LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER IN
MANAGEMENT AND INDUSTRIAL STRATEGY

MASTER´S FINAL WORK

DISSERTATION

THE APPLICATION OF SYSTEM THINKING IN PROJECT MANAGEMENT

ANNA DÚLIA MACHADO SANTOS

NOVEMBER – 2020

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SUPERVISORS:
PROFESSOR DOUTOR JOSÉ MIGUEL ARAGÃO CELESTINO SOARES
PROFESSOR DOUTOR ANTÓNIO JOÃO PINA DA COSTA FELICIANO ABREU

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ABSTRACT

The increasing level of complexity in organisations poses significant challenges for Project Management, demanding more sophisticated and rich methodologies that address issues efficiently. The holistic approach proposed by System Thinking field has been identified as a possible path for managers in the context of large organisations and/or complex problems. Hence, it is noticeable a growing body of literature focused in the application of System Thinking to the field of Project Management.

The present study aims to contribute to this growing body of literature through the application of System Thinking methodologies to a real situation from the point of view of the Project Manager. This case study is focused on a completed project related with IT development in a large multinational organisation, that faced execution problems.

The application of System Thinking methodologies allowed for better risk assessment in the project and for a concise understanding of the root problems causing execution problems. From the point of view of the Project Manager, this holistic approach enabled a more efficient analysis of the problem and the incentives at stake within the system as well for a better decision making than the traditional methodologies.

Keywords: Project Management, PMBOK, Complexity, System Thinking.

RESUMO

O crescente nível de complexidade nas organizações apresenta desafios significativos para a Gestão de Projetos exigindo metodologias mais sofisticadas e ricas para tratar dos problemas de forma eficiente. A abordagem holística proposta pelo Pensamento Sistémico tem sido identificada como um caminho possível para gestores no contexto de grandes organizações e/ou problemas complexos. Consequentemente, é percetível um aumento no volume de literatura focado na aplicação de Pensamento Sistémico à área de Gestão de Projeto.

O presente estudo visa contribuir para o crescimento do volume de literatura académica através da aplicação de metodologias de Pensamento Sistémico a uma situação real do ponto de vista de um gestor de projeto. Este estudo de caso está focado num projeto de desenvolvimento de TI concluído numa organização multinacional, que enfrentou problemas de execução.

A aplicação de metodologias de Pensamento Sistémico permitiu uma melhor avaliação de riscos do projeto e uma compreensão concisa da raiz dos problemas que causam problemas de execução.

Palavras-Chave: Gestão de Projeto, PMBOK, Complexidade, Pensamento Sistémico.

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LIST OF ABBREVIATIONS

CT1 – Contract Template 1

CT2 – Contract Template 2

CT3 – Contract Template 3

EPM – External Project Manager

EPM1 – External Project Manager 1

EPM2 – External Project Manager 2

EPM3 – External Project Manager 3

IMP – Internal Project Manager

IMP4 – Internal Project Manager 4

IT – Information Technology

HD1 – Head of Department 1

PM – Project Management

PMBOK – Project Management Body of Knowledge

RS – Repository System

RS1 – Repository System 1

RS2 – Repository System 2

RS3 – Repository System 3

ST - System Thinking

1. INTRODUCTION

1.1 Framework and Topic Justification

The increasing globalisation coupled with the intense technological development characteristic of our economy and created the need for fast evolving organisations. Organisations require fast transformation to be delivered in short time with perfect execution.

Project Managers are, therefore, faced with higher and more complex projects and demands. For the growing field of Project Management, the application of more holistic approaches such as System Thinking may allow for more efficient identification of problems. Especially, in multinationals or other large organizations composed by systems within systems with numerous inter-relations and co-dependencies, the contribution of different methodologies that stem from other scientific fields may have significant positive impacts.

1.2 Study Goal

This Final Master's Thesis constitutes a case study on the application of the System Thinking approach to an executed IT project developed for a multinational, from the point of view of the project manager. This study aims to understand the added value of this approach, especially in the identification of the root causes and problems of execution in the project. Different tools of System Thinking are applied in order to conduct a qualitative study on how the system evolves globally, the risks and incentives present in the system and its effects. The completion of this work contributes to the growing body of literature on the application of System Thinking to the field of Project Management.

1.3 Study Structure

This Final Master's Thesis is divided in five chapters. On the first chapter, the context, relevance and main goals of the study are explained. The second chapter presents a literature review and theorical foundations of System Thinking and Project Management, as well as an overview of the literature that aims to connect the two fields. Third chapter is dedicated to project description and problem statement, where a brief presentation of the project is done, followed by a brief description of project's problem statement. The fourth chapter encompasses the methodologies used, the techniques set out in chapter two are applied and the results obtained with this study are analysed and discussed. Fifth and last chapter of this study present conclusions, limitations and proposals for future research.

2. LITERATURE REVIEW

2.1 Project Definition

The Project Management Institute defines project as a temporary endeavour with a definite beginning and end, undertaken to create a unique product, service, or result, where the final deliverables may be tangible or intangible (PMI, 2017).

According to Rodrigues and Bowers (1996), project success constitutes a fundamental factor for the survival and prosperity of organizations. Staying ahead of competition, in an increasingly integrated global market, requires firms to implement alterations or innovations in different phases of the production process or costumer relation. The benefits from successful projects can be delivered directly from the creation of a new product or service, or by reducing certain operating expenses, or even through changes to the common working practices, redesign processes and update of personal and professional skills (Gomes & Romão, 2016).

2.2 Project Management

The management of projects is of considerable economic importance with demonstrated growth occurring across different sectors, industries and countries (Turner, et al., 2010; Winter, et al., 2006). Organizations have been adopting projects in their daily work to achieve their objectives and, therefore, the need for Project Management (PM) has been increasing (Papke-Shields & Boyer-Wright, 2017).

PM is a problem-solving method which involves planning techniques and methods that are similar to optimization theory (Abbasi & Jaafari, 2018). PM is concerned with delivering undertakings, on time, within budget, on scope (Geraldi & Morris, 2011). From the various definitions given by several authors, the one that stands out is the one from Project Management Institute (PMI, 2017) that describes PM *as the application of knowledge, skills, tools, and techniques to project activities to meet project requirements*. The increasing rate of change and the complexity of the new technologies and markets impose the need for quick and effective responses (Rodrigues & Bowers, 1996).

Crawford (2005) mentions that PM was developed as a set of practices that enable organizations to achieve their business objectives. Many organizations state that using PM techniques provides advantages like better utilization of financial, physical and human resources, improves customer relations, lowers costs and increases productivity, quality, reliability and profit margins (Schwalbe, 2016). For Jeremiah, Kabeyi and Kabeyi (2019) effective PM is a key factor in achieving a sustainable competitive advantage in the marketplace. There is an observable growth in the number of professional associations, methodologies, standards and tools that seek to decrease errors that lead to failure (Davis, 2014).

Traditional (*known as waterfall*) and Agile approaches are the main PM methodologies used currently (Cruz, 2013). Traditional approach is considered a rigid model, resistant to changes and with a well-defined sequential process (Soares, 2004; Teixeira, 2014). In traditional PM the idea is to fix the scope of the project and focus on controlling the project cost and schedule by controlling changes to scope. A project is deemed successful if the original requirements are met within the budgeted cost and schedule (Ozkan & Kucuk, 2016, p. 328). Agile methods have emerged as an alternative to traditional approaches to PM, being based on a series of twelve principles, is premised on rapid response to development, leaving documentation and nonessential planning in the background (Vargas, 2016). The agile approach is faster, more informal and less bureaucratic process than waterfall approach (Taroco & Werner, 2007). The success in Agile is measured by the functioning of the software within the conditions for which it was developed, in order to serve users and pleases the customer (Oliveira, Curso & Mesquita, 2003).

As projects become more complex, the management tasks become overwhelmingly difficult (Gilbert, 1983). PM has changed from an art to a science over time because of increasing standardization, continuous refinement of concepts and development of specific computer software's (Jeremiah, et al., 2019).

2.3 PMBOK

As organizations started structuring their activities into projects, the demand for project managers increased as well as the interest of PM competences (Crawford, 2005). With increased globalization, the project manager should be able to work across networks, cultures, languages, geographical features coupled with collaboration soft skills (Jeremiah, et al., 2019). In this sense, organizations and project managers are looking for best practices for managing their projects, in order to bring greater value to their business (Kerzner, 2018).

PMBOK, standing for Project Management Body of Knowledge, was first published by PMI as a white paper in 1987 as an attempt to document and standardize accepted PM information and practices (Jeremiah, et al., 2019). PMBOK originated from the empirical knowledge of numerous project managers and is intended to be a guide to good practice for all kinds of projects (Vargas, 2016). This guide is one of the essential tools in the PM profession today and has become the global standard for the industry (Haughey, 2014). It's important to mention that PMBOK is a foundation upon which organizations can build methodologies, policies, procedures, rules, tools and techniques, and life cycle phases needed to practice PM (PMI, 2017).

In what follows, an explanation of the framework to understand and work through projects is outlined, according with PMBOK.

Projects comprise several key components, that interrelate to one another during the management of a project: Project Life Cycle, Project Phases, Phase Gate, Process Groups and Knowledge Areas, as shown in Figure 1.

The Project Life Cycle is the series of phases that a project passes through from its start to its completion. The phases may be sequential, iterative, or overlapping and projects can be mapped to the generic life cycle.

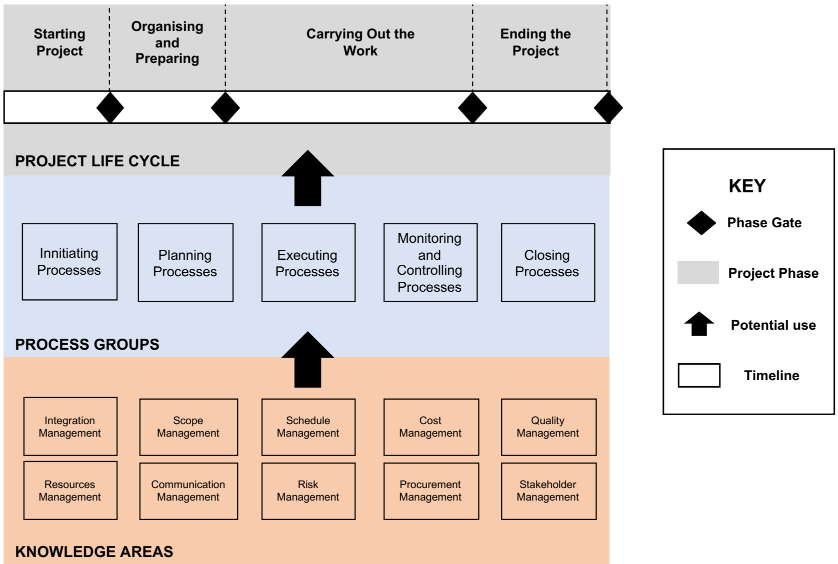


Figure 1 – Interrelationship of PMBOK guide key components in Projects

Source: Adapted from PMI (2017)

The Project Life Cycle is decomposed into Project Phases, where each one represents a collection of logically related project activities that culminates in the completion of one or more deliverables. There are generally one or more phases that are associated with the development of the product, service or result, which are called the development life cycle. These can be predictive, iterative, incremental, adaptive, or a hybrid model.

A Phase Gate, is held at the end of each Project Phase, representing the decision of continuation to the next phase, continuation to the next phase with modification, remain in the phase, repeat the phase or elements of it or end project. The management and execution of the series of PM activities is known as PM Processes. Every PM Process produces one or more outputs from one or more inputs by using appropriate PM and techniques. The output can be a deliverable or an outcome, which represents an end result of a process.

PM Processes Group is a logical grouping of PM processes to achieve specific project objectives. Process Groups are independent of Project Phases and are grouped in the five categories as follows:

- Initiating: processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.

- Planning: processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
- Executing: processes performed to complete the work defined in the project management plan to satisfy the project requirements.
- Monitoring and Controlling: processes performed to complete the work defined in the project management plan to satisfy the project requirements.
- Closing: processes performed to formally complete or close the project, phase, or contract.

Additionally, processes are also categorized by Knowledge Areas. A Knowledge Area is an identified area of PM defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques. Regardless of its interconnections, the Knowledge Areas are classified separately into 10 separate categories: Integration Management, Scope Management, Schedule Management, Cost Management, Quality Management, Resources Management, Communication Management, Risk Management, Procurement Management, Stakeholder Management.

The needs of a specific project may require one or more additional Knowledge Areas, meaning that 49 processes may apply to several different nature projects. Thus, it is through the project manager's ability to integrate the processes in these knowledge areas that makes it possible to achieve the desired project results.

2.4 Complexity in Project Management

Addressing complexity in Project Management has been under discussion in the literature. Scientific and technological progress has led to higher requirements on all dimensions of management, an important driver for the growing complexity (Wanqing, Zhang & Qin, 2018). On the other hand, the increasingly interconnected environments of organizations entail more challenging and burdensome processes of identifying the root causes of key variables and failures for project managers, accounting for a significant amount of complexity in PM (Papke-Shields, Beise & Quan, 2010).

The PMBOK links complexity within projects with the organization's system behaviour, human behaviour, and the uncertainty at work in the organization or its environment. System behaviour represents the interdependencies of components and systems, human behaviour represents the interplay between diverse individuals and groups, and, ambiguity represents uncertainty of emerging issues and lack of understanding or confusion.

In this context, characterized by increasing complexity and higher requirements, there has been a significant interest in the framework provided by the Systems Thinking approach. For Bakhshi, Ireland and Gorod (2016), the future success for project managers demands learning the past patterns of success and failure, and considering Systems Thinking tools to better understand these patterns and the links between complex factors. Other authors stress the important of learning effectively from past failures, Rodrigues and Bowers (1996) find more formal systemic analysis to be efficient in order to conduct learning from experiment exercises.

More importantly, as system complexity increases, many previously separate domains of knowledge become interconnected, for which the Systems Thinking approach becomes essential, according with Sheffield, Sankaran and Haslett (2012). For Arnold and Wade (2015), Systems Thinking is widely believed to be critical in handling the complexity facing the world in the upcoming decades. The following section of the Literature Review is focused on understanding the application of System Thinking to Project Management.

2.5 Systems Thinking and Project Management

Sankaran, Haslett and Sheffield (2010) observes that several journal papers published in the field of PM have been calling for the application of Systems Thinking. In addition to the complexity factor of projects that has been addressed, the literature proposes other important factors to bear in mind when making the case on the growing need to integrate new frameworks stemming from Systems Thinking (ST) into PM.

On the linkages between ST and PM, Sheffield proposes a quite straightforward connection. Drawing from Kim (1999) definition of a system "*any group of interacting, interrelated, or interdependent parts that form a complex and* *unified whole that has a specific purpose*", Sheffield argues that a project - the core value of a Project Manager's work - constitutes a system in itself. In fact, just like a system, a project is composed by interdependent parts that interact within and outside the defined boundaries. If we think, for example, of a project aimed at altering the set of tasks between two or more departments, the number of interactions and interrelated elements is far more complex than a typical production process and has close similarities to the systems studied in ST framework. Likewise, the specific purpose of the project is achieved through several tasks and processes, involving different stakeholders, just like a production process in a system. Maybe, even more important, is the striking resemblance to a system that is found in the always-changing atmosphere that characterizes a project, as put by the author: "*Project managers working on complex projects often state that they have experienced situations when everything seems to be going out of their control but the project finally settles down into a new state of equilibrium* (Syed & Sankaran, 2009)." Thus, the fact that projects constitute dynamic system in themselves is a key argument for the application of ST tools and methodologies.

In a case study conducted with the Peace Shield Air Defence System, in which system dynamics models were applied to a strategic project and its results were compared with similar projects, Lemétayer (2010) demonstrate that these ST tools greatly facilitated designing project schedules and resources, defining KPIs, risk assessment and performing lessons learned exercises. The authors attempt to explain the reasons behind the improvement in project performance with ST methodologies when compared to traditional tools, concluding that the dynamic complexity that defines projects – as it was explained above – requires methodologies that address this complexity. Furthermore, the researchers found that despite growing complexity in project development, traditional approaches:

- Assume projects to be static, which affects schedule and budget performance;
- Only allows for a separate analysis of functions and factors individually, when all are simultaneously fundamental; and
- Promote the perception that every project is unique, creating obstacles for systematic learning and knowledge transfers through projects.

In line with this perspective, Kapsali (2011) argues that the conventional project management approaches tend to underperform because projects are viewed as “islands” with closed boundaries and managed through prescribed formulas, which creates obstacles to see relevant connections and relationships outside the project boundaries and limiting flexibility and necessary deviations.

Additionally, in what regards complex projects, it is also important to highlight that in their nature they can be characterized as systems subject to high instability and unexpected changes. Kopczyński and Brzozowski (2015), underline this feature arguing that the precise and fixed planning associated with Traditional approaches in project management make them less effective to tackle high complexity.

Regarding the specific advantages of System Thinking applied to project Management, from the perspective of Emes and Griffiths (2018), outlined in a research paper sponsored by the Association for Project Management, the application of ST can have positive impact for complex projects in the following dimensions:

- Cost and schedule estimates improvement: the deterministic view that characterizes traditional linear thinking hinders the ability to anticipate unexpected events, additional tasks or rework that can arise when implementing new ideas or processes in a firm, which can significantly slow the process and increase the costs. Hence, since ST requires managers to look thoroughly at all the possible interactions between the elements involved in the project, it can enable project managers to foresee and manage possible bottlenecks;
- Final outcome enhancement: the broader and systemic view addressed by the ST methodologies allows managers to better understand and anticipate challenges in delivery or interface of the final product/solution implemented, increasing the value of the new solution; and
- Understanding stakeholders’ needs throughout the project cycle: since several ST tools require the manager to understand the system in place and its interactions with other systems, project managers can become

better equipped to understand the needs and constraints of all the stakeholders within and outside the boundaries of the system.

The positive impacts of applying this different framework in PM – outlined above – appear as especially significant to the initial phases of the project. According with Van Dyk (2002), while it is impossible to account for every possible disruption, ST allows managers to better understand and limit the project's vulnerability to unforeseen events that can emerge.

In the current entrepreneurial environment, the integration of ST methodologies in the managerial context may be further required, as projects involve more innovation or as innovation projects become more important. Kapsali (2011) explains that innovation projects have an intrinsic evolutionary and experimental nature, for which the ST framework proves to achieve more successful outcomes.

Empirical studies on this matter have demonstrated support for Kapsali's findings, Abreu and Urze (2016) applied ST tools to further aid the co-innovation process in a Case Study of Brisa's co-innovation network – Brisa is the largest operator of highways in Portugal. This study finds that Systems Thinking tools are effective in understanding the co-innovation networks (for both academic purposes and for the stakeholders involved). Consequently, Abreu and Urze details that tools such as *system archetypes* and *casual loop diagram* are applicable and efficient to better understand the co-innovation network and related processes in the context of Brisa's innovation efforts.

2.6 Systems Thinking in Project Management – Empirical applications

Despite the advantages outlined above and the unique benefits arising from ST in managing the complexity that characterises PM, surveys have found its application relatively limited. It is safe to acknowledge that implementing a methodology that proposes a shift in the way of thinking requires considerable effort. However, if the advantages outweigh the costs, a broader usage is to be expected.

In 2018, the Association for Project Management Research Fund conducted a survey on the usage of ST methodologies and tools in PM, covering different sectors and expertise in a series of interviews. In line with the literature, the authors of this survey highlight that "*Systems thinking is not widely practiced amongst project managers*", many respondents recognized that although some forms of ST were applied at least half of the time, its tools are not widely used in projects. Interestingly, the results demonstrate the ST is fostered and more widely applied in large projects, slightly greater for more experienced project managers and in sectors such as defence and aerospace. According with the survey, there is consensus amongst project managers regarding the effectiveness of the ST tools: respondents found rich pictures (65%), concept maps (59%), causal loop diagrams (58%) and soft systems methodology (52%) as very effective or extremely effective.

Given these findings, *what can explain the limited application of ST?* Interviewees agree that the level of awareness of these tools is still scarce as well as its additional value, which in turn, affects the support managers get when trying to apply these new procedures. Citing one respondent: "*Directors are more interested in the strategic view, and how what we are doing is going to deliver strategy*" and, it is "not strategic to the organization to use it [ST] in projects." These ideas seem to point to a higher focus on the results from the Directors' point of view, neglecting the processes. Another important obstacle underlined within the context of the defence sector (where its usage is greater) is the preconceived notion that ST is time consuming, which might entail delays on getting the product to market on time.

According with another author, the limited experience so far is another explanation for the fact that ST is being applied ad-hoc (Kapsali, 2011) .

Moreover, in another study, that also employed interviews to managers to understand how ST can be integrated within PM, the author finds that a more structured approach to use the techniques and tools of ST is required to ensure its benefits the project from start to finish (Van Dyk, 2002).

These empirical findings shed light on the limited use of ST methodologies in PM nowadays. More importantly, it highlights the obstacles encountered by project managers in the context of ST. In fact, it strikes as particularly relevant that some researchers find that ST has been applied ad-hoc and that a more structured approach is needed.

Following these observations on limitations or obstacles to ST application in Project Management, two key question arise: *Which type of projects should ST be applied to*? *ST methodologies complement existing PM methodologies or replace?*

Sheffield et al. (2012) argues that methodologies provided by ST are not to replace all the existing approaches, but rather to be applied in the specific context of complex projects. As shown in Figure 2, complex projects are characterized by a high number of interactions and high number of components of these projects. Thus, the high level of uncertainty associated with complex projects makes System Thinking a more effective methodology, whilst for the remaining types of projects traditional methodologies should be maintained for their efficiency.

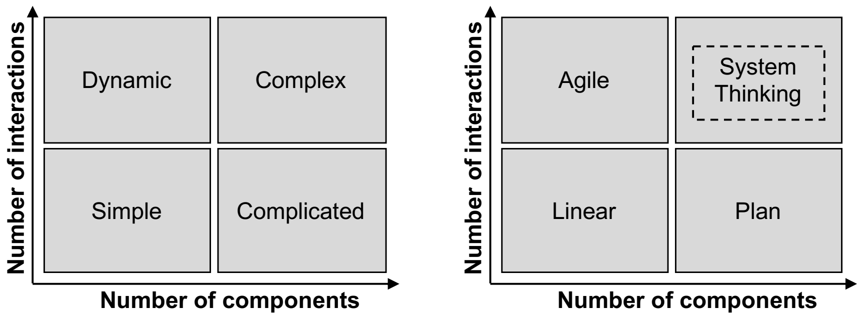


Figure 2 – Types of projects and Project Management Methodologies

Source: Adapted from Sheffield et al. (2012)

Kopczyński and Brzozowski (2015) also agree that ST is to be applied to complex projects, since ST enables managers to address problems of multi-project management in modern enterprises in dynamic environments. Additionally, it shifts the managers view from single project to a project portfolio-oriented approach. However, these authors opinions diverge from Sheffield, in the sense that they propose the transversal application of ST to all the existing methodologies.

In what follows, two methodologies of Project Management designed from the Systems Thinking concepts and specific tools are outlined: firstly, the one created by Sheffield et al. (2012), and secondly the methodology defined by Maani and Cavana (2007). These two methodologies were selected due to their relevance in the field as well as their detailed and complete features.

2.6.1 Project Management and Systems Thinking Methodology – (Sheffield, et al., 2012)

Sheffield's methodology, as per Figure 3, is structured with the purpose of providing the adequate guidelines for the on-going processes of problem-solving. Since it is a tool developed specifically for problem solving, it can be applied in the first and second stage of the standard life cycle, as defined by PMBOK, of a project (Van Dyk, 2002). Moreover, the fact that in complex projects problems tend to arise unexpectedly (unaccounted problems), this approach can also be applied in the third stage (implementation).

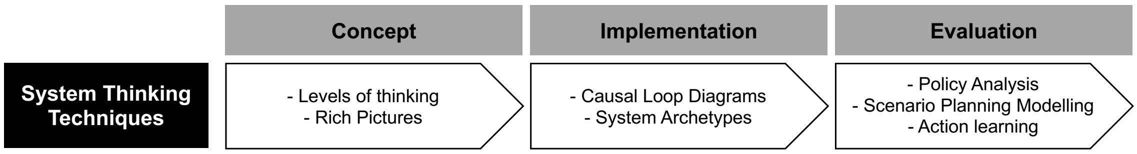


Figure 3 – System Thinking methodology

Source: Adapted from Sheffield et al. (2012)

For the Concept Phase, Sheffield's outlines two ST techniques to be applied: *Levels of Thinking* and *Rich Pictures*. *Levels of thinking* is a technique that structures the thinking process to understand the roots of the problem and its associated causes. This tool can be related with the *Iceberg Theory*, which demonstrates that we only see the superficial level and must explore the invisible levels that comprise patterns in order to fully understand and structure a problem. *Rich Pictures* is a tool used for the conception of the problem, enabling a more thorough understanding of the problem, how it affects and how it is viewed by the different individuals that take part in its system.

Secondly, for Implementation phase, project managers should apply *Causal Loop Diagrams* technique followed by the *System Archetypes* technique. The *Causal Loop Diagrams* technique consists in the process of depicting the interrelationship between variables within a system in order to identify open (positive) and closed cycles (negative containing reinforcing and balancing loop), the different relationships and cause and effect actions between the elements of the system and to understand patterns or bottlenecks. This technique can be considered as an improvement from the *Gantt Charts* tool, which details activities into a fixed and deterministic sequence that does not allow the manager to account for all the possible interactions between activities (Hitchins, 2003). Hence, this enhanced technique, the *Casual Loops Diagrams*, allows the managers to discover the root causes of the problem and leverages points that will allow to efficiently modify within the system.

Following the understanding of all relevant possible interactions and dynamics of the system, the *System Archetypes* technique enables the identification of common seeing patterns of behaviour in a system. They have regularly seen arrangements of cause and effect relationships between system parts and feedback loop that leads to similar observable outcomes over time. Each architype has a characteristic theme, storyline, pattern and potential for action being able to identify system architypes in various situations enables a deeper and quicker understanding of that system and can helps us design powerful interventions strategies.

Feedback loops uses arrows to show how parts of a system affect one another. Using this tool helps to smooth the focus away from linear cause and effect to seeing circular cause and effect. Often cause and effect relationships are described in a simply linear faction, as shown in Figure 4A, a cause creates an effect, and that is the end of the story. Casual loops on the other hand, as shown in Figure 4B, show us that the story doesn't end and continues. A problem affects the amount of action, which comes back around and affects the problem, which continues to affect the amount of action. Upon identification of potential causes for the ultimate effect within the system, each two elements relationship

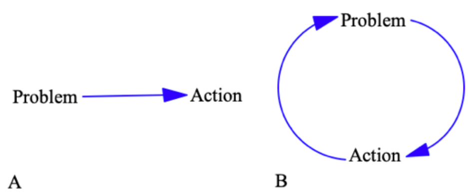


Figure 4 – Linear and Circular cause and effect lifecycle

Source: Self elaboration

are controlled by feedback loops. These loops can be classified as positive or negative relations, as shown in Figure 5. A "+" sign indicates that both elements change in the same direction or that the first element adds to the next. A "-" sign indicates that the elements change in opposite directions or that the first element subtracts from the next element. Considering simple and opposite relationships,

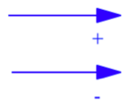


Figure 5 – Positive and Negative Loop

Source: Self elaboration

there exist two different loops that are classified according the way they change the system: reinforcing and balanced loops. On a reinforcing loop, feedback increases the impact of the change, because all elements being equal the elements continue to move in the same direction either rising of falling over time. As shown in Figure 6A, if employee performance goes up, his leader support behaviour goes up which causes employee performance to rise even higher. In contrast on the balancing loop, elements tend to neutralize the impact of change, because all elements being different the elements either oscillate or seek a goal. The story of the loop shown in Figure 6B describes how stress can go up and

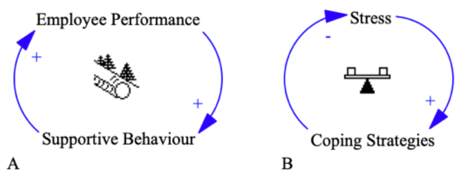


Figure 6 – Reinforcing and Balancing Loop

Source: Self elaboration

down as an oscillation, if the amount of stress goes up, the coping strategies to deal with that stress go up causing the amount of stress to go down, with the stress level down, coping strategies are reduced, thus allowing the stress level to go back up again. Additionally, feedback loops can have hash marks as shown in Figure 7, which represent a delay, a situation where it takes time before the effect plays out. Each delay has its own time duration which impacts when characteristics of relations become evident. Delay, reinforcing and balancing loops represent building blocks of constructing models and architypes.

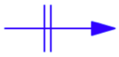
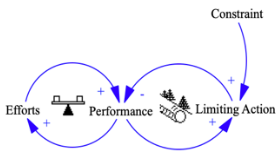
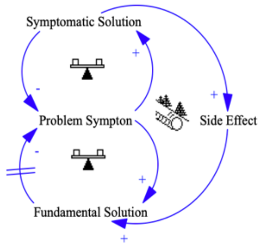
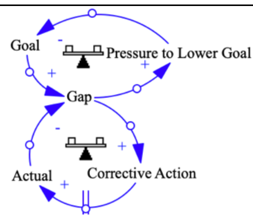
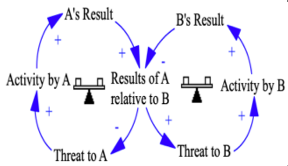


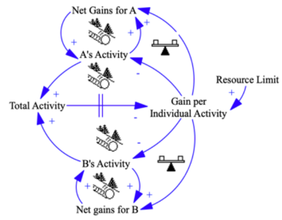
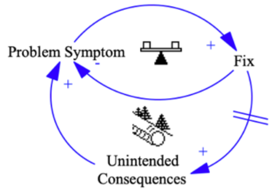
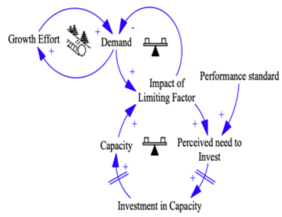
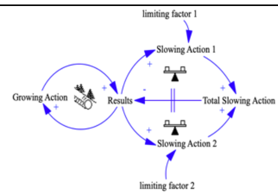
Figure 7 – Delay or Gap present on relation

Source: Self elaboration

Table I represents several examples of *Systemic Archityes* among Literature.

Table I – Systemic Archityes

Systemic Archityde	**Description**	**Structure**
Limits to Success	Archityde composed by a reinforced loop that creates conditions to grow and a loop that limits the amount of growth due to no adequate preparation to support growth, either because lack of capacity or skill. The limited constraint can degrade system state so much that the previous growth can be reverted and transformed into stagnation and even to decline.	
Shifting the Burden	Consists of two balancing loops, where both are trying to correct the same problem symptom and bring system back to balance. The above circle represents the quick fix, a symptomatic intervention, it often solves the problem symptom rapidly but only momentarily. The bottom circle which has a delay represents a more fundamental response to the problem although the effects of the latter normally will take longer to become evident, the fundamental solution will have an effective outcome.	
Drifting Goals	Represent a responsibility transfer structure in which the short-term solution involves allowing a fundamental long-term goal to decline, creating a vicious circle.	
Escalation	Describes a situation in which two people or organizations understand that their well-being depends on having a relative advantage over each other, when A feels threatened, responds aggressively, which will make B feel threatened and respond aggressively which will make A feel threatened, and so on. This model represents a competition between two parties that compete to achieve their goals by threaten themselves for the competition to end, by one of the parties to withdraw.	
Success to the Successful	Describes a dynamic where two parties require the same limited resources as one of them becomes more successful more resources are assigned, however the second one becomes less and less successful due to lacking resources. Problems arise if the competition is unproductive and interferes with the goals of the whole system, the two activities or agents might be decoupled, or they should receive a balanced amount of resources.	

Tragedy of Commons	Represent a situation where individuals use a commonly available but limited resource, based solely on their individual needs. Initially, they are rewarded for using it. However, with time they end up getting lower and lower returns, which makes them intensify their efforts. Finally, the resource ends up suffering significant reduction, wear or is totally used.	
Fixes that Fails	This structure show that our actions are usually driven to modify our state with respect to a short-term or long-term goal. Usually, long-term goals take more effort and time that short-term goals. In parallel, our performance indicators for short-term goal may be just symptoms of a problem that can be solved. When we focus on reducing the gap with respect to the short time, we are fixing only the symptom not the root cause issues. There may be exacerbated unintended consequences of solving symptoms problems, which include a false sense of progress, waste of valuable resources in improvements and the potential for intended consequences were fixing the symptoms without finding and fixing the real problem can generate larger or more acute problems.	
Growth and underinvestment	This architype come into operation when a company limits its own growth through underinvestment. That is, when companies build less capacity to meet the growing demand. This structure represents when a company does not reach its potential growth, despite being working in the best possible way. It is necessary to understand this structure so that companies know when to invest in order to reach greater productive capacity and do not expect their services to deteriorate.	
Accidental Adversaries	Reflects how opposition is created between groups that must and wish to collaborate. Each partner recognizes that they could support each other. However, when they take independent measures to improve their results, they focus more on their needs than those of their partners. Each partner's solution ends up being unintentionally harmful to the other.	
Attractiveness Principle	Similar to *Limits to Success* archetype but with multiple slowing actions. It is not only one activity which slows things down, multiple things may come in parallel to limit your growth. When things go bad, multiple things get attracted to that and both are going to affect the end results within a system.	

Source: Self elaboration

By analysing the problem through a common story found in the ST literature can better align the managers in finding the adequate solutions. Sankaran et al., (2010) states that the typical system archetypes found in projects are *Fixes that Fail, Shifting the Burden, and Tragedy of the Commons*.

For the third and last phase, Evaluation phase, Sheffield's proposes three techniques to apply. *Policy Analysis* technique that allows to enumerate possible policy options to solve a certain problem and choose the most efficient and practicable one. *Scenario Planning Modelling* technique that aims to explore possible future results from the scenarios originated with the solutions applied instead of forecasting outcomings of solutions applied, this technique enables to decrease risk associated to the solution taken. *Action Learning* technique is a tool that structures the process of exploring the lessons learned from the project, which generates individual, team and institutional value.

2.6.2 Project Management and Systems Thinking Methodology – Maani and Cavana (2007)

Maani and Cavana (2007) present another methodology for ST in PM which is illustrated in Figure 8. In general terms, this methodology is very similar to Sheffield's, however it presents five Phases with new techniques and establishes tools and processes more attune for implementation.

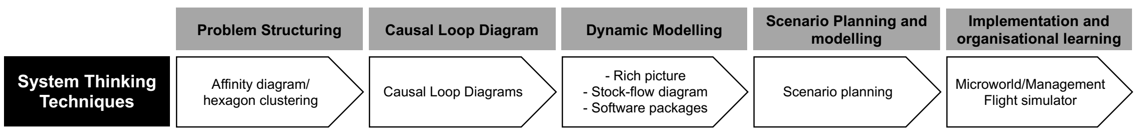


Figure 8 – ST methodology

Source: Adapted from Maani and Cavana (2007)

Firstly, in Problem Structuring phase, the authors introduce the *Affinity Diagram* and *Hexagon Clustering* technique that helps to organize a large number of ideas into their natural relationships.

Secondly, in the Dynamic Modelling phase, these authors also introduce into this methodology another important technique, *Stock-flow Diagram*. This technique can be understood as a more complex and rich view of a system when compared with *Casual Loop Diagrams* or as the following step to this latter model. The novelty of *Stock-flow Diagrams* in depicting a richer view of a system is that they require a distinction between flow and stock variables within a system: that is, stock variables which will continue to persist as they are accumulations, and flow variables which would disappear if the system were to stop or suffer from a bottleneck. Additionally, to the richer view it provides, this tool enables managers to think more thoroughly in each variable of the system and their relationships, as well as uncovering underlying or overlooked variables not accounted for required to make the flows and stocks match. *Software's Packages* that allows to perform computer simulations are recommended to put in practice since will reproduce a system behaviour and will help to increase projects quality and problem solving.

Lastly, in Implementation and Organizational Learning phase, these authors introduce the *Microworld/ Management Flight Simulator* technique. This technique allows project managers (experienced or not) to access to a project simulation model. In this simulation a user has several choices (run or set up a model), change values, learning to control a system by playing. This technique increases the learning environment around PM, as managers make decisions for the same problem and in the same originated environment.

3. CASE STUDY

The present study relates with the application of Systems Thinking within the Project Management field. The aim of this study is to understand how ST tools enable the understanding and conceptualization of a problem from the viewpoint of PM, through a case study related with an IT development project. In this specific case study, the main research question is to understand the significant completion failure of the project, with several deadline delays which originated costs for the company.

In the following sections the project is described as well as the timeline, tasks completed and the visible failures and delivery delays. Following this description, the methodology and specific ST tools to be applied are outlined.

3.1 Project Description

The Project main goal is to deliver a new version of a Repository System (RS) for a Multinational institution, that stores all contracts between the different service providers. More specifically, this system consists in a tool to archive celebrated contracts between, representing a global single harmonized contracts database designed to manage the internal contracts of all activities within the institution.

The contract is the formalized agreement between a service provider and service recipient, under which the provider provides to the beneficiary agreed services in accordance with agreed performance levels. The contract includes identification of parties, a description of services and their frequency, parties' responsibilities, key performance indicators, invoicing details, governance and escalation details, Local Regulation clauses and contingency plans associated in case of no service.

The main characteristics of the current Repository System (RS1), are the following:

- Stores active and signed contracts for a Multinational firm covering all contracts from five different regions: Asian Pacific, Europe Middle East and Africa, and North America.

- Helps to create accurate cartography of services exchanged between different business lines within Institution.
- Allows for supervision & control of smart sourced services, internal analysis and investigations on internal contracts.
- Available anytime and by all users from all business lines, functions, within different entities inside the Institution across the world.
- System enables the supervision of all active contracts and its compliance with Local Regulation – consisting a crucial working tool for the Legal department of the Multinational.
- System allows contracts customization and variable editing according to necessities.
- Workflow approach by worldwide stakeholders that contribute to an efficient dynamic drafting and review of contracts workflow.
- Reporting functionality available to extract reports to have full visibility on contracts within system and use of metadata to produce activity and process mapping.

This system is managed by the organization's Change Management department. The main responsibility of the team allocated to RS1 is to ensure the system's full functionality on both technical and operational aspects, namely access and review of the repository guidelines and procedures, understand and resolve possible IT issues, provide user guides and prompt support for all end-users, manage the access policy of the database for the several teams/regions. The team represents the first line of contact for all the stakeholders involved: which implies coordinating the Legal team (to ensure Legal compliance), the IT team for operational support and all the teams from the organization that are directly responsible for the execution of the contracts.

Furthermore, the team produces global, regional or local key performance indicators reports, requested by the organizations' upper management with recommendation.

For a Multinational Institution, this RS constitutes a vital management tool, as an accessible and constantly updated cartography of all the required production processes and the full description of task allocation. The Multinational dimension is especially relevant since the fragmentation of the work processes across different regions of the world that characterizes its workflow requires a complex management tool that enables the depiction of the different tasks, teams and its stakeholders. Moreover, this system enables the organization to maintain a valuable database on the Legal requirements per developed task and respective location in the world. On a different note, this system allows for performance evaluation, tracking and achievement harmonization for the different teams.

3.2 Project Problem Statement

The project of developing a new RS for the organization was initiated when a change in external regulatory standards implied the overhaul of the Contract Template: a central element for the system. In order to comply with the new regulatory standards, a new Contract Template had to be executed - Contract 1 (CT1) is replaced by Contract 2 (CT2) and a new RS has to be put in place (RS2), as well as new guidelines for all stakeholders.

Figure 9, depicted below, illustrates the phases of the project and the timeline for its completion.

The initial estimated time of delivery for this project was one year: that is the completion of the new Contract Template and the development and implementation of the new RS. The allocated Project Manager was the person responsible at the time for the functional support for end-users of RS1 – this employee, referred as EPM1 - was contracted via outsourcing, thus its time within the organization was limited. EPM1 framed, designed and assessed the project, concluding the first project phase. However, due to the external resource's contract term, EPM1 did not continue in the project after the initial three months, a new external resource was contracted for nine months and allocated as Project Manager, denominated EPM2. EPM2, planned, organized and prepared project and moved to implementation phase.

Within the first two years of the project, CT2 was published, but RS2 continued under development. Since RS2 was not delivered at the intended date, the Change Management Team allowed for CT2 to be put in place in RS1. Although not the ideal situation it allowed for the firms' compliance with regulatory standards.

The EPM2's contract was extended by three months in order to conclude project. However, the new deadline was not met once again, and EPM2's contract finished while RS2 was still under development. During the second year of the project, a third external resource was allocated as Project Manager of the project, denominated as EPM3, with a new deadline of nine months in order to conclude the implementation and close the RS2 project.

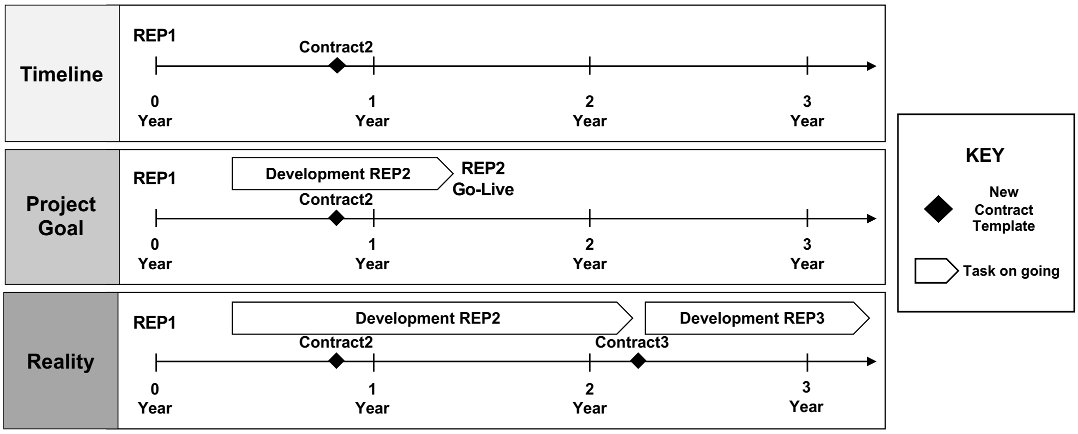


Figure 9 – Project Timeline Preview VS Reality

Source: Self elaboration

By the end of the new nine-month mark, the system was not yet ready to be put on production. EPM3's contract was extended for more three months in order to conclude project. After two and half year, the system was fully developed, and the project moved to the testing phase in order to identify any defects before the final production phase.

It is in this critical project phase that a new setback arises, the regulatory standards change once again, creating the need to develop a new Contract Template – Contract 3 (CT3) is released. Contrary to CT2, there was no preview of this new Contract Template to appear. Following the established procedures, a new RS, this time RS3, had to be developed in order to be compliant with the new contract template and regulation associated.

The Project Manager - EPM3 - reframed the project and gathered the new requirements and specifications to be added. A new extension of three months to the EPM3's contract was undertaken as the new deadline for project completion.

Once more, the project deadline was not met: the new RS3 was designed but the performance tests had not yet been performed.

At this stage, a new Project Manager was needed. It was decided to allocate an internal resource, denominated IPM4. This resource had specific knowledge regarding the Contract Template functionality and was performing functional support to RS1 for one and half year.

IPM4 reframed the project and realized that all project documentation and engagement was low quality or non-existent. A priority for IPM4's work was to structure and compile the necessary information for the project: creation of a project log with all tasks, dependencies and criticalities in order to follow-up, a business requirements database with types of requirements and functionalities, define the tasks and procedures to perform training, videos, user guide, access policy and FAQs documents to all end-users for RS3.

Currently, at the time of the development of this work project, IPM4 managed to complete all project stages. The new RS will replace the former one RS1 in the upcoming months. In summary, the project was developed in the course of three years, with an expected delivery date of one year, making up for a two-year delay with five target date delays.

From IPM4's standpoint, the main focus has been to conclude the project successfully. However, when joining a project in progress with clear setbacks that span for the course of two years, understanding the obstacles and errors involved has become a critical aspect of the work process.

4. METHODOLOGY

The conceptual model applied in this research is adapted from a ST model, developed by the Association for Project Management, that outlines in a structured process the logical questions and thought processes to accurately understand a problem and its root causes. For each step one or more ST tools are proposed. This conceptual model is depicted in Figure 10.

In the first step, *what is happening* - the visible events and patterns are identified and structured. For this stage, the ST technique applied is proposed by Sheffield in the concept phase, *Levels of Thinking*, by applying the *Iceberg Theory*. The following step aims to identify the stakeholders and elements, through the *Actor Map* tool. These two steps enable the third step: the identification and understanding of casual relationships within the project. The *Casual Loop Diagram* technique is applied to build a visual depiction that will reveal all internal and external stakeholders network relations that influence project and how they interrelate. The fourth step applies an important ST tool: The *System Architypes*. Through this technique, the behaviours and trends of the system will be revealed, leading us to understand and identify broader causes and relationships within the system. The final step is to develop hypotheses for the problem's causes.

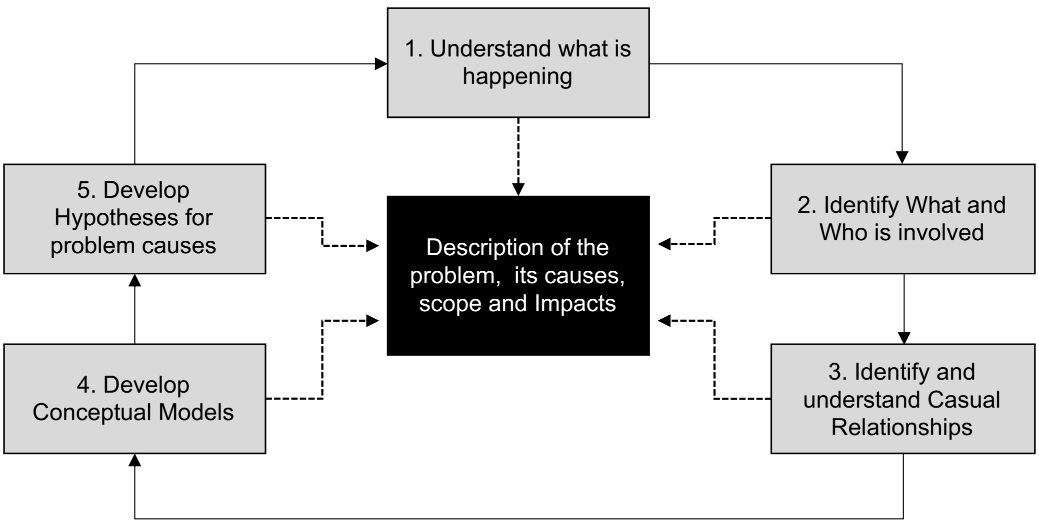


Figure 10 – ST application to identify and understand a problem

Source: Adapted from APM Systems Thinking SIG (2018)

4.1 Understand what is happening

4.1.1 Events

In order to *Understand what is happening* it was applied Sheffield's ST technique *Levels of thinking* using *Iceberg model*.

From the project description, the visible setbacks are the following:

- Work incomplete on time with a gap of almost two years between the first deadline and current days, creating necessarily an overbudget for the department and inefficiencies for the company as a whole;

- Involved three different external Project Managers contract resources (one resource with one extension of three months and one resource had two extensions of three months representing six months on total) that didn't conclude project.

- Project and work timeline from end to end weren't met, involving more external resource contracts and a budget increase.

- At the time of project development (implementation phase) a new need arose (CT3) and put into jeopardy all RS2 work.

- There was no project log in place, which is an essential aspect for any project.

4.1.2 Patterns of Behaviour

The principal patterns that are visible are: the several deadline extensions made to project final date, the frequent change in the Project Manager and the frequent resort to outsourcing contracts. Table II depicts these patterns.

Table II – Project Patterns

Project Phase	Project Accountability	Project Manager	Time allocated Project	Reason for failure
Start Project	Head of Department 1	Outsourcing – EPM1	3 months	Not enough time
Organize and Planning; Implementation	Head of Department 1	Outsourcing – EPM1	12 months (+3 months extension)	Unknown
Implementation	Head of Department 1	Outsourcing – EPM1	15 months (+ 6 months extension)	Unknown
Implementation	Head of Department 2	Insourcing – IPM4	-	-

Source: Self elaboration

4.1.3 System Structures

Following the *Levels of Thinking* methodology, it is important to understand the causes and relationships in the identified patterns.

Pattern 1: Four deadline extensions

One of the deadline extensions can be accounted for the second change in Regulation standards, impacting the design of a new Contract Template and a new RS layout. Considering the nature of this project and its purpose, if a risk assessment exercise had been undertaken in the preparation phase of this projects, the Regulation changes could have been predicted and its impact could have been minimized. Hence, one first root cause is identified: lack of proper risk assessment in the first stage of the project.

However, this only explains one of the deadline delays. The other repeated deadlines extensions, three in total, have the following patterns and relationships: outsourcing of project management, constant change in Project Managers and lack of backlog and project cartography that would be fundamental in a project that spans for more than two years with frequent changes in its main PM. Another root cause that can be identified is the constant undervaluation of the time expected to complete the project and an inaccurate assessment of its complexity.

Finally, it is important to mention another cause for these delays that relates to the other patterns identified: the fact that the project lacked an organized and structured cartography (decisions and conclusions in each phase, main actors involved) in a project that changed frequently Project Manager also explains the need for more time to complete the project than initially projected.

Pattern 2: Frequent change in Project Manager

As explained before in the project background, the fact that the first Project Managers in this project were outsourced implied changes in the central actors for this project.

However, the fact that these contracts were frequently defined for a time period that proved to be insufficient for the project completion reveals that either the project complexity and necessary tasks were ineffectively estimated or that the Project Managers involved didn’t meet the expectations.

Pattern 3: Several Outsourcing Contracts

As it is known, outsourcing decisions can be explained by different organizational factors that will not be explained in this case study. However, it is possible to conclude that the complexity of the project and the number of stakeholders involved within the firm (the Project Manager had to contact frequently several teams within the organization) were underestimated. Currently, it is observable that having as a Project Manager a member that belongs to the organization, with functional knowledge in the system being developed, is better equipped to carry this project.

To summarize the patterns and its causes, it is found that the three patterns identified, and its causes are highly interrelated. The main issue that arises from the analysis of the three patterns is that the complexity, tasks and time required for the project appear to be underestimated – which can be summarized as an inaccurate conceptualization in the first stages of the project. The problem in the first stage of project is also visible from the insufficient risk assessment conducted in the project, that didn't allow to consider possible new changes in external regulatory standards. Moreover, the contracts celebrated with the outsourced Project Manager appear to lack important project guidelines, such as keeping an updated cartography of the decisions and steps made through the project to ease in the case of change in PM.

4.1.4 Mental models

The last step of the *Levels of Thinking* methodology relates to the mental models and assumptions that are believed to originate in the system.

The good beliefs are that the project has to be delivered and concluded quickly; end-users need system as soon as possible in order to be compliant with Regulation, defined as one year of project. The bad beliefs that seem to appear are that the Head of Department (HD) prefers to take more time and deliver than to assume projects' failure, in order to reframe it or acknowledge that one year is not enough for project completion.

4.2 – Identify What and Who is involved

The next step in this methodology is to identify the actors and elements involved, and how their specific relationships.

Table III describes all the stakeholders of the project and tool end-users and their respective incentives. Developing this mental map enables the understanding of the actors who may influence the project directly.

Table III – Stakeholders Incentive Mapping

Stakeholder	Incentive
Sponsor	REP2 /REP3 to be implement and close project.
Project Manager	REP2 /REP3 to be implement and close project with all documentation and proper management.
IT	Build tool and deliver.
Project Stakeholders	Give their contribution to the project and REP2/REP3 to be delivered as soon as possible.
Region 1, 2 and 3	REP2/REP3 to be ready to use as soon as possible, secure system that protects all contracts (confidentiality), system with all SLAs from Institution, all SLAs always up to date, Contract stakeholders with ability to change autonomously.
Legal	Ensure system is compliant with Contract3 demand by external Regulator.
Contract Teams	REP2/REP3 to be ready to use as soon as possible, secure system that protects all contracts (confidentiality), system with all SLAs from Institution, all SLAs always up to date, Contract stakeholders with ability to change autonomously.
Business Teams	System that gives minimum burden and workload as possible; accessible any time, editable any time, pass workload to Contract Teams.
Operational Manager	Ensure that contract information match Business Teams reality.
Functions	Ensure that contract information match assessment previously performed on project.
Signatories	Ensure that all activities have contracts in place.
Audit	Accessible any time, ensure that contract is dully performed and match currently activity on place.
Monitoring and Performance Teams	Accessible any time, ensure that KPIs contract are established and being performed by Business Teams.
Local Regulation	Provides additional criteria (depending on location) to be add to contract.
European Regulation	Provides all standards to be met.

Source: Self elaboration

Table III serves as a core tool to develop the *Actor Map*. The visual depiction is shown in Figure 11, where we can identify the relationships between project stakeholders and system end-users: side A represents involved project stakeholders and side B represents end-users of the current system available and future end-users of system new version under development.

Within side A we can find:

- Sponsor: the main actor responsible for the full supervision of the project, keeping track of the budget and providing validations, adjustments and guidance considering Project Manager feedback.
- Project Manager: responsible for planning, executing, monitoring, controlling project activities by ensuring that project is on time and budget. Acts as coordinator for all business resources within project and centralizes communication between Regions and IT.

- Region 1, 2 and 3 represent end-users from Asian Pacific, Europe Middle East and Africa, and North America and provide functional requirements.
- Legal team: provides Regulation requirements needed and validation of regulatory requirements and is the Contract Template issuer.
- IT: does the coordination of all IT resource working on project development. Centralizes communication between Project team and IT, provides tests guidelines for end-users, develops requirements and enhancements to system.

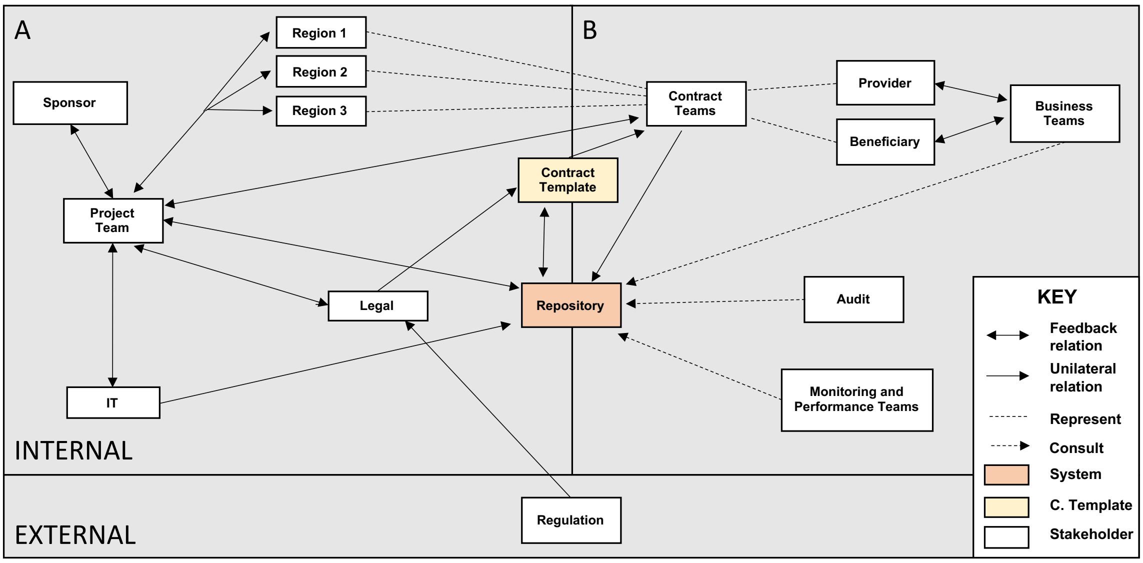


Figure 11 – Actor Map

Source: Self elaboration

Within B side we find:

- Contract teams: represent provider and beneficiary, they are accountable for the submission of Contracts to signature and insert Contracts into RS1. They liaise with Business teams to discuss and have information to include information under Contracts.
- Business, Audit and Monitoring & Performance teams: consult RS1 in order to have information regarding Contracts that are under screening.

The external player influencing internal environment is Regulation, which imposes standards that Legal team has to apply to Contract Template and communicates to Contract teams and Project Manager.

It is important to note that the crucial player of this diagram is the Project Manager in both sides of diagram. On one hand, this actor is the main stakeholder of the RS under development. On the other hand, interacts and communicates with end-users.

4.3 – Identify and understand Casual Relationships

Casual Loop diagrams constitute an important tool in ST methodologies, as they structure and help to identify the important relationships and challenges within the project. The *Casual Loop Diagram* built to depict this project and its main interactions is shown in Figure 12. It's critical to mention that Figure 12 was built with a specific software to create Causal Loop Diagrams called *Vensim*.

From this mental framework, it is understood that there are four important areas of the project: System Development (represented in brown), System Management (represented in purple), Employee Productivity (represented in orange) and System Maintenance (represented in green).

System Development constitutes the set of variables and relationships that are related with the operational tasks of the developing the RS2/3. We find that every time there is a customer requirement, there are associated increases in the line of work (product scope, architecture design) which in turn affects the project duration, productivity and costs. Consequently, this relationship originates a feedback in the System Management area (which represents the variables related with the governance around the project). Disruptions in System Development that impact directly project schedule, additional tasks and performance capacity have a negative impact in the System Development cycle element.

Employee Productivity represents a negative feedback that reflects when a task falls behind schedule or if there is an essential customer requirement. Upper management will orient workers to either work overtime or delay other tasks so that the schedule is met.

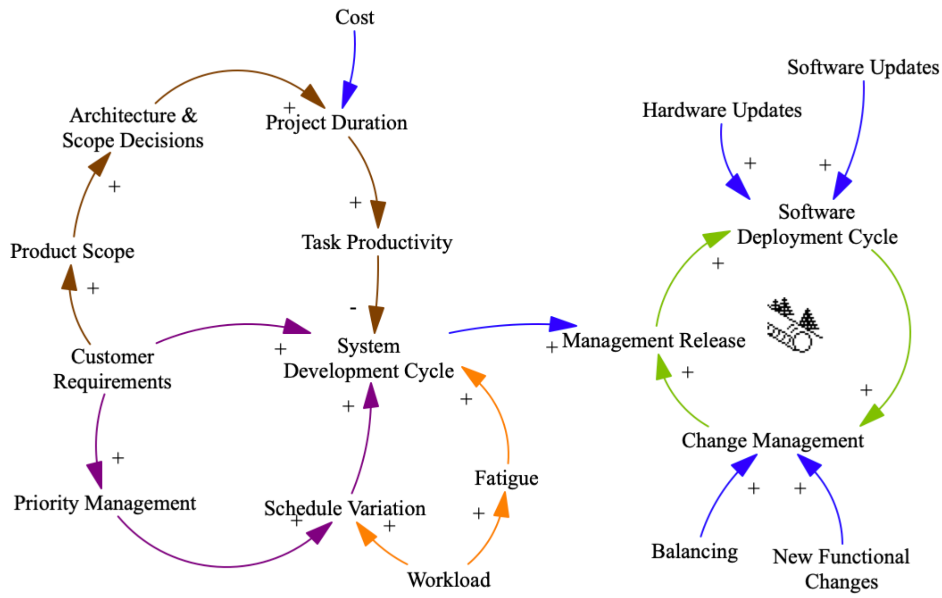


Figure 12 – Casual Loop Diagram

Source: Self elaboration

The System Maintenance represents a reinforcing loop that depicts the post development maintenance activities that involve deploying the software to meet the customer business requirements identified. Critical to point that System Maintenance area represents the unique loop within this system.

4.4 – Develop Conceptual Models

The *Shifting the Burden* architype application to the previous Causal Loop Diagram was developed using Vensim software and is shown in Figure 13.

The selection of a Project Manager for this project, determined by the Head of Department 1 (HD1), through external contracts is one of the main disruptions throughout the project lifecycle. Contracting EPMs instead of an IPM originated the following direct costs: cost increase, training demand for each EPM and the subsequent increase of project duration (two years delay). However, this management decision produced more impactful costs in the long run for the organization in what regards the crucial continuous improvement of this IT Management Tool – RS. Having disregarded the role of PM to external sources which frequently changed originated the loss of functional knowledge and expertise regarding RS and Contract functionality, reflected in the lack of project documentation, business requirements description, quality of communication

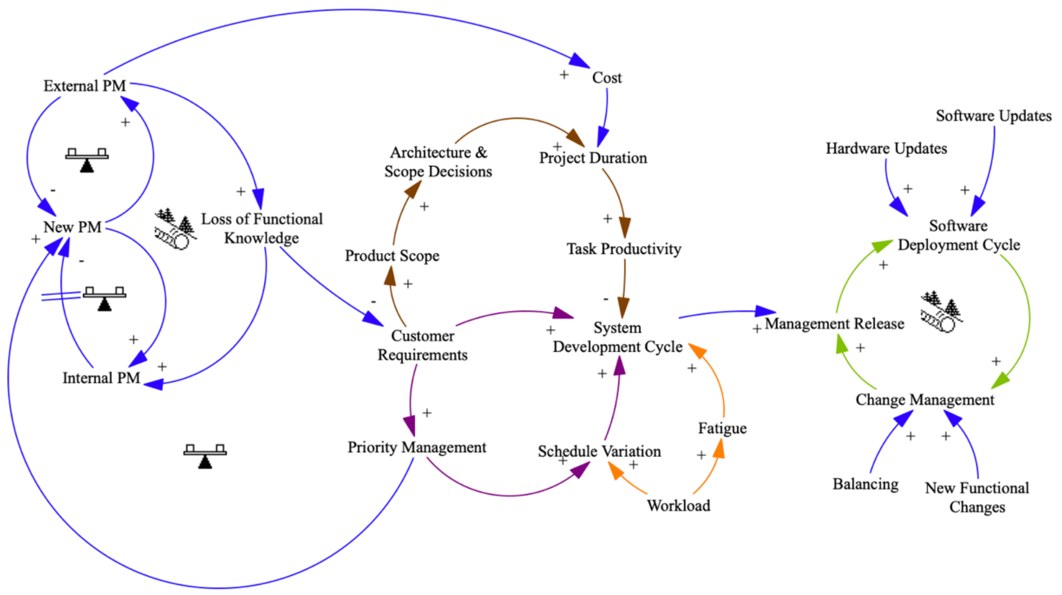


Figure 13 – Casual Loop Diagram with System Architype

Source: Self elaboration

from EPM to EPM, insufficient risk assessment analysis and poor stakeholder's engagement.

Therefore, this disruption can be better explained by the *Shift the Burden* architype, since this decision represents a quick solution with not only negative direct effects but especially critical side effects with long term costs.

As was previously noted, after the almost two-year delay, the Head of Department 2 understood the implications of this management decision and decided to allocate an IPM. This decision can solve the *Shift the Burden* issue in two critical aspects.

Firstly, the IPM selected had functional knowledge expertise on RS1 and Contracts, enabling better risk assessment and evaluation of the project's complexity and demands.

Secondly, the selection of an IPM aligns the incentives of the upper management with the incentives from the Project Manager itself, since the conclusion of the work is not related with a contract with a fixed term defined externally but with the conclusion of the project itself.

4.5– Develop Hypotheses for problem causes

The application of the *System Architypes* helps to reveal the behaviour adopted by HD1 regarding Project Manager recruitment position. Taking this into account, the following hypotheses were developed:

- HD1 believes symptomatic solution application will be effective to answer upper management demands by contracting an external Project Manager three times rather than an Internal (fundamental solution) and by extending the deadline three times rather than evaluate past failure.
- HD1 believes functional knowledge will be built and prevail. HD1 didn't calculate that the frequent change in PM originated loss of expertise and noticeable disregard for the importance of project documentation.
- HD1 underestimates the complexity of this project and the need of cross-staffing. Where the Actor Map and Casual Loop Diagram technique demonstrate the complex relationships of this project.
- HD1 didn't consider the important of being involved on decision-making.

5. CONCLUSIONS

5.1 – Main Conclusions

The main goal of the present work was to study if System Thinking techniques may be applied successfully to understand problems arising in management projects (namely transformation projects), in order to understand if System Thinking has a positive and added value in projects problem-solving.

The ST methodologies and techniques applied derived from Sheffield and APM. The main findings from this case study can be described as follows:

The application of ST techniques allowed the exploration of new perspectives and scenarios that had not been considered before (through the traditional methodology applied) as well as the identification of all project's risks and critical impact dependencies.

Furthermore, the holistic approach that characterizes ST provides efficient problem analysis tools that enable a Project Manager to understand the big picture without disregarding critical aspects, alternative scenarios and possible risks. ST techniques also add significant value in complex projects since the identification of potential risks and a more complete overview of possible bottleneck points allows the Project Manager to reach solutions for an organization with impacts on the both short and long term. From the organization's point of view, this case study also reveals that the ST approach allows managers to look at projects/problems and its impact on the whole firm providing more efficient solutions; whilst traditional techniques tend to focus the view on a specific department, team or goal.

Therefore, from this case study we find that the ST approach allows Project Managers to improve the exercise of problem conception, make better decisions that benefit the firm as whole and decrease the appearance of bottlenecks and risks (allowing for cost avoidance throughout the project).

As a Project Manager with experience work in PMBOK methodologies in several projects, it is important to note that at first glance ST techniques require more time to be spent in the first phases of the project (problem solving and project conception) than the traditional approach.

From a cost-benefit perspective, considering the significant positive impact of these tools as well as the time required to execute them, the case for applying all the techniques as in this case study is to be considered for complex projects. For projects with a lower degree of complexity (depending on the number of teams, actors, incentives and elements), ST techniques should not be disregarded but instead selected to complement traditional methodologies. Through this case study, *Actor Map* and the *Casual Loop Diagram* tools were found to be more efficient than traditional methods to identify risks and root causes for the project. Additionally, these two tools allowed the Project Manager to better align the incentives from the stakeholders of the project, which is key for a transformation project's success.

5.2 – Limitations and Future Research

During the development of this Final Master's Thesis some difficulties were encountered. Firstly, System Thinking with Project Management is a relatively new topic within Portuguese academic literature, making the number of studies scarce.

Secondly, the present study is a qualitative approach and only previews how system evolved globally. Aligned with this, a future research recommendation is to use a software like *Vensim,* which allows to analyse more thoroughly the systems that composes a system, create a simulation and preview system behaviour in the future.

Furthermore, for future research, an important contribution would be to apply traditional methodologies alongside ST methodologies in all phases of the project to understand and compare the different outputs in terms of decision making as well as to make an accurate assessment of the added value of this alternative approach (through a cost-benefit analysis).

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