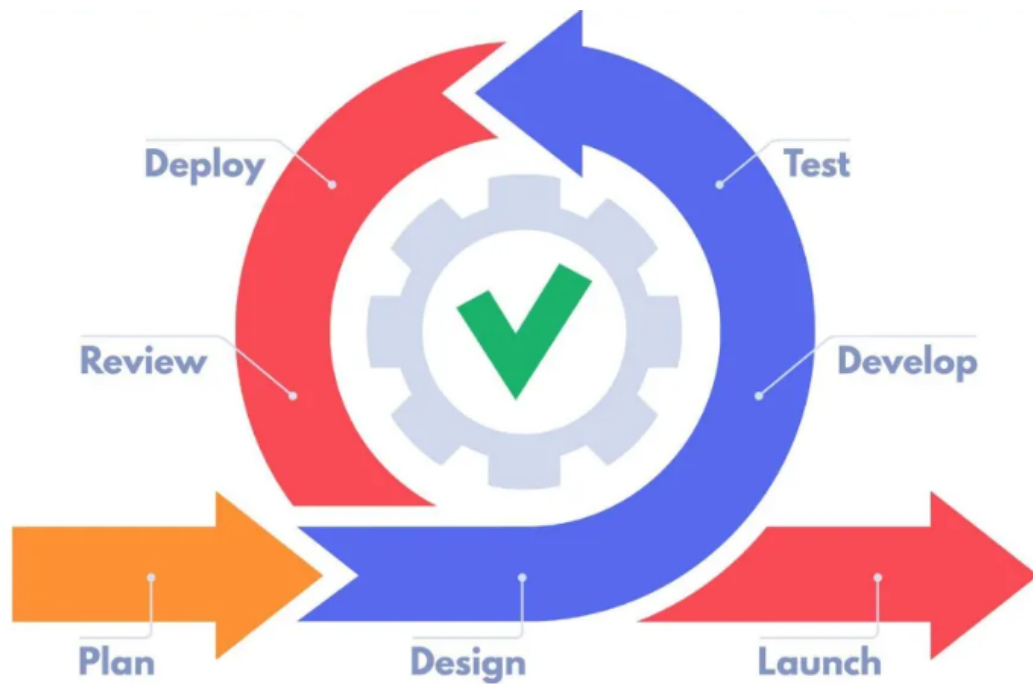
Figure 5. Agile methodology

Source : (BHASIN, 2020)

The figure above shows One iteration of the agile methodology which consists of the following stages :

- **Analyse** - This phase consists of analysing the gathered customer requirements and feasibility

- **Plan** - This consists of planning the number of iterations and timing that one iteration has to be completed in.

- **Design** - This phase consists of system designing and software architecture of the expected deliverable on the basis of initial specifications.

- **Build** - this phases consists of building or developing the product deliverable according to the customer requirement and as planned in the planning and design phase

- **Test** - This phase consists of testing the built partial product in order to show it to the customer.

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- **Review** - this phase consists of showing the partial product to the customer and getting feedback from them. Usually this is the deciding phase of the methodology

- **Launch** - This phase consists of the product deliverable which has been launched according to the customer requirements

Therefore the project team usually enters the launch phase at the end of the cycle after delivering the product, but decision making for another iteration will usually be done in the review phase where the customer gives the feedback for the partial deliverable. In Case there is a change in his requirements the cycle will be repeated and another cycle will start. This process continues until the customer is fully satisfied with the product deliverable.

Some well known Agile methodologies are :

- Scrum

- Kanban

- Lean

- Extreme programming

2.2.1 The Agile Manifesto

The Agile Manifesto which was created in 2001 by 17 developers guides employees to understand the focus and the foundation of the Agile approach.

Principles	Agile Manifesto
1	The top priority is to continuously give value addition to clients in order to satisfy them.
2	Customers can alter their requirements at any time, thus it is vital to accept changes.
3	Delivering working software regularly with shorter time scale
4	Throughout the project, businesspeople and developers need to work together daily.
5	Motivated individuals should build the project and be supported and trusted to complete the project.
6	Face to face communication is the most effective way for information transfer
7	The primary progress measure is the working software
8	The team and sponsors should be able to maintain a constant speed indefinitely.
9	Good design and technical excellence enhances agility
10	Simplicity in the processes is essential
11	The design , requirements arise out of self organising teams
12	seeking for improvement and effectiveness at regular interval

Table 2. Agile manifesto
Source: (SALZA, 2018)

2.2.2 Scrum

Scrum is one of the most often used methodology in the recent decade as there has been a lot of emphasis on product development and one of the best ways to achieve success in it is through adopting scrum. It was initially developed by Schwaber in 1995 for software development methodology which adopted the agile principles (HRON, 2022). Scrum encourages small times and fast work. According to the scrum guide , Scrum is a lightweight framework that helps people, teams and organisations generate value through adaptive solutions for complex problems (Schwaber, K. and Sutherland, J. 2020). Even though scrum was introduced to streamline the software development processes there is no reason why it cannot be used in any other field or industries therefore experts have used them in the military for deploying ships and universities have used them for implementation of projects (SCHWABER, 2020).

The scrum theory can be based on the two things namely empiricism and lean thinking. Empiricism means to make the decision on the basis of observation and experience. Lean thinking emphasises on not focusing on wasteful and unproductive activities.It purpose is to remove the waste and focus on necessary points which will enhance productivity (SCHWABER, 2020).

The scrum has some basic terminology to get familiar with like scrum master, product owner, scrum team, sprint, Product backlog and sprint backlog.

Scrum master : This role consists of making sure that the development team works towards a common goal and there is nothing impacting them from external factors. The scrum master also ensures that every team member knows the scrum values (SCHWABER, 2020).

Product owner - Product owner is responsible for giving the product requirements to the development team. They manage the project by coordinating with stakeholders. His main goal is also to maximise the product value through the scrum team (SCHWABER, 2020).

Scrum team - the scrum team is the development team who are cross functional and self organising in nature. This team is responsible for developing the product and creating value for the product through customer feedback in the review stage. Eg : coders and testers (SCHWABER, 2020).

Sprint - Sprint is a small interval of time which usually lasts from two to four weeks where the implementation of the ideas are done. There are usually no changes made during the sprint (SCHWABER, 2020).

Product Backlog - Product backlog is the list of product requirements /features which has to be in the final product. It is not constant and is changed whenever there is a request from the customer for a better final product (SCHWABER, 2020).

Sprint Backlog - Sprint backlog is the product requirements which will be implemented in a particular sprint (SCHWABER, 2020).

To categorise the above terms under the scrum framework scrum roles consists of scrum master, product owner and the development team. Scrum artefacts consist of the product backlog, sprint backlogs, product increments and burndown charts. Scrum events are noted as the Sprint planning, daily scrum, Sprint review and sprint retrospective.

- **Sprint Planning** - this phase consists of planning the sprint by collecting the requirements for the sprint, time span, team members etc

- **Daily scrum** - Daily scrum is done every day before the start of the sprint to focus on the important tasks of the sprint.

- **Sprint review** - Sprint review consists of checking and observing the working of the new functionality which was created during the sprint.

- **Sprint retrospective** - Sprint retrospective is more about understanding what went right and what went wrong during the sprint and determination of scope of improvement for the future sprint.

(Schwaber, K. and Sutherland, J. 2020)

The Whole scrum process is shown below :
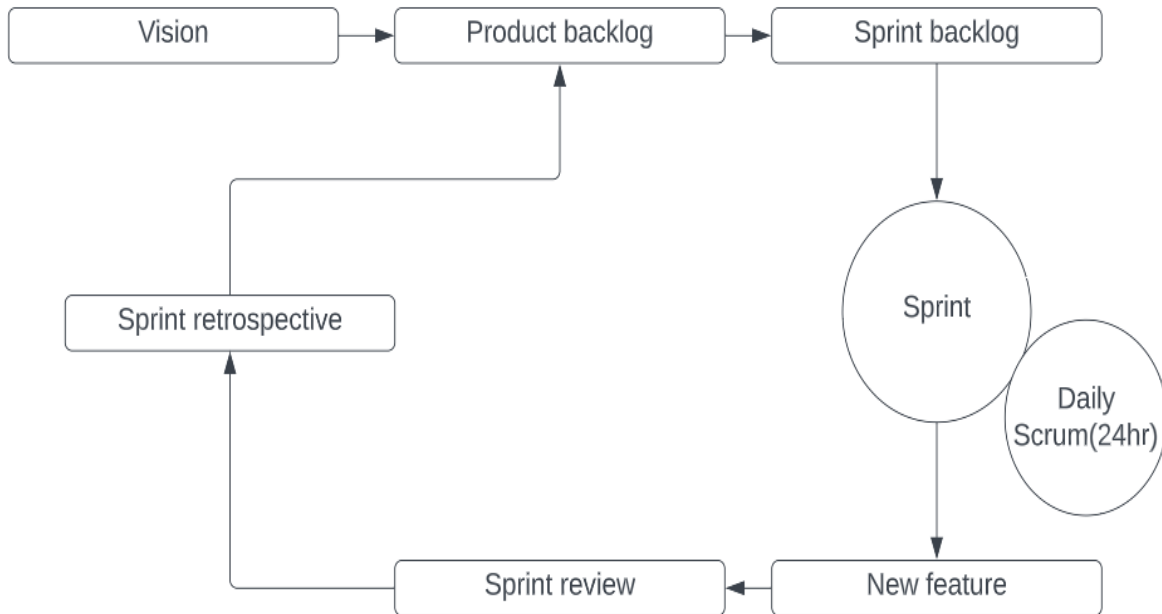
Figure 6.Scrum process

Source: based on (HRON, 2022)

The scrum process usually begins with a meeting with the internal and the external stakeholders who share their vision of the end product which are saved as user stories. From this the product owner will split into product requirements and add them in the product backlog which can be changed anytime.Then a small chunk of the product backlog (list of tasks) is taken for a sprint and this becomes the sprint backlog, list of tasks that need to be completed in a sprint.

The team will coordinate and start finishing the tasks and parallelly the scrum master will ensure of the development team's productivity at the daily scrum.Then once the sprint is completed, the new functionality is shown to the product owner and further a sprint review is conducted where external and internal stakeholders are invited to give a review about the new feature.

Based on the feedback the product backlog is updated. The sprint retrospective is held determining what went right and what went wrong in the process and making necessary changes for the improvement of the next sprint (HRON, 2022).

The sprint review is focused on the product and the sprint retrospective is focused on the process. Further the process continues as another set of tasks are taken from the product backlog and the sprint is repeated until every task is complete. This methodology makes sure that every cycle provides productivity and efficiency eventually paving a way towards a quality product (HRON, 2022).

2.2.2.1 Advantages of Scrum

The scrum involves a lot of self organising and cross-functionally skilled people who are supported by scrum masters in order to increase the usage of time to ensure high quality product.

Some major advantages of scrum can include :

- High efficiency due to short term work cycle

- Better way to deal with uncertainties

- Enhances delivery predictability

- Higher quality of the product

(ANON., 2023)

2.2.2.2 Disadvantages of Scrum

Some disadvantages of scrum are :

- Requires skill training and experience to implement it successfully as before getting into scrum it is important for the employees to understand the values the scrum theory offers

- It requires organisational structural change as incorporating scrum is about fast and short work cycles.

    (ANON, 2023)

2.2.3 Lean Project management

The history of lean dates back to Post world war times as the Japanese had lost the war and had limited equipment to manufacture goods. Therefore the United States sent consultants in order to help the companies in terms of manufacturing abilities. The combined work of the consultants with Toyota gave birth to the concept of Just in Time(JIT). Just in Time aims to tackle the bottlenecks and increase efficiency in the flow of the process. The founder of Lean was a toyota engineer named Taiichi Ohno. Kanban also actually adopts the same principles as lean which includes limiting work in progress , Simple process, removing bottlenecks and many others (EBY, 2017).

The concept of lean focuses on eliminating three types of waste. These wastes are known as 3M, Muda , Muri and Mura. Muda means the wasteful activities that consume resources without increasing the efficiency or any value to the process. Muri refers to the overusing of resources. It can mean overusing the equipment or employees are working overtime without a reason. This usually results in increase in costs and decrease in productivity. Mura refers to inconsistency in the performance of work . It results in again the decrease of efficiency and increase in costs (EBY, 2017).

The Major seven areas of waste in lean are :

- **Over production** - As the name implies, it is more focused on product manufacturing than on meeting internal or external demands. It happens as a result of early capacity use and insufficient transparency of genuine demand. Double handling and the creation of extra inventory caused by overproduction eventually drive up costs. Several instances include overflowing warehouses and an abundance of material stock on the assembly lines (HELMOLD,2020).

- **Overprocessing** - Over processing relates to the unnecessary work done by the employees which is more than required by the customer. Examples include high tolerances and, duplication of efforts (HELMOLD, 2020).

- **Waiting** - The holding period during which an employee has waited for a specific action to start is known as waiting. This gives the employee the ability to properly allocate resources and avoid unproductive tasks. Examples of this include waiting for supplies, stopping processes because of malfunctioning equipment, etc. This may be the result of an inadequate material flow and deficiency in documentation. Waiting reduces the effectiveness of the task and the employee's motivation, both of which lower production (HELMOLD, 2020).

- **Inventory** - Inventory has a significant impact on cash flows, so it's crucial that there isn't an excessive amount kept on hand. Excess inventory storage can increase capital expenses and make it difficult for teams to identify real issues with the handling of the inventory. Overfilled warehouses, buffer stocks in production, crowded hallways, etc. are a few examples of this. It takes careful planning and attention to the inventory across the value chain to maintain this control (HELMOLD, 2020)

- **Transportation** - Excessive transportation can be considered as major area for wasteful activity as the managers would not want to spend their manpower and resources for unnecessary transportation. One example

according to Marc Helmold is the transfer of one product from one area to another with help of material handling devices, transport trucks etc. It is considered as waste because the workers can utilise their time even better in other activities than transportation. Usually the reason for this can be poor layout design , distance between the function areas and many more. This increases the operation cost, decreases the productivity and increases the time requirements in the project (HELMOLD, 2020)

- **Defects** - Defects represent the quality of the product manufactured. If the standards of the product do not match with the customer requirement then it will be under this part. The consequence of this can be additional work, additional space and increased lead time (HELMOLD, 2020)

- **Motion** - Motion represents the many unnecessary steps taken in order to create value but it is not created. It leads to higher cost and also decreases productivity. It is the excessive movement of man and resources within the environment. It is usually the consequence of Improper analysis of the work. Examples for this can be Long ways between machine and missing materials. This excessive motion can also lead to increase in lead time and capacity (HELMOLD, 2020).

2.2.3.1 Core Principles of Lean
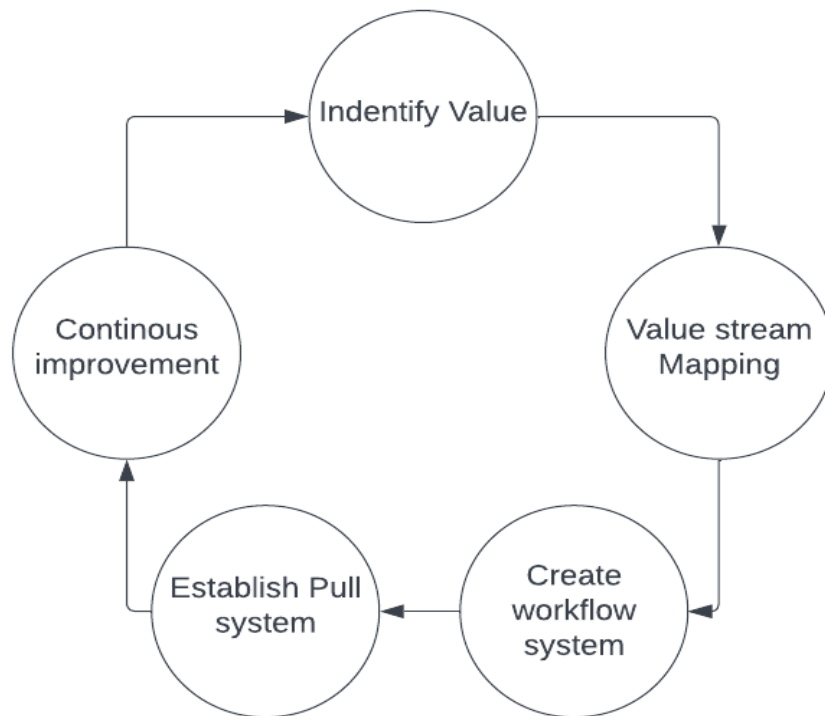
Figure 7. Lean process

Source: Own contribution

As mentioned in the above paragraphs, lean is based on the toyota production system. Lean incorporates five major principles in order to be used as a project management methodology.

Here are the five guiding principles of Lean -

- **Identify Value in process of Value chain** - Identification of the value is usually the end product which is needed by the customer.therefore value chain would be any process or work which is adding value to the creation of the end product, Any work or process which is not adding value will be removed and considered as wasteful as the customer will not be willing to pay for it.

- **Conduct value stream mapping:** Value stream mapping is all about visualising and giving clarity to the managers. The value stream map contains the actions and people who will be responsible for the creation of the final product. This gives a clarity to monitor the processes and understand who will be responsible for the respective processes.

- **Create a continuous workflow system**: Continuous workflow system ensure the teams get the work done smoothly without any interruptions or bottlenecks.Kanban uses a similar workflow system where the main process divided into simpler and achievable tasks which has the potential remove bottlenecks and ensure there is a better collaboration within the team.

- **Establish a pull system which is customer centric:** Pull system is an efficient lean technique which starts new tasks only when the old ones are completed and there is demand for it. This ensures quicker and efficient work with minimal effort. Only with the establishment of the pull system can the continuous workflow remain stable.

- **Establishment of continuous improvement:** Continuous improvement principles ensures that there is a continuous effort by the team members to improve the process. Usually If there is any problem occurring in the above principles it can be handled through this. Parallel the management also makes sure that the team works within these principles to make sure it is successful.

(HELMOLD, 2020)

2.2.4 Kanban

The concept of Kanban comes from japanese word meaning 'signboard'.this was introduced by toyota in 1947 as a tool for visual process management that could give clear understanding of the knowledge and tasks which were in turn used for the Just In Time approach.The Kanban bases its values on the removal of bottlenecks and reduction of wasteful activities during the project. This Idea was later on introduced in the software development field by David.J.Anderson in 2014 (ALAIDAROS, 2021).

One of the most famous examples of working with kanban can be shown in the company 'spotify'.Spotify's IT operations team was not able to scale according to the needs of the company as the company was growing at constant pace. Therefore the main problem was scalability. In order to solve this problem they implemented kanban,they created a simple IT kanban board where there were three verticals which were **to-do**, **In process** and **done** and there were three horizontals which were divided according to their specification of Tangible, Intangible and expedite.They set a low work in progress limit to ensure many intangible were completed. Therefore with the usage of kanban the team were able to decrease the lead time by a significant amount and also get most of their internal tasks done (NAYDENOV,2023).

In the automotive industry, the system is designed to hold the appropriate amount of inventory and deliver the semi finished goods only when necessary.This helps the manufacturing sectors who are producing multiple products at the same workstations,therefore needing different raw materials at different times.It allows production only when there is demand from the customer side. Kanban has allowed better productivity, reduction of lead time and increment of valuable taks only. In order to understand where it can be applied clearly , an example can be considered. In a recent study, an Emblem manufacturing company for automotive companies had three emblems to manufacture. These emblems went through various processes like injection moulding, chrome plating, painting , assembly and final packaging. As there are three different parts to be manufactured through various processes it can be the right precondition for a push system to be adapted like kanban (SINGLA, 2019).

The Kanban board consists of steps like backlog , doing and then completed. It is very helpful in maintenance projects as you can consider step 1 as entry of the complaint from the customer, then step 2 as the processing and solving of the issue and finally step 3 as solved and delivered back to the customer. It works on the pull system which will be explained in the further paragraphs. Similar to the scrum framework kanban is a process oriented framework which aims towards continual delivery. In the software development field, Kanban can be adapted in the manner where a bunch of issues are taken into the backlog and then everyday the team plans to choose a small chunk of the backlog and divide it into a number of smaller tasks and complete them one after the other.

2.2.4.1 Kanban Principles

Kanban relies on five principles which have given it the necessary characteristics. Kanban gives freedom for the teams to make decisions on their own unlike the traditional waterfall approach, where the team has to get the permission of the project manager for changes in tasks. The practice also includes the management of an efficient work flow system by the calculation of lead time and cycle time which help the teams to improve the process further (ALAIDAROS, 2021).

The Principles can be given as follow

- **Limiting WIP**: Limiting the work in progress is a core principle which defines the maximum number of tasks that has to be on the list which will control the flow of work. This will make sure that team is efficient and productive by not overloading them with unnecessarily high number of tasks

- **Visualising the Workflow** : As the explanation is in the statement itself, it encourages highlighting the tasks and work being done to make sure every team member knows clearly what is happening.

- **Measuring and managing the flow** : Measuring flow is essential as it gives the teams a scope for improvement. Here the focus is more on the improvement of the process more than the removal of waste.

- **Making process policies explicit** : Creating policies define the limitations and boundaries the teams have to work on, giving it effectiveness to the process. It encourages teams to work in a well defined environment.

- **Continuous Improvement** : this is one of the core principles on which kanban lies. It represents the scope of improvement opportunities in the processes. Regular improvements can lead to success in a project.

(ALAIDAROS, 2021)

2.2.4.2 Kanban Process flow
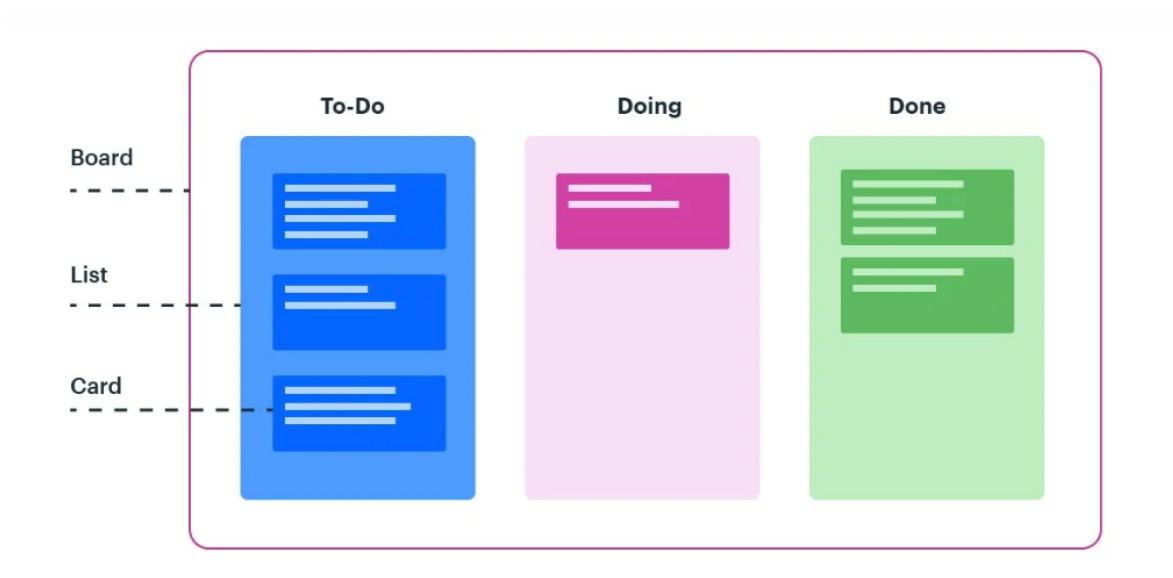
Figure 8. Kanban process flow

Source: (ANON., 2022)

The simple kanban board shown above has three steps, such as to-do, doing, and done. The board is the collective name for this structure, which is broken up into a number of lists and then into cards. Lists are used to categorize the state of the work that is being done. The team's tasks are represented by cards, which are moved from one list to the next (from left to right) until they are finished. After one is finished, another is taken, and so on. The foundation of the Kanban technique is the idea that the team's productivity and the amount of work required are equal. The

most crucial aspect of kanban is that, like lean, it is significant because it is straightforward (AL AIDAROS, 2021). Therefore Major steps of this kanban board are

- To- do which represents future tasks.

- Doing which represents present work in progress.

- Done which represents completed work.

2.2.4.3 Kanban Advantages and Disadvantages

Kanban provides a lot of advantages for its users through simplicity and better employee collaboration.Some Advantages of using kanban are :

- Easy to use kanban methodology

- Promotes team collaboration

- The methodology gives continuous improvements to the process

- Visualising gives better monitoring abilities for the team members.

- Lower wastage and costs

- Increases quality control

Here are some disadvantages of Kanban :

- Kanban does not fit a dynamic environment where everything is changing, It requires a certain level of stability and consistency.

- It does not have the ability to perform an iteration for the software development process.

 (AL AIDAROS, 2021)

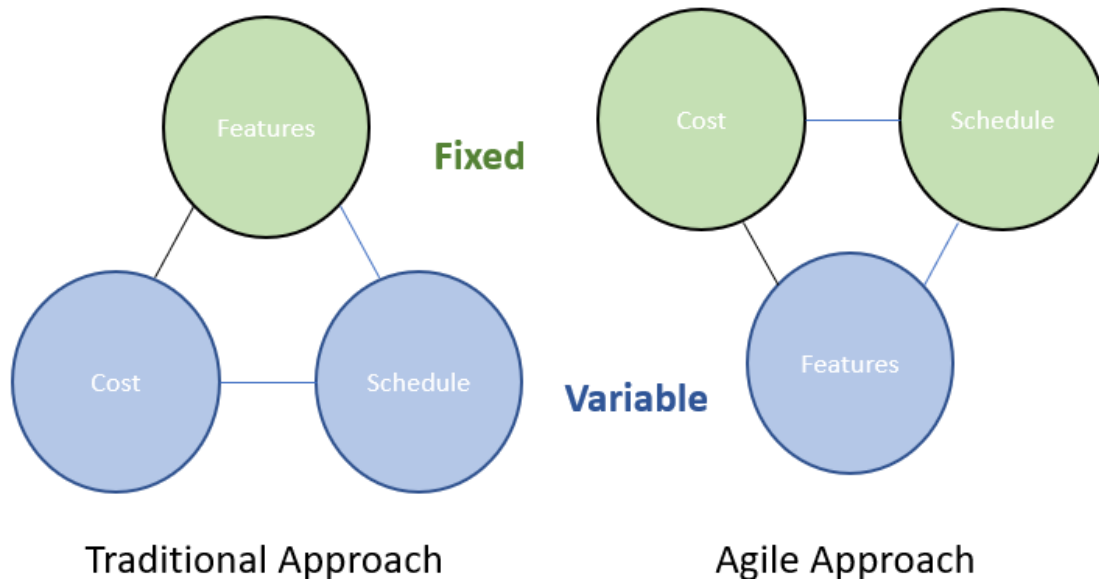## 2.3 Comparison between Waterfall and Agile methodologies

Figure 9. waterfall and agile comparison
Source: Based on (KPI, 2018)

A study in an IT company showed that the respondents had different opinions while choosing different methodologies. They would choose a traditional methodology when they exactly knew the requirements of the customer and the goals of the project were known. Agile was choosing when there were vague definition of requirements , Agile supported flexibility and traditional supported a sequential structure to the project .It is also important that incase of traditional methodologies the customer involvement is less therefore if the project client does not have enough knowledge about the technicalities of the product to check in between the processes therefore they are only interested in the final product.On the other side the Agile methodology is chosen when dealing with complexity and frequent changes are expected in the project (BUSHATI, 2021).

From a study made by Thesing about understanding the differences between the traditional waterfall and agile methodologies, there are some interesting and detailed differences and characteristics found out. The study was done with 15 experts from many industries which gave them different perspectives:

1. **Characteristics of Agile and Traditional waterfall** : the study shows that there is a big difference in the planning character and core of the project work, work culture , leadership of the team , evolution towards the project goal and documentation had considerable differences.

2. **Advantages of Traditional waterfall methodology** :

- fixed roles, processes with clear responsibilities

- Stable systematic and documented planning

- Measurability of progress

- high efficiency by planning

(THESING, 2021)

3. **Advantages of Agile methodology** :

- Fast response to requirement changes

- Rapid error identifications

- Flexibility is high

- Low Risk of false developments

- Regular optimization of project processes

- No limitation in the process of finding a solution

(THESING, 2021)

4. **Disadvantages of traditional waterfall methodology** :

- wrong planning due to abstract predictions or specifications

- Difficulty to formulate all requirements in detail at the beginning

- Correction in cost is intensive due to complex plans

- High planning and documentation effort at the beginning

- Low Customer involvement cause low feedbacks

- Less flexibility due to rigid sequence of the project

(THESING, 2021)

5. **Disadvantages of Agile Project methodology** :

- Success depends on self organising teams

- Teams work full time on the project

- Iterative development can require more budget

- High capacity requirements of users for testing

(THESING, 2021)

Parameters	Traditional Waterfall Methodology	Agile Methodology
Requirements	Well - defined	Flexible and changing
Nature	Sequential	Incremental and iterative
Teams	Directed by the project manager	Self organising
Customer	Low involvement	High Involvement
Documentation	High Documentation	Low documentation
Scope	Well defined in planning	Challenging, as it changes for every sprint and customer changes
Decision making	Final decision by project manager	Final decision by collaboration of the team
Monitoring	After the end of each phase	Everyday
Testing	End of project	Regular & Repetitive
Planning	Initial phase	Progressive

Table 3.Comparison of waterfall and agile methodology

Source:(KASHYAP,2021)

3. Types of IT Projects

Due to the new technological standards and ease of implementation most of the global companies are digitizing their process in order to decrease the paper work and effort involved. This is why there has been a big rise in the IT domain in the past decade making it one of the most vital domains of an organisation.

The 4 Main types of Information Technology infrastructure projects :

- **Web development** - Web development projects include the establishment of websites for online retailers, booking platforms, and so on. A typical web development project process will comprise numerous steps, beginning with project research to determine the purpose, goals, and requirements. Once completed, the planning process begins with the creation of a site map and wireframes, after which the team continues on to designing and finally coding (back-end development). After these processes are completed, testing, reviewing, and launching can take place. The final stage involves the monitoring and regular updating of the website (SENTIENT DIGITAL, 2022). The web development project methodology is usually dependent on how long and complex the project is. If short and simple traditional approach is considered, but for any other case it is suggested to use the agile methodologies (ADCI Solutions, 2019).

- **Hardware development** - Digital disruption like Internet of things is never possible without the hardware systems. Usually hardware system projects include building data servers (SENTIENT DIGITAL, 2022). the hardware development process can be best done in 5 stages where in the first stage the feasibility study is done with checking the features, configurations etc the second stage includes the creation of concept and actual design.The design of mechanical and industrial comaponents are alos considered in this stage. Stage three comprises of prototyping where a prototype is created ,the objective of this phase is to ideate the feasibility of the features. Once the prototying is done the design for manufacturing and maufacaturing is

done in the final stage and review (DUBEY, 2022). We can consider the hardware process as very similar to any other engineering projects ranging from automotive to machinery manufacturing therefore we consider traditional waterfall will be suitable or more defined process would be suitable for these types of projects.

- **Software development** - the software projects include ERP(enterprise resource planning), CRM(customer relationship management) softwares to operating system upgrades(SENTIENT DIGITAL, 2022). The researches show with comparison to waterfall implemented project the agile implemented projects have shown 24% higher success rate in IT projects and twice higher in software development projects. It is also claimed that the scrum project were delivered 37% percent faster compared to waterfall projects.therefore on the basis of the statistics it can be assumed that software projects can be best performed with an agile approach (LEONG, 2023)

- **Network** - Computer Network projects include cloud computing, proactive cyber security and network segmentation projects (SENTIENT DIGITAL, 2022). Network projects are about heightening the security and improving efficiency of existing networks. Network security projects involves implementing security measures to protect the organisation's network from external and internal threats. The project may include the installation of hardware components such as firewalls and intrusion detection systems, as well as the implementation of security policies and procedures.

4. Real case : Skoda IT project governance models and IT methodologies

Skoda Auto is a Czech automobile manufacturer founded in 1895 as Laurin & Klement. In 1925, it was acquired by Skoda Works and the company changed its name to Skoda Auto. Today, Skoda Auto is part of the Volkswagen Group and produces a range of cars from small hatchbacks to SUVs. Skoda is known for its practical and reliable vehicles with a focus on value for money. The brand has a strong presence in Europe and emerging markets, and is expanding globally. Skoda has also been successful in motorsports, particularly in rallying.

Skoda IT project management involves planning, organising, and controlling the resources, timelines, budgets, and risks associated with IT projects. Skoda IT project managers work closely with stakeholders, such as business units, software developers, and external vendors, to ensure that IT projects are aligned with the company's strategy and objectives. IT project management in Skoda auto has a well defined framework and methodology for the process that needs to be completed in the project. The rules and requirements have been standardised for the all IT project irrespective of the departments. The project steering committee are the decision makers of the project who choose the project manager for the specific project (MACHAC, 2023).

Summarization of rules and regulation is mentioned below :

- In the organisational structure the project manager is the one securing resources for the project and the manager of the department is the one who will provide the agreed resources(technical, personnel, Financial and other).

- Project documentation is centralised in a pre- defined workspace

- In case of change management or change requests after the ideation phase the steering committee makes the decision on the analysis of the change request.

- The project can be terminated or suspended only by the decision makers of the project.
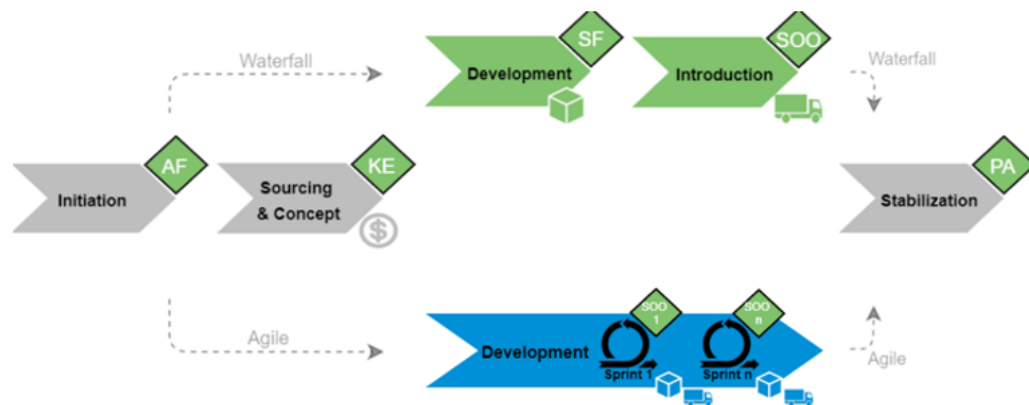
(MACHAC, 2023)

4.1 IT Project process

Figure 10. IT project process

Source: (MACHAC, 2023)

A typical IT project at Skoda Auto has Initiation phase , conceptualization phase , development phase and stabilisation phase. After being evaluated and aligned with organisational objectives, a project enters its beginning phase. The project's initiation phase and conception phase are its first steps, during which the project manager's responsibilities are established, the requirements are outlined, the project charter is created, and lastly, the methodology is decided. These phases also produce the technical definition and the ongoing monitoring of the project's viability, benefits, resource allocation, and team formation. The actual work is done during the following phase of development, which also involves ongoing project progress monitoring. The stabilisation process then includes comparing the project's planned and actual variables, as well as any lessons learned. and final report creation. Then the project is handed over to the customer of the project(it does not have to be an external client, can also be internal (MACHAC, 2023).

4.2 The choice of methodology

In Skoda Auto, the choice of the methodology usually takes place in the initiation phase. Some characteristics like market environment, customer engagement , innovation type, work modularity and Impact of mistakes during the development are considered as points to help make the decision between the project management methodologies.

Characteristics	Agile	Waterfall
Market environment	Customer needs and possible solution are often changing	Market environment is stable and not changing too often
Customer engagement	Close Cooperation and fast feedback loops are feasible	The requirements are clear from the outset and will remain unchanged. Customers are not available for constant cooperation
Innovation type	The problems are complex, the solutions are unknown and the scope of the project is not clearly defined. Product specifications are subject to change. The creativity and originality of the solution and the time to market are important. Cooperation between different disciplines can be beneficial.	Similar tasks have been addressed in the past and innovators believe the solutions are clear. Detailed specification and plans can be predicted with great accuracy and we should adhere to them.problems can be solved sequentially in functional forces.
Work modularity	Development increments are of value to the customer and can be used by the user. The work can be divided and performed in fast iterative cycles. Last minute changes are manageable and accepted	Customers cannot begin testing parts of the product until the last part is ready. Last minute changes are very expensive or even impossible.

| Impact of mistakes during the development | They provide valuable feedback and instruction | They can have a negative effect on the project budget |

Table 4. Insights for choosing PMM
Source: (MACHAC, 2023)

5. Project Success

Project Success has been measured in various ways throughout the years. In a Study conducted, it was found that schedule , cost, quality and Scope were the four attributes that the project success was measured on. As schedule represents the timing of the submission of a project to the customer, Cost represents the variance in which the project budget was planned and budget actually spent. Quality represents the degree of quality of the product or the project delivered to the customer. Scope represents how well the project or the product fits in requirements to the customer (HRICZÓ, 2021). As explained in the introduction section, a study conducted showed that project management methodology contributes to 22.3% of project success. This gives an opportunity for the usage of innovative techniques in choosing the project management methodology which can contribute to project success (HAZEM, 2019).

To achieve project success in the IT domain, project managers need to establish clear project objectives, requirements, and success criteria, engage stakeholders throughout the project's lifecycle, and apply effective project management methodologies and techniques. Additionally, project managers should continuously monitor and evaluate the project's performance and make adjustments as needed to ensure that the project is on track to meet its goals and objectives.

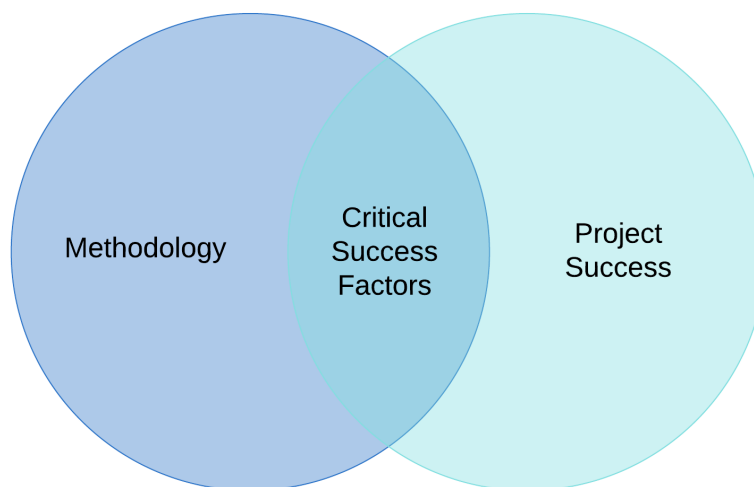## 5.1 Relation between Methodologies and project success

Figure 11. relation between methodology and project success

Source: Own contribution

Inorder to measure success it has to be defined and this definition comes from the critical success factors, as these project success depends directly on them (PURWANINGSIH, 2020). As the critical success factors are factors that must be achieved in order to achieve project success, the methodologies create the conditions or structures for these factors to be achieved. The relation between Project management methodologies and project success is evident in any project as the project management methodologies give the project managers the flexibility and conditions to handle the projects without much restructuring. It is also claimed that the methodologies make it easier for the new project managers to handle the projects with a strong foundational base (HAZEM, 2019). Methodologies create limitations and help in monitoring and control during the course of the project which will be critical for project success.

A recent study conducted in 2019 claimed that the main dimensional project success factors are Project efficiency, Organisational benefits , Project impact, future potential, stakeholder satisfaction. These dimensions include the time constraints, budget constraints, scope, purpose achieved , end-user satisfaction, sponsor's satisfaction and many more (HAZEM, 2019). Another study published in the International Journal of Project Management found that "*the experience of the*

project team in the usage of the methodology has a significant impact on project success." The study suggests that a team's experience with a methodology can influence their ability to effectively implement the methodology and adapt to changes throughout the project lifecycle (SERRADOR,2015).

5.1.1 Critical success Factors of IT Project management success

Nowadays in the Information technology domain, the definition of success for every project is dependent on that specific project. The critical success factors can be considered as parameters or conditions that have a significant impact on the project and. In a way the project success is directly dependent on them (PURWANINGSIH, 2020).

For many projects the criteria for success are usually in terms of cost,schedule and scope, similarly a study conducted to understand the impact of project management methodology on project success considered these variables as major criteria for project success (JOSLIN, 2019). In another study in the information technology domain for the telecommunication industry showed that the following parameters were considered as the critical success factors for IT project success and also 12 reference have similar results :

- Customer involvement

- Capability of the team

- Capability of the leadership of the project manager

- Requirement management

- Clear project objective

- Top-level management support and organisation culture

  (PURWANINGSIH, 2020)

The above sections show us how every project management methodology has its own characteristics which can be suitable or unsuitable for a project. Depending on the project characteristics, the project manager chooses the project management methodology and accordingly it will have an impact on the project success.

6. Consideration of parameters

According to the literature review conducted in earlier sections of the research, it is assumed that certain parameters influencing the selection of project management methodology are taken into account. Following are the parameters considered for choosing a project management methodology :

- Scope of the project

- Experience of team members in the usage of methodology

- Cost of the project

- Schedule of the project

- Customer engagement

- Customer requirements

- Change management

- Project complexities

- Frequency of Monitoring

6.1 Impact of parameters to choose a methodology

Every parameter considered has its own kind of impact on the project which has to be considered while choosing the project management methodology. This section gives a detailed idea of how and why theses parameters are important to consider :

- **Project Scope** : Scope can be considered as one of the most important metrics to measure project success which is why it is a part of the 'Iron triangle'. A project scope defines what needs to be done and what should not be done in the course of the project. Scope management is the management of the project scope which is usually done with the help of a work breakdown structure which is a clear simplification of the project tasks to the simplest form (HASSAN,2021). Scope is always defined in the initial stages of the project. In the waterfall approach the scope is defined in the initial stages and change in the scope can lead to scope creep eventually leading the project to failure. In the Agile approach the scope can be considered to be variable as the requirements are changing.Thus management of scope between traditional and agile approach creates a major difference between the two.

- **Cost & schedule** : Cost and schedule are a part of the iron triangle and are considered as critical success factors in many projects. The behaviour of these variables can be designed with the help of the methodology. In the IT domain for software development, the cost and schedule vary in waterfall methodology and is fixed in agile methodology (KPI, 2018).

- **Customer engagement** : Engaging with customers can help identify areas for improvement. Engaging with customers throughout the project or process improvement initiative can help gather feedback and make necessary adjustments to the project to ensure its success. By involving customers in the process, their needs and preferences can be considered, but it is the choice of the customer to increase their involvement in the project. As explained in the previous section of the research, customer engagement is another big difference between the traditional and agile methodologies. Traditional waterfall does not encourage the involvement of customers, a

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customer can only view the product after it is ready. But in the case of agile it is a different scenario where the customer is involved in every phase of the project.

- **Customer requirements** : Throughout the course of a project, customer needs may change often. Agile methodology is better suited for projects where there is a significant level of uncertainty in the requirements as they are flexible and responsive to changing requirements. Traditional techniques frequently rely on an in-depth procedure for gathering needs up front. Agile approaches, on the other hand, use a more iterative approach to requirements management, which can be more successful in projects where requirements are not clearly specified or may change often.

- **Change management** : Change management in traditional and agile vary a lot as structure for change in traditional is rigid as the project manager has to make a request and go through a formal procedure inorder to make any change. Escalations in traditional waterfall methodology are rigid. But as the agile approach is flexible in nature the change management is much easier compared to traditional waterfall as the team makes the necessary changes and decisions and moves forwards with the change.

- **Team experience and skills in the usage of methodology** : The usage of methodology by team members is an important consideration when choosing a methodology for a software development project. Different methodologies have different approaches, processes, and practices that require different levels of expertise and commitment from team members. For instance, a team that is new to Agile development may struggle to adopt the practices and principles of Agile methodology, which could impact their ability to deliver quality software on time and within budget. On the other hand, a team that is experienced in Agile methodology may find that a traditional waterfall approach is too rigid and does not allow for the flexibility and collaboration that they require to be successful. Therefore, it is important to consider the skill level and experience of team members when selecting a methodology. A methodology that is well-suited to the team's skills and experience is more likely to be successful and lead to better outcomes.

- **Project complexity**: project complexity is an important factor that has to be considered while choosing a project management methodology as it defines many interdependencies and individual variables which have to be managed efficiently in order to achieve project success. A complex project is better suited to agile as there will be a lot of interdependencies and uncertainty that the project will be dealing with. a simple project can be suitable for a waterfall approach.

- **Frequency of monitoring the project**: The frequency of monitoring is considered important because every methodology has its own kind of structure which influences the frequency of monitoring of the project. Agile monitoring is done every day in the daily standups and in traditional it is usually at the end of every phase of the project, therefore it is usually done weekly or monthly.

7. Data collection method and Design Of the Questionnaire

The data collection method has been chosen as the questionnaire. The practitioner's will be evaluating the importance of the considered parameters for choosing the methodology. The target population for this survey is **project managers in the Information technology** domain. These managers will evaluate the importance of the parameters on a likert scale from 1 to 5, 1 being '**not important**' for choosing the methodology and 5 being '**Important**' for choosing the methodology. We have considered the likert scale inorder to point out the most important parameter. It is designed in this form because it will be easier for understanding the questionnaire and the answers received will be clear. The parameters which will have a **mean greater than 3(50%)** will be considered as important for choosing a project management methodology and will be added to the selection optimization model.

The mean will be calculated on the formulae :

$$\bar{x} = \frac{\sum x}{n}$$

- $\bar{x}$ = sample mean
- $\sum x$ = sum of each value in the sample
- n = number of values in the population

Figure 12. mean of the sample

Source: (BHANDARI,2023)

Questionnaire :

1. Name of the occupation:

2. Experience in handling IT projects(number of years):

3. Evaluate the importance of considering the following parameters when choosing a IT project management methodology on a scale of 1-5.

- Scope of the project (milestones, objectives, limitations, resource allocation etc.)

- Cost of the project

- Schedule of the project

- Project complexity (eg: multiple interdependencies within the projects or simple project)

- Customer Engagement in the project

- Team skills and experience in the usage of methodology

- Customer Requirements

- Change management during the courses of the project(Managing changes in terms of escalation, last minute changes)

- Frequency of Monitoring the Project (everyday, weekly ,monthly monitoring)

7.1 Results of the questionnaire

Results from the questionnaire show the answers from 10 project managers from the information technology domain. With reasonable experience base and practice in the field, the practitioner's opinions are considered to be valid and insightful for the research. The project managers from various companies who handled IT projects answered the questionnaire and here are their occupation and experience in handling the IT project which gives credibility to the answers that were recorded.

Name of your occupation :	Experience in handling IT projects(Number of years)
Automation project manager - IT	4
IT coordinator	8
Project manager	2
Project manager - AVT	5
IT Project Leader	5
Product owner	20
IT project manager	10
Project Manager	5
Project manager	5
IT coordinator	20

Table 5. occupation and experience of respondents
Source: Own contribution

Scope of the project(milestones, objectives, limitations, resource allocation etc.)
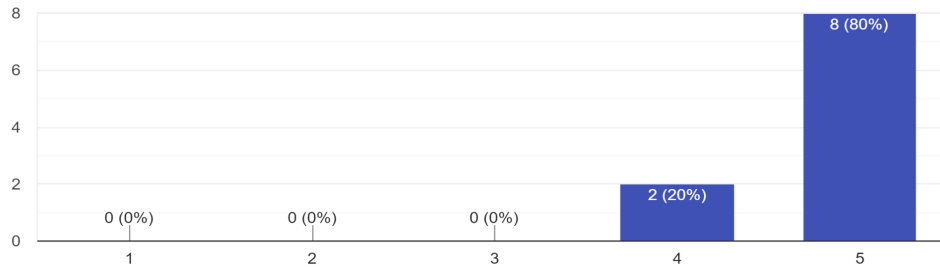10 responses

Figure 13. scope of the project

Source: Own contribution

Out of ten people, eight scored the scope of the project as 5 and two rated as 4. With a mean of **4.8 out of 5** , scope of the project is the most important parameter which has to be considered for choosing the project management methodology.
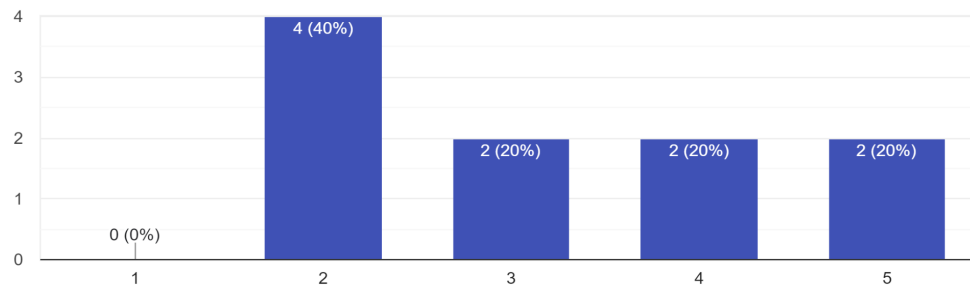
Cost of the project
10 responses

Figure 14. cost of the project

Source: own contribution

Cost of the project had a lot of varied and differentiated responses as every company has its own strategies for choosing the parameters. We have received varied responses, but with a mean of **3.2 out of 5** this parameter has just managed to pass the criteria for consideration in the conceptual model.
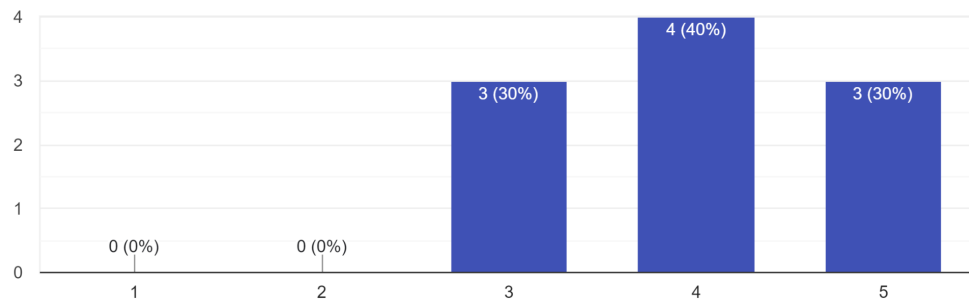
Schedule of the project
10 responses

Figure 15. schedule of the project

Source: own contribution

The schedule of the project was rated more than 3 making it clear that it is important for choosing a project management methodology. The mean of this parameter was rated **4 out of 5.**

Project complexity (eg ; multiple interdependencies within the projects or simple project)
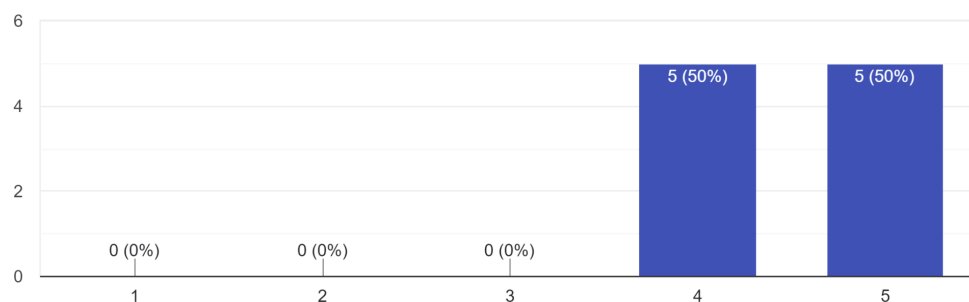10 responses

Figure 16. Project complexity

Source: own contribution

The complexity of the project was also on a high priority for choosing the project management methodology. All of the respondents rated it in the range of 4 or 5. The mean of this parameter was **4.5 out of 5** which was one of the most important parameters to be considered for choosing the project management methodology.
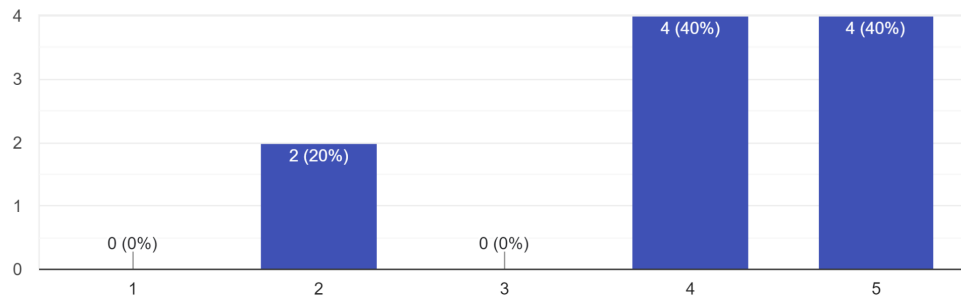
Figure 17. Customer engagement

Source: own contribution

Most of the respondents rated customer engagement as a high priority for choosing the methodology. Out of ten respondents, eight rated 2, everyone else rated it as 4 or 5, highlighting the general importance of the parameter. The mean is **4 out of 5.**
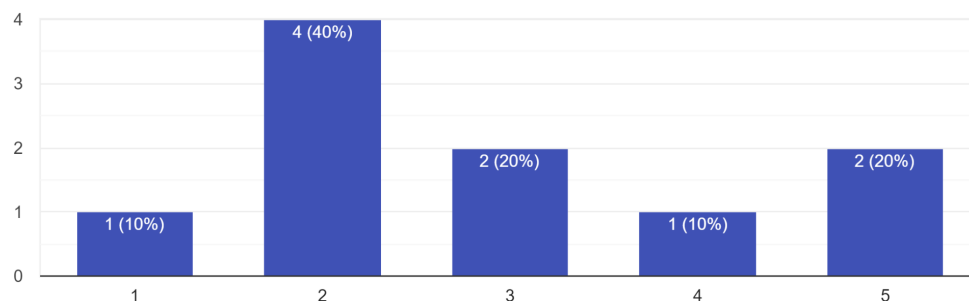

Figure 18. Teams skills

Source: own contribution

Most of the respondents scored this parameter low as they thought it was not important for choosing a project management methodology, but some rated it high. out of the mixed responses received we got a mean of **2.9 out 5** which did not pass the criteria for it to be considered in the model.
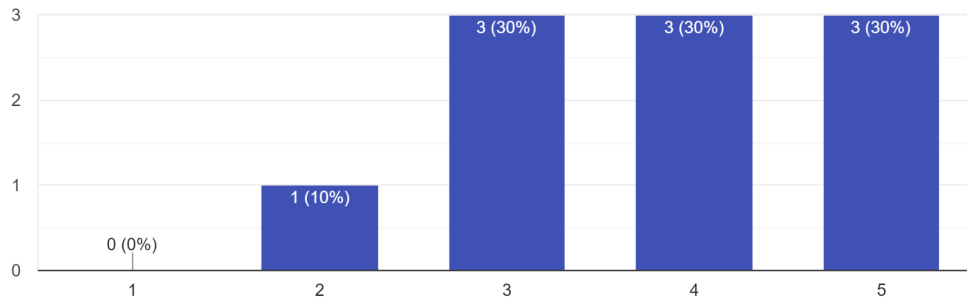
Figure 19. Customer requirements

Source: own contribution

Customer requirements got varied responses but most of it was towards the high priority for considering it for choosing the project management methodology.the mean of this parameter was **3.8 out of 5**.

Change management during the courses of the project(Managing changes in terms of escalation, last minute changes)
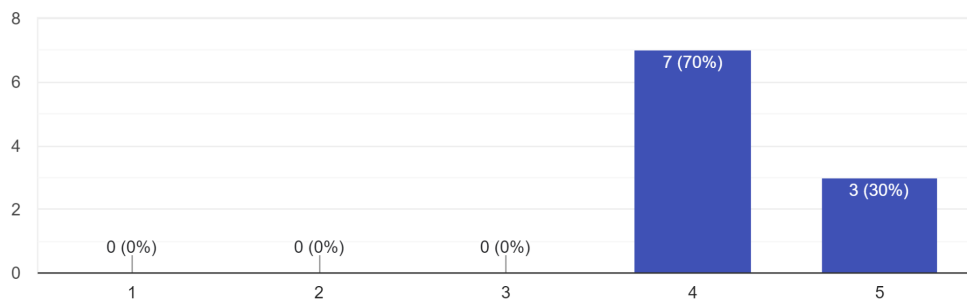10 responses

Figure 20. Change management

Source: Own contribution

Change management got the highest priority after the scope of the project as all respondents rated it at 4 or 5 making it a priority for considering choosing a methodology. The mean of this parameter was **4.3 out of 5.**

Frequency of Monitoring the Project (everyday, weekly ,monthly Monitoring)
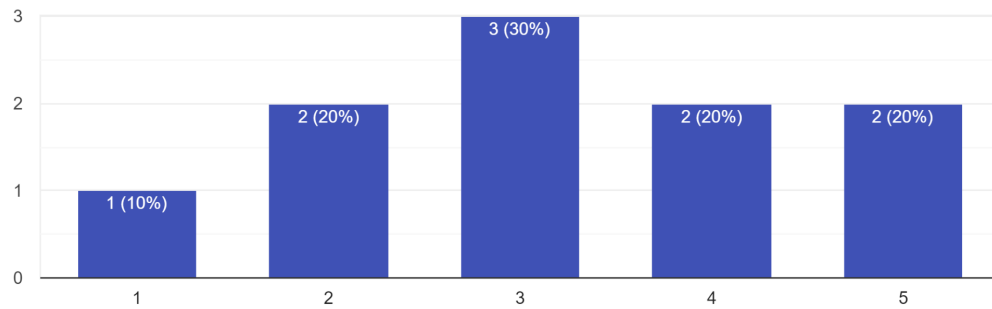
10 responses

Figure 21. Frequency of monitoring

Source: Own contribution

The frequency of monitoring the project got varied responses as three out of respondents considered it to be inclining towards not important and four considered it to be important. therefore we got a **mean of 3.2** which made it eligible for it to be considered in the conceptual model.

7.2 Ranking of the parameters

The following parameters are the parameters which have been considered for the decision optimization model for choosing the project management methodology. The below parameter have passed the criteria of been rated more than 3(50%) and have been ranked according to their importance based on the answers of the respondents:

1. Scope of the project - mean: 4.8/5

2. project complexity - mean 4.5/5

3. Change management during the course of the project - mean 4.3/5

4. Schedule of the project - mean 4/5(on the basis of votes more than 3)

5. customer engagement - mean 4/ 5

6. Customer requirements - mean 3.8/5

7. frequency of monitoring - mean 3.2/5(on the basis of votes more than 3)

8. Cost of the project - mean 3.2/5

8. Structure of the selection optimization model

The conceptual model's structure is straightforward because there are only two options for each parameter. Every parameter has two options that were developed based on the literature review, for instance, the scope of the project can only be fixed or variable in a project. If the scope is *"Fixed"* it means that the project manager has defined majority of the tasks, resources, and responsibilities of the project and remain in that manner through out the project. As a result, they can choose a traditional waterfall methodology because the methodology supports it. An agile approach is preferable when the user's selection of *"variable"* indicates that the items mentioned above have not yet been identified clearly , which can potentially lead to change lead to a change later.

8.1 Guidelines for the model

- The user considers the parameters one by one and chooses the option given.
- For every parameter there are two options available which will show them which methodology is suitable for that particular parameter.
- Once all the parameters have been chosen, which every methodology is suitable for most of the parameters is considered to be the suitable methodology for the project.
- The user should not discard the parameters which are showing him towards the other methodology as all parameters which have been considered in the model are important for choosing a methodology instead he needs to make some adjustments or changes in these parameters on the basis and specifications of his project so that it can be suited with the most desirable methodology.

8.2 Limitations of the model

- In rare cases there can be a tie between the parameters, in these situations the user will be the decision maker on the individual specification of their project.
- The model is only valid for the information technology domai

8.3 Model for selection optimization of the project management methodology
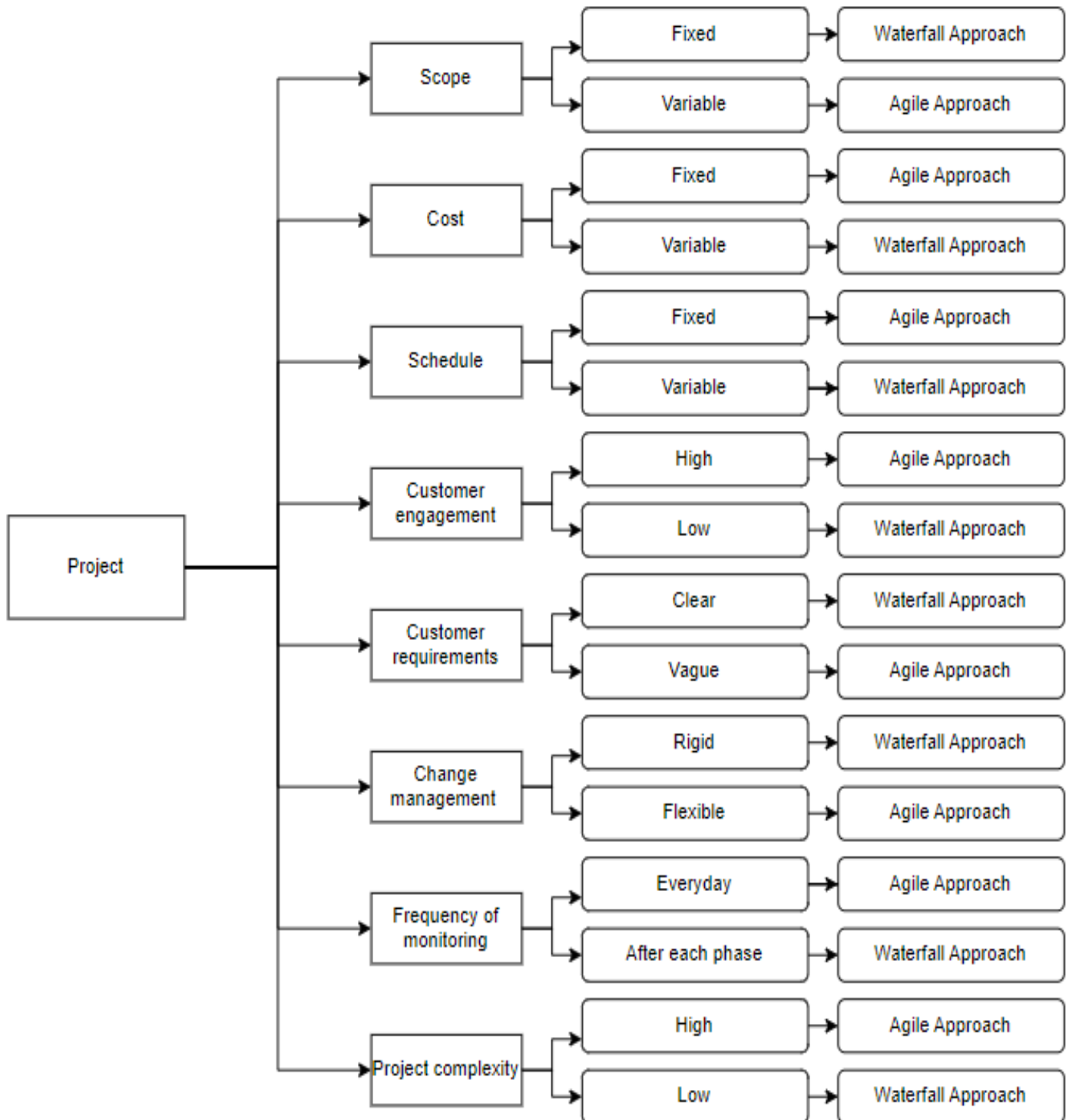

Figure 22. Selection optimisation model

Source: own contribution

9. Conclusions and future directions :

The study highlights the significance of project management methodologies and their impact on project success. The relationship between project success and methodology is crucial as the methodology structures the entire project and provides a specific direction, ensuring that the project remains focused on its objectives. Well known methodologies like agile and waterfall were compared inorder to find the major differences between the two. Then parameters which impacted the choice of the methodologies and also were important for project success were identified and validated. Through the help of these parameters a selection optimization model was created. The objective of the selection optimization model was for choosing the appropriate project management methodology is to assist project managers in making informed decisions. It can also be beneficial for new or inexperienced IT project managers to understand the critical parameters that can influence their methodology choices. Future research can focus further into the various methodologies under the agile umbrella, providing valuable insights to project managers in the information technology domain. The model can be further refined and improved in the future research, focusing on making it more specific to all methodologies and providing better decision making capabilities for IT project managers.

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