NOVA IMS Information Management School

MGI

Master Degree Program in

Information Management

A FRAMEWORK FOR LEVERAGING ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT

Rea Todorović

Dissertation

presented as partial requirement for obtaining the Master Degree Program in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

A FRAMEWORK FOR LEVERAGING ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT

By

Rea Todorović

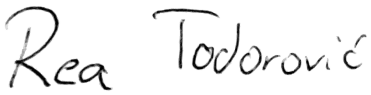
Master Thesis presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems and Technologies Management

Supervisor: Vítor Duarte dos Santos, PhD.

November 2022

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.



Zürich, 28.11.2022.

ABSTRACT

This dissertation aims to support the project manager in their daily tasks. As we use artificial intelligence (AI) and machine learning (ML) in everyday life, it is necessary to include them in business and change traditional ways of working. For the purpose of this study, it is essential to understand challenges and areas of project management and how artificial intelligence can contribute to them. A theoretical overview, applying the knowledge of project management, will show a holistic view of the current situation in the enterprises. The research is about artificial intelligence applications in project management, the common activities in project management, the biggest challenges, and how AI and ML can support it. Understanding project managers help create a framework that will contribute to optimizing their tasks. After designing and developing the framework for applying artificial intelligence to project management, the project managers were asked to evaluate. This study is essential to increase awareness among the stakeholders and enterprises on how automation of the processes can be improved and how AI and ML can decrease the possibility of risk and cost along with improving the happiness and efficiency of the employees.

KEYWORDS

Project Management; Artificial Intelligence; Machine Learning; Machine Learning Algorithms; Small and Medium Enterprises

Sustainable Development Goals (SGD):

INDEX

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AGI Artificial General Intelligence

AHP Analytical Hierarchy Process

AI Artificial intelligence

ANI Artificial Narrow Intelligence

ANN Artificial Neural Network

ASI Artificial Super Intelligence

CNN Convolutional Neural Network

CPM Critical path method

EVM Earned Value Management

FDD Feature-Driven Development

GA Genetic Algorithm

IPMA The International Project Management Association

IS Information system

IT Information Technology

KNN K-Nearest Neighbour

NLP Natural Language Processing

PERT Program Evaluation Review Technique

PM Project Management

PMI Project Management Institute

RACI Responsible, Accountable, Consulted and Informed Matrix

SME Small and Medium Enterprises

SVM Support Vector Machine

1. INTRODUCTION

Project management (PM) is important part of each enterprise. The first known practice of Project management was constructing the Pyramid of Giza (Al-Sarraj & al Najjar, 2019). The history of PM has been long as humanity started to evolve. As we know, project management started in the mid-1950s when organizations started to apply PM tools and techniques, for instance the Critical path method (CPM) and Program Evaluation Review Technique (PERT) (Azzopardi, n.d.). One of the most used tools is the Gantt chart, which Henry Gantt made in 1917 (Al-Sarraj & al Najjar, 2019). The project management institution (PMI), the most respected organization in the PM world, is moving forward with discipline and other institutions such as universities. Even though PM has developed strongly over the years. The current situation and development are not so strong given how the business world is evolving; one example is that the Gantt chart is one of the most widely used tools in the discipline. Software usage in project management started in the 1970s and 1980s (Al-Sarraj & al Najjar, 2019). In 2020 the research shown that only twenty-three percent of organizations use project management software (Hines, 2020), and forty-four percent of managers do not believe in software used for management projects (Lim, 2020). In the fast-changing world, a quick response for adaption is necessary. Project managers have to move forward with available technology. Day-to-day work in this discipline is a recurring task that causes twenty-nine percent of the project that be mostly or always completed on time (Hines, 2020). Statistics show that there is space for improvement which could lead to higher satisfaction of the project's team members.

Artificial Intelligence (AI) is changing human beings' daily lives and theirs working environment. Additionally, it is highly used in communication with customers, known as chatbots, data analysis, and data representation. Moreover, evolution of the cars, there is a possibility of autonomous driving, as well in the hospital in specific countries are used robots which are transferring blood from one department to another, same as in logistics, there are many more examples of usage of AI. AI is one of the ways of the future enhancement of Project management. The software for project management is starting to be used more due to the pandemic COVID-19; the rapid change of working environment forced project managers to adapt due to situation. A case in point of using AI in project management is machine learning algorithms, such as support vector machine, which can help project managers predict the scheduling of tasks. If the same team works on a different project, the algorithm can be "learned" to optimize or predict their tasks and prevent future mistakes due to history of their risks in a project. Further, it can be learned to listen to audio and read a task, which needs to be developed for a project (Deshmukh & Monah, 2021).

The AI became a middle point of any technology development. The concept of AI existed in the 80s and 90s, but it was not that important because there was no corresponding technology progress at the time. In addition, we have more data available, known as Big data. Computers are more powerful than ever before. We use cloud computing, which makes AI development and implementation less expensive. The last thing is development and combination of powerful algorithms (Yakubu, 2022).

1.1. MOTIVATION

The capabilities of AI are vast but insufficiently developed in particular areas. Project management is slowly evolving, and plenty of tasks are done manually and repetitively. An AI is not commonly used due to lack of data and expertise, but it can be a significant help, and objectives can be easier achieved; furthermore, it can decrease plentiful failed projects in the IT. AI can have benefits such as reducing expenses, efficiency, and predictive analytics (Ash, 2019).

Moreover, interest in this topic elevated when I started to work as a project management intern and later as a junior project manager. Desire to understand project management and artificial intelligence made me decide to research the topic in favor of understanding the future and feasible improvements in project management. Considering how to make better decisions based on reliable collected data. The predictions with Artificial intelligence are a big step towards being a better project manager, doing Agile methodologies with a pattern of previous implementations. For instance, in SCRUM methodologies, every day is a meeting (SCRUM daily). As a project management intern, I would: create notes, update all the tasks, create an issue in the board of today's challenges, plan the sprint. Team members would struggle to predict the length of tasks and the complexity of the stories because lack of knowledge regarding the technology, tasks or project, which creates confusion for the project team. In many cases the prediction is not very well done; consequently, the sprint is not going as planned, and the deadline for the project is postponed.

Furthermore, the forecast shows that by 2030 – eighty percent of the project management tasks will be exchanged with Artificial Intelligence. In this case, repetitive tasks, scheduling, and the administrative part of the project management will be improved, consequently decreasing human errors. Project managers will have more time to commit to their team and improve the aspect of team management (Al-Sarraj & al Najjar, 2019).

Additionally, importance of a manager to be a leader is underrated. The overworking and unhappy team in consequence is unproductive, as well they could consider quiet quitting. Being a leader means giving team motivation, supporting team when needed, providing opportunities for personal and professional growth. Communication is one of common challenges in the teams in addition it is one of the most crucial aspects of working in the team; because of that reason it is relevant to make sure that communication is clear and truthful. Clear communication in the team can upscale the overall experience with the project.

To conclude, the motivation is to find the path of optimizing project management daily tasks in furtherance of beneficial improvement of enterprise project and satisfaction of the project team.

1.2. OBJECTIVE

With a better understanding of PM and AI, this paper aims to leverage artificial intelligence tools and techniques in daily project management. The main research question is "How can small and medium enterprises (SMEs) simply implement artificial intelligence in day-to-day project management?"

To understand the problem and develop the solution, the following intermediate objective is defined:

- Understanding project management processes and methodologies;
- The understanding evolvement of Artificial Intelligence;
- Explaining AI tools and techniques;
- Existent application of AI tools and techniques to project management;
- Understand usage of AI tools and techniques and the will to implement them;
- Propose a framework that small and medium enterprises could use to find the easily applicable solution and define which is foremost to use existing tools and algorithms;
- Validate the framework.

2. METHODOLOGY

The methodology used in this research is Design Science Research. Design Science Research (DSR) is a research methodology in which is related human challenge and designer is providing an innovative artifact in order to solve the challenge (Hevner & Chatterjee, 2010).

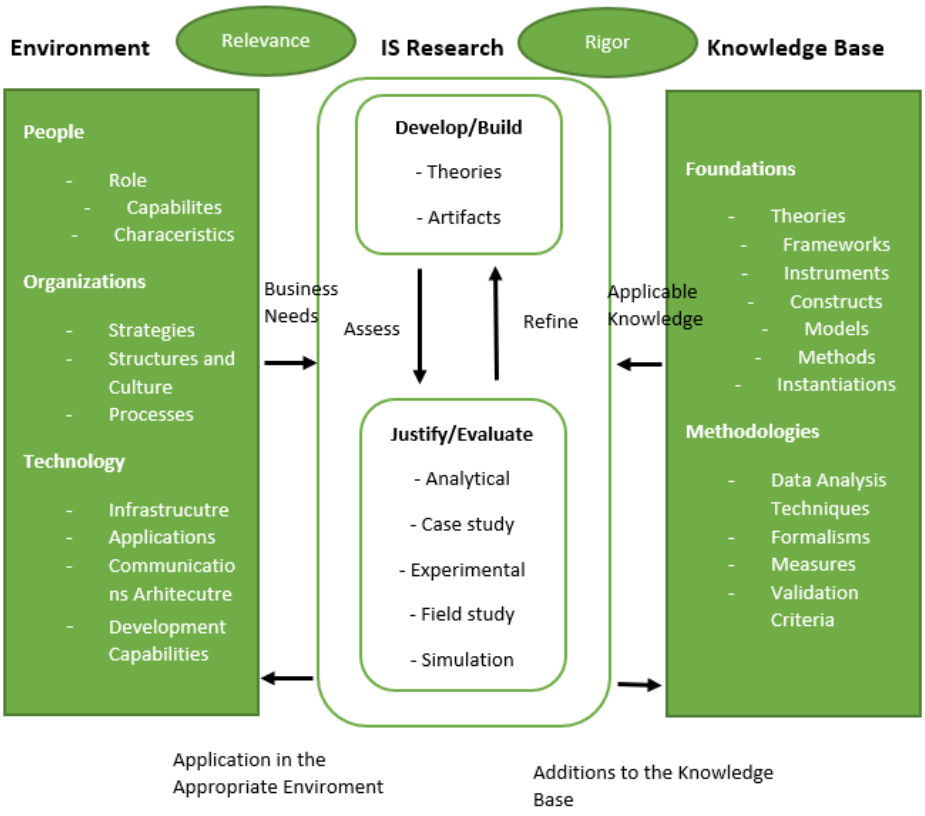


Figure 2.1 The framework of Design Science Research (adapted from Hevner et al., 2004).

Figure 2.1. is representing the design research science created by Hevner et al. (2004). The environment defines all the issues inside of the area of interest. An essential aspect of the environment is people, organizations, technology. All three areas are affecting each other. In the area of the people are essential roles, capabilities, and characteristics. Organizations contain strategies, structure & culture, and processes. Relevance in technology is infrastructure, applications, communication architecture, development capabilities. The environment shows the researcher what things need to consider for future research. Information system (IS) research is divided into two phases: develop/build and justify/evaluate. The behavioral science explains through development and justification, while design science passes through building and evaluation to meet all the environment's needs. Goals that are wanted to be achieved are truth and utility. The knowledge base consists of foundations and methodologies. The foundation of the knowledge base is theories, frameworks, instruments, constructs, models, methods, instantiations. Methodologies that can be used are data analysis, techniques, formalisms, measures, and validation criteria. Foundations are used in develop and build phase, while methodologies are used in the justifying and evaluate phase (Hevner et al., 2004).

There are three cycles in design science research. The first is the relevance cycle which contains understanding the environment and their requirements and the field testing. Another is the design cycle correlating between the development and building and evaluating the design of the research and processes. The rigor cycle is the last one that creates a connection between the foundation, experience, and used methodologies (Hevner, 2007).

The Hevner & Chatterjee (2010) design science research contains six steps: problem identification and motivation; definition of the objectives for a solution, design, and development; demonstration; evaluation; and communication (Figure 2.2.).

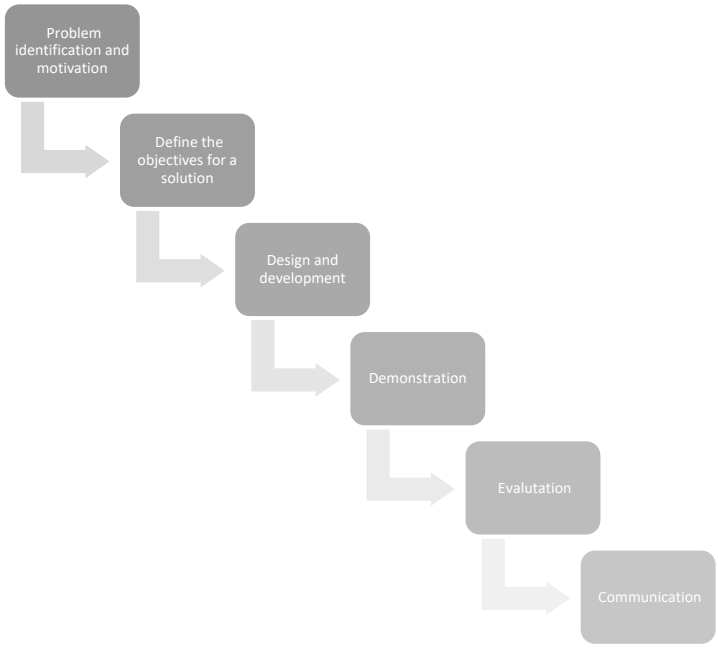


Figure 2.2 Six steps of Hevner design science research (adapted from Hevner et al., 2004)

In this research is used Hevner Design Science Research. Firstly, I will explore the environment which is small and medium enterprises. What is the project manager's role, capabilities, and main characteristics. For better understanding, I did systematic literature review. Understanding their enterprises and technologies is covered in literature review chapter.

For the next cycle, after understanding the exact needs of the Project managers, I will start to develop a set of theories on how to improve the current work state of the Project managers and how to optimize work in future. Afterwards, developing the framework for leveraging AI in PM, it needs to be evaluated by the experts in the field of study. When the framework is evaluated, the third cycle of the design science research connects theories that will be explored and evaluated, frameworks of the work of the Project managers, and the comparison of similar AI models once made with the new and improved ones one. Methodologies used in the justifying and evaluating phase will be explained, presented, and applicable to this research. Finally, validation criteria will be set to present how valid the new framework is and how it can help the future of enterprise project managers.

3. LITERATURE REVIEW

The chapter explains project management statistics that affect the implementation of the framework. The overview explains two perspectives of project management and the methods commonly used to perform a project. Furthermore, the project management tools, techniques and skills are explained in the chapter and the challenges and opportunities in the discipline.

Next, the chapter gives an overview of the history of AI, benefits and challenges of AI-based technologies, and a description of some of the existing tools. Finally, the chapter discusses how AI tools can be applied in project management.

The literature review provides a high-level overview of each discipline and describes their relationship.

3.1. PROJECT MANAGEMENT CONTEXT

Industries are changing rapidly likewise opportunities project management discipline. According to research (PMI, 2017) by 2027, employers will in need for 87.7 million working individuals in project management-oriented roles. On an annual basis, employers will need 2.2 million new project-oriented positions each year until 2027(PMI, 2017). Which creates new opportunities and need for agility for discipline. Projects are becoming more complex, and there is a need to use the available technology to reduce the gaps. According to the research by Gartner, the routine of the work done currently by managers will be sixty-nine fully automated by 2024(Sakpal, 2020). Eighteen percent more projects are falling because organizations do not leverage or have outdated project management technology, and forty-two percent of the failed project of the time (PMI, 2019).

3.1.1. Overview

Project managers have different views on project management, including how to choose and perform the methodologies. Furthermore, overview of the different perspectives in project management and overview of the methodologies will be summarized.

There are two perspectives of project management: task perspective and organizational perspective.

The task perspective considers that project objectives should be defined by using the project triangle at the start of the project (Andersen, 2016). The project triangle presents need of balancing the challenge of triple constraints in the project management which are scope, cost and time (Asana, 2021). Solutions of projects cannot be low-cost in scheduled time and high-quality. An example of using a triangle is if the project owner wants to add a new feature (scope), then its deadline must be extended (time), or it requires hiring new people (cost)(Microsoft, n.d.).Nowadays, there are more variations of the project management triangle. The purpose is the same: with complex projects, it is important to understand the value of this triangle.

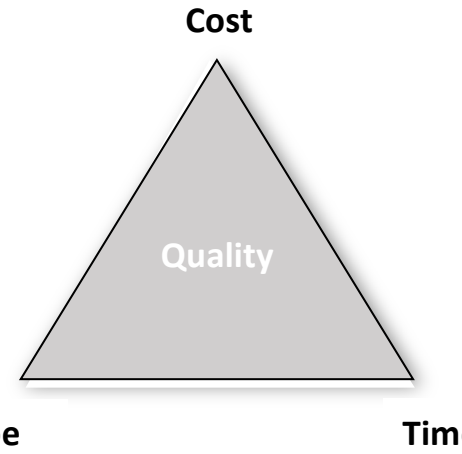


Figure 3.1 Project management triangle (adapted from Team, 2019)

Additionally, using methods like Work Breakdown Structure, which utilizes the technique that integrates scope, cost, and schedule baselines, ensure that project plans are in alignment and creates a network of the broken-down tasks (*Work Breakdown Structure*, n.d.). Detailed project planning focuses on the tasks planned at the beginning of the project. The objective is to finish the project inside the deadline. The role of the project manager is following the project's progress, supporting team members and removing obstacles in the project. Following the work of the team members, the project manager is performing risk analysis to ensure the project will finish as planned and successfully. Reporting of the progress is continuous and detailed. In the idealistic view, the project is delivered on time with expected results and planned budget (Andersen, 2016).

By research of Andersen (2016) the organizational perspective, called the Scandinavian School of Project management, considers that project is a temporary organization that performs the assignment given by permanent organization. Stakeholders should work together to achieve the goals of the project. There are two ways of performing a project. If the project must give a better product, it should be extended if necessary. If the tasks become unworkable, they should be finished earlier, not extended without purpose. The project's primary purpose is to create value in the base organization. Making any change in the organization is no easy task. To make it happen, it will take the permanent organization and project organization to be in constant cooperation and parallel fulfil the necessary tasks to perform the change. As in the tasks perspective, cost and time are essential here; they are used as framework conditions that can be exceeded. In the beginning, the project should have a global plan and detailed plan as it starts when everyone has more knowledge about it.

Moreover, the project manager is doing uncertainty analysis in which he investigates to find any opportunity and challenge. How specific change will affect the base organization, give certain opportunities, and defend the project from interferences. Stakeholder analysis is a process of identification for whom the project is relevant, which is their level of participation, interest, and influence, as well as the communication between project team and stakeholder, how often communication and reporting should happen (Newell, 2020). Transformational leadership is a leadership style that guides the people with vision; vision is followed as a main guidance (Jeanes, 2019). Rolling-wave planning is process of project planned in waves, the planning is based on milestones-oriented assumptions (Heranandez, 2016).

In the research survey of Andersen (2016) forty-three percent of project managers think that their main objective is executing a given task, while twenty-five percent focus on creating desirable development in receiving organization. More project managers make revolutionary approaches than evolutionary ones, which means delivering "*high-value-first progress towards the currently defined and approved requirements and then seeking to obtain and use realistic, early feedback*" (Gilb, n.d.).

3.1.2. Current methodologies

As project management is developing and evolving, methodologies are becoming more agile. In the project management, there are mentioned some of well-known methodologies (Jovanovic & Beric, 2018):

1. Project Management Institute (PMI) methodology –is the most known methodology, created by prestigious Project management institute. PMI identifies ten knowledge areas (*A Complete Guide to the PMI PMBOK Method | Smartsheet*, n.d.): Project integration management, Project scope management, Cost management, Quality management, Human Resources Management, Communication Management, Negotiation in procurement management, Time management, Risk management, Project stakeholder management. Despite ten knowledge areas, the PMI methodology contains five groups of project management processes: group of initiation processes, group of planning processes, group of execution processes, group of monitoring and controlling processes, and a group of closing processes (Jovanovic & Beric, 2018);
2. The International Project Management Association (IPMA) methodology represented in the manual with 29 project manager competencies. They are divided into three subcategories: People, Perspective, and Practice(Hartney, 2018);
3. PRINCE2 methodology – developed for managing information technology (IT) projects. There are nine basic elements: Organization, Planning, Control, Phases, Risk management, Quality in the project environment, Configuration management, Change (Jovanovic & Beric, 2018);
4. Agile methodologies – set of frameworks and practices based on Agile Manifesto and 12 principles. SCRUM, Extreme Programming, and Feature-Driven Development (FDD) are the most known frameworks. Most IT companies are using hybrid agile methodologies to handle projects. The importance of Agile is to be able to adapt to the fast-changing world (*What Is Agile Software Development?*,2015);
5. Six Sigma methodology – data-driven methodology consists of business tools, statistical theories, and quality control knowledge to improve business processes. The purpose is to get rid of any defects in the processes*(Six Sigma Definition, What Is Six Sigma Methodology*,n.d.);
6. The lean methodology consists of methods that minimize the was by implementing continuous feedback, review, and increasing efficiency. The five-core principle is value, value stream, flow, pull, and perfection (*Fundamentals of Lean Methodology Explained With Examples*, 2021).

3.1.3. Tools and techniques

To be able to perform discipline, each project manager uses specific tools and techniques. Each project manager uses different tools and techniques suitable to an enterprise needs and methodologies. Tools and techniques that are commonly used are (Tereso et al., 2019) :

- Kick-off meeting – first meeting with the project team and product owner to establish common goals and the project's purpose. It answers 5 W's (who, what, where, when, why, and how) (Atlassian, n.d.);
- Activity list – a list that includes all scheduled activities needed in the project. Descriptions of activities are detailed to ensure every team member understands each activity (Brown, 2021);
- Milestone Planning – planning based on important deliveries, customers and external dates (Miranda, 2019) ;
- Work Breakdown Structure;
- Requirements Analysis – analysis which are the minimal viable product;
- Project Scope- the document includes a detailed description of deliverables and how they will be accomplished (Atlassian, n.d.);
- Baseline Plan – Project plan includes time baseline, scope baseline, cost baseline, and quality baseline (Teamwork, n.d.);
- Progress Meetings – usually once a week, the purpose of tracking the process of the project;
- Gantt Chart – bar chart showing the project's schedule, on the left side are activities and on the top of the table date (Deen, 2016);
- Progress Report – report in which are information about the project updated. The report aims to show management and client changes or adjustments about assignments, schedules, or budgets (University of Arkanasas, 2016);
- Client Acceptance Form – a document that shows that all requirements are met and accepted by the client;
- Project Closure Documentation – all documents made during the projects (invoices, contracts with vendors, commissions, fees, etc.) should be signed by the client, creating the project's final report (Ray, 2019).

Moreover, the most important ten categories of measuring performance in project management literature review are (Silva et al., 2014):

- Time;
- Cost;
- Quality;
- Customer satisfaction;
- Organization-Management;
- Staff;
- Efficiency;
- Scope;
- Communications;
- Changes.

Mentioned tools, techniques, and categories of measuring performance in project management, have to be analyzed, planned and performed by project manager. Due to the volume of documentation, project managers have their way of documenting progress of project because of that reason new challenges are happening which is lack of structured project data.

3.1.4. Challenges and Opportunities

Despite the tools and techniques are used, discipline has some challenges. According to (*What Is Natural Language Processing?*, n.d.) the ten main challenges in Project management are lack of coordination, requirement engineering activities, change management activities, allocation of tasks, cost and effort estimation, lack of a uniform process among different development sites, lack of knowledge management and transfer among teams, lack of trust, lack of control, conflict management. In other words, the issue is communication in the team, resource management, and project estimation. Usually, these issues happen in the first and second project cycle, project initiation and planning. Lack of knowledge of how to begin a project with the right tools can lead to these issues mentioned before. Consequently, the project rate of failure is high. According to Hefley & Bottion (2021) the project is falling are lack of performance and did not achieve the specified outcome, overrun in costs, over the deadline, and changes in scope during project execution.

One of the preventions of these challenges is in the software project management system. Nowadays, finding proper software for project management that contains all the features that project managers need is a problem. The ideal software project management system characteristics would be increasing efficiency and time savings, accessibility to project information, automated data capturing and validation, flexibility and adaptability, simplicity of the system, and intelligence. Accessibility to project information is one of significant challenges in the software for PM; while working on projects, it is hard to find one place to add all necessary information. Automated data capturing and validation, issue with data is not solved with a new software solution, one of the problems is entering incorrect and non-quality data. Tools should be flexible and easy to adapt as much as possible; every company should be able to adapt software solutions according to their business. Some software solutions are too complex, which should be as simple nowadays because of already too complex projects. An intelligent system would be beneficial for each project manager to him to be able to focus on different daily tasks(van Besouw & Bond-Barnard, 2021).

As van der Aalst (2021) described, one of the ways is automation. There are two types of automation: Process and Task automation. Task automation is based on one task (e.g., auto-filling form) and based on an end-to-end process (e.g., webshop - from checkout to payment).

Hybrid intelligence is often in digital transformations, adopting digital solutions instead of manually doing the task or process. Hybrid intelligence combines two forms of intelligence: human intelligence, which represents people, their experiences characterized by flexibility, creativity, empathy, instinctively and machine learning represents data and algorithms, characterized as fast, efficient, cheap, scalable, and consistent (van der Aalst, 2021). Hybrid intelligence can be seen in multiple areas in each enterprise likewise “robots” that are led by humans.

3.2. PROJECT MANAGEMENT

The growth of project management has been very steep in the past years, but it will increase even more. Project management, a discipline that is intriguing many professionals, is applied almost in every enterprise. The core of this discipline will be explained in this chapter.

3.2.1. Project life cycle

The project life cycle includes five phases, also called five process groups. Five process groups are divided into Initiating, Planning, Executing, Controlling, and Closing (Vargas, 2001).

The first phase is Project initiation, in which the project manager must prove that project brings certain value to the business. One of the steps is to create a business case representing the need to have this project. The next step is the project charter which is a document that contains main information about the project for the presentation to executives, and it includes an executive summary, project scope, requirements, risk management, business stakeholders, project team, responsibility matrix, goals, or benefits, deliverables, start, and end date, project manager (MacNeil, 2022).

The second phase is Project planning, the critical and crucial phase(Pellerin & Perrier, 2018). The goal of the phase is to create a detailed project plan. The project plan is a more detailed document than the project charter, including work breakdown structure, Gantt chart, Risk analysis, Responsible, Accountable, Consulted and Informed (RACI) matrix, budget(Project Management, n.d.).

Project execution starts after planning and reallocating resources; this phase aims to deliver requirements to a stakeholder (Project Management, n.d.).

Project Controlling is happening as parallel process as project executing. This phase aims to monitor each team member's progress and performance and follow the planned schedule and budget. In this phase, quality control is important to deliver the project as stakeholders require (Project Management, n.d.). The project is controlled by comparing the actual and baseline project schedule created in the planning phase. One of the tools for measuring goals is earned value analysis, s-curved method (Pellerin & Perrier, 2018).

Project Closing is the last stage of the project life cycle; the goal is to present deliverables to stakeholders. Suppose deliverables meet the stakeholders' requirements and are approved. In that case, documentation should be completed, and resources signed off after a satisfaction survey is conducted for most enterprise’s project managers and project managers (Project Management, n.d.).

3.2.2. Project manager skills

In this chapter are explained project management skills. Every professional project manager must have a particular set of skills. A variety of certificates, educations, methods distinguish project managers, but specific certificates do not represent entire knowledge or capabilities; consequently, Project Management Institute (PMI) created the Project Management Institute Talent triangle presented in Figure 3.2 (PMI, 2015):

- Technical Project Management represents domain expertise and certification specific. It contains Agile practices, Data gather and modeling, Earned value management, Governance (project, program, portfolio), Lifecycle management, Performance management, Risk management, Schedule management, Scope management, Time, budget and cost estimation, etc.;
- Strategic and Business Management is a representation of business-oriented skills. It includes Benefits management and realization, Business acumen, Business model and structures, Competitive analysis, Customer relationship and satisfaction, Industry knowledge, Legal and regulatory compliance, Marketing awareness and conditions, Operational functions, Strategic planning, analysis, and alignment;
- Leadership represents competency in guiding and motivating. Skills that are needed to have are: brainstorming, Coaching and mentoring, Conflict management, Emotional intelligence, Influencing, Interpersonal Skills, Listening, Negotiation, Problem-solving, and Team building.

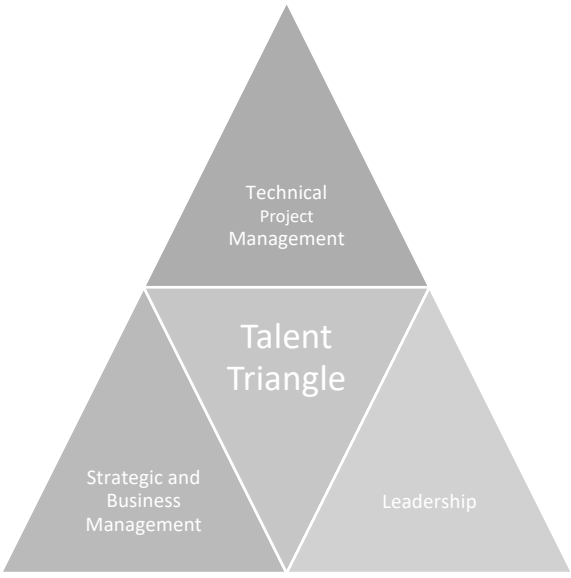


Figure 3.2 The PMI Talent Triangle (adapted from PMI, 2015)

On the other hand, the PMI triangle is not the only institution that proposes project managers' skills. Therefore, the author Horváth (2019) created an integrated two-dimensional project management competency model. Presenting vertical and horizontal dimensions of competencies, the categories on vertical dimension are standards (Attitude, Skill, Knowledge) and on horizontal dimension is

represented different content elements of project management competencies which are Technical, Human and, Conceptual and organizational. The purpose of this kind of model is to be able to do practical implications and analysis of the project manager's skills.

Project manager is required to have wide set of skills to perform their profession, because of that reason the technological solution could support their everyday tasks and make it more sustainable for project manager to manage one or more projects in parallel.

3.3. ARTIFICIAL INTELLIGENCE

In this paragraph will be described the overview of artificial intelligence. Afterwards the tools and techniques of AI are mentioned and possibilities which they provide.

"Field of artificial intelligence (AI) is concerned with not just understanding but also building intelligent entities – machines that can compute how to act effectively and safely in a wide variety of novel situations"(Russell & Norvig, 2021).

According to Russell & Norvig (2021) AI has two dimensions to reconstruct human behavior: human vs. rational and thought vs. behavior. These methods are used in psychology, economics, engineering, mathematics, statistics.

In 1950, Alan Turning created the Turning test, based on the question, "*Can a human evaluator distinguish between a human and a machine using only natural language conversation*?" (van der Aalst, 2021). Which led to "*Can a machine have a mind, mental states, and consciousness in the same way that a human being can*?" (van der Aalst, 2021).

Russell & Norvig (2021) are defining the Artificial intelligence as following:

- Acting humanly. To pass the Turning test, the computer should be able to process natural language to be able to communicate with humans, to have knowledge representation to be able to store what it knows or hear, to have automated reasoning to answer the question and create a conclusion based on it. The last is machine learning to adapt to new situations and detect a pattern. For the total Turning test, the robot needs to pass computer vision and speech recognition and robotics to move objects;
- Thinking humanly. In order to think humanly, there are three ways of human thoughts, introspection, psychological experiments (observing human acts), brain imaging (observing brain acts);
- Reasoning. Solving any logical problem written in logical notation would be one of the possibilities of AI. It is not only a logical problem in the world, especially in the time we are currently living in, there is uncertainty. Constant uncertainty can be solved by probability theory, which will understand raw perceptual information to process into prediction in the future;
- Acting rationally. The computer should be able to be a rational agent; he should act to perform the best outcome or at least the best-expected outcome. The problem with

rationality is the perspective of what is rational. Rationality can be perceived differently by a different human being.

To conclude, the artificial intelligence did not reach all four points mentioned previously, but it is leading to that direction. Even tough, artificial intelligence is not new field in information technology but nowadays, it started to be widely used and it is still in progress of development.

3.3.1. Techniques, types, and tools of Artificial Intelligence

The most important AI techniques are (Pedamkar, 2019a) :

- Machine learning – machines are not programmed to perform a task; they are learned to improve performance automatically. One subset is deep learning which is based on artificial neural networks for predictive analysis (Pedamkar, 2019a)
- Supervised Learning – using labeled data to classify data and predict outcomes (*Theory of Mind*, n.d.);
- Unsupervised learning – predict undefined relationships (meaningful patterns in data) (*Theory of Mind*, n.d.);
- Self-Supervised learning uses unsupervised learning and can work with data that do not have data labelled by humans(*Theory of Mind*, n.d.);
- Natural Language Processing- machines can process human language (Pedamkar, 2019);
- Automation & Robotics – automation is created to improve productivity and decrease costs by machines doing repetitive tasks. Robotics is made to perform high-volume repetitive tasks that adapt to different circumstances (Pedamkar, 2019a) ;
- Machine Vision – machines can capture visual information and analyze it. Converts image to digital data then processes data by digital signal processing (Pedamkar, 2019b)

There are two types of Artificial intelligence (Pedamkar, 2019b):

- Based on Functionality – Classifying AI on their ability to think and feel like a human
    a. Reactive Machine – Replication of human ability to react to different stimulants. It cannot apply information or experiences to new decisions (Pedamkar, 2019b);
    b. Limited Theory- Have the ability of the reactive machine and it is able and can apply information or experiences to new decisions (Pedamkar, 2019b);
    c. Theory of Mind – ability to understand human minds (emotions, thoughts, needs) and after the response to that recognition of the human state (*Theory of Mind*, n.d.);
    d. Self-Aware AI – Will be able to have their own emotions (*Theory of Mind*, n.d.).
- Based on Capabilities – Classifying AI to have higher capacity than a human being
    a. Artificial Narrow Intelligence (ANI) - includes only tasks for which they are programmed; they cannot perform any other tasks that are not specified. As mentioned before, it is based on a combination of reactive and limited memory(George, 2022);

b. Artificial General Intelligence (AGI) is able to train, learn, understand, and perform functions the same as human beings. They are just hypothetical now (Pedamkar, 2019b);
c. Artificial Super Intelligence (ASI) will be able to perform all the human tasks but with the ability of superior data processing, memory, and decision-making (George, 2022).

3.3.2. Possibilities and challenges of AI

The constantly circulating question is "Should we use AI or not?". Many are the advantages of AI: it helps humanity automate processes, have more time to focus on more important questions, improve everyday work and become efficient, have more free time, and help the production of goods and services. Even though there are many advantages, "What are the real risks we are taking with a new approach to the new technology?" Some of them are lethal autonomous weapons, surveillance and persuasion, biased decision making, impact on employment, safety-critical applications, cybersecurity (Russell & Norvig, 2021).

3.3.2.1. Possibilities of AI

There is more talking about Artificial intelligence leaders; will they replace the human leaders? Research by Grotenhermen et al. (2020) covers the question. As the main importance in leadership is trust and transparency, based on research, employees will have difficulties understanding AI-based decisions. Because of it, they will not have trust in the intelligent system. While in complex decision making, both have advantages and disadvantages, e.g., an intelligent system will be able to process more information. At the same time, humans can use this intuition and all relevant features to make decisions.

Accordingly, to help humans in everyday work, scientists worldwide have pre-built AI capabilities. Cognitive services mean adding human-like capability to the application. We can divide them into four capabilities (Yakubu, 2022):

- Vision - Image Understanding, Text extraction, Image captioning, Form recognition, Video indexing, Facial recognition and Spital analysis;
- Speech - Speaker recognition, Speech to text, Custom neural voices, Speech transition;
- Language – Entity extraction, Sentiment analysis, Intent understanding, Text and document translation, Q&A creation;
- Decision – Anomaly detection, Roof-cause analysis, Metric monitoring, Personalization.

These capabilities can be applied in the everyday business work-life, e.g., creating Chatbot with Frequently Asked Questions. The chatbot will contain image understanding, Intent understanding, text and document translation.

The research by Ulrich et al.(2021) is shown in figure 3.3. The organization sees the opportunities of AI in SMEs, which is the first step towards developing and implementing those solutions. In conclusion, the most critical and realistic opportunity for SMEs is the Automation of processes already available through the platform Power Automate from Microsoft. The second one is the Efficient use of data;

using Power BI today, any data can be represented with a few clicks, which can improve decision making and the overall picture of the situation in the enterprise. The saving potential is important for business, and fewer resources are necessary when the processes are automated. The illustration shows the potential to apply those AI opportunities in Project management, e.g., automation of processes, efficient use of data, better decision making.

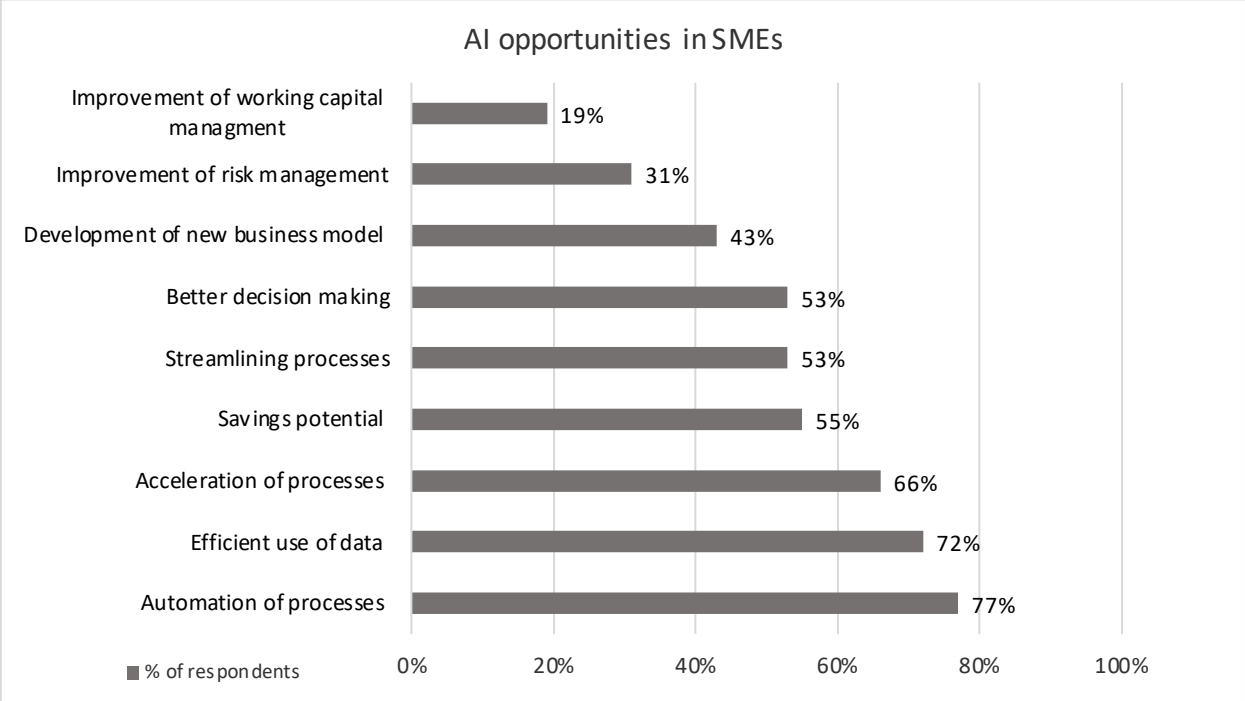


Figure 3.3 AI opportunities in SMEs (adapted from Ulrich et al., 2021)

The adoption of Artificial intelligence is progressing; forty-seven percent of questioned companies said that they embedded at least one AI capability(Chui & Malhorta, 2018) In comparison, in 2021, fifty-six percent of respondents adopted at least one AI function (Chui et al., 2021).

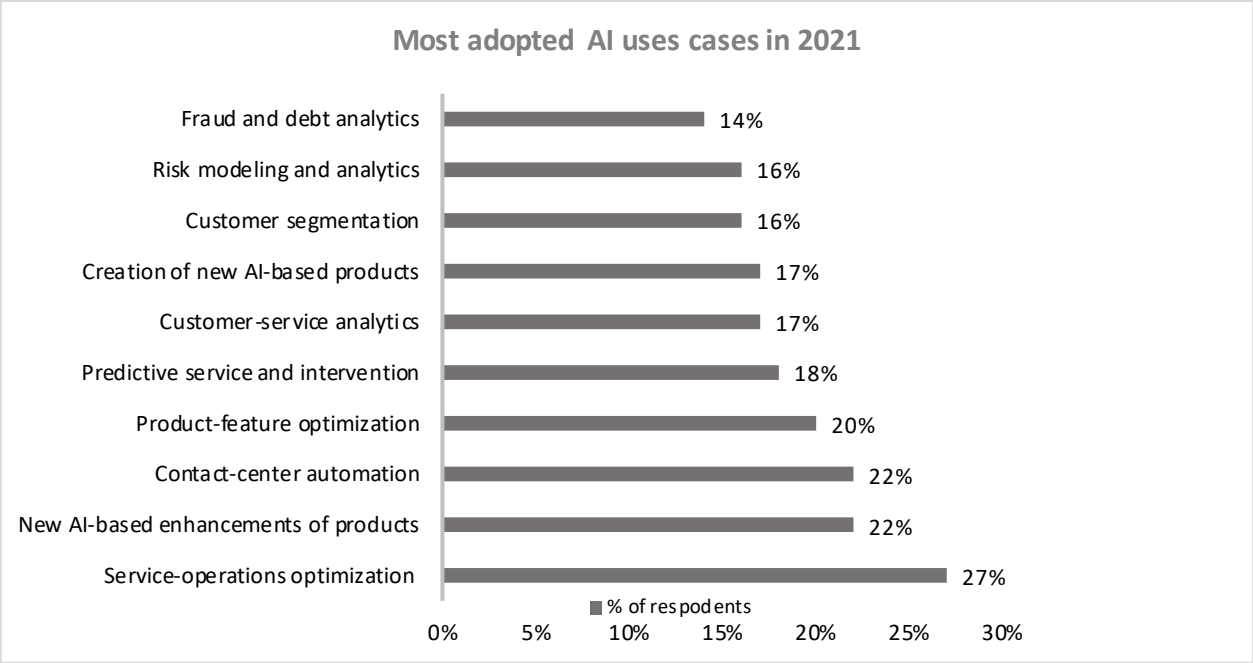


Figure 3.4 Most adopted AI use cases (adapted from Chui et al., 2021)

Research by (Chui et al., 2021) represents that the most adopted case is service-operation optimization, which can automate the processes. Second, chatbots and data analytics do new AI-based product enhancements and contact-center automation.

In 2018, the most digitized companies with the average level of digitization were more than fifty-one percent, embedded in business process at least one function is as most implemented capability is a virtual agent or conversational interfaces. Machine learning, natural-language text understating, computer vision, robotic process automation, natural-language speech understating, natural-language generation, physical robotics, and autonomous vehicles(Chui & Malhorta, 2018). Data is concluding that using Chatbots is almost in every enterprise, as well the translation of human languages is important and evolving.

Benefits of using AI in the business are (Microsoft, 2021):

- Free up time by automating complex business processes;
- Improve product quality through defect detection;
- Increase uptime with predictive maintenance;
- Enhance customer service with an intelligent chatbot;
- Prevent fraud and compliance risk;
- Forecast revenue more accurately;
- Drive customer loyalty by personalizing experiences;
- Close more deals through advanced lead scoring;
- Ensure product availability by optimizing supply chains.

The mentioned benefits are significant for any business improvement. It can significantly decrease the expenses of the enterprises.

3.3.2.2. Challenges of AI

In Latinovic (2022) research, software engineers who understand more than basic users believe that AI-driven tools will never substitute software engineers. However, they favor AI-enhanced tools that can help them in daily work, e.g., notifying colleagues about the push on GitHub.

Software engineers who are ready and open to a technological change struggle to accept AI in an enterprise, but not accepting Ai as a solution is not the only barrier to enterprises. According to research Ulrich et al. (2021) these are significant challenges for enterprise:

- Lack of competence;
- Obstacles at implementation;
- Data problems;
- Deficiencies in IT infrastructure;
- Financial barriers;
- Lack of commitment from top management.

The most significant barriers for adoption organizations AI according to research (Chui & Malhorta, 2018) :

- Lack of clear strategy for AI;
- Lack of talent with appropriate skillsets for AI implementation;
- Functional constrain end-to-end AI solution;
- Lack of leader's commitment;
- Lack of technological infrastructure;
- Lack of amount of available data;
- Uncertain or low expectations for return on AI investments;
- Under resourcing for AI in the line organization .

In comparing both listed challenges, the conclusion is lack of available data, lack of the commitment of top leaders in the enterprise, problematic and not stable IT infrastructure, lack of knowledge.

3.4. Applying AI tools and techniques to project management

According to research by Lahmann et al. (2018) there are four main evolutions (integration and automation, chatbot, machine learning-based project management and autonomous project manager) of AI in project management which are explained in details in the next paragraphs.

The first one is integration and automation, which is in progress. Integration and automation of standardized daily tasks through workflow integration and process automation. Per instance using Jira Work Management templates for initiating a project or having notification of SharePoint when someone makes a change in the document, as well as the connection between Microsoft Project and Planner (every task in Microsoft Project can be assigned to a person and that task is going automatically in Planner of a person that is task assign to). Integration and automation will continue to develop. Project managers will have more time to focus on different aspects other than projects (e.g., human resource management). Possibilities of integration and automation are mentioned before, and by research, they are already implementing many companies.

Chatbot assistants are the second phase of AI evolution. As chatbots are evolving over the years, their possibilities are increasing. Chatbot with the ability of Natural Language Processing allows the chatbot to understand concepts, entities, ideas, and know-how to respond to most of the employee's questions(Bhaskar, 2019). They can organize meetings, find different data, answer questions to a team member, look at the daily agenda of a team member or project manager, e.g., for daily stand-up in SCRUM methodology, they can ask the three main questions to members. The advantage of chatbots is more free time for a project manager to create more value. However, the disadvantage is changing in a project manager role and adapting to a different project management approach (Lahmann et al., 2018). Project management bots in current research of Auth et al. (2019) are divided into three categories:

1. Specialized in PM (such as PMOtto);
2. Vendor-side extensions are products to support project teams (such as T-bot and Who-bot for Microsoft teams). T-bot is an assistant who teaches how to use Microsoft team, and Who-bot answers questions "Who know about..." (McDonald, 2016);
3. Extensions for third-party products such as Stratejos, which creates a project assistant bot for Atlassian products (Auth et al., 2019).

Machine learning-based project management is the third phase in project management evolution. With the help of a developer, project professionals can create software based on Machine learning that will learn from previous projects and suggest possible schedules. Data analysis will show possible risks, changes, or opportunities that the project manager should do to perform on time in the budget (Lahmann et al., 2018). Match the right resource to the proper role nowadays Human Resource software can choose the eligible candidate for their company, the same will be for choosing the team members for a project(Burger, 2017). Guide in making decisions, with machine learning and a large volume of data with an understanding of key performance indicators, can make recommendations for complex decisions (Bhaskar, 2019).One of the issues is analyzing a large amount of data; AI can do it. The rule-based schedule will increase the productivity of the project manager for each project planning (Alshaikhi & Khayyat, 2021). Data-driven project management databases must be combined with the experience and initiation of the human project manager. Focus on resource management, planning and controlling cost, time, risk, and quality. It will be based on *"PERT, CPM, Earned Value Management (EVM), Analytical Hierarchy Process (AHP), and Six Sigma"* (Auth et al., 2019).

The last phase is Autonomous project management, it will only need input and invention from the project manager, and it will be able to perform in small, non-complex projects and use sentimental analysis algorithms to understand inputs from stakeholders and customers. This kind of AI system will never perform entirely without humans (Lahmann et al., 2018). According to the research of Alshaikhi & Khayyat (2021), the automated project manager will not be able to substitute a human project manager. Virtual Partner can be one of the solutions of AI. If AI acts as a Virtual partner, the project manager will focus on an innovative mindset, customize their knowledge to perform the digital transformation, have data science skills, and privacy and security knowledge(Al-Sarraj & al Najjar, 2019). It can identify relationships and trends, intelligent real-time analysis, optimize schedules, enhance data, and improve portfolios, provide business insights, human capital optimization, status reporting, risk management support, active assistance, research new trends and experts (Alshaikhi & Khayyat, 2021). The advantage of an autonomous project manager is better employee evaluation, proportional assign the tasks, automated monitoring, errors, and warnings based on data but the skill

that robotical project manager can have been an emotional part of delivering the project, which is very important and unpredictable (Burger, 2017).

The AI will be able to assist in projecting manager in the following tasks (Johnsonbabu, 2017) :

- Define the project scope;
- Align with business areas;
- Analyze risks;
- Create project schedules, timelines, and budgets;
- Assign tasks to the relevant resources;
- Implement software and other technical components;
- Assess project outcomes;
- Track issues.

According to Al-Sarraj & al Najjar (2019), there are five ways that AI will transform project management, Business insights, Risk management, Human Capital Optimization, Action Take, Active Assistance. Flittering data, creating relationships between them can remove unnecessary information and give relevant data, which will help in the decision-making to a manager. Virtual Assistants can help managers follow the newest trends in project management and business, researching the new publications. Optimize schedules by forecasting duration and resource management with previous knowledge of projects. Facing the issue of not entering any data about projects can help with an AI system that will provide recommendations for those data. Using accuracy of AI can suggest based on historical data and warn if there is any potential risk. Incorporation of natural language processing to scan emails and documents to check the potential issues or liability. There are a few ways of how AI can optimize human resources: calculating the best allocation of resources, identifying skills for a specific job, showing the training which is customized just for the employee, predicting excess or shortage of resources, providing feedback about the project manager's behavior and competency. Combining AI systems with other solutions can make a considerable change in project management work; updating data automatically from other solutions or recognizing people and adding them in software can help to optimize the work. The active assistance of AI can help report the progress to different stakeholders or top management, generate the reports, listen to meetings, and assign tasks to people with target dates, send out actions and follow-ups.

3.4.1. Challenges for implementation of AI in project management

The project management triangle mentioned in the chapter provides three main project management fields: technical, strategic, and business management, and leadership. Artificial intelligence can perform technical skills because it is based on data and analytical skills. Strategic and business management is impossible to be done by only AI; AI can support PM to make a better decision. The last skill is that humans can only provide leadership; AI does not have emotion and cannot understand people (Lahmann et al., 2018).

One of the barriers AI is still having is the availability and non-quality data. Performing tasks only that is programmed. According with Alshaikhi and Khayyat (2021) the following factors need to consider:

- The implementation and development of AI are expensive and not for every enterprise;

- Replacement of employees will replace many jobs with AI robots or software, increasing unemployment and the need to change jobs;
- With the passivity of the human, we will get used to having machines doing tasks in a shorter period than humans;
- Lack of understanding system, need for experts in AI, and education about AI will be necessary to have the AI system in daily lives.

In conclusion, there are a few challenges for not implementing AI, but the issue is that current solutions do not have the possibilities and flexibility to adapt to enterprise, and enterprises are not ready to have additional expenses on new software and platforms. Today in every enterprise is a need for the project, which is becoming very complex. The decision to implement AI is not easy, and there is no information gathered in one place to understand how to apply AI in a project manager's daily life. There are platforms like Power Automate in which each project manager can automate their processes, but the issue with this kind of platform is that not every project manager has the knowledge to use it and maintain it.

3.4.2. Advantages of implementing AI in PM

The advantages for implementing AI are:

- As much as AI can be implemented in the daily work of PM, the PM will have more time for leadership, people and stakeholder management, communication, storytelling, empathy, emotional intelligence, negotiation (Lahmann et al., 2018);
- Creating an ecosystem for knowledge management, when employees leave the workspace, they will understand the pattern of workplace behavior(Burger, 2017);
- Deliver untiring objectivity and vigilance; as mentioned before, the non-quality data and information are a problem in project management, and it can be partly fixed with the implementation of AI (Burger, 2017);
- Predictive analysis, according to McKinsey research (as citated in Balaji et al., 2018) in one-thousand and eight hundred projects, thirty percent are completed on time. Implementing machine learning algorithms into project management software can increase the percentage of projects finished on time;
- Improve productivity and efficiency; automating daily tasks and receiving notifications about the projects from the system can make time for the project team to implement innovations and improvements in the project(Bhaskar, 2019);
- Cost-effectiveness, reliability, permanency, and addressing particular uncertainties (Alshaikhi & Khayyat, 2021).

In conclusion, there are many advantages of implementing AI in Project management. In the long term, every enterprise would benefit from AI implementation. Employees will have more time to focus on the challenges and innovation, which is important to be in the flow with trends in this fast-pacing world.

3.4.2.1. AI solutions

In section are mentioned some of the most relevant AI solutions for project management are listed:

- Stratejos – messaging bot is posting questions to a team about progressing in the tasks (Burger, 2017);
- ZiveBoxs – collaborative application which is empowered by Big data analytics, AI bots and task organization(Crunchbase, n.d.) ;
- Rescoper - application helping with project planning and keeping projects on track (Eigelbach, 2017);
- ClickUp – cloud-based work platform for all businesses. Providing tools for process, task, time management, collaboration, and reporting (Santos, 2021);
- Cisco Spark, Redbooth with Api.ai – messaging bot that is asking questions to a team regarding the progress (Burger, 2017);
- Polydone – cloud platform for managing projects and resources (K., 2020);
- Clarizen - Project management software for managing work, automating processes, and collaborating across the enterprise(*Scalable Project Management Software*, n.d.);
- TARA – project management software for visibility and predictability of the project plans (*Define, Plan & Track Mission-Critical Product Updates*, n.d.) ;
- PMOtto – virtual assistant which advises on tasks, costs, and resources(Hofmann et al., 2020);
- Cloverleaf – a platform that shows insights into project teamwork (Hofmann et al., 2020);

Therefore, the solutions are starting to rise, but a small number of enterprises have decided to add them to the budget or implement them. Most of the solutions are expensive, or they still lack particular needs in project management. There is not enough flexibility in the software or platforms, which is one of the most important aspects when enterprises choose solutions. Most enterprises still use Excel from Microsoft because it is embedded into everything, they use it daily, and there is no additional cost.

4. PROPOSAL FOR FRAMEWORK ON USING ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT

Researching and learning about the main concepts of artificial intelligence and understanding its application in different areas brought different perspectives on where and how it can be used in our everyday life without noticing it. Project management methodologies, even though it is highly used in every enterprise, there are still many aspects that are not entirely realistically developed. After learning about those gaps and available tools, the dissertation's research question could be answered: "How can small and medium enterprises (SMEs) simply implement artificial intelligence tools in day-to-day project management?"

Implementing artificial intelligence is one factor that could improve project management, budget, planning and resources in each enterprise. The framework's objective is to give an overview to the project manager who does not have a technical background, how they can implement artificial intelligence, and the steps in planning such a project.

Moreover, the framework contains all the necessary steps for a project manager to plan the artificial intelligence project and to understand if it is feasible to implement AI in their enterprise.

4.1. ASSUMPTIONS

The studied literature review about the project management gaps and opportunities, the main concepts of artificial intelligence and their application, and which methods are suitable for each project management process are presented in the following subchapter. The inspiration for the proposed framework is based by from this literature review findings:

- The project managers will be subleased by Autonomous artificial intelligence, and this assumption is made by how fast technology has been moving in the recent decade (Gil Ruiz et al., 2020);
- The prediction is that 2023 to 2035 will be a period of Machine learning in Project management (Gil Ruiz et al., 2020);
- Slow progress in developing AI is because the private sector is still not focused on investing in Project management (Gil Ruiz et al., 2020);
- Artificial neural networks have proven to be powerful tools for optimizing the cost effect function, summed as the relative magnitude error between the current ANN output and the desired (target) output, which leads to the smallest value of cost (Rankovic et al., 2021);
- Project management triangle is incredibly hard to comfort (Song Deng & Ma, 2021);
- Project Risk management is the most developed knowledge area in Artificial intelligence;
- The AI implementation that will have the most impact on the risk is in the area of monitoring risk and performing quantitative risk analysis (Fridgeirsson et al., 2021);
- The most minor implementation of Artificial Intelligence was found in the stakeholder management knowledge area;

- The research done by Fridgeirsson et al. (2021) presents the stakeholder management only higher impact can have monitoring stakeholder engagement;
- By the research of Fridgeirsson et al. (2021), which was conducted on 81 participants, the AI effect on ten knowledge areas in the next ten years will be increased. From the research the highest impact will have 58% of participants believe that AI will have a very high or high impact on project cost management. 51% thought that the impact would be very high or high on project schedule and 47% on project risk management, the lowest results were the stakeholder management which was 21% of respondents voted for very high or high;
- The most important knowledge areas for the project success are time, risk, and scope (Zwikael, 2009).

Based on what was studied in the literature review, the ten knowledge areas in project management best describe the gaps and opportunities in which AI could be applied. The project management book of knowledge contains forty-nine processes categorized into ten knowledge areas. This framework will be used forty-nine processes to represent the possibility of having useful Artificial intelligence tools or algorithms (Sebastian, 2019).

Ten Knowledge Management processes (Project Management Institute, 2017) :

- Project Integration Management – Identifying, defining, combining, and coordinating different processes and project management activities with Process Groups;
- Project Scope Management - used to ensure that all work and processes are included to complete the project;
- Project Schedule Management – processes which are helping to manage the project on the time;
- Project Cost Management – planning, estimating, budgeting, financing, funding, managing, and controlling costs for a future project to have an approved budget and to be completed with a planned budget;
- Project Quality Management - ensuring meeting stakeholder expectation it is including the organization's quality policy, which is used in planning, managing, and controlling all processes during the project to ensure the expected product/service quality;
- Project Resource Management – processes to ensure that necessary resources for the projects are identified, acquired, and managed;
- Project Communications Management – processes of planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition of project information must be done on time in order to have success project;
- Project Risk Management – processes of planning, identification, analysis, response planning, response implementation, and monitoring the risks of the project;

- Project Procurement Management – processes of need to purchase or acquire product, service;
- Project Stakeholder Management – processes for identifying people, groups, or organizations, analyzing expectations and impacts on the project, and developing effective strategies to involve stakeholders in the project.

Table 4.1 presents basic processes in project management used in the framework for leveraging artificial intelligence in project management. In each section of table 4.1 describes which processes are in each knowledge area.

Table 4.1 Project Management Process Groups and Knowledge areas (adapted from Project Management Institute, 2017).

Knowledge Areas	**Project Management Process Groups**				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
Project Integration Management	Develop Project Charter	Develop Project Management Plan	Direct and Manage Project Work, Manage Project Knowledge	Monitor and Control Project Work, Perform Integrated, Change Control	Close Project or Phase
Project Scope Management		Plan Scope Management, Collect Requirements, Define Scope, Create WBS		Validate Scope, Control Scope	
Project Schedule Management		Plan Schedule Management, Define Activities, Sequence Activities, Estimate Activity, Durations, Develop Schedule		Control Schedule	
Project Cost Management		Plan Cost Management, Estimate Costs, Determine Budget		Control Costs	
Project Quality Management		Plan Quality Management	Manage Quality	Control Quality	
Project Resource Management		Plan Resource Management, Estimate Activity Resources	Acquire Resources, Develop Team, Manage Team	Control Resources	
Project Communications Management		Plan Communications Management	Manage Communications	Monitor Communications	
Project Risk Management		Plan Risk Management, Identify Risks, Perform Qualitative Risk Analysis,	Implement Risk Responses	Monitor Risks	

		Perform Quantitative Risk Analysis, Plan Risk Responses			
Project Procurement Management		Plan Procurement Management	Conduct Procurements	Control Procurements	
Project Stakeholder Management	Identify Stakeholders	Plan Stakeholder Engagement	Manage Stakeholder Engagement	Monitor Stakeholder Engagement	

Tables 4.2 and 4.3 provide an overview of research articles that aim at implementing several AI algorithms in different knowledge areas.

Table 4.2 Literature review of machine learning algorithms and knowledge areas.

Machine learning algorithms	***Project Integration Management***	**Project Scope Management**	**Project Schedule Management**	**Project Cost Management**	**Project Quality Management**	**Project Resource Management**	**Project Communications Management**
Artificial Neural Networks	Dynamic Prediction of Project Success Using Artificial Intelligence (Ko & Cheng, 2007)			Artificial Neural Network Architecture and Orthogonal Arrays in Estimation of Software Projects Efforts (Rankovic et al., 2021)		Artificial Neural Network Architecture and Orthogonal Arrays in Estimation of Software Projects Efforts (Rankovic et al., 2021)	How to manage a task-oriented virtual assistant software project: an experience report (Li et al., 2022)
Byesian Network			Artificial Intelligence Applied to Project Success: A Literature Review (Magaña Martínez & Fernandez-Rodriguez, 2015)	Project cost risk analysis: A Bayesian networks approach for modelling dependencies between cost items (Khodakarami & Abdi, 2014)			
Case-Based Reasoning		Modelling a Project Scope Using a Case-Based Reasoning Approach (Serpell & M.Rueda, 2007)					

Decision tree			A Nearest Neighbor extension to project duration forecasting with Artificial Intelligence (Wauters & Vanhoucke, 2017)	A hybrid software cost estimation approach utilizing decision trees and fuzzy logic (Papatheocharous & Andreou, 2012)		A Proposed Model for Predicting Employees' Performance Using Data Mining Techniques: Egyptian Case Study | Journal of Computer Science IJCSIS (Nasr et al., 2019)	
Fuzzy approach	Dynamic Prediction of Project Success Using Artificial Intelligence (Ko & Cheng, 2007)			A hybrid software cost estimation approach utilizing decision trees and fuzzy logic (Papatheocharous & Andreou, 2012)	Simulation-Based Fuzzy Logic Approach to Assessing the Effect of Project Quality Management on Construction Performance (Corona-Suárez et al., 2014))		
Genetic algorithms	Smart optimization for mega construction projects using aritificial intelligence (Aziz et al., 2014) ; Dynamic Prediction of Project Success Using Artificial Intelligence (Ko & Cheng, 2007)		Research on Software project Scheduling Based on Genetic Algorithm (Song Deng & Ma, 2021) Project Scheduling with limited resources unsing a genetic algorithm (Montoya-Torres et al., 2010)				
k-Nearest Neighbour			A Nearest Neighbor extension to project duration forecasting with Artificial Intelligence (Wauters & Vanhoucke, 2017)				
Memetic algorithm			Mathematical modeling and a memetic algorithm for the integration of process planning and scheduling considering uncertain processing times (Jin et al., 2016)				

Naive Bayes						A Proposed Model for Predicting Employees' Performance Using Data Mining Techniques: Egyptian Case Study | Journal of Computer Science IJCSIS (Nasr et al., 2019)	A Proactive Management Assistant Chatbot for Software Engineering Teams: Prototype and Preliminary Evaluation (Hefny et al., 2021)
Natural Language Processing			Towards Effective AI-Powered Agile Project Management (Dam et al., 2019)				How to manage a task-oriented virtual assistant software project: an experience report (Li et al., 2022) Use of chatbots in project management (Cīrule & Bērziša, 2019)
Random Forest			A Nearest Neighbor extension to project duration forecasting with Artificial Intelligence (Wauters & Vanhoucke, 2017)				
Support Vector Machine			A Nearest Neighbor extension to project duration forecasting with Artificial Intelligence (Wauters & Vanhoucke, 2017)			A Proposed Model for Predicting Employees' Performance Using Data Mining Techniques: Egyptian Case Study | Journal of Computer Science IJCSIS (Nasr et al., 2019)	A Proactive Management Assistant Chatbot for Software Engineering Teams: Prototype and Preliminary Evaluation (Hefny et al., 2021)

No compatible machine learning algorithm that could be applied to Project Stakeholder Management has been found. Columns four and five of Table 4.3 do not refer to knowledge areas, but rather to project management processes. The Bayesian model and genetic algorithm can help choose project management methodology. Software effort prediction uses a decision tree to predict an enterprise's effort in adding new software to their architecture.

Table 4.3 Literature review of machine learning algorithms and knowledge and other areas.

Machine learning algorithms	Project Risk Management	Project Procurement Management	Project Stakeholder Management	Project management methodology Selection	Software effort prediction
Artificial Neural Networks	Problems and Countermeasures of Financial Risk in Project Management Based on Convolutional Neural Network (Wei & Ding, 2022) - CNN	Application of Artificial Intelligence to optimize forecasting capability in procurement (Kiefer & Ulmer, 2019)			
Bayesian Network	Project cost risk analysis: A Bayesian networks approach for modeling dependencies between cost items (Khodakarami & Abdi, 2014); Risk Simulation Based on Variational Bayesian Neural Network in Integrated Management Systems operational risks; (Dyakonova & Odinokov, 2021)				
Decision tree					Software effort prediction: a hyper-heuristic decision-tree based approach (Basgalupp et al., 2013)
Fuzzy approach	An Approach in BOT Project Selection Based on Fuzzy QFD and TOPSIS with Consideration of Risk (Bazleh & Roghanian, n.d.) ;A Fuzzy Approach for Risk Analzsis with Application in Project Management (Khanmohammadi & Jassbi, 2012)			Project Management Methodology Selection Using SWOT-Fuzzy AHP(Demirtas et al., 2014)	
Genetic algorithms				A Novel Approach for Agile Software Development Methodology Selection Using Fuzzy Inference System (Rai et al., 2018)	
Natural Language Processing	A risk prediction model for software project management based on similarity analysis of context histories | Elsevier Enhanced Reader (Souza Filippetto et al., 2021)				

Machine learning algorithms

Most of the ML algorithms mentioned in Table 4.2. and Table 4.3. are commonly used in various industries. The objective of the chapter is the description of each mentioned algorithm. Described algorithms are k-nearest neighbor, random forest, support vector machine, Bayesian network, genetic algorithm, natural language processing, artificial neural network (conventional neural network), case-based reasoning, memetic algorithm, decision tree, naïve Bayes, fuzzy logic. Below, a short description of important algorithms is provided.

K-Nearest Neighbour (KNN) K-nearest Neighbor is a machine learning algorithm is used for classification and regression problems. The algorithm adds all cases by deciding the majority vote to k-neighbor. The case is added to the class with the most common features (Tavasoli, 2022).

Random Forest Random Forest is a selection of many decision trees. Each decision tree is classified. The new object is classified based on its attributes, and the tree has the votes for its classification. The forest chooses the classification of the object based on the most votes (Tavasoli, 2022).

Support Vector Machine (SVM) Support Vector Machine supervised algorithm is applicable for data classification and regression problems. The algorithm requires the training of models and testing with training datasets. It is used for linear and non-linear classifications. Multiple possibilities made algorithms better than neural networks (Song Deng & Ma, 2021).

Bayesian network It is the most used method for data classification (Song Deng & Ma, 2021). A Bayesian network is a graphical model that demonstrates the knowledge about a topic, each node is a random variable, and each edge presents conditional probability to the node (Yang, 2019).

Genetic Algorithm (GA) Multiple different methods are based on nature all evolution processes of living organisms can be used in resolving and optimizing different issues (Gil Ruiz et al., 2020). GA is working in a way that the individual, which is a chromosome represents a solution. A population comprises individuals and each generation (Ko & Cheng, 2007). The algorithm is suitable for applying large, complex, and challenging issues (Song Deng & Ma, 2021).

Natural Language Processing (NLP) Machine learning method that can recognize and interpret human data and text (*What Is Natural Language Processing?*, n.d.)

Artificial Neural Network (ANN) Neural networks attempt to simulate how the human brain works as closely as possible and are currently used in several fields, including medicine, engineering, and construction management (Gil Ruiz et al., 2020). An algorithm is suitable to use for forecasting complex linear and non-linear problems (Serpell & M.Rueda, 2007). ANN is parallel-distributed processors made of neurons (processing units) that performs computation and store knowledge(Ko & Cheng, 2007).

Convolutional Neural Network (CNN) Convolutional Neural Networks are part of ANN. The main improvement in CNN is that it uses a large number of identical copies of the same neuron, which allows for an expression of a computationally large model while not expanding the number of parameters. It can recognize the same object as an object even if it has similarities with the learned object(Le, 2018).

Case-based reasoning Using old, similar experiences to solve a new issue(Kolodner, 1992).

Memetic algorithm Memetic algorithm is an extension of the genetic algorithm, the main difference is that the memetic algorithm already contains pre-populated agents (Moscato & Cotta, n.d.).

Decision tree is a graphical presentation of the choices and their results in the shape of a tree(Mahesh, 2019). One of the most know algorithms. It is structured as a tree in which the nodes are attributes, branches are outcomes, and leaves are classes (*Decision Tree*, 2017).

Native Byes Naive Bayes is a supervised classification algorithm based on the Bayes theorem. The classifier assumes that the existence of the specific feature is unrelated to the existence of the other feature (Mahesh, 2019).

Fuzzy approach Logical reasoning which is referred to a family of many-valued logic, meaning that it can be used in complex and poorly defined issues. It uses values [0,1] as 0 is totally false, and one is totally accurate(Cintula et al., 2021). Fuzzy logic systems stimulate human-level decision-making by imitating rational decisions in uncertainty (Ko & Cheng, 2007).

4.2. Framework

The literature review results provided the theoretical support needed to create a framework that could be used in small and middle enterprises. The creation of this framework is inspired by the lack of one centralized resource that helps project managers without technical knowledge to understand whether a project-management-related issue is solvable with the use of AI. This framework promotes the use of AI in project management and provides guidance for its implementation to enterprises. Moreover, the framework can be adapted to the users' needs and resources.

The research focus is the main aspects of AI and ML that needs to be considered while deciding on this implementation in the enterprise and the guide to find the suitable implementation path. The details of each algorithm or model are not in the scope of this research, and they should be investigated in detail for future implementations.

4.2.1. Framework of leveraging Artificial intelligence in Project management

The literature research concluded that Artificial intelligence is still not developed enough in business. One of the gaps in applying AI in project management is not having a platform that contains tools. Many AI platforms can solve project management challenges, which are explained later in the paragraphs. Nowadays, Artificial intelligence can be used more and give project managers more time to focus on the people aspect rather than tasks that are not valuable for people development. Considering this gap, the framework represents how we can deploy Artificial intelligence in the everyday work of the Project manager.

The diagram proposed in Figure 4.1 guides project managers through the process of choosing an AI-based technology that could improve their everyday tasks' efficiency.

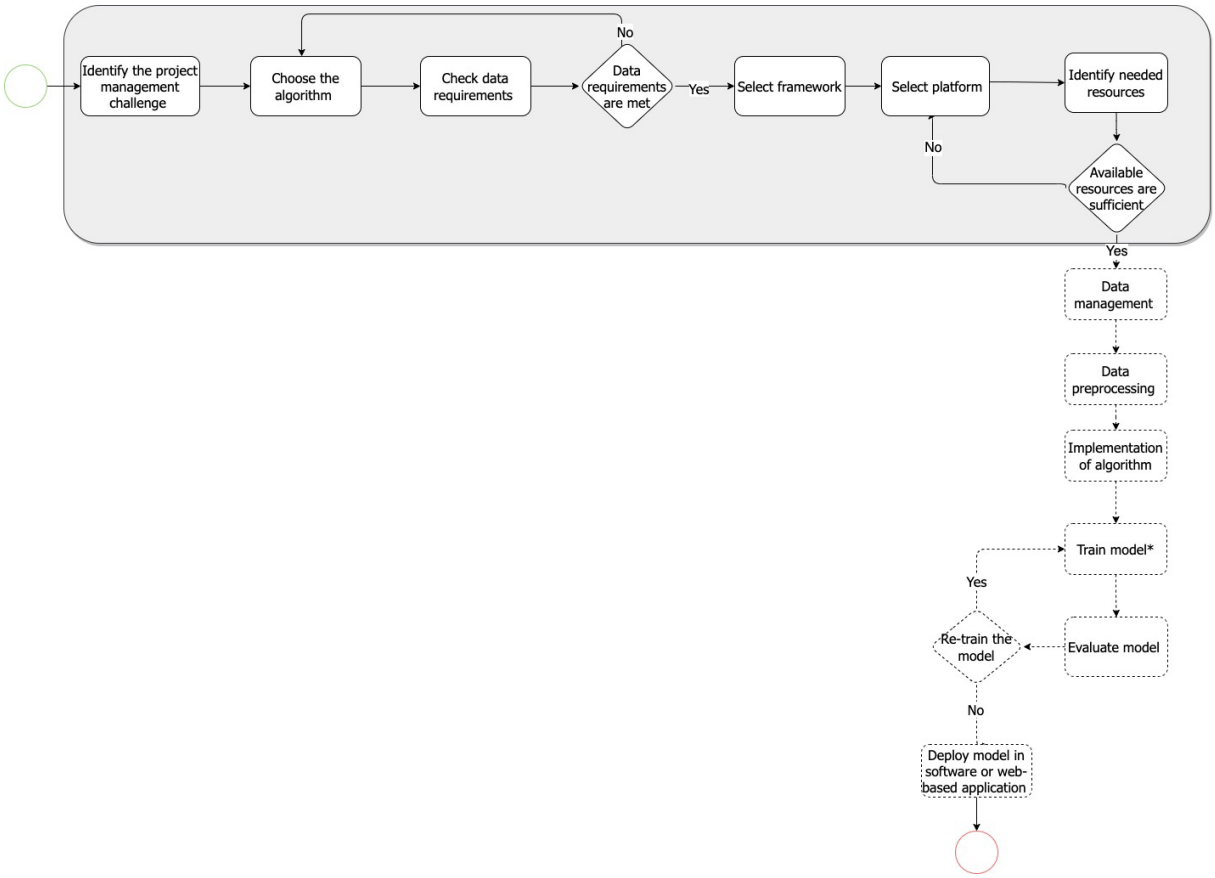


Figure 4.1 Framework of leveraging AI in project management.

Following, all the steps of the diagram are described.

The first step is to identify which of the ten knowledge areas needs improvement. This is done through a questionnaire, described later.

The second step is to choose a machine learning algorithm, which should be identified in Tables 4.2 and 4.3, according to the chosen knowledge area of interest.

The third step suggests data quantity for each algorithm and how to tackle the lack of data points.

The step of selecting a framework describes each framework and suggests one based on the previously chosen algorithm.

The following step is selecting the platform. The suggested platforms are some of the commonly used for the development cycle of tools leveraging artificial intelligence. Table 4.10 describes the supported machine learning algorithms and frameworks for each platform.

The sixth step identifies the needed resources and reflects on the results of the previous step. This step includes a table which could be used for business case preparation and analysis of the investment.

After the last step, the implementation of the machine learning algorithm can start. The creation and implementation of the model are not in the scope of the dissertation.

4.2.2. Identify the project management issue

The first process in the framework is identifying the current project management challenge. It presents users with an overview of their organization's most common challenges in Project management.

As the first step, it is essential to identify which project management issues are in the enterprise. These questionnaires give an overview of possible issues. Prioritizing the issues is of the same importance as understanding which one is causing the delays or overbudgeting in the project.

The first questionnaire is based on the project management triangle. In project management, the triangle represents the quality and constraints of the projects. The nature of the triangle is that only two points can be chosen. The questionnaire is based on the prioritization of the points in the triangle, which in the first step of the framework, can give an overview and direct the next step in the table. The decided ranking in Table 4.4 provides an overview of where to focus in Table 4.5.

Table 4.4 Main priorities in projects

Which of these areas is the main priority?	Please rank it from 1 to 3, with 1 as the main priority and three as the lowest priority.	Proceed to table 4.5.
Cost		i) j)
Scope		b) c) d) e)
Time		f) g) h)

After completing table 4.4., in case the challenge is not yet addressed, the next step is to fill in the questionnaire in Table 4.5. The questionnaire is based on the ten Project management knowledge areas. It is created using the Likert scale rating. Each question should be answered from 1 to 5. The meaning of each point is: (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree(Joshi et al., 2015). The answers that are more than 4 points should be used in the next step (Table 4.6).

Table 4.5 Identify the most challenging project activity in the enterprise

Priority areas	Where do you find the challenges in Project Management?	Mark the answer from 1 to 5
a)	Develop Project management Plan	1 2 3 4 5
b)	Direct and manage project work	1 2 3 4 5
c)	Monitor and Control Project Work	1 2 3 4 5
d)	Control Scope	1 2 3 4 5
e)	Define Activities	1 2 3 4 5
f)	Plan schedule management	1 2 3 4 5
g)	Estimate Activity Duration	1 2 3 4 5
h)	Develop schedule	1 2 3 4 5

i)	Plan cost management	1 2 3 4 5
j)	Estimate Cost	1 2 3 4 5
k)	Plan Resource Management	1 2 3 4 5
l)	Estimate activity resources	1 2 3 4 5
m)	Manage communication	1 2 3 4 5
n)	Plan risk management	1 2 3 4 5
o)	Identify Risks	1 2 3 4 5
p)	Perform qualitative risk analysis	1 2 3 4 5
r)	Plan risk responses	1 2 3 4 5
s)	Implement risk responses	1 2 3 4 5
t)	Plan procurement management	1 2 3 4 5
u)	Plan quality management	1 2 3 4 5
v)	Manage Quality	1 2 3 4 5
x)	Selection of Project management methodology	1 2 3 4 5
y)	Software effort prediction	1 2 3 4 5

After deciding the most important challenges, it is important to prioritize the only three challenges that should be a focus in the implementation of artificial intelligence.

Table 4.6 Questionnaire of the most critical challenges

Which of the challenges are the most important for the enterprise?	**Rate on the scale from 1(the highest priority) to 3 (the lowest priority)**	**Machine learning algorithms (Table 4.7.)**

The machine learning algorithm should be chosen in the next step after deciding the three most critical challenges. In table 4.7, the column machine learning algorithms presents the possible algorithms to use, described earlier.

Table 4.7 Choosing the suitable machine learning algorithm for the project management challenges

Project management challenge	**Machine learning algorithms**
Develop Project management Plan	1.1.,1.5.,1.11.
Direct and manage project work	1.1.
Monitor and Control Project Work	1.1.

Control Scope	1.6.
Define Activities	1.2.
Plan schedule management	1.1.,1.12., 1.9.,1.4.,1.13.
Estimate Activity Duration	1.1.,1.2.,1.8.,1.9.,1.12.,1.13.,1.7.,1.4.
Develop schedule	1.1.,1.2.,1.12.,1.7.,1.13.
Plan cost management	1.9.,1.5.,1.13.,1.11.
Estimate Cost	1.9.,1.5.,1.13.,1.11.
Plan Resource Management	1.4.,1.9.,1.10.,1.5.
Estimate activity resources	1.5.,1.4.,1.9.,1.10.
Manage communication	1.5.,1.10.,1.2.,1.4.
Plan risk management	1.4.,1.5.,1.6.,1.11.,1.13,1.2.
Identify Risks	1.11.,1.13,1.2.
Perform qualitative risk analysis	1.5.,1.6.,1.11,1,2.
Plan risk responses	1.5.,1.6.,1.11.,1.2.
Implement risk responses	1.5.,.1.6.,1.11.
Plan procurement management	1.5.
Plan quality management	1.11.
Manage Quality	1.11.
Selection of Project management methodology	1.1.,1.13.
Software effort prediction	1.9.

4.2.3. Choosing the algorithm

After identifying the project management issue, the next step is to choose the algorithm (Table 4.8.). The algorithm should be chosen based on challenges from Table 4.5. If the chosen algorithm is unsuitable for the implementation, the other one should be chosen. When an algorithm is chosen, it is important to understand how to train the model and which data requirements are needed.

Table 4.8 The machine learning algorithm and belonging type of learning

Algorithm		**Type of learning** (Fumo, 2017)
Genetic algorithm	1.1.	Supervised and unsupervised
Natural Language Processing	1.2.	Supervised
Support Vector Machine	1.4.	Supervised

Artificial Neural Network	1.5.	Supervised
Case-based reasoning	1.6.	Supervised
Random forest	1.7.	Supervised
Memetic algorithm	1.8.	Supervised/Unsupervised
Decision tree	1.9.	Supervised
Native Byes	1.10.	Supervised
Fuzzy logic	1.11.	Supervised/unsupervised
K- Nearest Neighbour	1.12.	Supervised
Bayesian Network	1.13.	Supervised

4.2.3.1. Supervised learning

Supervised learning is a machine learning task functioning based on mapping input to and output. The algorithms included in this way of learning need external assistance, which means that datasets have to be separated into train and test datasets; the usual separation is 80% for training sets and 20% for the training set. The algorithm based on the dataset creates a pattern that can be used for regression or classification (Mahesh, 2019).

Supervised learning must be trained. Data scientists must provide enough data to model to recognize the right solution. If we have different objects which the model should recognize, we need to learn that a rounded shape is called a circle(*Supervised Machine Learning - Javatpoint*, n.d.).

There are two types of problems in supervised learning (*Supervised Machine Learning - Javatpoint*, n.d.) :

- Regression
    a. Used in the predication of certain variables in which input and output variables are in a relationship
- Classification
    a. Categorized output variable between two classes

To learn the supervised learning model can apply the following steps:

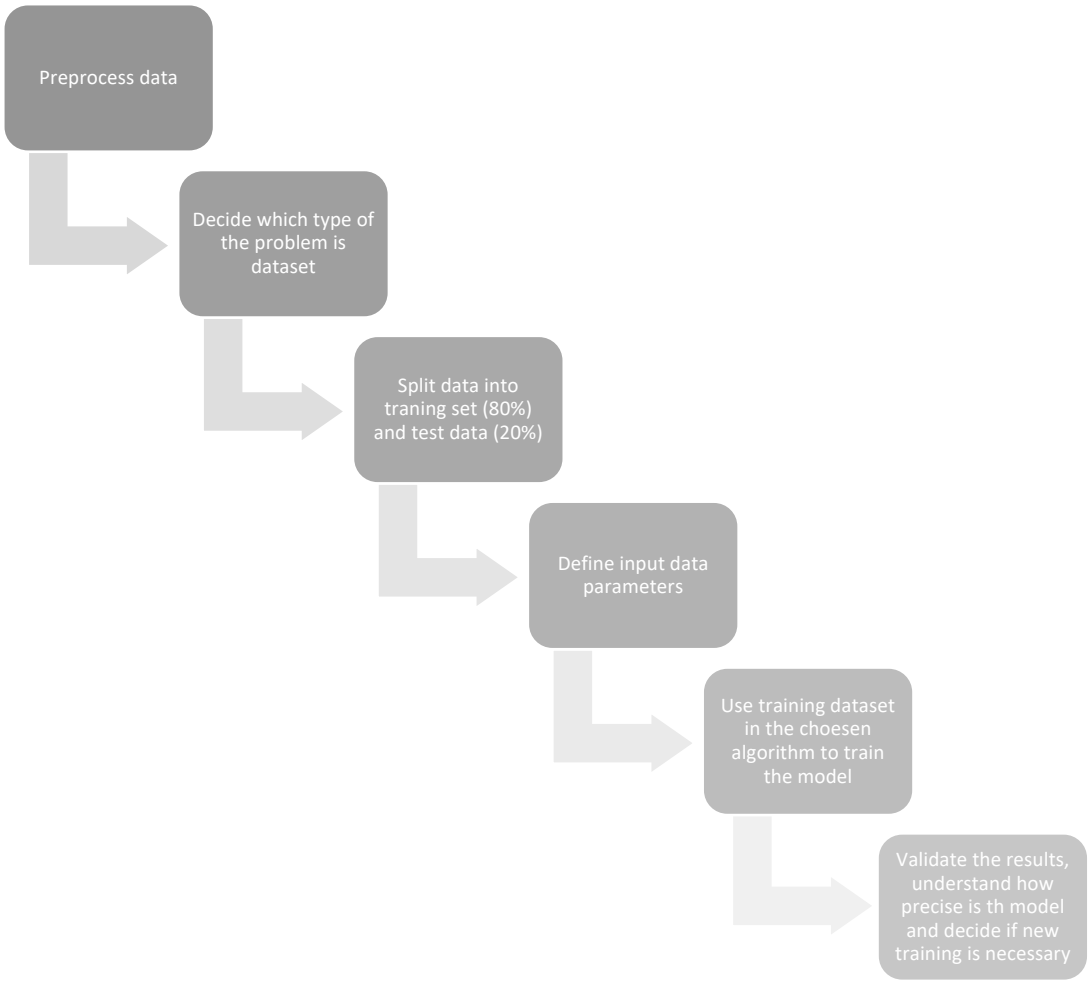


Figure 4.2 Supervised learning algorithm steps (adapted from Supervised Machine Learning - Javatpoint, n.d.)

4.2.3.2. Unsupervised learning

Unsupervised learning is not trained by datasets, and the model is finding similarities in patterns and insights; in some cases, because it is not trained, it can be inaccurate. Algorithms are independent and learn independently; when new data is entered, it uses previously learned patterns (Mahesh, 2019). An algorithm is used in marketing, for instance, to find the group of customers that buy the same product and the recommendation is a similar product to the same group.

In unsupervised learning are two different types of problems:

- Clustering
    a. Grouping method in which objects are grouped based on similarities
- Association
    a. Finding relationships between variables in data, variables that take place together in a database

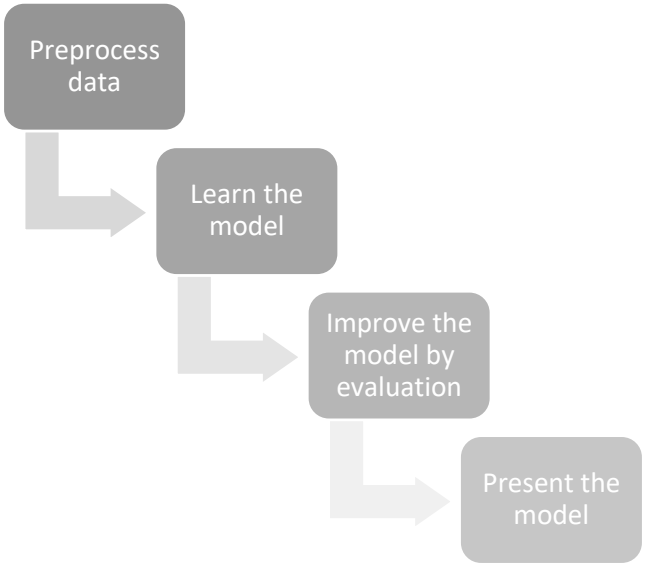


Figure 4.3 Unsupervised learning steps (adapted from Sanatan ,2017)

4.2.4. Check Data Requirements

The third step in the framework is to check the data requirements. The data quantity differs depending on which algorithm was decided based on the previous step. Understanding how much data is necessary to train the model is not defined, but some indicators can help to choose the machine learning algorithm.

To have more define which data quantity is necessary, there are some rules and recommendations (Table 4.9). The golden rule is that data needed for the algorithms must be ten times more than the number of features (Tharwat, n.d.).

Table 4.9 Data quantity for each algorithm (adapted from Odetayo ,1993 ; Anshul Saini, 2021; Nugaliyadde ,2016; Yao ,2020; Best Practices for Creating Training Data | AutoML Tables | Google Cloud ,2022.)

Algorithm	Data quantity
Neural Network	Large data set At least 10 times the degree of freedom (10 weights, 100 data points)
Naïve Bayes	Small datasets (At least 10 to 50 times more rows than columns in the table)
Support Vector Machine	Any dataset (At least 10 to 50 times more rows than columns in the table)
K-nearest neighbor (k-NN)	Large dataset (At least 10 times more rows than columns in the table)
Decision tree	Large dataset

	(At least 10 to 50 times more rows than columns in the table)
Genetic algorithm	More than 300 population
Memetic algorithm	Large datasets
Bayesian network	Large datasets
Natural Language Processing	Large datasets
Artificial Neural Network	Any dataset
Case-based reasoning	Small datasets
Random forest	Any datasets (At least 10 to 50 times more rows than columns in the table)
Fuzzy approach	Large datasets

Based on table 4.9, most of the algorithms require a large dataset. The next recommendation should be considered if the datasets do not contain enough data points to proceed with the machine-learning algorithm. The needed number of data points is defined if the model is regression or classification; Regression models have at least fifty times more rows than columns, and classification at least ten times more than columns (*Best Practices for Creating Training Data | AutoML Tables | Google Cloud*, 2022).

Few different techniques on how to proceed if there is a lack of data (Alencar, 2018):

- Transfer learning;
- Data Collection Process;
- Synthetic Minority Oversampling Technique – using minority data class and creating new data point based on k-nearest neighbor;
- Learning curve.

The learning curve method and Dr.Steenger method (n.d.) should be used to understand how much data is necessary for the model:

Learning curve method (Theophano, 2019):

a. Learning curve equation: $y = 100+ b_1 x^{b_2}$
b. The variables in the learning curve equation are:
    i. Y= classification accuracy;
    ii. x= training set;
    iii. b_1 and b_2 = learning rate and decay rate.

The method for calculating data quantity by (Dr. Steeger, n.d.):

c. Each group should be hundreds or thousands of data points, which means if we have three groups and 100 data points per group will be 3 x 100 = 300.

d. The next step is to understand which percentage is more data points than data properties, the number should be in the hundreds (e.g., 300), and there are 5 properties. 5 x 300% = 15.
e. The previous step calculated 300 data points per group and 15 more necessary data points than properties, resulting in 300 x 15= 4500 data points.
f. The next step is to calculate for each parameter should have independent examples, it should be in tens. The model has 5 parameters and 10 independent examples, 5 x 10% = 50% more data points than in the previous step. As a result it is 4500 x 0.5 = 9000 data points are needed for this algorithm.

Recommendations by (Gonfalonieri, 2019) :

- Missing data cannot be more than five percent;
- Linear models such as linear regression or logistic regression should have fewer parameters in case of not enough data;
- If the hypothesis is intuitive, less data is needed.

In conclusion, while lack of data remains one of the main issues in project management, solutions are available to deal with such scenarios.

4.2.5. Select Framework

After the selection of the algorithm, a suitable framework for its deployment should be chosen. In this step, five commonly used frameworks are explained and contain the supported algorithms.

Scikit Learn. Scikit-learning open-source machine learning tool. Built on the top of NumPy, SciPy, and matplotlib. It has the features to be used for feature extraction and selection, cross-validation, model selection, pre-processing, enabling methods, and dimensional reductions(*How to Choose an AI Problem-Solving Tool in Machine Learning*, n.d.). Supported algorithms:

- Supporting vector machines;
- Random forests;
- Gradient boosting;
- K-means;
- Supervised models, such as classification, regression, and clustering.

TensorFlow. TensorFlow is Google's open-source library for machine learning and artificial intelligence. It supports deep learning and can be accessed from a mobile device. The language is Phyton or C++. Do not have pre-trained models of AI. Not suitable for decisions or predictions because the framework passes through input data via multiple nodes(Kothari, 2022). The framework can be operated on any CPU or GPU. Multi-dimensional arrays of higher dimensions mean it is excellent with a large amount of data. The following machine learning algorithms are supported (Turing, n.d.):

- Linear regression;
- Classification;
- Boosted tree classification;

- Deep learning;
- Boosted tree regression;
- Deep learning classification;
- Supporting vector machine;
- Natural learning processing.

PyTorch open-source machine learning library, mainly used with the Phyton programming language. Easy to learn, use, and integrate with IOS and Android. Suitable for large data sets and high performance (*How to Choose an AI Problem-Solving Tool in Machine Learning*, n.d.). The following machine learning algorithms are supported (*How to Choose an AI Problem-Solving Tool in Machine Learning*, n.d.):

- Computer vision;
- Deep learning;
- Natural language processing;
- Reinforcement learning.

Caffe2. Caffe2 is an open-source machine learning tool. It uses C++ programing language (Kothari, 2022). The artificial intelligence tools and machine learning algorithms can be used by Turing (n.d.) and Kothari(2022):

- Used for computer vision;
- Speech recognition;
- Translation;
- Chatbots;
- Image recognition;
- Convolutional neural networks deep learning network;
- Preloaded trained neural networks.

XGBoost Extreme Gradient Boost is an open-source machine learning algorithm used to implement a gradient-boosting decision tree. The following problems are solvable: regression, classification, and user-pre-defined challenges. It is fast because due to multithreading (Turing, n.d.).

Choosing the proper framework depends on the development team's preference and on the support for the chosen algorithm. Frameworks have very similar features, although there are slight differences between them.

4.2.6. Select Platform

Artificial intelligence is becoming one of the biggest technology trends. In 2022, the commonly used AI platforms are AWS AI Services, Microsoft Azure AI, Google Cloud AI, and IBM Watson Machine learning (Gartner, 2022). Leaders in Artificial intelligence platforms are the most prominent IT enterprises whose products are commonly used in enterprises around the world. Decisions between AI platforms can depend on the use of software or operating systems in an enterprise.

Table 4.10 shows recommendations for which cloud platform to choose, based on the supported algorithms and frameworks selected in the previous steps.

Table 4.10 AI Platform recommendation (adapted from Altexsoft ,2021; AI & Machine Learning Products | Google Cloud, n.d.;, Machine Learning – Amazon Web Services, n.d.; Azure AI Platform – Artificial Intelligence Service | Microsoft Azure, n.d.)

	AWS SageMaker	**Azure Machine Learning**	**IBM Watson Machine Learning**	**Google AI Platform**
Classification	+	+	+	+
Regression	+	+	+	+
Clustering	+		+	+
Supported Frameworks	TensorFlow, PyTorch, Scikit-learn, Phyton, Caffe2	TensorFlow, Scikit-learn, PyTorch	TensorFlow, Keras, scikit-learn, XGBoost, PyTorch	TensorFlow, Scikit-learn, XGBoost, Keras
Conversational AI	+	+	+	+
Algorithm support	Genetic algorithm, NLP, Decision tree, SVM, KNN, ANN, Native Bayes, Fuzzy logic	Fuzzy, NLP, Decision tree, KNN, ANN	Support Vector Machine, NLP, Decision tree, KNN, Naïve Bayes Fuzzy logic, Naïve Bayes Linear regression	Fuzzy logic, NLP, Decision tree
Programming languages	Phyton, R	Phyton, R,	Python, R, Scala	R, Python
Data importing	Preparing data with Jupyter notebooks	Importing data with drag and drop	Importing data with Watson Knowledge Catalog. Preparing data with Jupyter notebooks	Data integration from Google Colab. Easy set-up of notebook
Build and Train model	Splitting data with Python, the possibility to use predetermined algorithms. Performing tasks automatically.	Splitting data with column selection, easy interface, and feature of training the model	Building model with Jupyter notebook (R, Scala, Phyton) or AutoAI	Models are run on TensorFlow. Models can be trained in any language.

Test and deploy	Deploying model with Jupyter notebook	Drag and connect the trained model	Deploying with Jupyter notebook	Deployed model is on Google Cloud Machine Learning

Azure Machine Learning is a good option for teams without significant experience in machine learning. Sage maker, Google AI Platform, and Watson Machine Learning require Jupyter notebooks and Python knowledge.

In the case of lacking human resources, each platform offers pre-made models which can be adapted and trained accordingly to the need of the enterprise.

4.2.7. Identify Needed Resources

The next step in the framework is the identification of resources: understanding if the enterprise has enough capacity to start the new project implementation. Investment analysis is a crucial step before starting the implementation. Table 4.11 contains the questions that lead to the final step of this framework (project planning).

Table 4.11 Questionnaire for the resources

Resources	
Project management challenge	
Machine learning algorithm	
Framework	
Platform	
Custom-built models or premade models?	
How many team members?	
Who are the team members?	
Will all the team members work full-time on the project?	
Cost estimation of the project	
Time estimation of the project	

Recommendations for the estimating human resources, cost, and time estimation:

- The project team should be composed of a Software engineer, machine learning researcher, data scientist, machine learning engineer/data engineer, product manager, and UX designer (Skuza, 2020);
- At least a data scientist and a developer are required in the case of the premade models;

- By the research of (*AI Pricing | How Much Does Artificial Intelligence Cost in 2020?*, n.d.) :
    a. In 2020, custom AI solutions were priced from $6,000 to $300,000 for a solution, and third-party AI software is up to $40,000 per year;
    b. Custom-built chatbot starts from $6,000;
    c. Custom-built data analysis system starts from $35,000.
- According to the research (*2020 State of ML - Algorithmia*, 2020), the process from a trained model into scaled production is eight to thirty days and thirty-one to ninety days. Most of the responders work in an organization with less than five hundred employees, and almost fifty percent of the responders in the company have one to ten data scientists. The programming language recommendation is Phyton.

The cost of the implementation depends on the project management challenge, the size of the team, and the country in which the implementation is done. The cost of using AI platforms can be found on their official pages. The long-term benefit of implementing artificial intelligence is significantly more than the initial cost.

4.3. USE CASE (DEMONSTRATION)

This chapter demonstrates recommendations on how to use the methodology according to the literature review studies.

The implementation of Artificial intelligence should be decided between the project managers and, as an outcome of the framework, have written the business case for the investment analysis.

The first meeting should be between all project managers in an enterprise. The goal of the meeting is to discover gaps in their projects, which are the biggest challenges they are facing. In furtherance for meeting to be productive, every project manager must analyze their challenges from past projects. The focal point of a meeting is gathering the list of challenges. Documents that should be sent to attendees before a meeting are table 4.12, table 4.13, and table 4.14. The meeting should have two topics: analyzing the most significant challenges and deciding how to proceed with the challenges.

Table 4.12 presents the ranking of the main priorities of the areas in Project management. Assuming time is the highest priority and cost is the lowest priority.

Table 4.12 Main project priorities

Which of these areas are the main priority?	Please rank it from 1 to 3, with 1 as the main priority and 3 as the lowest priority.	Proceed to table 4.13.
Cost	3	i) j)
Scope	2	b) c) d) e)
Time	1	f) g) h)

In the next step, as the highest priority is time, it is necessary to proceed to the f, g, and h rows in Table 4.13.; as we have different challenges, we must proceed to all challenges. The answers marked as 1 are the lowest challenge, and those marked as 5 are the highest challenge for the Project manager.

Table 4.13 Main challenges in projects

Priority areas	Where do you find the challenges in Project Management?	Mark the answer from 1 to 5
a)	Develop Project management Plan	1 **2** 3 4 5
b)	Direct and manage project work	1 2 **3** 4 5
c)	Monitor and Control Project Work	1 2 **3** 4 5
d)	Control Scope	1 2 3 **4** 5
e)	Define Activities	1 2 **3** 4 5
f)	Plan schedule management	1 2 3 **4** 5
g)	Estimate Activity Duration	1 2 3 **4** 5
h)	Develop schedule	1 2 3 **4** 5
i)	Plan cost management	1 **2** 3 4 5
j)	Estimate Cost	1 **2** 3 4 5
k)	Plan Resource management	1 **2** 3 4 5
l)	Estimate activity resources	1 2 3 **4** 5
m)	Manage communication	1 2 **3** 4 5
n)	Plan risk management	1 2 3 **4** 5
o)	Identify Risks	1 2 3 **4** 5
p)	Perform qualitative risk analysis	1 2 **3** 4 5
r)	Plan risk responses	1 2 **3** 4 5
s)	Implement risk responses	1 2 **3** 4 5
t)	Plan procurement management	1 2 3 4 5
u)	Plan quality management	1 **2** 3 4 5
v)	Manage Quality	1 **2** 3 4 5
x)	Selection of Project management methodology	1 **2** 3 4 5
y)	Software effort prediction	1 **2** 3 4 5

In table 4.14. the highest challenges are marked as 4 and more; in the next step is crucial to decide and prioritize just three of them. The prioritization provides an overview of the main project's challenges.

Table 4.14 Challenges prioritization

Which of the challenges are the most important for the enterprise?	Rate on the scale from 1(the highest priority) to 3 (the lowest priority)	Machine learning algorithms (Table 4.15)
Plan Schedule management	1	1.1.,1.12., 1.9.,**1.4**.,1.13.
Estimate activity duration	3	1.1.,1.2.,1.8.,1.9.,1.12.,1.13.,1.7.,**1.4.**
Plan risk management	2	**1.4**.,1.5.,1.6.,1.11.,1.13,1.2.

Table 4.15 contains three prioritized challenges; after the challenges are prioritized, the next step is to proceed to table 4 to understand which machine learning algorithms can be used.

Table 4.15 Project management challenges and machine learning algorithms

Project management challenge	Machine learning algorithms
Develop Project management Plan	1.1.,1.5.,1.11.
Direct and manage project work	1.1.
Monitor and Control Project Work	1.1.
Control Scope	1.6.
Define Activities	1.2.
Plan schedule management	1.1.,1.12., 1.9.,1.4.,1.13.
Estimate Activity Duration	1.1.,1.2.,1.8.,1.9.,1.12.,1.13.,1.7.,1.4.
Develop schedule	1.1.,1.2.,1.12.,1.7.,1.13.
Plan cost management	1.9.,1.5.,1.13.,1.11.
Estimate Cost	1.9.,1.5.,1.13.,1.11.
Plan Resource Management	1.4.,1.9.,1.10.,1.5.
Estimate activity resources	1.5.,1.4.,1.9.,1.10.
Manage communication	1.5.,1.10.,1.2.,1.4.
Plan risk management	1.4.,1.5.,1.6.,1.11.,1.13,1.2.
Identify Risks	1.11.,1.13,1.2.
Perform qualitative risk analysis	1.5.,1.6.,1.11,1,2.
Plan risk responses	1.5.,1.6.,1.11.,1.2.
Implement risk responses	1.5.,.1.6.,1.11.
Plan procurement management	1.5.
Plan quality management	1.11.
Manage Quality	1.11.

Selection of Project management methodology	1.1.,1.13.
Software effort prediction	1.9.

Table 4.16 provides machine learning algorithms that can be used in the challenge. The next part of the framework is to decide on the algorithm that will be used in solving the challenge. Those three challenges can be applied to the same algorithm, which is a Support Vector Machine.

Table 4.16 Machine learning algorithms

Algorithm		Type of learning (Fumo,2017)
Genetic algorithm	1.1.	Supervised/ unsupervised
Natural Language Processing	1.2.	Supervised
Support Vector Machine	**1.4.**	**Supervised**
Artificial Neural Network	1.5.	Supervised
Case-based reasoning	1.6.	Supervised
Random forest	1.7.	Supervised
Memetic algorithm	1.8.	Supervised/Unsupervised
Decision tree	1.9.	Supervised
Native Byes	1.10.	Supervised
Fuzzy approach	1.11.	Supervised/unsupervised
K- Nearest Neighbour	1.12.	Supervised
Bayesian Network	1.13.	Supervised

An algorithm Support vector machine is suitable for the enterprise because it does not require large datasets.

Table 4.17 Data requirements

Algorithm	Data quantity
Neural Network	Large data set At least 10 times the degree of freedom (10 weights, 100 data points)
Naïve Bayes	Small datasets (At least 10 to 50 times more rows than columns in the table)
Support Vector Machine	Any dataset (At least 10 to 50 times more rows than columns in the table)
K-nearest neighbor (k-NN)	Large dataset (At least 10 times more rows than columns in the table)

Decision tree	Large dataset (At least 10 to 50 times more rows than columns in the table)
Genetic algorithm	More than 300 population
Memetic algorithm	Large datasets
Bayesian network	Large datasets
Natural Language Processing	Large datasets
Artificial Neural Network	Any dataset
Case-based reasoning	Small datasets
Random forest	Any datasets (At least 10 to 50 times more rows than columns in the table)
Fuzzy approach	Large datasets

After decided an algorithm, the next step is to decide which machine learning framework to use. In this case, it is decided to use TensorFlow because it supports the algorithm. The next step is choosing the platform which will be used for implementation. As suggested, all platforms support the machine learning framework, and it is decided for AWS SageMaker. There were two factors for these decisions: support of the machine learning framework and algorithm, and AWS as a service is already used in the enterprise.

Table 4.18 Platform selection

	AWS SageMaker	**Azure Machine Learning**	**IBM Watson Machine Learning**	**Google AI Platform**
Classification	+	+	+	+
Regression	+	+	+	+
Clustering	+		+	+
Supported Frameworks	TensorFlow, PyTorch, Scikit-learn, Phyton, Caffe2	TensorFlow, Scikit-learn, PyTorch	TensorFlow, Keras, scikit-learn, XGBoost, PyTorch	TensorFlow, Scikit-learn, XGBoost, Keras
Conversational AI	+	+	+	+
Algorithm support	Genetic algorithm, NLP, decision tree, SVM, KNN, ANN, decision tree, native Bayes, fuzzy logic	Fuzzy, NLP, Decision tree, KNN, ANN	Support Vector Machine, NLP, Decision tree, KNN, Naïve Bayes Fuzzy logic, Naïve Bayes Linear regression	Fuzzy logic, NLP, decision tree

Programming languages	Phyton, R	Phyton, R,	Python, R, Scala	R, Python
Data importing	Preparing data with Jupyter notebooks	Importing data with drag and drop	Importing data with Watson Knowledge Catalog. Preparing data with Jupyter notebooks	Data integration from Google Colab. Easy set-up of notebook
Build and Train model	Splitting data with Python, the possibility to use predetermined algorithms. Performing tasks automatically.	Splitting data with column selection, easy interface, and feature of training the model	Building model with Jupyter notebook (R, Scala, Phyton) or AutoAI	Models are run on TensorFlow. Models can be trained in any language.
Test and deploy	Deploying model with Jupyter notebook	Drag and connect the trained model	Deploying with Jupyter notebook	Deployed model is on Google Cloud Machine Learning

The last step before implementation is to define the resources and decisions made troughs the process.

Table 4.19 Resource identification

Resources	
Project management challenge	Plan Schedule management
Machine learning algorithm	Support vector machine
Framework	TensorFlow
Platform	AWS SageMaker
Custom-built models or premade models?	Custom-built
How many team members?	5
Who are the team members?	Software engineer, data scientist, machine learning engineer, product manager, and UX designer
Will all the team members work full-time on the project?	Yes
Cost estimation of the project	~ 39,700 euros

Time estimation of the project	5 months

The cost estimation of each platform can be done on their official pages. As approximate estimation for this project on the AWS Calculator is 11.300 euros, accordingly to the average salary for IT salary in Lisbon, Portugal, which is 2,840 euros (*Information Technology Average Salaries in Lisbon 2022 - The Complete Guide*, n.d.). It is taken into consideration that on average, each team member works two months on the project, which is 28,400 euros.

In order to start the implementation of the applying artificial intelligence in Project management, it is necessary to write the business case. The business case requires the calculations, resources, and benefits of the Project. Each of the categories can be found in this research.

The implementation of artificial intelligence is not in the scope of this dissertation, but the steps are mentioned in the framework figure 4.1.

4.4. EVALUATION

The framework usability had to be validated, and because of that reason, the interviews were conducted. The objective of the interviews is to understand if the proposed framework would be helpful or inspiring to an interview subject to implement artificial intelligence in the future.

Therefore, the interviews were conducted with academic and business representatives.

Furthermore, the presentation in Appendix A is used as validation material for the proposed framework, as well as to explain the reasoning behind why the model was researched and created.

The interview was conducted via videoconferencing technology Zoom because of the physical distance. The interviewers agreed to be recorded to provide the transcript of the interviews.

4.4.1. Interviews

As mentioned in the previous paragraph, the interviews were conducted with academic and business representatives.

The academic representative is a professor from the Faculty of Organization and Informatics of University of Zagreb, who teaches subjects related to team and project management communication. The professors' academic knowledge gave a different overview of the framework.

The business representatives correspond to the IT Assistant in Project management working in Intesa Sanpaolo with one year of experience from Croatia and a leader in organizational transformation and change management in NetJets, with more than twenty years of experience in the project management field from Portugal.

Both business representatives work in different industries. Their knowledge and experience are valuable; on the other hand, they gave a different perspective on the proposed framework. The objective of the interview was to understand the usability of the proposed framework as well as the improvement of the framework.

1) Do you consider the proposed framework useful, and why?

IT Assistant in Project management

a. “The framework is a good idea; it could work; I am not very technical in this area.”

Professor from Faculty of Organization and Informatics

b. “I think your general idea, based on your experience but also the literature review and some research findings, is very valuable. This new way of approaching problem and applying AI in PM can definitely help practically for all the people how are starting in PM but also who have a lot of experience, based on their experience make product solutions that will increase later the quality of the project, reduce the risks and some problems with over-budgeting and breaking the deadlines. I think it would be both useful practical day to day in companies, also I think in the science approach it is also valuable are of approaching this. You used all the relevant resources from project management, organization and research the studies, because of the COVID 19; people started to work much more online, also, this some it and AI revolution which we are living for last 10 years, but we will live extensively in the next decade, all the jobs, and maybe non IT jobs are also becoming more IT, people like when computer works for them because they want to make their errors less. This is a good kind of checking tool. “

Leader in organizational transformation and change management projects

c. “I think yes, framework is useful, because I think one of the biggest challenges with project management is sometimes making informed decision with limited data and usually you have to rely on previous experience or a lot of the times it is guess work. For me the biggest challenge is the getting the estimate of the project that it is fairly accurate. Usually, people will estimate longer than it actually takes, or they will be overly confident and estimate shorter than it takes, so having something that it helps earthier based on data or data analysis, or some other AI mechanism. Support and provide guidance maybe for these tasks, and some certain parameters, complexity, experience of individual that is going to work on this, maybe the estimate is too optimistic or pessimistic and what is the middle ground and what is more accurate estimate for something. That is perspective it is going to have that sort of decision system support in project management. The second aspect is that can system like this give you the alerts of the risk that you are not seeing. In the nutshell I think proposed framework is useful.”

2) Do you have any criticism towards the proposed framework? Do you have any suggestion for the further improvements of the proposed framework?

- IT Assistant in Project management

- "No, the input is to identify issue, if our data does not match with algorithm, it can change the data, or correct the data, but is good option that we can choose different algorithm or platform. To choose the other platform that suits to our problem. For example, we can implement the artificial intelligence that learned from the previous project tasks or milestones. It would be great if the AI could give us the example of the task that we could use. Of course, the second main problem is the duration of the tasks. Sometimes the project managers cannot estimate, in the real-world things can happened that is not up to us, we need predict, we have risk management here, even the risk management sometimes that we cannot help."

- Professor from Faculty of Organization and Informatics
  - "The implementation of selected framework discusses in more details. Maybe we can use the Google Collab for implementation instead of Phyton. It very easy for beginners and people that want to be in this area. "
- Leader in organizational transformation and change management projects
  - "What are some common project management issues that could be solve, it does not need to be exhaustive but couple of examples. Because from the beginning I know it can be solved these types of the problems. Provide context to the person. The next one is choosing the algorithm, okay include in the presentation call out of few algorithms and give the example what is the special about algorithm A or B, and why we use those in context of project management. In terms of data requirement, maybe put some comments below saying what are some data requirements in the context of project management. Is it we need certain amount of data or certain quality? What kind of data do I need? I do not see it necessarily from just looking to diagram. The comment that I have for slide it show and tell, this is what is proposed and then tell me how or what. Put the details in the framework. "

3) Would you consider implementing the proposed framework?

- IT Assistant in Project management
  - "Yes, of course, from my practice and my work I find a met a lot of problems in PM; we can start from scheduling the project, identifying the milestones. "
- Professor from Faculty of Organization and Informatics
  - "I do not have too much experience in IT., but I work in IT teaching students. Definitely, yes, I will apply it. It is a good start with project management tools, but I think this framework could apply to different kinds of tools like communication tools and some other tools that are similar to PM tools, but they are not so complicated because of the data that are used in Project management. When you have trained algorithms, and when you use this framework, I think that it can be applied for more complex solutions or other applications that will be also useful for the not just teams, for all companies. In long-term vision of this project, it can be a business solution to be solved;

you never know, it is a very good idea, the problem is stressed very well, and it is real, it is not imaginative numbers, I think with framework, some benefits could definitely be made."

- Leader in organizational transformation and change management projects
    - "Yes, in terms of implementation. I looked at it in two ways. You could either try or build this from scratch with resources, in order to implement it you need some elements to build the business case around it. How much does it cost? Benefits of a framework, it is hard to quantify in normal amounts, for qualitative perspective is the reducing the risk, and improving project quality. Implementation is cost versus the benefit."

4.5. REVISED FRAMEWORK PROPOSAL

After introspective thinking about the experts' feedback, it was possible to produce a revised framework presented in Figure 4.4.

Firstly, the main difference in the revised framework is the framework presented in figure 4.1. and figure 4.4 there are added main points and examples of each step in the framework. In the first step, identifying the project management issue, the common project management challenges are added, which by the feedback of the interviewer, were the most mentioned while interviews. The most used ML algorithms are added in the step to choose the machine learning algorithm, defined as how many project management challenges contained these algorithms. The third step, checking data requirements, presents the most used ML algorithms and data quantity requirements. In the next step, select the machine learning framework, are mentioned machine learning frameworks which is explained in chapter 4. Moreover, select the AI platform, which contains the list of explained and proposed platforms. In the last step, which questions have been answered to decide to implement this framework in the future are presented.

Secondly, proposed by the academic represented, was to in the proposed to suggest a programing language that is beginner friendly. Google Colab can be used in creating machine learning models.

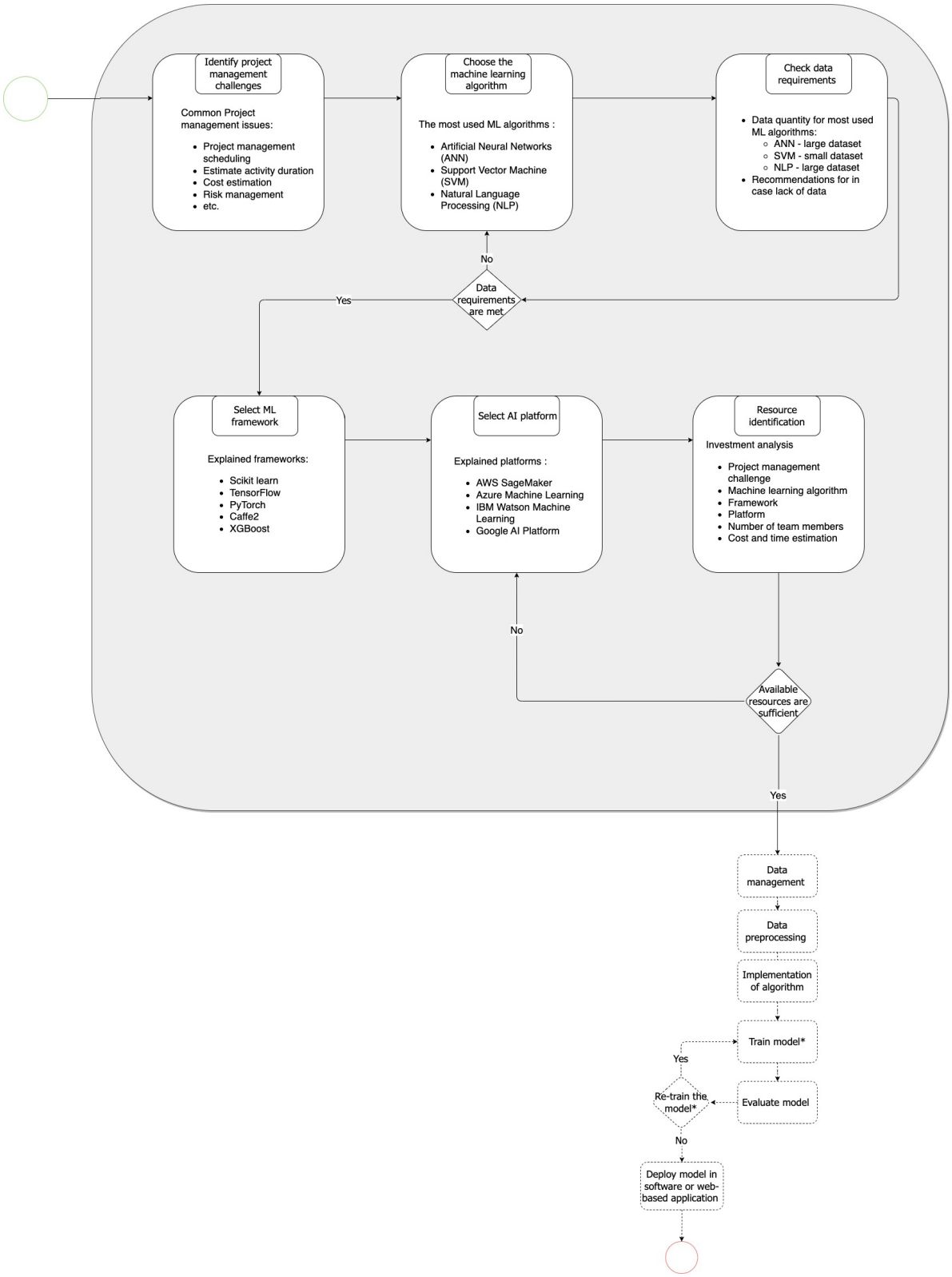


Figure 4.4 Revised framework proposal

5. CONCLUSIONS

The objective of this dissertation was to show and guide project managers in optimizing their day-to-day work. The proposed framework answers the research question “How small and medium enterprises (SMEs) can simply implement artificial intelligence in day-to-day project management?”. The proposed framework and extensive literature review achieve the objective of the research.

The framework was developed as six crucial steps for choosing the right path to an artificial intelligence implementation. Each step of the framework was carefully chosen based on the literature review. The framework should be used as guidance for project managers with little to no technical background but who need a “one-pager” to find information about the integration of AI into PM.

The validation was conducted with the interviews of three experts in different industries and experiences in project management to understand if the proposed framework is the right path to choose.

In conclusion, counseling with experts and hearing their feedback contributed significantly to the learning process. Moreover, the possibility of improving project management in daily work was an incredible experience. The most valuable outcome of this thesis is the contribution to improving the working processes of present and future project managers.

5.1. LIMITATIONS

Regarding the limitation of the proposed framework, it is important to outline the limitation in the research area.

Considering my academic career, Artificial Intelligence was a very new topic. While researching Artificial intelligence, there are no consistent definitions and separations on the topics. Several sources defined topics differently than others. Artificial intelligence is a broad area of information technology and understating the importance of the implementation was a steep learning curve. Otherwise, the topic of artificial intelligence is still in the progress of research; currently, it does not provide concrete answers to all issues in project management.

In order to use the framework, the development team must obtain datasets to implement the framework. Datasets are one of the issues in project management because of the unstructured data, saved in different structures and software over the years. Also, there is no available project management data on the web pages that provide different data sets. Most of the research is done on small datasets. Lacking data is one of the most significant issues in artificial intelligence implementation.

5.2. FUTURE WORK

In the future development of the framework, it would be interesting to include all the steps of implementing machine learning algorithms and the recommendation for solving the issues based on lacking data, preprocessing the data, or training the data. Expanding each step and continuously updating the framework is important because new information about project management and artificial intelligence is often changing. On the other hand, improvement could be made by providing

examples using this framework. Real-case scenarios could help and recommend which part of the framework to be more cautious.

BIBLIOGRAPHICAL REFERENCES

2020 State of ML - Algorithmia. (2020). https://algorithmia.com/state-of-ml

A Complete Guide to the PMI PMBOK Method | Smartsheet. (n.d.). https://www.smartsheet.com/content-center/best-practices/project-management/project-management-guide/pmi-pmbok-method

AI & Machine Learning Products | Google Cloud. (n.d.). https://cloud.google.com/products/ai

AI Pricing | How Much Does Artificial Intelligence Cost in 2020? (n.d.). Retrieved November 16, 2022, from https://www.webfx.com/martech/pricing/ai/

Alencar, R. (2018). *Dealing with very small datasets | Kaggle*. https://www.kaggle.com/code/rafjaa/dealing-with-very-small-datasets/notebook

Al-Sarraj, F., & al Najjar, R. (2019). *A Virtual Partnership? How Artificial Intelligence will disrupt Project Management and change the role of Project Managers*. 20.

Alshaikhi, A., & Khayyat, M. (2021). *An investigation into the Impact of Artificial Intelligence on the Future of Project Management*.

Andersen, E. S. (2016). Do project managers have different perspectives on project management? *International Journal of Project Management*, *34*(1), 58–65. https://doi.org/10.1016/j.ijproman.2015.09.007

Anshul Saini. (2021, October 12). *Support Vector Machine(SVM): A Complete guide for beginners*. https://www.analyticsvidhya.com/blog/2021/10/support-vector-machinessvm-a-complete-guide-for-beginners/

Asana. (2021). *The Project Management Triangle: What It Is and How to Use It • Asana*. https://asana.com/resources/project-management-triangle

Ash, A. (2019). *How Machine Learning will Change the World of Project Management*. Project Management Blog: Tips & Tricks | Easy Projects. https://explore.easyprojects.net/blog/how-machine-learning-will-change-the-world-of-project-management

Auth, G., Jokisch, O., & Dürk, C. (2019). Revisiting automated project management in the digital age – a survey of AI approaches. *Online Journal of Applied Knowledge Management*, *7*(1), 27–39. https://doi.org/10.36965/OJAKM.2019.7(1)27-39

Aziz, R., Hafez, S., & Abuol-Magd, Y. (2014). Smart optimization for mega construction projects using artificial intelligence. *Alexandria Engineering Journal*, *53*. https://doi.org/10.1016/j.aej.2014.05.003

Azure AI Platform – Artificial Intelligence Service | Microsoft Azure. (n.d.). https://azure.microsoft.com/en-us/solutions/ai/

Azzopardi, S. (n.d.). *The Evolution of Project Management*. Project Smart. https://www.projectsmart.co.uk/history-of-project-management/evolution-of-project-management.php

Balaji, A., Janardhanan, R., Johnston, S., & Noshir, K. (2018). *How predictive analytics can boost product development | McKinsey*. https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/how-predictive-analytics-can-boost-product-development

Basgalupp, M. P., Barros, R. C., da Silva, T. S., & de Carvalho, A. C. P. L. F. (2013). Software effort prediction: a hyper-heuristic decision-tree based approach. *Proceedings of the 28th Annual ACM Symposium on Applied Computing - SAC '13*, 1109. https://doi.org/10.1145/2480362.2480571

Bazleh, A., & Roghanian, E. (n.d.). *An Approach in BOT Project Selection Based on Fuzzy QFD and TOPSIS with Consideration of Risk*.

Best practices for creating training data | AutoML Tables | Google Cloud. (2022, November 15). https://cloud.google.com/automl-tables/docs/data-best-practices

Bhaskar, S. (2019). *5 Ways Artificial Intelligence (AI) Will Aid Project Management*. https://www.digite.com/blog/ai-in-project-management/

Brown, L. (2021). Defining Activity List And Examples in a Project. In *Invensis Learning Blog*. https://www.invensislearning.com/blog/define-activity-list-in-a-project/

Burger, R. (2017). *I, Project Manager: The Rise of Artificial Intelligence in the Workplace*. https://blog.capterra.com/i-project-manager-the-rise-of-artificial-intelligence-in-the-workplace/

Chui, M., Hall, B., Singla, A., & Sukharevsky, A. (2021). *Global survey: The state of AI in 2021 | McKinsey*. https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2021

Chui, M., & Malhorta, S. (2018). *Adoption of AI advances, but foundational barriers remain | McKinsey*. https://www.mckinsey.com/featured-insights/artificial-intelligence/ai-adoption-advances-but-foundational-barriers-remain

Cintula, P., Fermüller, C. G., & Noguera, C. (2021). *Fuzzy Logic* (E. N. Zalta, Ed.; Winter 2021). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2021/entries/logic-fuzzy/

Cīrule, D., & Bērziša, S. (2019). Use of chatbots in project management. *Communications in Computer and Information Science*, *1078 CCIS*, 33–43. https://doi.org/10.1007/978-3-030-30275-7_4/COVER

Comparing Machine Learning as a Service: Amazon, Microsoft Azure, Google Cloud AI, IBM Watson. (2021). https://www.altexsoft.com/blog/datascience/comparing-machine-learning-as-a-service-amazon-microsoft-azure-google-cloud-ai-ibm-watson/

Corona-Suárez, G. A., AbouRizk, S. M., & Karapetrovic, S. (2014). Simulation-Based Fuzzy Logic Approach to Assessing the Effect of Project Quality Management on Construction Performance. *Journal of Quality and Reliability Engineering*, *2014*, 1–18. https://doi.org/10.1155/2014/203427

Crunchbase. (n.d.). *ZiveBox - Crunchbase Company Profile & Funding*. Crunchbase. https://www.crunchbase.com/organization/zivebox

Dam, H. K., Tran, T., Grundy, J., Ghose, A., & Kamei, Y. (2019). Towards Effective AI-Powered Agile Project Management. *2019 IEEE/ACM 41st International Conference on Software Engineering: New Ideas and Emerging Results (ICSE-NIER)*, 41–44. https://doi.org/10.1109/ICSE-NIER.2019.00019

Decision Tree. (2017). https://www.geeksforgeeks.org/decision-tree/

Deen, D. (2016). *Gantt Chart - Long Form Info Page*. ProjectManager.Com. https://www.projectmanager.com/gantt-chart

Define, plan & track mission-critical product updates. (n.d.). https://tara.ai/

Demirtas, N., Tuzkaya, U. R., & Seker, S. (2014). *Project Management Methodology Selection Using SWOT-Fuzzy AHP*. 6.

Deshmukh, D., & Monah, N. (2021). Applications of AI in Project Management. In *Resources Library*. https://www.saviom.com/blog/applications-ai-project-management/

Dr. Steeger, J. (n.d.). *Machine learning: How much data do learning methods require? | Nordantech*. Retrieved November 16, 2022, from https://www.nordantech.com/en/blog/data-science/machine-learning

Dyakonova, E. v, & Odinokov, S. A. (2021). Risk Simulation Based on Variational Bayesian Neural Network in Integrated Management Systems. *2021 International Conference on Quality Management, Transport and Information Security, Information Technologies (IT&QM&IS)*, 20–22. https://doi.org/10.1109/ITQMIS53292.2021.9642831

Eigelbach, K. (2017). *AI can help manage your professional life*. https://www.wcpo.com/news/insider/rescoper-aided-by-covington-business-accelerator-uptech-enhances-project-management-through-artificial-intelligence

Fridgeirsson, T. V., Ingason, H. T., Jonasson, H. I., & Jonsdottir, H. (2021). An Authoritative Study on the Near Future Effect of Artificial Intelligence on Project Management Knowledge Areas. *Sustainability 2021, Vol. 13, Page 2345*, *13*(4), 2345. https://doi.org/10.3390/SU13042345

Fumo, D. (2017). *Types of Machine Learning Algorithms You Should Know*. https://towardsdatascience.com/types-of-machine-learning-algorithms-you-should-know-953a08248861

Fundamentals of Lean Methodology Explained With Examples. (2021). Simplilearn.Com. https://www.simplilearn.com/lean-methodology-article

Gartner. (2022). *Gartner Report Magic Quadrant for Cloud AI Developer Services*. https://pages.awscloud.com/Gartner-Magic-Quadrant-for-Cloud-AI-Developer-Services.html?sc_icampaign=gc_ml-gartner-report-nov&sc_ichannel=ha&sc_icontent=awssm-11567_gc&sc_iplace=banner&trk=0ca246b2-4754-451c-ac54-be060a3739ed~ha_awssm-11567_gc

George, P. (2022). What are the types of artificial intelligence? In *Betechwise*. https://www.betechwise.com/what-are-the-types-of-artificial-intelligence/

Gil Ruiz, J., Torres, J. M., & Crespo, R. G. (2020). The Application of Artificial Intelligence in Project Management Research: A Review. *International Journal of Interactive Multimedia and Artificial Intelligence*, *6*, 6–54. https://doi.org/10.9781/ijimai.2020.12.003

Gilb, T. G. K. (n.d.). *Tom Gilb & Kai Gilb - Helping you deliver Value to your Stakeholders | definition-Evolutionary-Project-Management*. Tom Gilb & Kai Gilb - Helping You Deliver Value to Your Stakeholders. http://concepts.gilb.com/definition-Evolutionary-Project-Management

Gonfalonieri, A. (2019, May 6). *5 Ways to Deal with the Lack of Data in Machine Learning - KDnuggets*. https://www.kdnuggets.com/2019/06/5-ways-lack-data-machine-learning.html

Grotenhermen, J.-G., Bruckes, M., & Schewe, G. (2020). Are we Ready for Artificially Intelligent Leaders? A Comparative Analysis of Employee Perceptions Regarding Artificially Intelligent and Human Supervisors. *AMCIS 2020 Proceedings*. https://aisel.aisnet.org/amcis2020/ai_semantic_for_intelligent_info_systems/ai_semantic_for_intelligent_info_systems/12

Hartney, J. (2018). *Overview of the IPMA Methodology*. https://www.projectengineer.net/overview-of-the-ipma-methodology/

Hefley, W. E., & Bottion, M. (2021). Skills of junior project management professionals and project success achieved by them. *International Journal of Information Systems and Project Management*, *9*(1), 56–75. https://aisel.aisnet.org/ijispm/vol9/iss1/4

Hefny, A. H., Dafoulas, G. A., & Ismail, M. A. (2021). A Proactive Management Assistant Chatbot for Software Engineering Teams: Prototype and Preliminary Evaluation. *NILES 2021 - 3rd Novel Intelligent and Leading Emerging Sciences Conference, Proceedings*, 295–300. https://doi.org/10.1109/NILES53778.2021.9600547

Heranandez, D. (2016). *ProjectManagement.com - Rolling Wave Planning*. https://www.projectmanagement.com/contentPages/wiki.cfm?ID=351295&thisPageURL=/wikis/351295/Rolling-Wave-Planning#_=_

Hevner, A. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information Systems*, *19*.

Hevner, A., & Chatterjee, S. (2010). Design Research in Information Systems. In *Integrated Series in Information Systems* (Vol. 22). Springer US. http://link.springer.com/10.1007/978-1-4419-5653-8

Hevner, A., Ram, S., March, S. T., & Park, J. (2004). Design Science in Information System Research. *MIS Quarterly*, *28*(1), 75–105.

Hines, V. (2020). *The state of Project managemen 2020*.

Hofmann, P., Jöhnk, J., Protschky, D., & Urbach, N. (2020). *Developing Purposeful AI Use Cases – A Structured Method and Its Application in Project Management* (pp. 33–49).

Horváth, V. (2019). Project management competence – definitions, models, standards and practical implications. *Vezetéstudomány / Budapest Management Review*, *50*(11), 2–17. https://doi.org/10.14267/VEZTUD.2019.11.01

How to Choose an AI Problem-solving Tool in Machine Learning. (n.d.). Retrieved November 19, 2022, from https://www.turing.com/kb/ai-problem-solving-tool-in-machine-learning

Information Technology Average Salaries in Lisbon 2022 - The Complete Guide. (n.d.). Retrieved November 27, 2022, from http://www.salaryexplorer.com/salary-survey.php?loc=2006&loctype=3&job=1&jobtype=1

Jeanes, E. (2019). transformational leadership. In *A Dictionary of Organizational Behaviour*. Oxford University Press. https://www.oxfordreference.com/view/10.1093/acref/9780191843273.001.0001/acref-9780191843273-e-303

Jin, L., Zhang, C., Shao, X., & Tian, G. (2016). Mathematical modeling and a memetic algorithm for the integration of process planning and scheduling considering uncertain processing times. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *230*. https://doi.org/10.1177/0954405415625916

Johnsonbabu, A. (2017). *Reinventing the role of Project manager in the Artificial intelligence era*.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). *Likert Scale: Explored and Explained*. *BJAST*(4), 157. https://doi.org/10.9734/BJAST/2015/14975

Jovanovic, P., & Beric, I. (2018). Analysis of the Available Project Management Methodologies. *Management:Journal of Sustainable Business and Management Solutions in Emerging Economies*, *23*(3), 1–13. https://doi.org/10.7595/management.fon.2018.0027

K., B. (2020). *Polydone Reviews 2022: Details, Pricing, & Features | G2*. https://www.g2.com/products/polydone/reviews

Khanmohammadi, S., & Jassbi, J. (2012). *A Fuzzy Approach for Risk Analysis with Application in Project Management* (pp. 41–62).

Khodakarami, V., & Abdi, A. (2014). Project cost risk analysis: A Bayesian networks approach for modeling dependencies between cost items. *International Journal of Project Management*, *32*. https://doi.org/10.1016/j.ijproman.2014.01.001

Kiefer, D., & Ulmer, A. (2019). Application of Artificial Intelligence to optimize forecasting capability in procurement. *Wissenschaftliche Vertiefungskonferenz 2019*.

Ko, C.-H., & Cheng, M.-Y. (2007). Dynamic Prediction of Project Success Using Artificial Intelligence. *Journal of Construction Engineering and Management*, *133*(4), 316–324. https://doi.org/10.1061/(ASCE)0733-9364(2007)133:4(316)

Kolodner, J. L. (1992). An Introduction to Case-Based Reasoning. *Artificial Intelligence Review*.

Kothari, A. (2022, November 2). *Top 9 Frameworks in the AI World*. https://geekflare.com/ai-frameworks/

Lahmann, M., Keiser, P., & Stierli, A. (2018). *AI will transform project management. Are you ready?* 8.

Latinovic, M. (2022). Automation and Artificial Intelligence in Software Engineering: HICSS-54. In V. prof. Pammer-Schindler (Ed.), *Hawaii International Conference On System Sciences (HICSS).* https://milanlatinovic.com/automation-and-artificial-intelligence-in-software-engineering-experiences-challenges-opportunities/

Le, J. (2018, April 19). *Convolutional Neural Networks: The Biologically-Inspired Model | Codementor*. https://www.codementor.io/@james_aka_yale/convolutional-neural-networks-the-biologically-inspired-model-iq6s48zms

Li, S., Guo, J., Gao, Y., Lou, J., Yang, D., Xiao, Y., Zhou, Y., & Liu, T. (2022). How to manage a task-oriented virtual assistant software project: an experience report. *Frontiers of Information Technology & Electronic Engineering 2022 23:5*, *23*(5), 749–762. https://doi.org/10.1631/FITEE.2100467

Lim, R. (2020). *15 Fascinating Project Management Statistics | Hive*. https://hive.com/blog/project-management-statistics/

Machine Learning – Amazon Web Services. (n.d.). https://aws.amazon.com/sagemaker/

MacNeil, C. (2022, June 4). *Project Initiation: The First Step to Project Management [2022] • Asana*. https://asana.com/resources/project-initiation

Magaña Martínez, D., & Fernandez-Rodriguez, J. C. (2015). Artificial Intelligence Applied to Project Success: A Literature Review. *International Journal of Interactive Multimedia and Artificial Intelligence*, *3*(5), 77. https://doi.org/10.9781/ijimai.2015.3510

Mahesh, B. (2019). Machine Learning Algorithms-A Review. *International Journal of Science and Research (IJSR)*. https://doi.org/10.21275/ART20203995

McDonald, K. (2016). *Microsoft Teams introduces T-Bot and Who-Bot - OnMSFT.com*. https://www.onmsft.com/news/microsoft-teams-introduces-t-bot-and-who-bot

Microsoft. (2021). *AI Business Basics*. 17.

Miranda, E. (2019). Milestone Planning: A Participatory and Visual Approach. *The Journal Modern Project Management*, *07*(02), 46–66. https://doi.org/10.19255/JMPM02003

Montoya-Torres, J. R., Gutierrez-Franco, E., & Pirachicán-Mayorga, C. (2010). Project scheduling with limited resources using a genetic algorithm. *International Journal of Project Management*, *28*(6), 619–628. https://doi.org/10.1016/J.IJPROMAN.2009.10.003

Moscato, P., & Cotta, C. (n.d.). *A Gentle Introduction to Memetic Algorithms*. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.77.5300&rep=rep1&type=pdf

Nasr, M., Shaaban, E., & Samir, A. (2019). *A Proposed Model for Predicting Employees' Performance Using Data Mining Techniques: Egyptian Case Study | Journal of Computer Science IJCSIS*. https://www.academia.edu/38371935/A_Proposed_Model_for_Predicting_Employees_Performance_Using_Data_Mining_Techniques_Egyptian_Case_Study

Newell, S. (2020). *Stakeholder Analysis*. https://www.productplan.com/glossary/stakeholder-analysis/

Nugaliyadde, A. (2016). *hat is the minimum samplWhat is the size required to train a Deep Learning model - CNN?* https://www.researchgate.net/post/What_is_the_minimum_sample_size_required_to_train_a_Deep_Learning_model-CNN/56baba4d64e9b21b058b456b/citation/download

Papatheocharous, E., & Andreou, A. (2012). A hybrid software cost estimation approach utilizing decision trees and fuzzy logic. *International Journal of Software Engineering and Knowledge Engineering*, *22*, 435–465. https://doi.org/10.1142/S0218194012500106

Pedamkar, P. (2019a). Artificial Intelligence Techniques | 4 Techniques of Artificial Intelligence. In *EDUCBA*. https://www.educba.com/artificial-intelligence-techniques/

Pedamkar, P. (2019b). Types of Artificial Intelligence | Understanding The Main Two Types of AI. In *EDUCBA*. https://www.educba.com/types-of-artificial-intelligence/

Pellerin, R., & Perrier, N. (2018). *A review of methods, techniques and tools for project planning and control*. https://eds.s.ebscohost.com/eds/pdfviewer/pdfviewer?vid=1&sid=8f4c9808-cb9c-46e8-9ba0-96e4831ea5d7%40redis

PMI. (2015). *Talent Triangle | Project management Institute*. https://www.pmi.org/learning/training-development/talent-triangle

PMI. (2017). *Project management - Job Growth and Talent Gap 2017-2027*.

PMI. (2019). *The Furture of Work - Leading the Way With PMTQ*.

Prakash Maheswari, J. (2018, December 21). *Breaking the curse of small datasets in Machine Learning: Part 1 | by Jyoti Prakash Maheswari | Towards Data Science*. https://towardsdatascience.com/breaking-the-curse-of-small-datasets-in-machine-learning-part-1-36f28b0c044d

Project kickoff meeting | The Workstream. (n.d.). Atlassian. https://www.atlassian.com/work-management/project-management/project-kickoff

Project Management. (n.d.). *Project Management*. ProjectManager.Com. https://www.projectmanager.com/project-management

Project Management Institute. (2017). *A guide to the Project Management Body of Knowledge (PMBOK guide) (6th ed.)*.

Rai, A. K., Agarwal, S., & Kumar, A. (2018). A Novel Approach for Agile Software Development Methodology Selection Using Fuzzy Inference System. *2018 International Conference on Smart Systems and Inventive Technology (ICSSIT)*, 518–526. https://doi.org/10.1109/ICSSIT.2018.8748767

Rankovic, N., Rankovic, D., Ivanovic, M., & Lazic, L. (2021). Artificial Neural Network Architecture and Orthogonal Arrays in Estimation of Software Projects Efforts. *2021 International Conference on INnovations in Intelligent SysTems and Applications (INISTA)*, 1–6. https://doi.org/10.1109/INISTA52262.2021.9548402

Ray, S. (2019). *5 Steps to Project Closure (Checklist Included)*. ProjectManager.Com. https://www.projectmanager.com/blog/project-closure

Russell, S., & Norvig, P. (2021). *Artificial Intelligence: a Modern Approach, EBook, Global Edition*. Pearson Education, Limited. http://ebookcentral.proquest.com/lib/novaims/detail.action?docID=6563568

Sakpal, M. (2020). *Gartner Predicts 69% of Routine Work Currently Done by Managers will Be Fully Automated by 2024*. Gartner. https://www.gartner.com/en/newsroom/press-releases/2020-01-23-gartner-predicts-69--of-routine-work-currently-done-b

Sanatan, M. (2017, May 19). *Unsupervised Learning and Data Clustering | by Sanatan Mishra | Towards Data Science*. https://towardsdatascience.com/unsupervised-learning-and-data-clustering-eeecb78b422a

Santos, J. M. D. (2021). ClickUp Review 2022: Best Features, Pricing, Pros & Cons. In *Project-Management.com*. https://project-management.com/pros-and-cons-of-using-clickup/

Scalable Project Management Software. (n.d.). Clarizen. https://www.clarizen.com/

Sebastian. (2019). The 10 Knowledge Areas & 49 Processes (PMBOK®, 6th ed.). In *Project-Management.info*. https://project-management.info/knowledge-areas-processes-pmbok/

Serpell, A., & M.Rueda, J. (2007). *Modeing a project scope using a case-based reasoning approach*.

Silva, H. M. D., Ezcurdia, M. A. P., Gimena, F. N., & Guerra, M. I. M. (2014). Performance Measurement In Project Management. *FACE: Revista de la Facultad de Ciencias Económicas y Empresariales*, *13*(1), 33–52. https://doi.org/10.24054/01204211.v1.n1.2013.955

Six Sigma Definition, What is Six Sigma Methodology. (n.d.). In *The Council for Six Sigma Certification*. https://www.sixsigmacouncil.org/six-sigma-definition/

Skuza, A. (2020, January 23). *How to staff an artificial intelligence team which can drive AI-powered product development? - Arek Skuza*. https://arekskuza.com/the-innovation-blog/artificial-intelligence-product-team/

Song Deng, S., & Ma, S. (2021). *Research on Software project Scheduling Based on Genetic Algorithm*.

Souza Filippetto, A., Lima, R., & Victoria Barbosa, J. (2021). *A risk prediction model for software project management based on similarity analysis of context histories | Elsevier Enhanced Reader*.

https://reader.elsevier.com/reader/sd/pii/S0950584920302391?token=9C937E4A480611455285B542CFE8AE73D1AFF61F9BA9A704231BC09949472B37A8630ECB36A2F0DE3FB8EA8CCCDA6A3E&originRegion=eu-west-1&originCreation=20220703104936

Supervised Machine learning - Javatpoint. (n.d.). https://www.javatpoint.com/supervised-machine-learning

Tavasoli, S. (2022, November 14). *Top 10 Machine Learning Algorithms You Need to Know in 2023 | Simplilearn*. https://www.simplilearn.com/10-algorithms-machine-learning-engineers-need-to-know-article

Team, I. L. X. M. (2019). *Project Management Triangle: A Triple Constraints Overview | EUR*. https://www.prince2.com/eur/blog/project-triangle-constraints

Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I., & Ferreira, M. (2019). Project Management Practices in Private Organizations. *Project Management Journal*, *50*(1), 6–22. https://doi.org/10.1177/8756972818810966

Tharwat, M. (n.d.). *Training Data for Machine Learning Algorithms Done Right! - John Snow Labs*. Retrieved November 15, 2022, from https://www.johnsnowlabs.com/training-data-for-machine-learning-algorithms-done-right/

The project triangle. (n.d.). https://support.microsoft.com/en-us/office/the-project-triangle-8c892e06-d761-4d40-8e1f-17b33fdcf810

Theophano, M. (2019, April 23). *How Do You Know You Have Enough Training Data? | by Theophano Mitsa | Towards Data Science*. https://towardsdatascience.com/how-do-you-know-you-have-enough-training-data-ad9b1fd679ee

Theory of Mind. (n.d.). https://www.w3schools.com/ai/ai_mind.asp

Ulrich, P., Frank, V., & Kratt, M. (2021). *Adoption of artificial intelligence technologies in German SMEs — Results from an empirical study*. 76–84. https://doi.org/10.22495/cgsetpt13

University of Arkanasas. (2016). *Progress report*.

van Besouw, J., & Bond-Barnard, T. (2021). Smart Project Management Information Systems (SPMIS) for Engineering Projects – Project Performance Monitoring & Reporting. *International Journal of Information Systems and Project Management*, *9*(1), 78–97. https://aisel.aisnet.org/ijispm/vol9/iss1/5

van der Aalst, W. M. P. (2021). Hybrid Intelligence: to automate or not to automate, that is the question. *International Journal of Information Systems and Project Management*, *9*(2), 5–20. https://aisel.aisnet.org/ijispm/vol9/iss2/2

Vargas, R. V. (2001). *A new approach to PMBOK guide 2000*. https://www.pmi.org/learning/library/chronologically-structured-approach-controlling-closing-process-7931

Wauters, M., & Vanhoucke, M. (2017). A Nearest Neighbour extension to project duration forecasting with Artificial Intelligence. *European Journal of Operational Research*, *259*(3), 1097–1111. https://doi.org/10.1016/j.ejor.2016.11.018

Wei, R., & Ding, D. (2022). Problems and Countermeasures of Financial Risk in Project Management Based on Convolutional Neural Network. *Computational Intelligence and Neuroscience*, *2022*, e1978415. https://doi.org/10.1155/2022/1978415

What is Agile Software Development? (2015). In *Agile Alliance* |. https://www.agilealliance.org/agile101/

What is Natural Language Processing? (n.d.). https://cloud.google.com/learn/what-is-natural-language-processing

Why every project needs a baseline project plan | Teamwork. (n.d.). https://www.teamwork.com/project-management-guide/baseline-project-plan/

Work Breakdown Structure. (n.d.). Workbreakdownstructure.Com. https://www.workbreakdownstructure.com

Yakubu, R. (2022). The Power of AI in Business. In R. Yakubu (Ed.), *Conference Building the Future*.

Yang, X.-S. (2019). Mathematical foundations. *Introduction to Algorithms for Data Mining and Machine Learning*, 19–43. https://doi.org/10.1016/B978-0-12-817216-2.00009-0

Yao, W. (2020). *What is the minimum amount of data needed when carrying out analysis via datamining techniques like decision tree?.* https://www.researchgate.net/post/What-is-the-mininum-amount-of-data-needed-when-carrying-out-analysis-via-datamining-techniques-like-decision-tree/5f169e0037fbdd615d266481/citation/download

Zwikael, O. (2009). The Relative Importance of the PMBOK® Guide's Nine Knowledge Areas during Project Planning. *Https://Doi.Org/10.1002/Pmj.20116*, *40*(4), 94–103. https://doi.org/10.1002/PMJ.20116

APPENDIX A

NOVA IMS Information Management School

A Framework for leveraging Artificial Intelligence in Project Management

Dissertation for obtaining the Master's degree in Information Management

Rea Todorovic

Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa

Acreditações e Certificações

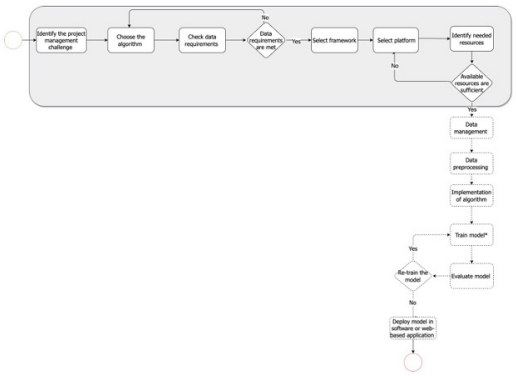
Motivation

1. 59% of Project managers lead 2-5 projects (Harrin, 2022).
2. The project is falling are lack of performance and did not achieve the specified outcome, overrun in costs, over the deadline, and changes in scope during project execution (Hefley & Bottion, 2021).
3. 18 % more projects are falling because organizations do not leverage or have outdated project management technology,(PMI, 2019).
4. 85 % of respondents say AI will change the way they do business in the next five years (PwC, 2019).
5. On an annual basis, employers will need 2.2 million new project-oriented positions each year until 2027(PMI, 2017).

Problem statement

1. Lack of efficiency in project management which leads project managers just to delegation of the tasks to the team members and missing deadline or overbudgeting.
2. Missing knowledge in Artificial intelligence area and specialist who can apply those knowledge.
3. Missing of framework of guided steps process in which artificial intelligence can be easily applicable.
4. Overwhelming number of sources related with Artificial intelligence with inaccurate information.
5. Lack of structured project management data.

Framework



Interview Questions

1. Do you consider the proposed framework useful and why?
2. Do you have any criticism towards the proposed framework? Do you have suggestion for the further improvements of the proposed framework?
3. Would you consider implementing the proposed framework?

Thank you !

Address: Campus de Campolide, 1070-312 Lisboa, Portugal
Phone: +351 213 828 610 Fax: +351 213 828 611

Acreditações e Certificações

Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa