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A framework to succeed planning of IT projects through the Machine Learning

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ABSTRACT

This discuss the issue of planning IT projects. To identify the key failure factors of this phase, we carried out a direct observation with IT development companies in order to extract as much information as possible and to identify these factors very quickly. This observation allowed us to identify these factors, analyse them, propose solutions to countermeasure them, and finally test the different proposed solutions.

The experimentation of the solutions allowed us to sort them, organize them by themes and develop them as they went along, to finish with the proposal of a complete framework to overcome the problems of IT project failure in the planning phase. The global solution therefore makes it possible to connect the proposed Framework with the machine learning. In order to carry out the planning on the one hand based on the Framework, and to test the planning carried out on the other hand using the Learning machine, and then to have a complete planning allowing the success of the project to be implemented.

Key words : IT project management, IT project planning, Digital Transformation, Machine Learning, IT project risks.

1. INTRODUCTION

The dematerialization of processes, while increasing the quality of services, has become one of the main priorities of companies today. This dematerialization is mainly based on the production of IT projects that are characterized by their uniqueness, urgency and complexity. This technological evolution continues to grow exponentially, but at the same time, it leaves behind new constraints and requirements to be managed.

As a result, IT project management must also evolve in order to pursue this development, and take into consideration the constraints of this evolution, while guaranteeing a quality that meets the expectations of these companies. However, in reality, the numbers are catastrophic, and the rate of failure and production of suffering IT projects continues to increase.

Indeed, according to the investigation data announced by the Standish Group International, in 2003, only 34% of projects were completed successfully, while 15% were cancelled before completion, and 51% were challenged, because they were over cost, over schedule and so on [1].

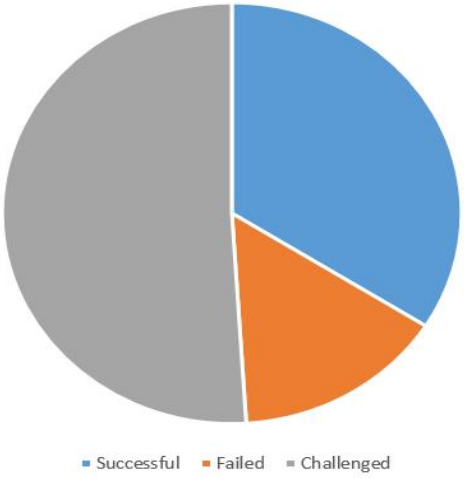

Figure 1: Success rate of IT projects, CHAOS [1] Report, 2003

Also, according the to the investigation data announced by the same group in 2013, only 39% of projects are successful, while 18% of projects are failing and cancelled before completion, and 43% of projects are challenged, because they were over budget and schedule [2].

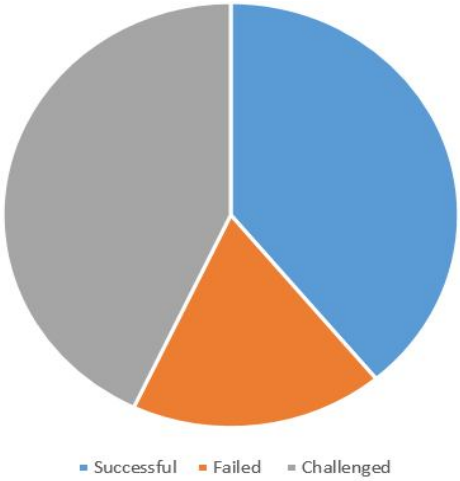

Figure 2: Success rate of IT projects, CHAOS Report, 2013

As well, in the recent report of 2015, it has revealed that only 29% of projects were completed successfully, while 19% of projects were failing and 52% of projects were challenged. According to the results of this report, it has become clear that companies need to work on improving methodologies for estimating IT projects, which have a direct impact on cost, planning and quality, because the three are related in IT projects [3].

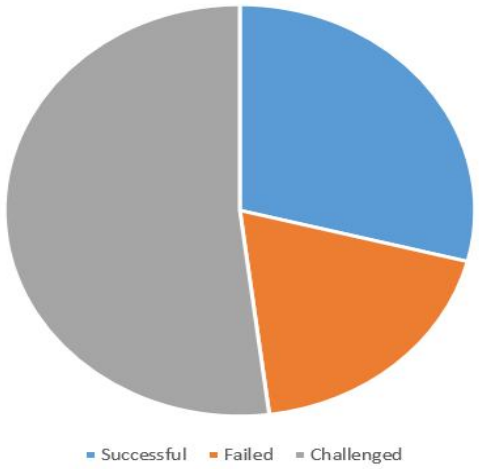

Figure 3: Success rate of IT projects, CHAOS Report, 2015

Similarly, according to the same survey from 2011 to 2015, it was identified that 56% of projects were delivered outside the budget, 60% of projects encountered planning delays, and 44% of projects did not achieve their objectives [3]. In this article, we focus on project planning, which remains one of the most common problems encountered (about 60%).

To solve this problem, we must first identify the parameters that led to these changes and the increase in the failure rate of IT projects, and identify the key factors for failure in IT project planning.

In summary, this article aims to address two very specific issues, which can be described by the following questions:

- How, when evaluating a project, could all the contingencies, events, and situations that the project could encounter during its development be taken into account?
- Is it possible to set up a framework to manage the planning phase of IT project lifecycle?
- Is it possible to exploit the potential of feedback through the implementation of an intelligent system as part of machine learning and a knowledge base?

2. LITERATURE REVIEW

Project Management Institute defines a project as a temporary enterprise initiated with the aim of providing a unique product, service or result [4]. In addition, PRINCE 2 defines a project as a temporary organization, created to deliver one or more project products in accordance with an agreed Business Case [5]. Both definitions agree that it is a temporary enterprise with a well-defined scope to deliver a project that is characterized by its uniqueness.

AFNOR X50-115 defines a project as a set of coordinated and controlled activities with start and end dates, undertaken to achieve an objective in accordance with specific requirements [6]. This definition highlights another project characteristic that takes the time necessary to address these objectives.
IT project refers to the information management systems of computer [7]. This is a specific type of project, which has its own characteristics. Indeed, IT projects are characterised by their emergency, uniqueness, one shot, short term and uncertainty [8]. These different definitions do not give a global vision on the project concept, and specifics of an IT project, which is also characterized by the complexity of its implementation, the risks that can occur at any stage of their production.

Project Management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements [4]. In addition, IT project management is the project management based on information technology, a special type of project management, and a new kind of project management that came into being and is being improved continuously with the development of information technology [9].

Three features define IT project management: abstractness, timeliness of information, communication, and uncertainty [10].

With the evolution of the digital age, the notion of IT project has changed, as it begins to take into consideration the characteristics of an IT project that we have just mentioned, as well as the constraints related to this digital evolution, in terms of product value, speed of delivery, production complexity and so on. This change implies the need and urgency to review the way IT project management is carried out in order to adapt it to these new requirements.

Project planning is an important aspect of project management, especially for projects that have a large number of tasks and are carried out over a long period [11]. For example, in the field of IT development, there is a rule imputation saying that 33% of the total project time (including functional specifications and design) is reserved for planning [12]. This encourages the urgency of analysing this project phase, which remains one of the most critical stages in the life cycle of an IT project.

General Dwight Eisenhower has said, “The plans are nothing. Planning is everything”. The analysis of his sentence leads to consider that, even if both concepts are necessary, the plans do not refer only to than static documents. Planning, on the other hand, involves a series of actions reactive and dynamic and allows uncertainty to be taken into account.

In project management, planning is defined as "the discipline whose purpose is to anticipate and monitor the objectives (deadlines, costs, etc.) of carrying out a project" [13].

Usually, the objective of project planning is as follows:

- Presentation of planned objects: tasks, activities, choices, intervals, etc. as well as constraints and orientations
- Calculation and optimization of the parameters of duration, cost, and task margins

Graph theory is generally used as a support for project planning, and is based on the following function:
G = (N; A), with N is the set of vertices per node and A is the set of arcs.

Project planning methods have features as inputs, and values, decisions, or optimizations as outputs. For each type of output, several tools are available (GANTT, GAAN, SATM, etc.). However, there is no methodology and no tool to have and group the different types of output possible by these methods.

These methods suffer from the uniqueness of the information gathered at the output of the process, and do not take into consideration risk management or the constraints and requirements of this new era.

In a study conducted by Bain & Company in 2017, based on a sample of 1012 companies, only 5% of organizations attempting digital transformation were able to meet or exceed their objectives. The gap between the need for digital transformation and the success of transformation makes organizations reluctant to attempt the transformation process [14]. This lack of understanding of the process leads to attempts at digital transformation, which often results in a decrease in the value of the organization [15]. Hence the need and urgency to update current project management methods, and specifically the planning phase, which is considered a very high-risk phase.

The discipline of machine learning is a subset of artificial intelligence that focuses on the ability of computer systems or machines to improve performance automatically throughout its experience [16]. With the addition of excessive data, machine learning refines the automotive learning process through training and leads to the adaptation of its algorithm. ML algorithms are used to implement the different models [17]. Machine learning can be categorized as follows: Guided, non-guided, semi-guided and reinforced learning [15].

The integration of machine learning is evolving exponentially, in E-commerce, in social networks, in the medical field, and others, but it is not yet integrated in the management of IT projects, which remain as risk projects, especially in an era when the business model of companies is the dematerialization and digitization of processes.

3. METHODOLOGY

3.1 Theoretical background

With ongoing development in technology, and the ever-changing challenges that exist in IT project management, several investigations have been conducted by different organizations. In this article, we focus on the surveys of the "Standish Group International" and specifically on their last report published at the end of 2016 (Table 1) [3].

Table 1: The Traditional resolution of all software projects from FY2011–2015 within the new CHAOS database.

	2011	**2012**	**2013**	**2014**	**2015**
Successful	39%	37%	41%	36%	36%
Challenged	39%	46%	40%	47%	45%
Failed	22%	17%	19%	17%	19%

In the same report, a survey was conducted according to the criteria and success factors of the projects (Table 2):

Table 2: The percentage of projects that were on budget, on time, and on target from FY2011-2015 within the new CHAOS database.

	On budget	**On time**	**On target**
Yes	44%	40%	56%
No	56%	60%	44%

In this article, we focus only on the "On time" factor, which is mainly related to project planning. In addition, to better understand this subject, we made a direct observation on two IT companies, for two years (1 year for each company), for about a hundred IT projects of different complexity, size and business area.

3.2 Hypotheses

The hypotheses were developed to test the way in which project schedules were produced and the actions taken to achieve the planned schedules. The observation concerned several sections and of the project life cycle of the projects to be implemented. For each phase, we identify problems related to production time, in order to analyse the causes, while taking into consideration the type of projects, technology

used, the experience of the teams in this technology, the complexity of the projects, and so on.

3.3 Population

The population that is the subject of this study for the analysis of the key factors of failure of IT project planning is that of IT project managers in IT services companies or IT agencies who are considered to be the most experienced in the field, given the variety of projects they manage.

3.4 Sample

A random sample of IT project managers was selected as a sample to identify project planning failure factors. The data collected were done through direct observation in the field.

3.5 Theoretical background

Three methods were used for data collection:

- A literature review based on surveys conducted by the Standish Group International.
- Observation and collection of information in the field.
- Field survey with IT project managers and teams, using interviews as a collection tool.

Observations and interviews were conducted with 15 IT project managers for approximately 100 IT projects. Projects were observed at different phases of the project life cycle in order to collect as much information as possible on the different project phases.

4 RESULTS

By analysing the success rates of IT projects between 2011 and 2015 (Table 2), we can see that the number of successful IT projects evolved between 2011 and 2013, while from this year onwards there was a significant decrease. This is also the case for challenging projects, which have undergone significant changes compared to previous years (before 2013).

As for the failure rate, its evolution remains relative. These statistics show perfectly that the number of suffering projects has grown exponentially since 2013.

To fully understand the reasons for these changes in statistics, which had a high success rate of IT projects before 2013, we tried to analyse what has changed over time. Indeed, in 1998 we were talking about NICT era (New Information and Communication Technologies), but in 2013, after 15 years, some of these technologies continue to be news, while others have appeared and the digital has stolen the spotlight [18].

This analysis of technological evolution over the years has allowed us to understand that the digital age has its own constraints, and that IT project management methods must evolve to meet the constraints of this era of digital transformation.

Observations on the work environment for 2 years in IT services enterprises allowed us to analyse several projects, on different phases, of various complexities, and several business sectors, without forgetting the technical and cultural environments that differ from one project to another.

The interviews with the project managers allowed us to identify specific topics and recurring issues in order to identify the main reasons for IT project failure, and specifically in the planning of IT projects.

Several planning, management methods and tools are in place, such as:

- GANTT, PERT, CPM, for methods based on deterministic activity networks, where all identified tasks will be proposed in the planning [18]
- GERT, for methods based on alternative activity networks, where activities whose implementation on the program is conditional [19]
- CAAN, to integrate stochastic and/or deterministic connections, where each node can only receive one type of connection
- SATM, which represents all tasks by simple nodes.

According to the data collected, for the implementation of the plan, and regardless of the used method, project managers respect the following steps:

- At first, the project manager tries to divide the project into batches and each batch into tasks
- For each task, they give an estimate of workloads
- In addition, for each task they give a start date and an end date of each task
- Project managers identify the resources needed to accomplish the planned tasks

Based on these elements, project managers set up the production planning, which remains an internal planning and a public planning, for the implementation of the system to be developed for end users.A delta between production planning and public planning is always set up, it represents a time of manoeuvre, or project risk, for any constraints that may occur along the way.

For the most experienced project managers, when production planning, they take into consideration non-functional tasks, such as setting up the working environment, and other services necessary to accomplish the tasks.

Beyond this particular type of task, they plan the internal and external communication, the various meetings, and the workshops necessary for the implementation of the project as a whole.

These methods and practices remain very limited, for the following reasons:

- The division of tasks must respect a certain nomenclature, specifying the role, action and business value of each task.
- These tasks must be as simple as possible and must respect the INVEST principle (Independent, Negotiable, Vertical, Evaluated, Sufficiently small, Testable)
- The division of the project into tasks is therefore not sufficient to produce a quality planning.

Because in reality, tasks are written in any way, and do not have a business value, nor management rules that allow their proper interpretation and estimation.

Beyond project tasks, project managers often forget non-functional and non-technical tasks, such as hardware, software, and the various needs that are related directly or indirectly to the project and that can hinder its smooth progress.

In addition, project managers estimate the tasks, but they are not the ones who will develop these tasks. The people most affected by these estimates are the teams that will be responsible for implementing these tasks. Hence the need to involve the project team from the planning phase of the project, in order to have parallel estimates and commitments. Involving development teams is a way to empower them and respect their production capacity.

The order of tasks must take into consideration two key factors, the business value of these tasks and dependency management. Indeed, several projects suffer either in terms of missed schedules or in terms of deliverable quality due to very poor dependency management.
The identification of dependencies from this phase, allows to reduce the risks of regressions afterwards, and to anticipate the necessary times for the correct implementation of these dependencies.

Making a quality planning is good, but setting up a strategy to respect this planning is even better. Indeed, Current management planning tools are not sufficient to better manage planning, a concatenation between several tools can manage many of the risks associated with managing IT project planning.

Based on the results of interviews and direct observation in the workplace, project-planning issues can be grouped as Figure.4:

Figure 4: IT Project planning issues

5 DISCUSSION

The multitude of methods and tools for IT project planning was not sufficient to overcome the constraints of this earlier project phase. Indeed, each of the methods presented is particular to a specific problem. To do this, this article proposes a very specific framework, which takes into consideration the different factors of failure of IT projects due to poor project planning. Subsequently, this article proposes to test the proposed planning using machine learning before applying it to the project, to check whether the proposed plan will allow us to succeed in this sensitive phase or not.

During the various observations, we analysed the encountered problems, in order to identify the cause, and we implemented solutions that we tested on other projects to verify if the proposed solution responds well to the problem encountered or not. The results of these experiments led us to the following proposed framework:

5.1 The project team

- Delegation of responsibilities to the team (delegation of important and/or urgent tasks)
- Choice of the project team taking into consideration the elements to be delegated
- The team's involvement in the production-planning phase (because they will do the work)
- The cost per worked day of each team member
- Identification of the team's roles, responsibilities, perimeters and powers
- Realization of the RACI project or RACI-VS according to the level of complexity of the project
- Setting up committees, according to the size and complexity of the project: COPIL, CODIR, COPROJ, etc.

5.2 Communication plan

Uncontrolled communication systematically leads to interpretations and misunderstandings. A communication

must be planned over time, and the time required for each type of communication must be estimated. To do this, the following elements must be respected and identified:

- The targets
- The communication risks
- Communication angles
- Upward or downward communication
- Communication strategy
- Communication measurement

5.3 Quality plan

This plan must be carried out taking into consideration whether:

- The company has a Quality Assurance and Control Plan
- The company does not have a quality assurance and control plan, in this case we are talking about the self-assurance quality plan

In the PACQ, no authority could be imposed on the management concerned, this time and the costs involved in this quality plan must be taken into account.

In the P2CQ, we have authority, this plan must be in adequacy with the nature of the project to be implemented (avoiding underestimation and oversizing).

5.4 Project management KPI

A project planning requires a means of measuring the progress of the project as it is deployed. This is referred to project management KPI. There are several methods of measuring how the project is progressing, and of identifying problems that do not arise from project communication.

Depending on the nature of the project, its complexity and the feedback from the team responsible for its deployment, a KPI (measurement software) must be identified to ensure the safety net and not to lose sight of it. Indeed, if a problem is detected only through the reading of the KPIs, it confirms the communication problem in the project team, and therefore it is an opportunity to anticipate communication risks and to plan it well.

5.5 Subdivision

The subdivision of a project, also called "PBS, Product Breakdown Structure according to PRINCE2" is a method that requires the grouping of sub-projects together. Each grouping is a part of the project. The batch may sometimes overlap over time or parallel each other.

The objective of a batch is to link the modules or applications that have the strongest interdependencies.
Two subdivision options are possible:

- Subdivision by business line
- Subdivision by objective

5.6 Batch planning

The batch planning makes possible to validate the number of teams to be put in parallel to carry out the entire project and to identify critical tasks at the deadline level, which could disrupt the general organisation of the project if they fall behind.

The main objective of this planning is to organize the subsequent production phases and to determine the number of teams to be compared over all or part of the project duration. Planning also makes it possible to determine the critical path and identify the works that are time-critical, not only in relation to the project objective, but also for the proper organization of the work.

To summarize the above, the framework proposes the following architecture:

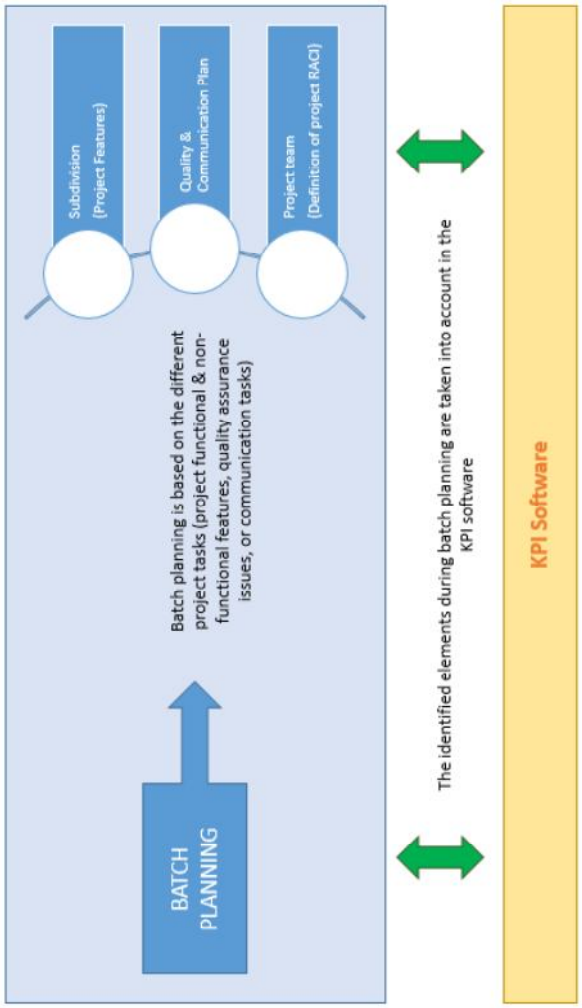

Figure 5: The proposed framework for managing the planning phase of IT projects

The management must define the project team, the quality and communication plan. Then, he moves on to the project subdivision, by identifying the different functional and non-functional features, with the persons in charge of each type of feature, to finish by estimating each one while taking into consideration the complexity and risk associated with each of the features. These different steps allow us to build what we call batch planning.

Each module of this framework has been tested in different projects to verify its reliability, and has been improved as experiments have progressed. The definition of each module of this framework is essentially based on the feedback of the manager and the project team, the project type, its complexity, its size and other criteria for the essential analysis of the project.

For each module, several methods are available, hence the interest of integrating the machine learning, for the analysis of the different project parameters in order to decide which method to respect when defining each module, and to ensure that the proposed plan is feasible or not and anticipate the various risks associated with IT projects planning.

To realize this system, we identify the:

- Input: the project parameters, the parameters of the quality and communication plan, the management method adopted, the KPI software used, subdivision and planning.
- Output: the project-planning success rate.

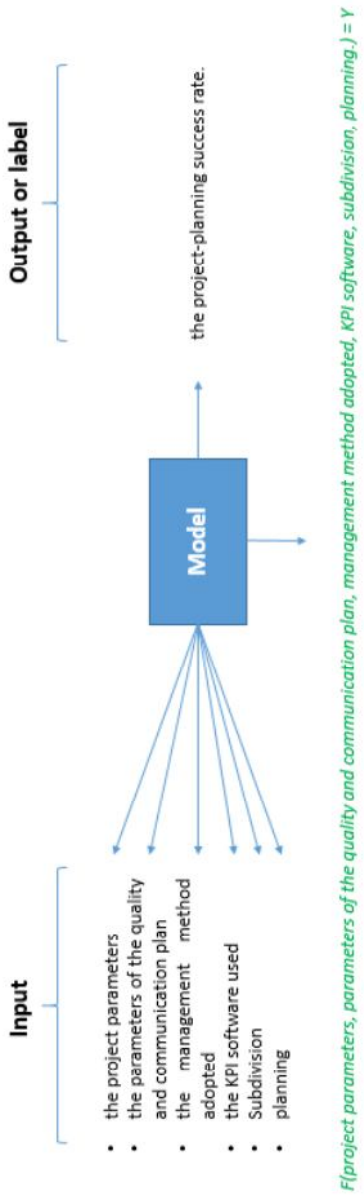

Figure 6: The proposed machine learning model for evaluating IT project schedules

This model (Figure 7) must be initiated by data (in the form of IT projects), while respecting the parameters defined as inputs. This data initiation phase must be followed by an automatic learning phase, in order to enable this function via the machine learning model to identify and deduce the key factors for successful IT project planning. The predictions proposed by the learning machine represent the outputs of the proposed system; they are in the form of a complete schedule. If the project manager wishes to modify the proposed schedule, he will have as output the success rate of the schedule following the modification, thus the critical data for its success.

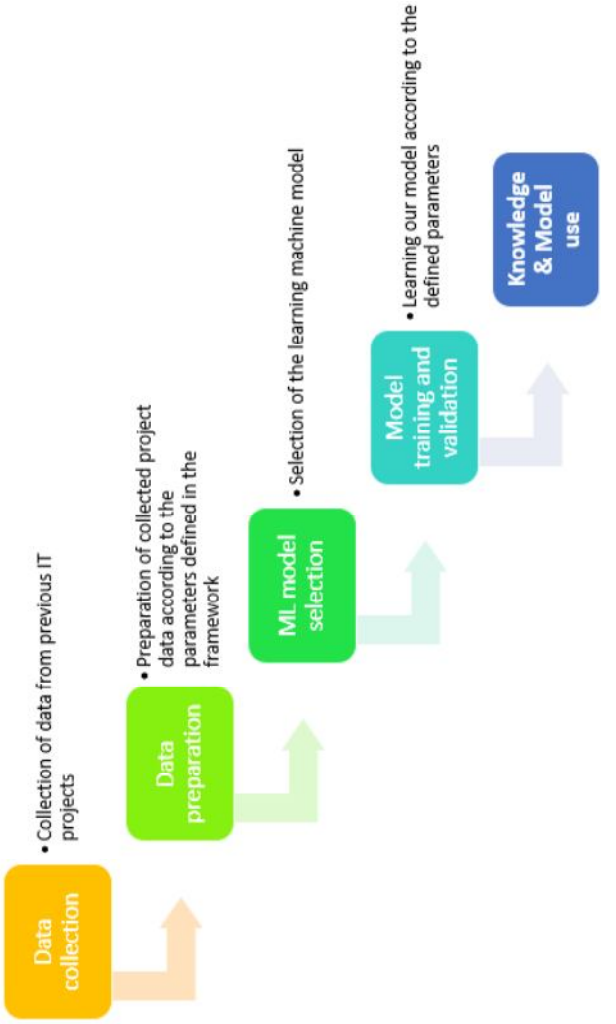

Figure 7: Steps carried out in the machine learning proposed process

To summarize, the machine learning will allow us to generate an IT planning in a few seconds, to analyse our existing planning, and decide if we should use it for the success of the project to implement, or improve it, and thus it will allow us to limit the risk of IT projects planning. The advantage of this model is that it is based on a framework that we had experienced in the workplace and that it has proven its impact on the success of IT project planning.

Figure 8 summarizes the overall functioning of this contribution, and the connection between the proposed framework and the implemented machine learning function. Indeed, the realization of the planning, while respecting the proposed framework makes it possible to fill the parameters of our function. Within the model, we have a decision tree which makes it possible to analyse these parameters (by analysing the various possibilities), and to return a percentage which represents the success rate of the proposed plan.

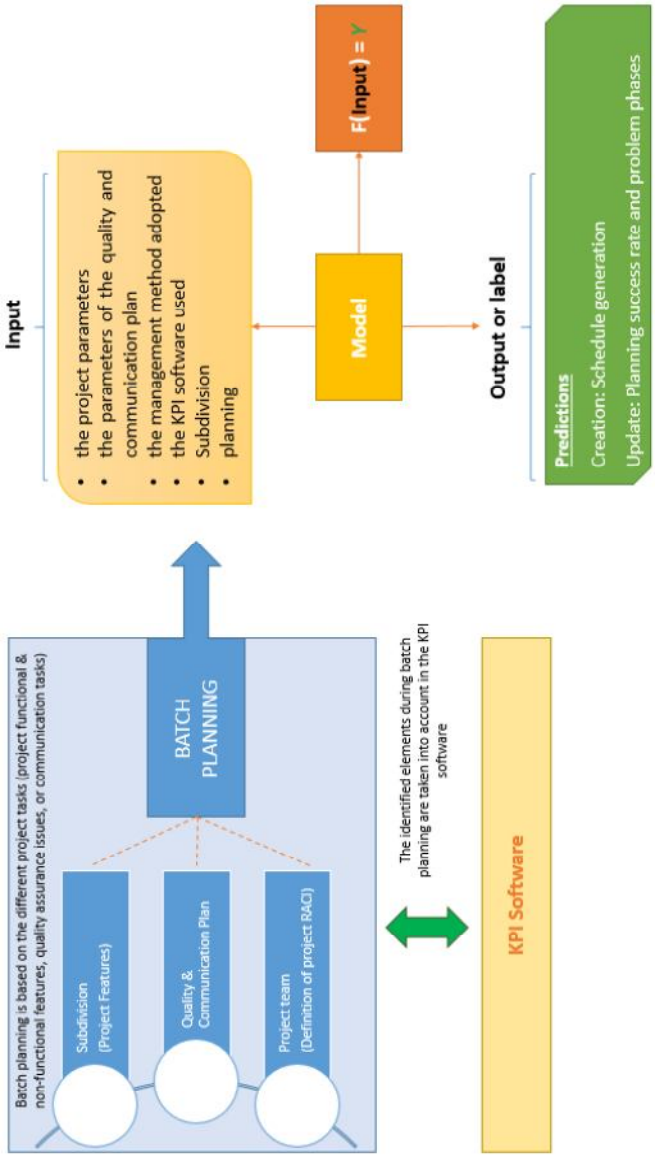

Figure 8: Proposal of a framework and integration of machine learning in the planning phase of IT projects

6 CONCLUSION

IT development is evolving and the constraints related to the implementation of this type of project are increasing very rapidly. This is especially in an era of digital transformation, which adds its own problems to the existing problems of IT project management. Indeed, one of the keys to measuring the success of IT projects is the respect of production time. This duration is prepared in a very early phase of IT project life cycle, which is the project-planning phase.

The objective of this study was to optimize this phase by proposing a well-defined framework that allows the success of this phase. This framework was proposed based on a direct observation of the workplace, through which we identified the most common problems and risks in IT project planning. Then, by identifying and analysing these problems, we

proposed solutions to overcome these risks, and as observations were made, we tested the proposed solutions, which allowed us to propose a complete framework for planning IT projects.

The respect of this framework is also based on the experience of the project managers who will execute it, and to avoid this problem of feedback, we used machine learning to test the proposed plan before its implementation, which allows us to verify the feasibility of respecting this planning, and also to check whether it was well designed or not. Our function allows to return a percentage that represents the success rate of the project, taking as an analysis criterion its planning.

On the machine learning side, future studies can focus on the development of this machine learning function, and even deep learning in order to provide a feedback on the success rate of the project, as well as the problematic parameters, and thus give a direct indication on the parameter concerned in order to improve it.

On the framework side, it is necessary to organize each parameter in the form of models, as an example, for the communication plan, we can choose between upwards or downwards communication, another example that concerns KPIs, is it the EVPM or KPI quality produced or KPI perceived quality, etc. This will simplify the work of our function, in order to return a model for each parameter, which will simplify once again this critical and anticipated phase of the IT project life cycle, as well as the increase in the success rate of this type of project.

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