Pós-Graduação em Ciência da Computação

A Substantive Theory of Decision-Making in Software Project Management

by

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Resumo

Contexto: No gerenciamento de projetos de software, o processo de tomada de decisão refere-se a um conjunto complexo de tarefas baseadas, principalmente, nas relações humanas e no conhecimento e background de cada indivíduo. Os fatores que afetam as decisões dos gerentes de projeto de software (GPs), bem como as suas consequências potenciais necessitam de atenção uma vez que atrasos e falhas de projeto estão relacionados a uma série de más decisões. **Objetivos**: Entender como os GPs tomam decisões com base em como eles interpretam suas experiências no ambiente de trabalho. Além disso, pretende-se identificar os antecedentes, moderadores e consequências dessas decisões para aumentar a eficácia no gerenciamento de projetos. **Método**: Primeiramente foi realizado um estudo exploratório com base em entrevistas semi-estruturadas com GPs de uma organização governamental brasileira de grande porte e de uma organização privada portuguesa de pequeno porte para analisar os fatores causais dos vieses cognitivos dos GPs e como estes lidam com eles, incluindo técnicas e as ferramentas utilizadas para minimizar os efeitos adversos dos vieses cognitivos. Os resultados iniciais sugeriram uma compreensão mais fundamentada dos mecanismos de tomada de decisão. Dessa forma, um protocolo mais amplo de pesquisa baseado em entrevistas semi-estruturadas foi realizado com GPs de uma organização governamental e de uma organização privada, ambas brasileiras e de grande porte. Foram realizadas entrevistas com engenheiros de software e gerentes de escritório de projetos para triangular os dados, que foram analisados usando técnicas de teoria fundamentada. Também foram utilizados dados de observações, análise de documentos e estudos selecionados a partir de uma revisão sistemática da literatura. **Resultados**: Verificou-se que a tomada de decisão no gerenciamento de projetos de software é baseada no compartilhamento de conhecimento em que o gerente de projetos de software atua como um facilitador. Este fenômeno é influenciado por fatores individuais, como experiência, conhecimento, estilo de liderança, e habilidades, e por fatores situacionais, tais como a autonomia, complexidade da tarefa, e competência técnica dos membros de equipe. **Conclusões**: Devido à incerteza e dinamismo inerente aos projetos de software, os GPs concentram-se em agir, monitorar e ajustar as decisões com base em argumentos. Além disso, o envolvimento dos membros da equipe na tomada de decisão visa minimizar o arrependimento de decisões e influência de vieses cognitivos por parte dos GPs, bem como maximizar o comprometimento dos membros da equipe.

Palavras-chave: Gerenciamento de Projetos de Software. Tomada de Decisão Naturalista. Engenharia de Software Empírica.

Abstract

Background: In software project management, the decision-making process is a complex set of tasks mainly based on human relations, individual knowledge, and cultural background. The factors that affect the decisions of Software Project Managers (SPMs), as well as their potential consequences, require attention because project delays and failures might be related to a series of poor decisions. **Aims:** To understand how SPMs make decisions based on how they interpret their experiences in the workplace. Further, to identify antecedents, moderators and consequences of those decisions to increase the effectiveness of project management. **Method:** Firstly, an exploratory study based on semi-structured interviews was conducted with SPMs from a large Brazilian governmental organization and from a small Portuguese private organization to shed light on the causal factors of SPMs' cognitive biases and how they deal with them, including techniques and tools they used to minimize the cognitive biases' adverse effects. The initial findings suggested that we needed a more grounded understanding of the mechanisms of decision-making. Thus, a broader research protocol based on semi-structured interviews was carried out with SPMs within a large Brazilian governmental organization and a large Brazilian private organization. We also conducted interviews with software engineers and PMO managers to triangulate the data, which was analyzed using techniques from grounded theory. Data from observations, document analysis and selected studies from a systematic literature review were also used. **Results:** We found that decision-making in software project management is based on knowledge sharing in which the SPM acts as a facilitator. This phenomenon is influenced by individual factors, such as experience, knowledge, leadership style, and skills, and by situational factors such as the autonomy of the SPM, task complexity and team members' technical competence. **Conclusions:** Due to the uncertainty and dynamism inherent to software projects, the SPMs focus on making, monitoring and adjusting decisions in an argument-driven way. Also, the involvement of the team members in decision-making aims to minimize the SPM's decision regret and cognitive biases as well as to maximize the team member's commitment.

Keywords: Software Project Management. Naturalistic Decision-Making. Empirical Software Engineering.

Acronyms

AHP	Analytic Hierarchy Process
CMMI	Capability Maturity Model Integration
CoP	Community of Practice
CSM	Certified Scrum Master
DAR	Decision Analysis and Resolution
GDMS	General Decision-Making Style
ICB3	IPMA Competence Baseline
IPMA	International Project Management Association
MACBETH	Measuring Attractiveness by a Categorical Based Evaluation Technique
MCDA	Multiple-Criteria Decision Analysis
MPS.Br	Melhoria de Processo do Software Brasileiro
NDM	Naturalistic Decision Making
PMBOK	Project Management Body of Knowledge
PMCD	Project Management Competency Development Framework
PMI	Project Management Institute
PMO	Project Management Office
PMP	Project Management Professional
SCRUM	Scrum is the name of the agile methodology, it is not an acronym
SLR	Systematic Literature Review
SPM	Software Project Manager

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Summary

1 Introduction

While organizations are permanent structures that emphasize functional arrangement, projects are temporary endeavors that are predicated on a deadline and the ultimate delivery of artifacts, products, services or quantified business values or benefits (LUNDIN and SÖDERHOLM, 1995). The temporary nature of projects and their deadline driven schedules require a decision-making process that lies at the core of the project processes to ensure that they are executed smoothly. Compared to organizations which are permanent structures and have routines, projects are temporary by nature and their implementation requires creative actions, practitioner's experience, and the ability to apply knowledge to development problems.

Despite the efforts to define recognized standards, methods, and processes for project management, we must recognize we are not dealing with an exact science following given laws or established rules. It is, rather, a complex set of tasks largely based on human relations and the specific knowledge, experiences, character, observation, and cultural background of each individual (HOGBERG and ADAMSSON, 1983).

The relevance of conventional approaches to the practice of project management, of the body of knowledge that governs it, and of the criteria for project success, has been contested in recent years by both practitioners and academics (CLARKE, 2010; SMALL and WALKER, 2010; LEYBOURNE, 2010; MCLEOD, DOOLIN, and MACDONELL, 2012). A total of 6 overarching categories emerged from a structured review of the rethinking project management (RPM) literature conducted by SVEJVIG and ANDERSEN (2015): contextualization, social and political aspects, rethinking practice, complexity and uncertainty, actuality of projects and broader conceptualization. These categories cover a broad range of different contributions with alternative perspectives on project management. The main critique focuses on the functionalist/positivist goal of disseminating "best practice" in project management to masses of practitioners, with an implicit belief in the possibility of the progressive rationalization of social action and of the commodification of the project management body of knowledge (CICMIL et al., 2006).

A rational approach to organizational decision-making and management processes is characterized by linearity of project life cycle model. It promotes the possibility of attaining project objectives through the sequential and progressive application of orderly methodology, including decision and action, thinking and doing, planning and implementation division as separate activities. However, according to Cicmil et al. (2006), there is a need for viewing “project” as a pattern of a complex process of conversational and power relating to organizational members with an instrumental rationality balanced with value rationality and reflexivity.

Cicmil et al. (2006) emphasized the need for understanding the lived experience of organizational members with work and life in their local project environments, called “project actuality”. The actions, decisions, and behaviors of the members are understood as being embedded in and continuously re-shaped by local patterns of power relations and communicative inter-subjective interaction in real time. According to the authors, researching the actuality of projects means focusing on social process and how practitioners think in action and in the local situation of a living present. It requires a theoretical shift from more common normative rational approaches towards a more developmental one which focuses on practical action, lived experience, and quality of social interaction.

Rather than just the classical lifecycle model of project management, Winter et al. (2006) pointed to a need for multiple images to inform and guide action at all levels in the management of projects. The authors emphasized the movement from narrow conceptualization of projects, which states a well-defined objective 'given' at the start, to a broader conceptualization of projects, as being multidisciplinary, having multiple purposes, not always pre-defined, but permeable, contestable and open to renegotiation throughout. Moreover, the authors pointed to the movement from trained technicians, who can follow detailed procedures prescribed by project management methods and tools to practitioners as reflective practitioners who can learn, operate and adapt effectively in complex project environments.

In software development and evolution, many decisions have to be made concerning processes, products, methods, techniques, and tools. All these questions are confronted by different constraints. Also, unlike other projects, the requirements of software projects are subject to frequent change. Such change and uncertainty make software projects more unpredictable than other projects, relying on the

knowledge and creativity of the individuals and the teams. In this sense, the instrumental approaches for project management are not sufficient for such a flexible product, uncertain, innovative and weakly defined as software (MCBRIDE, 2008). Moreover, since the feature that allows the software to become “almost everything” hinders planning and controlling in classic terms, the project success depends on how software project managers deal with the problems and make decisions.

Prior research on the changing context of IT projects (SAUER and CUTHBERTSON, 2004) has found the increasing levels of technical complexity, rate of technology change, importance of security, business change involved in projects, prevalence of virtual teaming, organizational instability, and interdependence with other organizations. In this context, Sauer and Reich (2009) promoted the reframing of IT project management through a new mindset formed by a combination of nine principles: focus on ultimate value; deep personal identification with project goals; investment in trust; devolved, collective responsibility; willingness to continually adapt; people development; learning orientation; creativity and innovation; and proactive view. The authors argued that the challenges of today’s IT project management are realized through devolved, collective decision-making. Given the similarities and saved the appropriate proportions, this view can also be related to software project management.

As with all important business decisions, project outcomes can be traced to decisions that were made at an earlier point in time. According to the Project Management Institute (2015), 47% of unsuccessful projects are impacted by poor decision-making. Therefore, overlooking the complexity of the decision-making process is a risk that could negatively impact the projects and, consequently, the organizational performance.

The importance of managing the way in which project decisions are made is evident by the numerous publications that discuss decision-making, particularly in the context of managing projects, of managing project risks, and more specifically of managing projects involving product development, such as decision-making as an integral part of project management (MCMANUS, 2004; POLLACK-JOHNSON and LIBERATORE, 2006; CLELAND and IRELAND, 2007; VIRINE and TRUMPER, 2008), decision-making in the global development context (BRETT, 2001; ESPINOSA et al., 2007; BOURGAULT et al., 2008), the relationship between

decision-making and risk (CHAPMAN and WARD, 2002; HUSSEY and HALL, 2007; DILLON and TINSLEY, 2008; WARKENTIN et al., 2009), and product development decisions (KRISHNAN and ULRICH, 2001; SCHMIDT et al., 2001; MESSERSCHMITT, 2004; BARRY et al., 2006; GUTIERREZ et al., 2008).

Traditional decision research has invested most of its energy in only one part of decision making, referred as decision event (VIRINE and TRUMPER, 2008). Research on decision events tends to focus on the ways in which decision makers pull together all available information into their choice of the best alternative. In this case, the decision maker surveys a known and fixed set of options, weighs the likely consequences of choosing each, and makes a choice. In natural settings, making a decision is not an end in itself, but a manner of achieving a broader goal. Decisions are embedded in task cycles that consist of defining what the problem is, understanding what a reasonable solution would look like, taking action to reach that goal, and evaluating the effects of that action (ORASANU and CONNOLLY, 1993).

Existing literature has proposed several tools and techniques to assist decision-making in software projects, which include: indicators (HOPPLE, 1986; BASILI, 1996), software project control centers (MÜNCH and HEIDRICH, 2004), checklists (KEIL et al., 2008), decision models (SAKTHIVEL, 1994; NGUYEN, 2006) or multicriteria decision analysis (WANG and LIN, 2003). Although these objective research approaches are useful for project managers, they adopt clear-cut simplifications of the phenomenon, ignoring relevant contextual variables, or the complex relationship that may exist among these variables. There is a gap in the literature in studying the decision-making phenomenon from the perspective of the software project managers.

In a recent systematic literature review on Behavioral Software Engineering (BSE), Lenberg et al. (2015) indicated that the research on human aspects of software engineering is growing and considering an increasing number of concepts from psychology and social science, but the results also show that several concepts have few studies in software engineering, such as decision-making. An understanding of the decision maker's behavior, and more specifically, the reasons for such behavior, is useful in the advancement of managerial decision-making. Rather than following the normative approach that attempts to improve the rationality of human decision-making, there might be merit in the support of an approach that is

descriptive, focuses on the human process and assumes that people are competent decision-makers (TURPIN and MARAIS, 2004).

This research is interested in understanding how software project managers make decisions by how they interpret their experiences in the workplace when making a decision, including the antecedents, moderators, and consequences of their decisions. In this sense, this thesis is based on the following question: **what are the perceptions of project managers about how they make decisions in software projects?**

Faced with the need to understand the complexity of their problems and to know how to manage the factors involved in this process, project managers incorporate their intrinsic values, using unconsciously, personal resources and experience to find a solution (THOMAZ, 2005). Even having knowledge of a particular area, some natural limitations to our thinking mechanisms can lead to potentially harmful choices. Decision makers are known to rely on a few judgmental rules, or heuristics, to simplify complex decision situations. Although these “rules of thumb” are often necessary and useful, they also introduce cognitive biases that can lead to severe and systematic errors in decision making (KAHNEMAN et al., 1982).

A considerable number of empirical studies have been carried out providing further support to the prominence of cognitive biases in strategic decision making (BUKSZAR and CONNOLLY, 1988; BATEMAN and ZEITHAML, 1989; LANT et al., 1992; DAS and TENG, 1999). However, there is a lack of empirical studies relating project management to cognitive biases, specifically in the software context. Therefore, this research also aimed to shed light on cognitive biases in software project management through the research question: **What are the perceptions of project managers about cognitive biases in software projects?**

Understanding naturalistic decision making requires that research methods must expand beyond the study of naive subjects in limited context environments. The methods, however, have to consider the performance of the expert operating in his or her regular environment with reasonable decision aids, time sequences, cue sets, and so on. The choice of the epistemological position (interpretative), ontological (constructivist) and methodological (qualitative) to analyze the phenomenon also gives to this research a novelty character regarding the way to address the problem. The choice of a qualitative and interpretative approach allows this research to

investigate aspects of the phenomenon, such as the individual and social ones, that often are not perceived by most quantitative research on positivist epistemological and objectivist ontological position (CRESWELL, 2013).

The main goal of this research project was to generate a substantive theory on how software project managers make decisions from their own perspective. According to Saunders et al. (2009), a substantive theory provides insights for a particular time, research setting and problem. A theory is useful because it helps to organize and narrow down the amplitude of a phenomena, thus contributing to predict new facts and relationships based on previously known facts and relationships, and indicating points that have not been convincingly explained (MARCONI and LAKATOS, 2010).

The theory proposed in this thesis contributes to the state of the art in three complementary ways. First, it advances the knowledge on this topic by providing a model through which the available knowledge on this field is analyzed and encompassed. Second, it enlightens decision-making in software project management by clarifying what individual and situational aspects are relevant to make better informed project decisions, as well as by pointing out practical challenges attached to the software project management practices. Third, it suggests crucial questions, worthy of further investigation, serving, thus, as a basis to substantiate and organize future research in this area.

1.1 OBJECTIVES

1.1.1 Main Objective

To understand how software project managers make decisions by how they interpret their experiences in the workplace when making a decision, including the antecedents, moderators, and consequences of their decisions.

1.1.2 Specific Objectives

- To identify the software project manager’s decision-making styles as well as the individual and situational aspects that are relevant to make better informed project decisions;

- To shed light on the causal factors of software project managers' cognitive biases and how they deal with them, including techniques and tools they use to minimize the cognitive biases' adverse effects;
- To synthesize the individual and situational factors from the literature that influence decision-making in software project management from a naturalistic perspective;
- To analyze the naturalistic decision-making models and compare them with the grounded one from this research.

1.2 THESIS STRUCTURE

This thesis is structured as follows: Chapter 2 presents a theoretical background regarding decision theories, focusing on naturalistic decision-making models as well as empirical studies of decision-making in software project management from a naturalistic perspective. Chapter 3 explains the research design as well as how the threats to validity and reliability were addressed. Chapter 4 presents the findings from an exploratory study on cognitive biases in software project management. Chapter 5 presents the results from the broader research on decision-making in software project management and, finally, Chapter 6 presents our conclusions and future work.

2 Theoretical Background

Decision-making is a complicated process that begins with the perception of the need for change and has its end in choosing and implementing a course of action among several viable (KIRKWOOD, 1997).

Almost everything that a person does involves decisions. Even the act of not making a decision is a decision (VIRINE and TRUMPER, 2008). According to some authors, a key element to making a decision is the existence of alternatives (i.e., the need to make a choice between at least two different things) and only one can be selected. Ofstad (cited in Eilon, 1979, pp. 135-136) gives a concise description of alternative definitions of a decision:

> "*To say that a person has made a decision may mean (1) that he has started a series of behavioral reactions in favor of something, or it may mean (2) that he has made up his mind to do a certain action, which he has no doubts that he ought to do. But perhaps the most common use of the term is this: 'to make a decision' means (3) to make a judgment regarding what one ought to do in a certain situation after having deliberated on some alternative courses of action*".

A major part of decision-making involves the analysis of a finite set of alternatives described in terms of evaluative criteria. From this perspective, the information requirements of a purely rational mode of decision making are daunting (CHOO, 2006): First, information is needed about the present state - what alternatives are currently available or should be considered; Second, information is needed about the future - what are the consequences of acting on each of the various alternatives; Third, information is needed about how to move from the present to the future - what are the values and preferences that should be used to choose between the alternatives.

As stated by Simon (1977), in most situations we do not have complete information about all feasible alternatives or we cannot afford the time and cost of attaining this full knowledge. According to the author, humans are only "boundedly rational" so that while they attempt to be rational, their rational behavior is limited by their cognitive capabilities and by constraints that are part of the organization. In this sense, people search for alternatives to satisfy certain needs rather than to maximize utility functions.

The rationality of the organizational decision maker is bounded in at least three ways (SIMON, 1977): (i) Rationality requires a complete knowledge and anticipation of the consequences that will follow on each choice. In fact, knowledge of consequences is always fragmentary; (ii) Since these consequences lie in the future, imagination must supply the lack of experienced feeling in attaching value to them. But values can only be imperfectly anticipated; (iii) Rationality requires a choice among all possible alternative behaviors. In actual behavior, only a very few of all these possible alternatives ever come to mind. As Brehmer (1990, p. 26) states in describing his research on dynamic decision making:

> "*The study of decision making in a dynamic, real-time context, relocates the study of decision making and makes it part of the study of action, rather than the study of choice. The problem of decision making is a matter of directing and maintaining the continuous flow of behavior towards some set of goals rather than as a set of discrete episodes involving choice dilemmas*."

Modern decision theory has been developed since the middle of the 20th century through contributions from several academic disciplines, pursued by economists, statisticians, psychologists, political and social scientists or philosophers. Basically, there are two types of decision theory: normative and descriptive. A normative decision theory is a theory about how decisions should be made to be rational, and a descriptive theory is a theory about how decisions are actually made.

Hansson (1994) pointed the following definitions to make clear the distinction between normative and descriptive interpretations of decision theories: (i) A decision theory is falsified as a descriptive theory if a decision problem can be found in which most human subjects perform in contradiction to the theory; (ii) A decision theory is weakly falsified as a normative theory if a decision problem can be found in which an agent can perform in contradiction with the theory without being irrational; and (iii) A decision theory is strictly falsified as a normative theory if a decision problem can be found in which an agent who performs in accordance with the theory cannot be a rational agent.

A central distinction among different decision-making theories and models is the extent to which they make trade-offs among attributes (PAYNE et al., 1993). A model is deemed non-compensatory if surpluses on following dimensions cannot compensate for deficiencies uncovered at an early stage of the evaluation process,

since the alternative will have already been eliminated (SCHOEMAKER, 1980). Conversely, being compensatory implies that a decision maker will trade-off between a high value on one dimension of an alternative and a low value on another dimension (PAYNE, 1976). Descriptive models are generally non-compensatory while normative models are typically regarded as being compensatory.

There are three basic paradigms through which this subject may be viewed: the formal-empiricist paradigm, the rationalist paradigm, and the naturalistic paradigm, which are described in Table 1. Although our focus is on the naturalistic paradigm from the descriptive theory, we briefly detailed the other two paradigms in the following sections.

Table 1. Paradigms of Decision-Making Research

	Normative Decision Theory		**Descriptive Decision Theory**
	Formal-Empiricist Paradigm	**Rationalist Paradigm**	**Naturalistic Paradigm**
Criteria for Normative Evaluation	Behavioral and Formal	Formal Only	Behavioral, Cognitive, and Formal
Style of Psychological Modeling	Formal	Cognitive-Eclectic	Cognitive-Integrated
Style of Empirical Observation	(a) Systematic Variation of Model Parameters (b) Artificial Tasks	(a) Demonstrations of Formal Errors (b) Simplified “Real World” Tasks	(a) Study of Decision Processes and Outcomes (b) Complex “Real World” Tasks

Source: Adapted from Cohen (1993)

2.1 NORMATIVE DECISION THEORIES

In the traditional decision research, the crucial part of decision making occurs when the decision maker surveys a known and fixed set of alternatives, weighs the likely consequences of choosing each and makes a choice. The decision maker evaluates the options regarding a set of goals, purposes, or values that are stable over time, and that he or she knows quite clearly.

Normative decision theories do not tell how people actually make decisions but provide formal methods for reaching optimal solutions. Derived from economic theory, the analytical approaches have been used to study tasks for which the decision makers could optimize the outcome of choice considering that the options, criteria, and values are known (KEENEY and RAIFFA, 1976; SLOVIC et al., 1977; EINHORN and HOGARTH, 1981).

The approaches from the normative decision theory serve as a benchmark for evaluating the rationality of people's unaided decisions. The criterion for rationality is logical consistency. The tasks used to assess rationality typically require people to integrate significant amounts of information and to reason statistically, that is, to revise their probability estimates of outcomes as additional information is provided. Although some researches indicate that experts can reason statistically within their own domains under certain task conditions (NISBETT et al., 1983), in general, people’s intuitive statistical judgments do not conform to the rational consistency of formal models.

Considerable research on heuristics and biases has shown the limitations of human reasoning involving statistical reasoning (KAHNEMAN et al., 1982). These researches, grounded in normative theories, examine the psychological shortcuts people take to get around their own information-processing limitations when dealing with probability judgments in highly uncertain situations. These heuristics often lead to systematic biases or errors compared to normative standards (KAHNEMAN et al., 1982). The normative decision theory is based on two paradigms: formal-empiricist and rationalist, which are briefly described in the following sections.

2.1.1 FORMAL-EMPIRICIST PARADIGM

Up to the late 1960s, researchers on decision making focused on fit their theories to observed behavior and to have normative plausibility. If behavior failed to fit a model, they did not condemn the behavior as irrational; instead, they regarded the model as inadequate to describe behavior and to evaluate it (BARCLAY et al., 1971; LEE, 1971; BEACH et al., 1987). In this case, the experimenter's task was to propose a new formal description of the anomalous behavior.

According to a normative rule for choice under uncertainty, one should select the option that has the highest expected value. Expected value is a probability-

weighted average of all outcomes which is calculated by multiplying each possible outcome by its probability of occurrence and then summing the results (VIRINE; TRUMPER, 2008).

In their book Theory of Games and Economic Behavior, von Neumann and Morgenstern (1947) proposed the expected utility theory, which uses utilities associated with the outcomes. The next significant step in the evolution of formal-empiricist models replaced frequency-based probabilities with subjective probabilities or personal degrees of belief. Savage (1954) and De Finetti (1964) developed formal systems for merging subjective preferences and subjective probabilities in a new normative rule, called Subjectively Expected Utility (SEU), which specify consistency relationships that probabilities and utilities should satisfy. The Bayesian decision theory (BERGER, 1985) is one of the most known theories from this paradigm.

The formal-empiricist paradigm focused on behavioral testing of formal models, not on the cognitive processes that actually underlie decisions. The models themselves impose mathematical consistency constraints on a subject's judgments and preferences but make no reference to psychological representations.

As shown in Table 1, the formal-empiricist paradigm: (a) allowed human intuition and performance to drive normative theorizing, along with more formal, axiomatic considerations; (b) used the resulting normative theories as descriptive accounts of decision-making performance; and (c) tested and refined the descriptive/normative models by means of systematic variation of model parameters in artificial tasks.

2.1.2 RATIONALIST PARADIGM

The rationalist paradigm takes decision theory as a norm that is fully justified by its formal properties, not by its fit to the way people, in fact, make decisions. The practical application of this prescriptive approach is called Decision Analysis, and aimed at finding tools, methodologies, and software to help people make better decisions (KEENEY, 1982). The systematic and comprehensive software tools developed in this way are called Decision Support Systems (POWER et al., 2015).

According to Virine and Trumper (2008), Decision Analysis is not a fixed process, but rather an adaptable framework that can be tailored to an organization to

meet its specific needs. In general, the steps of a Decision Analysis process are presented in Table 2.

Table 2. Steps of a Decision Analysis process

Phase	Step
Decision Framing	Identification of Problems or Opportunities
	Assessing Business Situation
	Determining Success Criteria
	Identifying Uncertainties
	Generating Alternatives
Modeling the Situation	Creating Models for Project Alternatives
	Quantifying Uncertainties
Quantitative Analysis	Determining What is Most Important
	Quantifying Risks Associated with Project
	Determining the Value of New Information
	Deciding on a Course of Action
Implementation / Monitoring / Review	Implementing the Best Alternative
	Monitoring the Project Implementation
	Review of the Decision Experience

Source: Adapted from Virine and Trumper (2008)

When modeling the situation, there are typically multiple and conflicting criteria that need to be evaluated. The quantitative analysis of such criteria is supported by a variety of approaches and methods, such as Analytic Hierarchy Process (AHP) (SAATY, 2008) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) (BANA e COSTA and VANSNICK, 1994), both of them implemented by specialized decision-making software. The Multiple-Criteria Decision Analysis (MCDA) is a sub-discipline of Operations Research that explicitly considers multiple criteria in decision-making environments (GRECO et al., 2005).

While the formal-empiricist paradigm tailored formal models to fit decision behavior, the rationalist paradigm uses formal models to critique decision behavior.

Rationalism attributes discrepancies between behavior and a model to the irrationality of decision makers, not to flaws in the model.

Decision Analysis considers that people are subject to common psychological pitfalls and that its techniques help to avoid those pitfalls. According to Tversky and Kahneman (1974), unaided decision process employs heuristics, which includes, but is not limited to:

- **Availability heuristic**, which refers to the judgment of the probability of the occurrence of events by how easily these events are brought to mind;
- **Representativeness heuristic**, which relates to the tendency to categorize a thing as good or bad based on a description;
- **Anchoring and adjustment heuristic**, which refers to the use of a reference point when trying to quantify something.

Under many conditions, those heuristics can lead to severe and systematic errors, called cognitive biases. The notion of cognitive biases was introduced by Tversky and Kahneman (1974) who demonstrated several replicable ways in which human judgments and decisions differ from rational choice theory. Basically, the cognitive biases can be classified into: (i) *behavioral biases*, which influence how we form our beliefs, such as the illusion of controlling something that we cannot influence; (ii) *perceptual biases*, which can skew the ways we see reality and analyze information, such as overconfidence which can affect our ability to make accurate estimates; (iii) *probability and belief biases*, which are related to how we judge the likelihood that something will happen and can especially affect cost and time estimates; (iv) *social biases*, which are related to how our socialization affects our judgment; and (v) *memory biases*, which influence how we remember and recall certain information.

Decision bias researchers promote a picture of normative theory as a fixed benchmark, immune to descriptive influence. The emphasis on human irrationality was a by-product of the rationalist paradigm (ORASANU and CONNOLLY, 1993). At the deepest level, biases are violations of consistency constraints imposed by decision theory. As in formal-empiricist experimentation, there has been virtually no effort to explore cognitive processes more directly by means of verbal protocols, interviews, or other process-tracing techniques.

The rationalist paradigm promoted a desirable transition to cognitively oriented theories of performance by adopting a less desirable tactic: creating a rigid normative concept as a straw man, and designing experiments that often do little more than discredit the straw man (ORASANU and CONNOLLY, 1993). As shown in Table 1, the rationalist paradigm (a) adopts a static and purely formal view of normative standards; (b) gives an explanatory account of reasoning in terms of a diverse set of unrelated cognitive mechanisms; (c) experimentally demonstrates errors with pre-structured and pre-quantified “real-life” stimuli.

2.2 DESCRIPTIVE DECISION THEORIES

A descriptive theory is a theory about how decisions are actually made. According to Orasanu and Connolly (1993), eight important factors characterize decision-making in naturalistic settings:

- **Ill-structured problems:** Real decision problems rarely present themselves in the complete form the event model suggests. Observable features of the setting may be related to one another by complex causal links, interactions between causes, feedback loops, and so on. Therefore, there are several equally good ways of solving the same problem when a task is ill-structured.
- **Uncertain dynamic environments:** In a context of incomplete, imperfect and ambiguous information, observers are unsure of what they saw, and diagnostic tests leave open a range of possible diseases. Moreover, the environment may change quickly within the time frame of the required decision.
- **Shifting, ill-defined, or competing goals:** In the real world, it is rare for a decision to be dominated by a single, well-understood goal or value. The decision makers are expected to be driven by multiple purposes, not all of them clear, some of them opposed to others.
- **Action/feedback loops:** The fact that there are multiple opportunities for the decision maker to do something may be helpful in that early mistakes generate information that allows corrective action later, including dealing with side effects of the initial actions.

- **Time stress:** In time pressure situations, decision makers experience high levels of personal stress, with the potential for exhaustion and loss of vigilance. Also, their thinking will shift in the direction of using less complicated reasoning strategies.
- **High stakes:** Contrary to the decision research which involves subjects who are not invested in the task at the same level that they would be outside the laboratory, in the real world the stakes matter to the participants who are likely to feel stressed but who will take an active role in arriving at a good outcome.
- **Multiple players:** A decision may be distributed over a set of partly cooperative, partly competitive individuals who try to coordinate their activities. It can be hard to make sure all team members share the same understanding of goals and situational status so that relevant information is brought forward when needed in the decision process.
- **Organizational goals and norms:** The values and goals that are being applied will not be simply the personal preferences of the individuals involved. The organization may respond to the decision maker's various difficulties by establishing more general goals, rules, and standard operating procedures.

2.2.1 NATURALISTIC PARADIGM

The Naturalistic Decision Making (NDM) paradigm distinguishes from both the formal-empiricist and the rationalist paradigms by a more pronounced concern for decision making in realistic, dynamic, and complex environments (ORASANU and CONNOLLY, 1993). From the naturalistic perspective, an unquestioning acceptance of the relevance of classical normative standards is untenable, because real-world decision makers appear to use qualitatively different types of cognitive processes and representations.

The naturalistic paradigm agrees with the rationalist approach (and differs from the formal-empiricist approach) in its explanatory emphasis on cognitive representations and processes. By focusing on the way people actually handle complex environments, the naturalistic paradigm illuminates the functions that cognitive processes serve. As a result, it stands a better chance of developing a successful and coherent set of explanatory models.

According to Orasanu and Connolly (1993), the nature of errors that people make in real settings is different from the biases described by rationalist research. The naturalistic point of view does not wholly banish the idea that errors occur when people make decisions. In this perspective, biases represent a failure of metacognitive processes that facilitate problem recognition and retrieval of appropriate solutions, that monitor for potential problems in a decision process, and that verify and revise proposed solutions.

Nine models of decision making in the naturalistic decision paradigm were grouped into two categories: process models and typological models (LIPSHITZ, 1993). The process models depict decision-making as a sequence of activities differing between them regarding the type of decisions and the nature of the sequences which they describe. The models from this category are: Noble's model of situation assessment; Klein's model of Recognition-Primed Decisions; Pennington and Hastie's model of explanation-based decisions; Montgomery's dominance search model; and Beach and Mitchell's image theory.

Typological models, on the other hand, classify decision processes by type, for instance as intuitive or analytical, and discusses the contingencies under which each type is or ought to be used. The models from this category are: Rasmussen's model of cognitive control; Hammond's cognitive continuum theory; Connolly's model of decision cycles; and Lipshitz's model of argument-driven action.

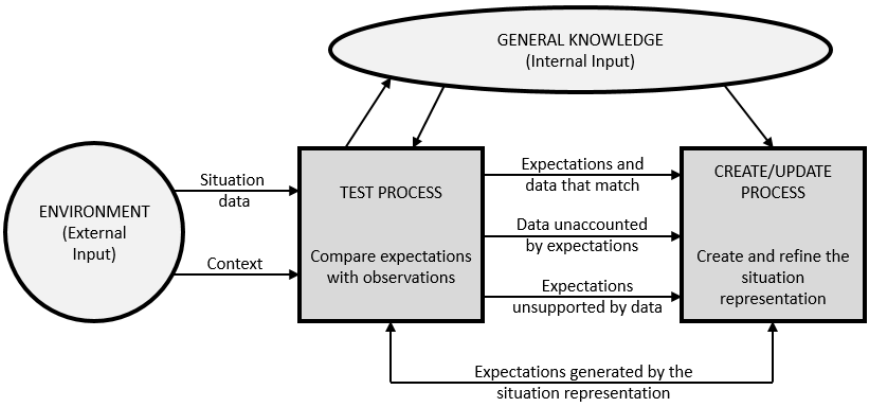
All of them have the same conclusion: People do not generate and compare option sets. Instead, they use prior experience to rapidly categorize situations relying on some synthesis of their experience to make these judgments. From this perspective, making a decision means committing oneself to a course of action where plausible alternatives exist, even if the person does not identify or compare these alternatives. The nine models are described in the following sections.

2.2.1.1 Noble's Model of Situation Assessment

The model of situation assessment (NOBLE, 1989) focuses on a crucial aspect of decision making: situation assessment. Concrete information on the situation is combined with context information and general knowledge retrieved from the decision maker's memory to form a tentative representation of the situation. To the extent that the expectations do not match this information, the representation is

refined or rejected for a new representation that is tested, refined, or rejected in turn. People can sometimes decide what to do by observing that the current situation is similar to other previously observed situations, and that actions that worked in those situations may also work in the new one. The steps of the model are described in Figure 1.

Figure 1. Situation Assessment Model



Source: Adapted from Noble (1989)

In this model, various types of previously solved problems are organized as reference problems in memory, which specify the problem objective, general solution method, and situation conditions that indicate the applicability of the solution method. During an assessment, those reference problems that match the current problem are activated, and the problem solution methods associated with these activated reference problems become candidate actions.

2.2.1.2 Klein's Model of Recognition-Primed Decisions

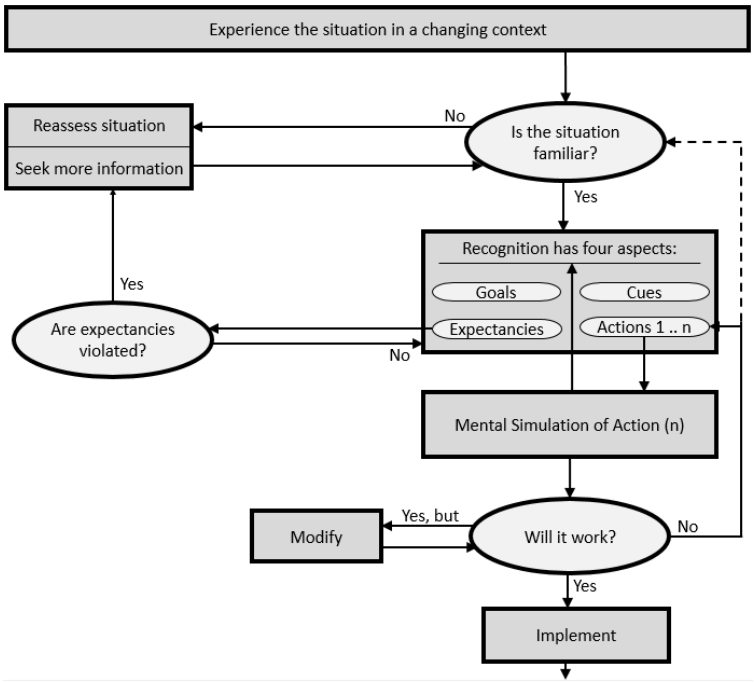
According to Klein (1989), contrary to the traditional definition of decision making as choosing among alternatives, proficient decision makers rarely compare among alternatives. Instead, they assess the nature of the situation and, based on this assessment, select an action appropriate to it. This process, called Recognition-Primed Decision (RPD), consists of three phases (see Figure 2):

- **Situation recognition** refers to the recognition of the situation as typical or novel. The decision maker identifies critical cues that mark the type of the situation and causal factors that explain what is happening and what is

going to happen. Based on these, he or she sets plausible goals and proceeds to select an appropriate action.

- **Serial option evaluation** refers to the evaluation of the action alternatives one at a time until a satisfactory one is found. Actions are selected from an action queue where they are arranged according to this typicality. Thus, the first action evaluated is that rated as the most typical response.
- **Mental simulation:** In order to evaluate if an action is satisfactory, the decision mentally simulates the successive steps to be taken, the potential outcomes, the likely problems, and if and how these problems can be handled. As a result of the simulation, the decision maker either implements the action as is, modifies it, or rejects it altogether and turns to examine the next action in his or her action queue.

Figure 2. Recognition-Primed Decisions Model



Source: Adapted from Klein (1989)

There are four important aspects of situation assessment: (a) understanding the types of goals that can be accomplished, (b) increasing the salience of cues that are important within the context of the situation, (c) forming expectations which can serve as a check on the accuracy of the situation assessment, and (d) identifying the

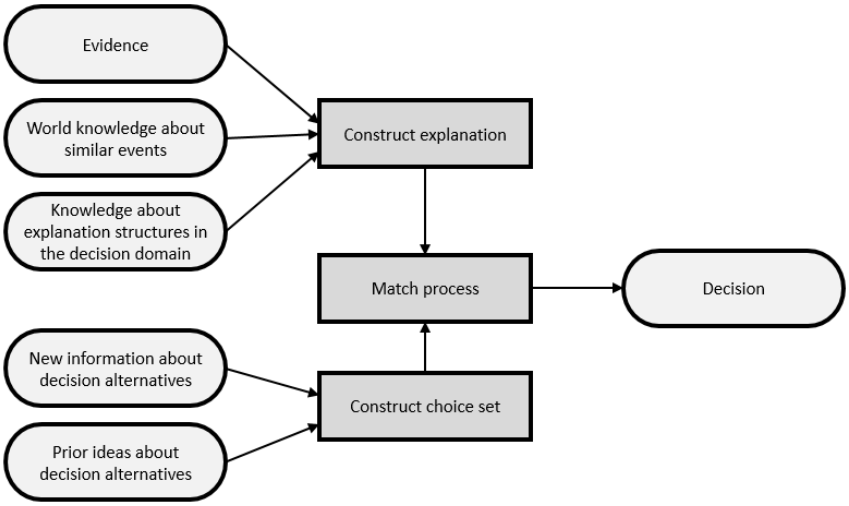
typical actions to take. The RPD model underscores the crucial role of domain-specific knowledge and experience in decision making.

2.2.1.3 Pennington and Hastie's Model of Explanation-based Decisions

Pennington and Hastie (1988) suggest that the story-based decision-making process is a particular case of how decisions are generally made in situations where people have to process large amounts of information that is incomplete, and presented sequentially in a temporal sequence. To cope with this situation, people construct a causal explanation based partly on the evidence and partly on inferences.

The distinctive assumption in the explanation-based approach to decision making, which depends on the specific task or domain, is the hypothesis that decision makers construct an intermediate summary representation of the evidence, and that this representation, rather than the original raw evidence, is the basis of the final decision. The model of explanation-based decisions is illustrated in Figure 3.

Figure 3. Explanation-based Decisions Model



Source: Adapted from Pennington and Hastie (1988)

According to the explanation-based model, decision makers begin their decision process by constructing a causal model to explain the facts. Concomitant with, or after the construction of a causal model of the evidence, the decision maker is engaged in a separate activity to learn or create a set of alternatives from which an action will be chosen. A decision is made when the causal model of the evidence is successfully matched to an alternative in the choice set.

The explanation-based approach depart from the common assumption that, when causal reasoning is involved in judgment, it can be described by algebraic or logical computations that lead directly to a decision (EINHORN and HOGARTH, 1986). Instead, causal reasoning plays a subordinate but critical role by guiding inferences in evidence evaluation and construction of the intermediate explanation.

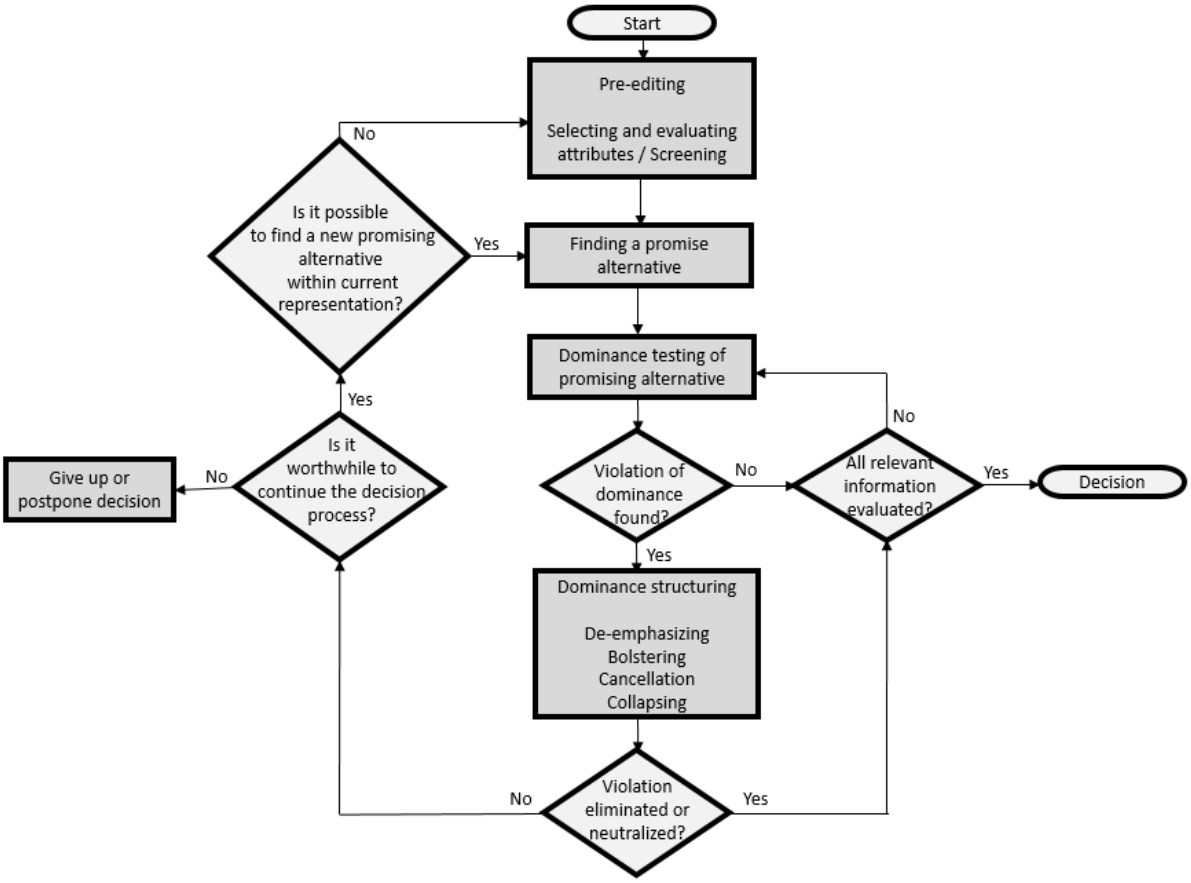
2.2.1.4 Montgomery's Dominance Search Model

According to Montgomery (1983), people search for a dominant alternative when several of them are available. The dominance of an alternative considers if it is at least as attractive as its competitors on all relevant attributes, and exceeds each of them on at least one attribute. The search for a dominant alternative goes through four phases (see Figure 4):

- **Pre-editing:** At this stage, the decision maker selects the attributes that are relevant for his or her decision and uses them to screen alternatives that are obviously unacceptable.
- **Finding a promising alternative:** At this stage, the decision maker picks an option that seems to be most promising because it is most attractive on a particularly important attribute.
- **Dominance testing:** At this stage, the decision maker tests if the promising alternative is, in fact, the best available option according to the criterion of dominance. If the criterion holds, the option is selected. If the promising alternative falls short of this criterion, the decision maker proceeds to the stage of dominance structuring.
- **Dominance structuring:** The goal of this phase is to restructure or reinterpret given information in such a way that a promising alternative becomes dominant. To achieve this end, the decision maker uses various methods to neutralize or eliminate the disadvantage(s) associated with the promising alternative, which includes deemphasizing the likelihood or value of such a disadvantage or an advantage relating to a non-promising alternative. Alternatively, the decision maker may bolster or enhance the benefits of the promising alternative (or the disadvantages of non-promising options). Two additional operations are: cancellation, where the

decision maker counterbalances a disadvantage by relating it to an advantage that has some natural connection to the advantage and collapsing, where two or more attributes are collapsed into a more comprehensive attribute. If a promising alternative is not found to be dominant, the decision maker tries to make it to one by reinterpreting its standing compared to its competitors.

Figure 4. Dominance Search Model



Source: Adapted from Montgomery (1983)

According to this model, the search for dominance structure has two advantages. First, it is compatible with the limited capacity of human information processing: focusing on a small number of alternatives and attributes and accentuating the differences between them makes it easy to identify the preferred alternative with no further calculations. Second, and more importantly, the availability of a dominant option helps decision makers to persist in its implementation.

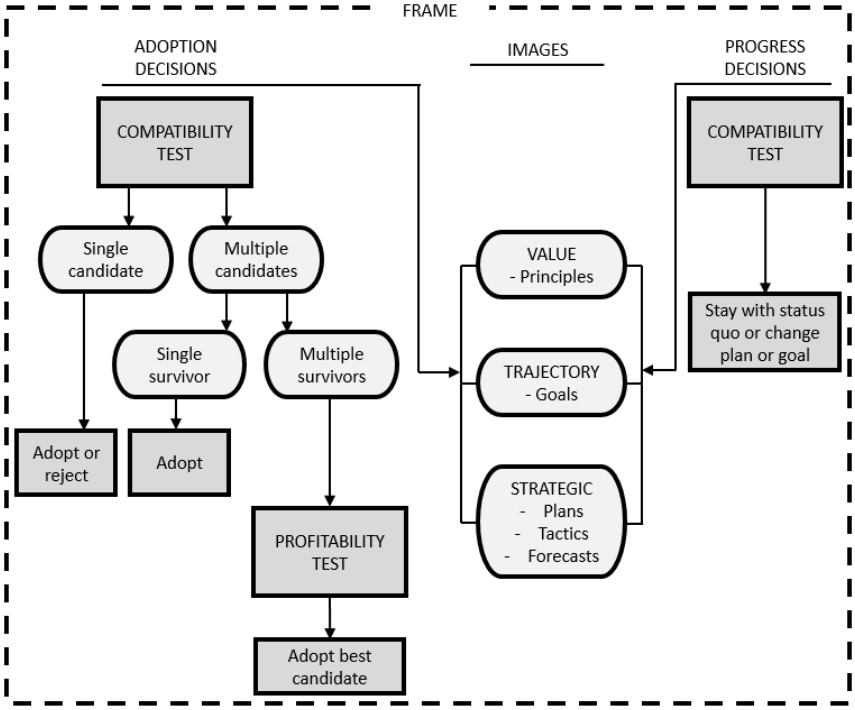
2.2.1.5 Beach and Mitchell's Image Theory

According to Beach and Mitchell's image theory (BEACH and MITCHELL, 1987), decision makers possess three decision-related images or cognitive structures that organize decision makers' values and knowledge and constrain decisions they can make: (i) the *value image* consists of the decision maker's principles, namely, his or her notions about what is right and wrong and the ideals to which he or she aspires; (ii) the *trajectory image* consists of concrete goals that the decision maker attempts to achieve; and (iii) the *strategic image* consists of plans and tactics to achieve a goal as well as forecasts of implementing a plan. The principles, goals, and plans that drive a certain decision correspond to the answers to "*why?*", "*what?*" and "*how?*" respectively.

The process of identifying the goal and the process of recalling a policy for it if one exists consists of framing the decision. A frame is that portion of his or her store of knowledge that the decision maker brings to bear on a particular context in order to endow that context with meaning. According to the image theory, illustrated in Figure 5, decision-making consists of:

- **Adoption decisions:** These decisions concern the addition of goals and plans to the decision maker's current agenda. They are primarily based on a compatibility test: a candidate goal or plan is adopted if it does not violate the decision maker's three images beyond a threshold, which varies from one decision maker and one situation to another. If more than one candidate survives this test, the decision maker selects the best of them by using a test of profitability, a collective label for various methods of choosing among alternatives.
- **Progress decisions:** There are two types of progress decisions, and both pertain to plans. First, progress decisions are used to support adoption decisions by projecting forward in a similar fashion to Klein's mental simulation. The second type of progress decisions is used to decide if an implemented plan actually achieves its objectives. Both types of progress decisions are made by test of compatibility.

Figure 5. Image Theory



Source: Adapted from Beach and Mitchell (1987)

2.2.1.6 Rasmussen's Model of Cognitive Control

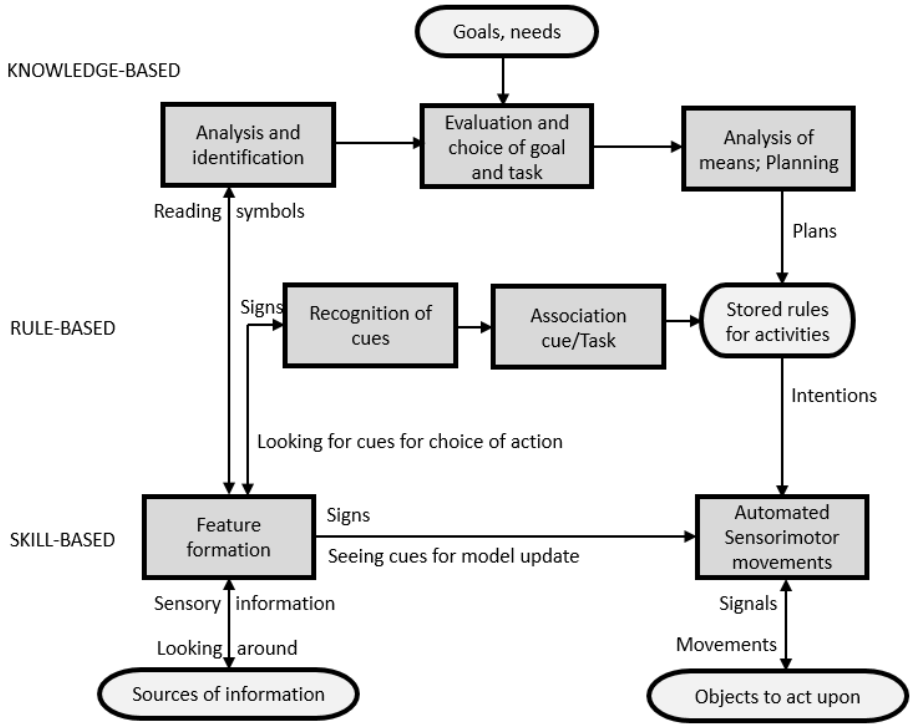
According to Rasmussen (1983), practical decision making is a continuous control of the state of affairs in a dynamic environment which is dependent on the tacit knowledge of context and cannot be separated from action planning. The complex interaction among the different levels of cognitive control of action in a dynamic environment leads to different kinds of decision making. The author suggests three types of behavior that are controlled by qualitatively different cognitive mechanisms (see Figure 6):

- **Skill-based behavior:** This type of behavior includes expert sensorimotor performance (e.g., speaking, bicycle riding), which runs smoothly and efficiently without conscious attention. Skill-based behavior is controlled by a dynamic mental model that enables the rapid adjustment to feedback from actions.
- **Rule-based behavior:** This type of behavior is controlled by rules and know-how that can be stated explicitly by the decision maker. Both skill-based and rule-based behaviors are characteristic of expert performance.

The fuzzy boundary between them depends on the extent to which behavior is executed automatically or attentively.

- **Knowledge-based behavior:** Whereas skill-based and rule-based behaviors are appropriate for familiar situations, effective action in novel situations requires a deeper understanding of the nature of the situation and explicit consideration of objectives and options.

Figure 6. Cognitive Control Model



Source: Adapted from Rasmussen (1983)

2.2.1.7 Hammond's Cognitive Continuum Theory

According to Hammond (1988), the cognitive processes that guide decision making can be located on a cognitive continuum which ranges between intuition and analysis. A process is more intuitive to the extent that it is executed under low control and conscious awareness, a rapid rate of data processing, high confidence in an answer and low confidence in the method that produced it. The author suggests further that whether decisions are made more or less intuitively is a function of two factors. The first factor is related to failure: decision makers tend to become more analytical when snap judgments fail, and more intuitive when careful analysis fails. The second factor is the nature of the decision maker's task. According to

Hammond's inducement principle, certain task characteristics induce the use of more intuitive processes.

Hammond's correspondence-accuracy principle suggests that judgments are most accurate, and hence decision making is most effective when the location of the cognitive process on the cognitive continuum matches the location of the decision task on the task continuum. Thus, changes in the characteristics of tasks lead to predictable changes in the nature of cognitive processes. In sum, Hammond suggests that real-world decisions are made in a quasi-rational mode, namely a mixture of intuition and analysis.

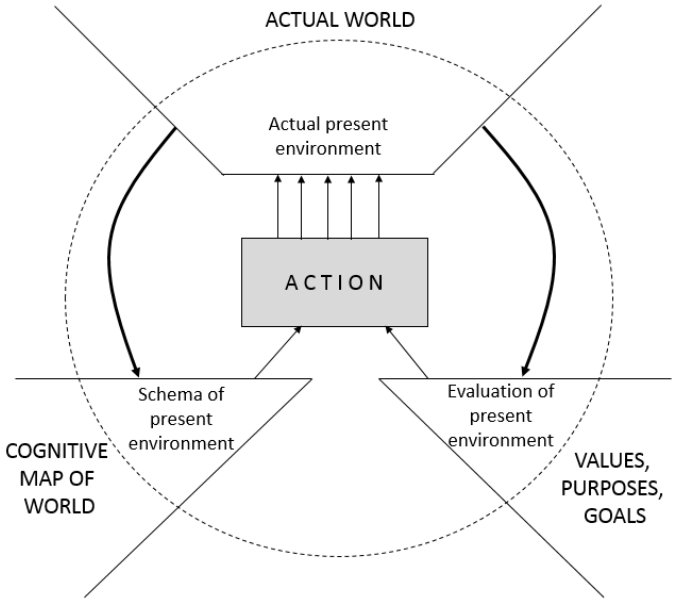
2.2.1.8 Connolly's Model of Decision Cycles

The essence of Connolly's decision cycles model (CONNOLLY, 1988) is the cyclical interplay between situation assessment, evaluation of alternatives, and action. The author argues that, since processes of making real decisions are dynamic, it is improper to analyze them as isolated instances of choosing among alternatives.

The decision cycles model consists of three domains (actual world, decision maker’s cognitive map of this world, and his or her values) and two cycles (perceptual cycle and decisional cycle), as shown in Figure 7. In the perceptual cycle, feedback on the consequences of action adjusts the cognitive map on which action was based. In the decisional cycle, the same feedback regulates the goals for which it was taken. The particular contribution of the decision cycles model is its emphasis on the role of exploratory action and the consequences of action on shaping both cognitions and values.

Since acting and thinking are intertwined in the decision cycles model, Connolly (1988) suggests distinguishing between two qualitatively different decision processes: action-last or tree-felling, and action-first or hedge-clipping. Tree-felling exemplifies decisions that are made in one fell swoop following a period of planning. In contrast, hedge-clipping illustrates decisions that are made incrementally in a series of steps.

Figure 7. Connolly's Model of Decision Cycles



Source: Adapted from Connolly (1988)

Connolly (1988) emphasized that, when it is difficult to define precise goals and outcomes of isolated actions, it makes more sense to find ways step by step than to invest time and effort in thinking thoroughly ahead. Plans are of limited value when the future is uncertain, and goals are ambiguous, and reacting to feedback requires less cognitive effort than exhaustive planning.

2.2.1.9 Lipshitz's Model of Argument-driven Action

Lipshitz (1989) developed the conceptualization of decision making as argument-driven action. The author suggests that consequential choice, matching, and reassessment are three generic modes of making decisions that differ in terms of six basic attributes of decision processes: framing (how the decision problem is defined), form (how action is selected), uncertainty (the nature of the doubt which has to be resolved in order to act), logic (the underlying rationale for acting in this way), handicaps (the barriers to making quality decisions), and therapies (the methods of improvement that are compatible with the preceding five characteristics):

- **Consequential choice:** Consequential choice problems are framed as forward-looking choices. The decision process thus takes the form of comparing among alternatives and uncertainty pertains to the likelihood and attractiveness of future outcomes. The logic underlying this type of reasoning reflects a belief that people act wisely when they visualize the

future and plan accordingly. A principal handicap to deciding well this way is the limited human information-processing ability. A variety of therapies for this limitation is based on formal models of optimal choice and psychological research judgment under uncertainty.

- **Matching:** Matching problems are framed as situation, which invokes a rule that dictates proper conduct based on personal experience, professional standards or social norms. Matching is blocked by uncertainty concerning the nature of the situation. The underlying logic reflects a belief that people act wisely when they use their experience or the experience of others, and the principal compatible therapies are training and expert systems.
- **Reassessment:** Reassessment problems are framed as objections to a certain course of action owing to uncertain present or future circumstances. This mode is distinct in that the decision maker is already committed to a particular course of action, which means that the principal handicap to high-quality decisions is uncritical implementation owing to past decisions or wishful thinking. The therapies called for include various methods for enhancing critical thinking. The underlying logic reflects a belief that prescience is impossible, acting often precedes thinking, and the best thing to be done is reflecting critically on own values and assumptions.

2.3 A COMPARISON OF THE NATURALISTIC DECISION-MAKING MODELS

How decisions ought to be made, and how they can be improved, has been traditionally approached by analytical models that prescribe precise problem definition, diagnosis, generation of alternatives, and choice. The nine models reviewed were developed by different researchers using different methodologies to study different questions in a variety of realistic settings.

The nine models suggest that real world decisions are made in a variety of ways. The diversity of form among these models indicates the difficulty of trying to understand and improve real-world decisions in terms of a single concept. The reviewed models emphasize different cognitive processes that are related to creating images of the situation, most notably categorization (e.g., of situations, Noble, Klein, Rasmussen), the use of knowledge structures (e.g., schema, Beach and Mitchell,

Connolly) and the construction of scenarios (e.g., in the form of storytelling and mental modeling (Klein, Pennington and Hastie, Beach and Mitchell, Lipshitz).

All nine models include an element of situation assessment, reflecting a shift of focus from the controlled environments, where problems are defined and presented by the experimenter to the real world, where they have to be identified and defined by the decision maker. Some tie it directly to the selection of an action (Noble, Rasmussen's, and Hammond's, Lipshitz's); others suggest that it is a preliminary phase that initiates a process of evaluation of alternatives (Klein, Pennington and Hastie, Montgomery, and Beach and Mitchell). Lastly, Connolly refers to situation assessment (i.e., cognitive mapping) as one of the levels of his decision cycles model. All nine models suggest that making decisions in realistic settings is a process of constructing and revising situation representations as much as a process of evaluating the merits of potential courses of action.

All nine models reject the notion that decisions are made as discrete and isolated events. The dynamic quality of decisions is conceptualized in two basic fashions. Hammond, Rasmussen, and Connolly suggest that decision makers switch between intuitive and analytic decision making as a function of changing task requirements. Noble, Klein, Montgomery, Beach and Mitchell, and Lipshitz suggest a two-phase sequence in which a typically quick preliminary selection based on matching or compatibility rules is followed by a more deliberate evaluation that they term updating, mental simulation, dominance search, profitability testing, and reassessment, respectively.

The models developed in the 1980s created a basis to the development of descriptive accounts through cognitive field research methods. Two challenges related to the naturalistic models are the construction of a theory of decision-making in the real world and learning to apply these models effectively to help decision makers make better decisions. In order to meet both challenges, it is necessary to progress from the high-level terminology that the models currently use, such as framing, pattern seeking, recognizing typicality, and matching to more specific descriptions of how these processes are carried out in particular contexts.

2.4 DECISION-MAKING STYLES

A person's decision-making style depends on a significant degree on how he or she thinks about and assesses information (MYERS, 1962). While some are more comfortable with an objective analytical approach, others are confident in being guided by their feelings and emotions. People who trust information that is concrete will seek out facts and knowledge from others, while those who rely on intuition and instinct may be more likely to make decisions without much participation from others.

According to Harren (1979), decision-making style is an individual characteristic mode of perceiving and responding to decision-making tasks. Driver et al. (1993) proposed that decision-making style is a learned habit and that the fundamental differences among styles concern the amount of information considered during a decision process and the number of alternatives identified when reaching a decision. Although decision-making styles are considered stable across time, researchers acknowledge some fluidity due to situational circumstances (GATI et al., 2010; GALOTTII et al., 2016)

Previous research has identified various categories of decision-making styles. The number of hypothesized styles ranges from one (ALLINSON and HAYES, 1996) to five (SCOTT and BRUCE, 1995) different styles. The General Decision-Making Style (GDMS) proposed by Scott and Bruce (1995) is widely used and well validated (LOO, 2000) and categorizes the decision-making styles into rational, intuitive, dependent, avoidant, and spontaneous. A rational style is characterized by a comprehensive search for information, inventory of alternatives and logical evaluation of choices. An intuitive style is characterized by attention to details in the flow of information rather than systematic search for and processing of information and a tendency to rely on feelings. A dependent style is characterized by a search for advice and guidance from others before making important decisions. An avoidant style is characterized by attempts to avoid decision-making whenever possible. Finally, a spontaneous style is characterized by a feeling of immediacy and a desire to come through the decision-making process as quickly as possible.

2.5 DECISION-MAKING IN SOFTWARE PROJECT MANAGEMENT

Software projects involve dealing with trade-offs between characteristics, preferences and quantities while maintaining a balance between requirements,

expectations, perceptions, opportunities, and risks. Myers (1985) states that more than half the cost of complex software development is attributable to decisions made in the ‘upstream’ portion of the development process, namely, requirements specification and design. Traditional software development models like waterfall and spiral follow a sequential approach where the ‘upstream’ and ‘downstream’ aspects of development are clearly distinguishable. However, modern approaches like agile methods are more emergent and evolutionary and rely on frequent feedback and interaction between and within self-organized teams while attempting to address change and uncertainty in the requirements.

According to SOFTEX (2013), during a software development project, there is usually enough time to make decisions based on a more detailed analysis, as suggested by the rational perspective. In this sense, some authors such as Costa et al. (2004) indicate that both managers and technicians need to base and justify their decisions formally to allow them to be reused in future decisions, facilitating the knowledge sharing, organizational learning, and the process improvement.

According to Ruhe (2003), decision-making significantly affect all stages of the project lifecycle and thus processes and decision support systems are essential to increase the projects’ efficiency and quality. The Software Engineering Decision Support Systems aims to generate new insights from online investigations in a virtual model-based world, from offering facilities to better structure the problem as well as in ranking and selecting alternatives. Sound modeling and knowledge management is combined with a variety of techniques of analysis, simulation, and decision-making (RUS and COLLOFELLO, 1999).

Reference models and international standards, such as Capability Maturity Model Integration (CMMI) (SEI, 2010), Melhoria de Processo do Software Brasileiro (MPS.Br) (SOFTEX, 2013), ISO/IEC 12207 (ISO/IEC, 2008) and ISO/IEC 15504 (ISO/IEC, 2003) require formal processes of decision-making to obtain a certification or to achieve certain levels of maturity on software processes. The Decision Analysis and Resolution (DAR) is a support process area at maturity level 3 of CMMI with the purpose of analyzing possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria. It states that not all software decisions should be subjected to a formal DAR process, but only the critical decisions, which include: decisions that may move the project timeline; design

decisions that could have a major impact on system performance; and decisions that have legal implications. According to the standard, a formal evaluation process involves the following specific process: (i) establish guidelines for decision analysis; (ii) establish evaluation criteria; (iii) identify alternative solutions; (iv) select evaluation methods; (v) evaluate alternatives; and (vi) select solutions. Likewise, the MPS.Br defines the Decisions Management Process (SOFTEX, 2013). The Project Management Body of Knowledge (PMBOK Guide) (PMI, 2013) suggests some tools and techniques for decision making, such as sensitivity analysis, Monte Carlo simulations, SWOT analysis and decision tree.

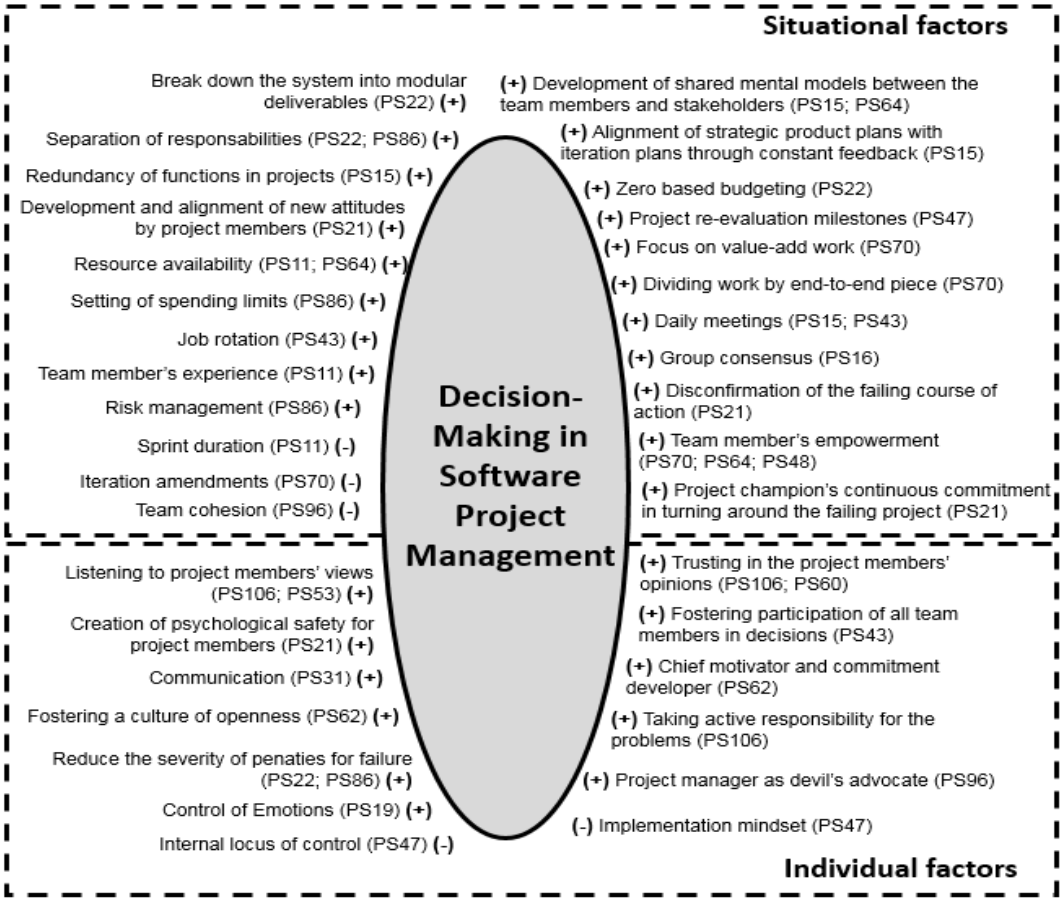
As stated earlier, existing literature has proposed several tools and techniques to assist decision-making in software projects. Although these objective research approaches are useful for project managers, they adopt clear-cut simplifications of the phenomenon.

2.5.1 FINDINGS FROM A SYSTEMATIC LITERATURE REVIEW

Based on a Systematic Literature Review (SLR) (CUNHA et al., 2016c), empirical studies published in journals and conference proceedings about decision-making in software project management from a naturalistic perspective were identified. As pointed out by the naturalistic theorists when referring to the participants, we focused on empirical studies with software project managers from the industry instead of students, which reduced the number of the selected papers. The SLR protocol is described in Appendix B.

Since decision-making is a broader construct which is related to a variety of areas, there is not a systematic way of categorizing the findings. In order to organize them, we divided the factors that influence decision-making in software project management into situational and individual factors, as illustrated in Figure 8. Each factor has a signal which represents a positive or negative impact on decision-making as well as the primary studies in which they were mentioned. Also, to make clear the context in which each factor was identified, we grouped the primary studies into three categories: agile development projects, escalation and de-escalation of commitment and software project manager's competences.

Figure 8. Individual and situational factors extracted from literature



Agile Development Projects

Agile software development changes the nature of collaboration, coordination, and communication in software projects. It involves a radically new approach to decision-making in software projects since project teams deliver working software in short iterations, which results in more frequent, short-term decisions, compared with a traditional software development approach.

Some challenges to shared decision-making in agile development were identified by Moe et al. (2012) [PS15], including the need for alignment of strategic product plans with iteration plans through constant feedback and development of shared mental models between the team members and stakeholders. The authors also pointed out the required transitions from specialized skills to a redundancy of functions and from rational to naturalistic decision-making as well as that daily meeting is essential for preventing decision-hijacking (i.e., some team members making decisions without informing the others). Drury-Grogan and Orla (2013) [PS11]

found that a rational decision-making process based on Mintzberg's model was followed in the sprint planning and daily scrum meetings, although the teams may not have been consciously aware they were following a particular decision-making process. The model, which is composed of three phases (problem identification, solution development, and selection of best alternative) was not necessarily done in a sequential format, though they often developed only one solution, rather than some solutions from which to choose. The authors concluded that rational decision-making is influenced by sprint duration, which placed pressure on teams to make decisions quickly, team member's experience and resource availability.

Drury-Grogan (2014) [PS70] aimed to understand the agile teams' critical decisions that relate to the golden triangle of project management success factors, grouping them into four categories: quality, dividing work, iteration amendments and team satisfaction. According to the author, regarding decisions on quality, agile teams believe in making decisions to do only value-add work rather than wasting time on non-value add functionality. Critical decisions for dividing work and iteration amendments refer to better ways of doing the iteration work. The author suggests that the teams have to work on a specific functionality, learning all the technical competences required rather than splitting the work across teams which creates scheduling and dependency issues. Also, they emphasized the difficulty in project planning caused by iteration amendments after sign-off. Finally, team satisfaction as a critical decision means that senior management must trust agile teams to make more decisions, allowing agile teams to own their functionality and implementation.

Drury et al. (2012) [PS64] analyzed decisions made during the iteration cycle of agile projects and identified six key obstacles to these decisions: unwillingness to commit to decisions; conflicting priorities; unstable resource availability; and lack of: implementation; ownership; empowerment. The effects of these obstacles include a lack of longer-term, strategic focus for decisions, an ever-growing backlog of delayed work from previous iterations, and a lack of team engagement. Tessem (2014) [PS48] focused on how empowerment is enabled in agile and non-agile software development teams. According to the author, agile developers have more possibilities to select work tasks and influence the priorities in a development project due to team empowerment. They also seem to put a higher emphasis on the value of information when making a decision and have more prescribed activities to enable

low-cost information flow. More power is obtained through the achievement of managing roles for the non-agile developers who show interest and are rich in initiatives. The participation from the engaged developers ensures good decisions, which also depends on a good team structure, including respect among team members.

According to an exploratory longitudinal study, McAvoy and Butler (2009) [PS96] found that cohesive teams can exhibit problems such as groupthink or the Abilene Paradox (i.e., a form of collective decision making where a group decides on a course of action that no single member would have taken if they were the decision maker). The authors argued that the role of project manager in agile development initiatives needs to be reassessed, with project managers taking on the role of devil's advocate in the decision-making process. In order to evaluate the effects of the combination of expert opinion in software projects estimation, Molokken-Ostvold and Haugen (2007) [PS16] used the planning poker technique and concluded that group consensus estimates were less optimistic than the mechanical combination of individual estimates for the same tasks.

Coyle et al. (2013) [PS43] assessed the existence of group process losses during decision-making in an agile software development team, such as groupthink and inappropriate Influences and group member domination. The authors provided some recommendations, such as encouragement of generation of new ideas from each team member during decision-making within agile practices; when reaching a decision or pursuing a particular course of action, ensuring such decisions are evaluated and communicated effectively within the team; facilitating daily stand-up meetings effectively; and rotating team members and their roles when possible.

Escalation and De-escalation of Commitment

Escalation of projects happens when resources continue to be devoted to a project despite negative information indicating that the project is in trouble. In order to break the escalation cycle, de-escalation of commitment or the reversal of escalating commitments to failing courses of actions can be adopted to channel valuable resources to more productive uses. Given that the cost of project abandonment is high, it may be important to learn how project managers can redirect troubled projects in escalation situations.

Korzaan and Morris (2009) [PS47] contributed to a better understanding of the psychological factors and personality traits that lead to project escalation. The authors argued that implementation mindset (i.e., focus on the plan of action for goal achievement), and internal locus of control (i.e., tendency to perceive outcomes as either a function of their own behavior) were found to be significant predictors of the project managers' intention to continue a troubled project. The findings suggest strategies, such as Project Re-evaluation Milestones (PRMs), which can be incorporated into the project management methodology to help overcome the personality traits and states that lead to project escalation. Through the use of such PRMs, managers can contribute to ensure the re-evaluation of the gap between organizational needs and project objectives and expected project outcomes with a deliberative rather than implementation mindset. The incorporation of PRMs will also produce a more participative decision-making environment that will help to avoid the discounting of negative information.

According to Newman and Sabherwal (1996) [PS22], through a 17-year period longitudinal study, the project and psychological determinants affected the decision to increase commitment, whereas social and structural determinants influenced the decision to withdraw commitment to the project. The authors suggest the following tactics to avoid escalation of commitment: First, the effects of sunk cost may be minimized through a regular reconsideration of the project using such techniques as zero-based budgeting, which, instead of using the previous budget as a base, it involves a complete review and justification of the entire budget amount. Second, breaking down the system into "modular deliverables" to make easier to stop a failing project because at least the previously developed modules would be available. Third, escalation may be avoided through separation of responsibilities, such as excluding individuals who initially approve an IS project from the group that evaluates its progress later. Finally, making the penalties for failure less severe so that individuals are not afraid of being fired or getting demoted for supporting an IS project that eventually fails.

Pan et al. (2004) [PS21] focused on how the commitment transformation process can be enacted successfully, grouping the findings into five lessons: (i) de-escalation can be triggered when previous failing course of action is disconfirmed through tempering project managers' or members' delusional optimism, which could

be caused by cognitive biases or organizational pressures; (ii) project champion's continuous commitment is necessary for a successful turnaround despite further risk of continuing the escalation cycle; (iii) the creation of psychological safety for project members, either by removing barriers to change or by eliminating the threat inherent in past failures can help to break the escalation cycle; (iv) cognitive restructuring or new standards of judgment and evaluation learned may help project members surrender their faith in prior failing courses of action; and (v) behavior alterations by project members in order to be congruent with the new attitudes and behaviors required in the alternative courses of action.

Pan (2006) [PS86] provided a deeper understanding and explanation of the hidden dilemmas in project decision-making during IS project development and identified five types of decision dilemmas: justification, sunk cost, ambiguity, opportunity cost, and completion. The authors suggested the reduction of the desire for self-justification by separating initial and subsequent project decision-making, using group rather than individual decision-making mechanisms, and reducing the severity of penalties for failure. The sunk cost can be minimized through encouraging decision makers to set spending limits and make available alternative projects for investment. The ambiguity can be reduced by conducting serious project audits and assessing risks early and often during the development process. The opportunity cost can be evaluated by a setting a minimum rate of return targets and considering what the objectives are and whether they are best served by the status quo or an alternative course of action.

Software Project Manager's Competences

In a study to investigate what software development project team members consider to be a good project manager, Medina and Francis (2015) [PS106] pointed out two characteristics related to decision-making: taking active responsibility for problems promptly and for the consequences of their decisions and listening to project members' views and involving them in decisions and the planning process, which includes participation instead of order-giving/taking and trusting in the project members' opinions. In a distributed development project, Al-Ani and Redmiles (2009) [PS53] pointed out that while decisions are predominately made in consultation with

team members, the leader is usually the decision maker regardless of team distribution or size.

Rose et al. (2007) [PS62] used a qualitative grounded theory to develop the basis for a competence approach to understanding software project management. The authors pointed out that it is of particular importance that team members do not sit on their own problems for long stretches of time since it consumes valuable resources, but seek help from colleagues and from the project manager. The authors emphasized that the project managers have to foster a culture of openness and a certain amount of shared decision making. They also must be the chief motivator and commitment developer, and understand the sources of motivation in individual team members. Taylor and Woelfer (2011) [PS60] aimed to examine the leadership behaviors of IT project managers, with the goal of exploring the types of leadership behaviors they used to keep their projects on track. The authors pointed out the need for engagement of the team in all aspects of the project planning and decision making to build a sense of ownership of the project among the team members.

Dillon and Taylor (2015) [PS31] explored the competences of IT project managers and showed that competences associated with communication decisions (i.e., what to communicate, who to communicate to, how to communicate, and when to do so) are equally, if not more, important than functional communication skills (i.e., speaking, writing, and listening skills). Also, the competences associated with escalation decisions (i.e., what issues to escalate and when to escalate them) are essential for the effective performance of the project management role. Taylor (2007) [PS07] examined the decision-making processes of experienced IT project managers at the initial start-up stage of their projects and at key decision points during project execution. Findings showed an intertwining of rational and naturalistic modes of decision-making, and a possible link was revealed between the use of rational methods and fewer subsequent problems. In particular, greater reliance on the naturalistic approach may contribute to poor project performance in terms of management of contingencies and expectancies about client relations.

Palaciosa et al. (2013) [PS19] explored the implications of hard decisions in the context of software development projects, and, more in deep, the emotional consequences of making hard decisions in IT organizations. The findings showed the complex emotional consequences and difficulties that managers must face in hard

decision-making processes, in which the negative emotions, such as anxiety or resignation, are present in all hard decision making, even if the sample is composed of highly-skilled professionals**.**

2.6 CLOSING REMARKS

In software projects, mainly those ones with agile characteristics, the locus of decision-making moves from the project manager to the software development team, and the decision-making process changes from individual and centralized to shared and decentralized. Important decisions on what to do and how to do it are made through an interactive process involving many people who influence each other, not just a single person, which is reflected by the majority of the factors extracted from the empirical studies.

When dealing with cognitive biases, early research on decision-making had pursued purely mathematical models. The problem is that these experimental conditions were not very representative of field settings where the theories would have to be applied. In the software project context, no empirical studies were found considering the “real world” context. The escalation of commitment situations, in turn, has primarily been studied using laboratory experiments examining the effects of variables such as personal responsibility for failure, thus being unable to incorporate social determinants adequately. Very few empirical studies, as presented earlier, were not based on controlled environments.

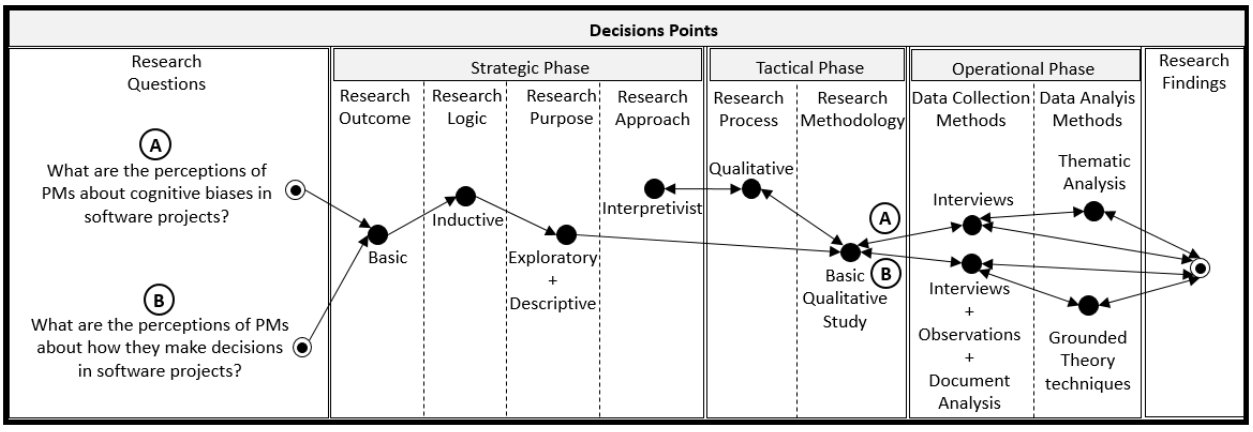
An understanding of the decision maker’s behavior and the reasons for such behavior is essential in the advancement of managerial decision-making to the development of more appropriate prescriptive decision-making methods.

3 Research Design

The choice of the research design that guide the researcher must be aligned with the type of the research and its goals (REMENYI et al., 2000). According to Creswell (2013), a researcher should make use of a methodology to guide the research project from identifying the epistemological position underlying the researcher's philosophical attitude against the object of research until the procedures for collecting and analyzing the data.

The nature of the research design requires a structured and efficient means to deal with the research activities (CRESWELL, 2013). Therefore, it is important to address some decisions points when conducting empirical software engineering research (WOHLIN and AURUM, 2014). These decision points are grouped into three phases: strategic, tactical and operational, which are presented in Figure 9. The strategy phase enables the researcher to conduct the research systematically according to the expected research products, thus involving decisions on research outcome, logic, purpose, and approach. The tactical phase includes decisions on how to operationalize the research activities, thus involving decisions on research process and methodology. Finally, the operational phase includes decisions on actions that will be taken when implementing the research, including data collection methods and data analysis techniques.

Figure 9. Research method



In general, the studies that investigate the decision-making process in software projects showed elements of a positivist assumption. According to Myers

(1997), a positivistic approach assumes that the reality is an objective fact and can be described by measurable properties which are independent of the observer. However, this study aims to bring the researcher to the research subject from the point of view of the individuals through an inductive logic and exploratory and descriptive purpose in an attempt to explore aspects that can often be hidden. Therefore, it is necessary a different epistemological positioning to consider subjectivity and complexity inherent to the studied phenomenon.

In this sense, the epistemological positioning chosen is interpretivism, which recognizes the subjectivity of the researcher. The interpretivism argues that the purpose of the human sciences is to understand human action (SCHWANDT, 2000). In this line, as stated by Merriam (2009), the focus of analysis is related to the concern to understand how participants socially construct the reality. In this process, the participant uses his or her subjectivity based on his or her experiences and gives meaning to the phenomenon being analyzed. The ontological stance that will be adopted in this study is based on constructivism. According to Sandberg (2001), in this perspective, the reality is not objective, nor it is something ready; it is socially constructed. The decision-making process in software project management cannot be analyzed in a single dimension or isolated from one context or situation.

The decisions related to the research design considered the expected outcome for this basic research: a substantive theory of decision-making in software project management. There are three different levels of theory: grand (formal), middle-range and substantive (SAUNDERS et al., 2009). A grand (formal) theory changes the way we reflect on the world, thus being universally applicable. Middle-range theories are more restricted in their application and unlikely to change fundamentally the way we think about the world. Substantive theories, in turn, are restricted to providing insights for a particular time, research setting and problem. They enhance our understanding of specific problems and offer guidance for actions that need to be undertaken in field settings. They may also, in combination with other substantive theories that present similar propositions, lead to the development or refinement of middle-range theories. According to Glaser and Strauss (1967, p. 79):

> "*Substantive theory is a strategic link in the formulation and generation of grounded formal theory. We believe that although formal theory can be generated directly from data, it is more desirable, and usually necessary, to start the formal theory from a substantive one. The latter not only provides a stimulus to a "good idea" but it also gives an initial direction in developing relevant categories and properties and in choosing possible modes of integration. Indeed it is difficult to find a grounded formal theory that was not in some way stimulated by substantive theory*."

As stated by Eisenhardt (1989), the process of theory generation must be systematic and explicit. Although we did not consider each organization as a case study, but as different contexts in order to diversify the collected data, we followed the roadmap for building theories from case study research proposed by Eisenhardt (1989) with some considerations: (i) the participants were intentionally selected based on the constraint of being managing a project during the research; (ii) we used only qualitative data collected through the interviews, observations and data analysis; (iii) this research was conducted by one researcher. A second researcher was responsible only to conduct the interviews in Organization A during the first phase of the research; and (iv) since we did not consider each organization as a case study, we did not tabulate the evidences for each organization. These activities are marked with **X** in Table 3, which describes the process proposed by Eisenhardt (1989).

Table 3. Process of building theory from case study research

Step	Activity	Reason
Getting Started	Definition of research question	Focuses efforts
	Possibly a priori constructs	Provides better grounding of construct measures
	Neither theory nor hypotheses	Retains theoretical flexibility
Selecting cases	Specified population	Constrains extraneous variation and sharpens external validity
	Theoretical, not random, sampling **X**	Focuses efforts on theoretically useful cases (i.e., those that replicate or extend theory by filling conceptual categories)

Continuation		
Step	**Activity**	**Reason**
Crafting Instruments and Protocols	Multiple data collection methods	Strengthens grounding of theory by triangulating of evidence
	Qualitative and quantitative data combined **X**	Synergistic view of evidence
	Multiple investigators **X**	Fosters divergent perspectives and strengthens grounding
Entering the Field	Overlap data collection and analysis including field notes	Speeds analyses and reveals helpful adjustments to data collection
	Flexible and opportunistic data collection methods	Allows investigators to take advantage of emergent themes and unique case features
Analyzing Data	Within-case analysis	Gains familiarity with data and preliminary theory generation
	Cross-case pattern search using divergent techniques	Forces investigators to look beyond initial impressions and see evidence thru multiple lenses
Shaping Hypotheses	Iterative tabulation of evidence for each construct **X**	Sharpens construct definition, validity and measurability
	Replication, not sampling, logic across cases	Confirms, extends and sharpens theory
	Search evidence for “why” behind relationships	Builds internal
Enfolding Literature	Comparison with conflicting literature	Builds internal validity, raises theoretical level, and sharpens construct definitions
	Comparison with similar literature	Sharpens generalizability, improves construct definition, and raises theoretical level
Reaching Closure	Theoretical saturation when possible	Ends process when marginal improvement become small

Source: EISENHARDT (1989, p. 533)

The following subsections details each step to create the substantive theory.

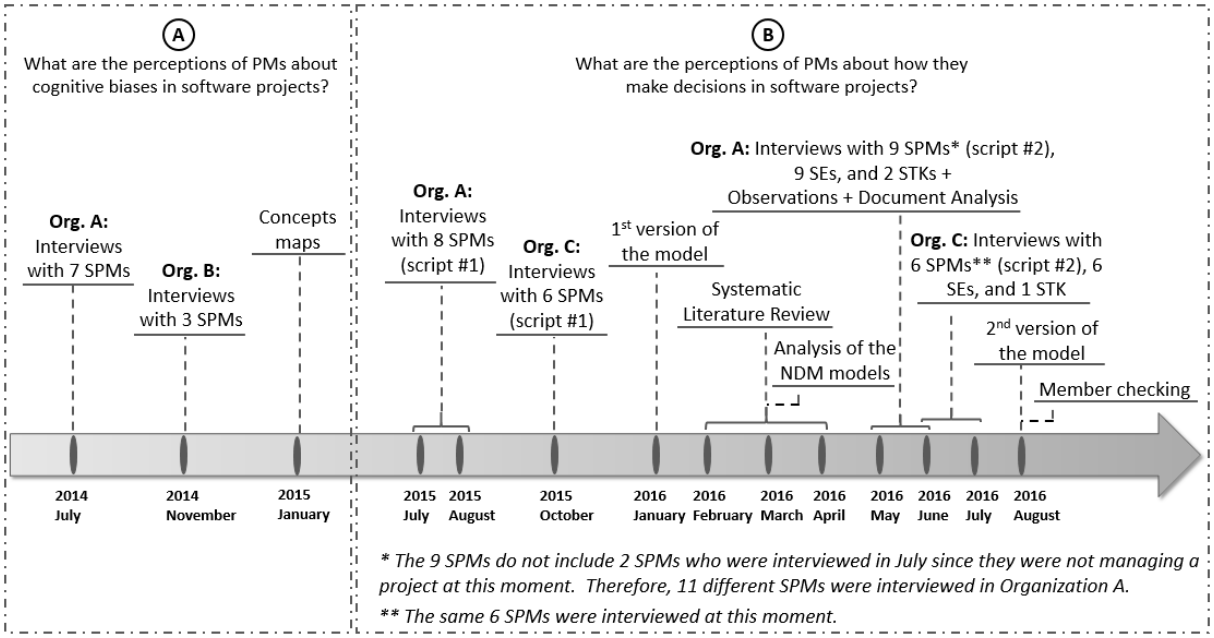
3.1 GETTING STARTED

Decision makers are known to rely on a few judgmental rules, or heuristics, to simplify complex decision situations which can introduce cognitive biases. Since there is a lack of empirical studies relating project management to cognitive biases, specifically in the software context, we initially aimed to understand the perceptions of software project managers about cognitive biases in software projects by shedding light on the causal factors of SPMs' cognitive biases and how they deal with them, including techniques and tools they use to minimize the cognitive biases' adverse effects. Through an exploratory study, eight cognitive biases were evaluated based on semi-structured interviews with seven active software project managers from a large Brazilian governmental organization and three software project managers from a small Portuguese private organization.

The interviews were conducted in a large Brazilian governmental organization (Organization A) during 2014 July and in a small Portuguese private organization (Organization B) during 2014 November, as shown in Figure 10. The small Portuguese private organization was founded in 2001 with a focus on design and product development such as Web Portals and Systems Integration by using the latest Microsoft technologies. The software development process of this projectized organization is widely based on agile practices. The collaborators have a broad experience in projects for clients in a diversity of company sectors, such as telecommunications, finance, industry, distribution, tourism and public sector. The large Brazilian governmental organization is detailed in Appendix E.

All the interviews with the experienced SPMs from this phase of the research totaled 5 hours and 49 minutes of audio time. The preliminary findings (CUNHA et al., 2014, 2015a, 2015b, 2015c), detailed in Chapter 4, suggested that we needed a more grounded understanding of the mechanisms of decision-making. Thus, a broader research protocol, described in the following subsections, was prepared in order to understand the perceptions of the software project managers about how they make decisions in software projects. This second phase was conducted in Organization A and in a large Brazilian private organization, referred as Organization C, which is detailed in Appendix F.

Figure 10. Timeline of data collection



We did not use any priori theory and, consequently, no pre-defined hypotheses to retain theoretical flexibility, as recommended by Eisenhardt (1989). A systematic literature review on decision-making in software project management from a naturalistic perspective was conducted only after the elaboration of the first version of the model (CUNHA et al., 2016a, 2016b), as shown in Figure 10, in order to compare our findings with the literature and to support the refinement of the interview script. The analysis of the naturalistic decision models was also conducted at this moment.

3.2 SELECTING THE CASES

Enterprise environmental factors refer to conditions, not under the control of the project team, that influence, constrain, or direct the project. These factors are considered inputs to most planning processes, may enhance or constrain project management options, and may have a positive or negative influence on the outcome. Two of these factors are related to organizational structure and organization type.

The organizational structure can affect the availability of resources and influence how projects are conducted, ranging from functional to projectized, with a variety of matrix structures in between (PMI, 2013). In a functional organization, there is not a formal project manager assigned, but rather a functional manager,

sometimes with the assistance of a project expediter or a project coordinator. The matrix organizations can be classified as weak, balanced, or strong depending on the relative level of power and influence between functional and project managers. The balance matrix organization recognizes the need for a project manager, but it does not provide the project manager with the full authority over the project and project funding. Finally, in a projectized organization, most of the organization's resources are involved in project work, and project managers have a great deal of independence and authority.

The purposive and convenience sampling in this basic qualitative research aimed to increase the diversity of the collected data by choosing different contexts: a large governmental balanced matrix organization (Organization A) and a large private projectized organization (Organization C).

3.3 CRAFTING INSTRUMENTS

As recommended in the literature (MERRIAM, 2009), we used multiple data collection methods: interviews, document analysis, observations, and questionnaires. During the second phase of the research, semi-structured interviews with three groups of participants from Organization A and C were performed using different interview scripts: a) software project managers, to obtain information about their experience when making decisions; b) software team members; and c) functional and PMO managers, both of them to obtain their perspectives about how decisions are made by software project managers. These last two groups were important to triangulate the information collected from the software project managers. The interviews scripts, which are detailed in Appendix C, were composed of open-ended questions and included different types of questions, aimed at exploring experience and behavior, opinion and values, feelings, knowledge and the background of the participants.

The questions were presented in a funnel format, beginning with general questions and moving towards more specific ones (RUNESON and HOST, 2008). This initial questions (see Interview Script #1 in Appendix C) are focused on understanding the general aspects of decision-making. The general questions encouraged important reflections bringing more details when answering the specific questions, thus making possible to understand how past experiences can influence

preferences, feelings, and behavior. They also served to build a close and trustful relationship between the researcher and the interviewee. All positive question had a corresponding negative one, e.g. "*Q7. What does your organization offer or do to stimulate good project management?*" and "*Q9. What does your organization do that difficult the project management?*".

As discussed by Argyris and Schön (1974), there could be a gap between how people define a concept and how they actually perceive, describe and react to it in practice. Thus, two questions were included in the interview guide to identify adjective sets used to describe an efficient and an inefficient SPM as well as the characteristics related to decision-making (see Appendix C): "*Q31. How would you describe a colleague who has a good performance as a software project manager?*" and "*Q34. How would you describe a colleague who has a bad performance as a software project manager?*". These questions were followed by the questions: "*Q32. Among the mentioned skills, which ones are essential to a good decision maker?*" and "*Q35. Among the mentioned skills, which ones are essential to a bad decision maker?*".

We validated the interview scripts by conducting pilot interviews with two experienced software project managers from different organizations. We made minor adjustments to the phrasing of some questions and also timed the pilot interviews to have an estimate of the duration of the actual interviews. It was important to give the participants an estimate on the time they would spend while participating in the research. We estimated 60 minutes for the initial interviews, which was consistent with duration of the actual interviews.

Based on the findings consolidated in the first version of the model (CUNHA et al., 2016a, 2016b), a new interview script was elaborated to deepen our understanding of the identified categories in the first version of the model (see Interview Script #2 in Appendix C). During the refinement of the interview script, we analyzed measures of individual differences in decision-making thus having questions adapted and included in our interview script.

"Individual differences" is a broad term covering any variable that differs between people from decision style to cognitive ability to personality. The measures of individual differences in decision making can be divided into measures of style, approach, and competence. For the purpose of our interview script, we analyzed the

following measures: General Decision-Making Style Instrument (SCOTT and BRUCE, 1995), Compensatory Style Questionnaire (ZAKAY, 1990), Decision Style Scale (HAMILTON et al., 2016), Melbourne Decision Making Questionnaire (MANN et al., 1997), Regret Scale (SCHWARTZ, 2002), Elaboration on Potential Outcomes (NENKOV et al., 2007), and Proactive Decision Making (SIEBERT and KUNZ, 2016). Finally, after the consolidation of the revisited model, we applied questionnaires to some SPMs during member checking (HARPER and COLE, 2012), also known as informant feedback or respondent validation, to validate the findings, improving accuracy, credibility, and internal validity of our interpretations (see Appendix D).

3.4 ENTERING THE FIELD

Since the instruments were defined, we selected the participants and determined how the observations and documents were analyzed, as described in the following sections.

3.4.1 PARTICIPANT SELECTION

Sometimes projects are structured in such a way that there are multiple project managers involved, and this opens the possibility where some responsibilities may not be fully or adequately defined, thus opening the possibility of disagreement and the related conflict. For the purpose of this work, we considered projects managed by only one SPM. We sampled project managers from two different organizations to increase the richness of the data. The unit of analysis was the SPM who was actively managing a project during the research. During the interviews we collected data about decisions but did not investigate or sample specific decisions.

Because emerging patterns based on a considerable variation are likely to have more value (MERRIAM, 2009), we aimed for a good coverage of age, background, education, years of employment in the organization, and management of different types of projects in the organization to ensure a fertile sample. Eleven SPMs were interviewed from Organization A, and six SPMs were interviewed from Organization C, totaling seventeen SPMs. All of them were interviewed twice, except two, who were not managing projects during the second round of interviews, which

were conducted to deepen our understanding of the identified categories in the first version of the model.

For each SPM, one team member was interviewed in order to triangulate the data, totaling 15 software engineers. These software engineers had a leader role in the projects and were selected considering the following questions asked to each SPM: *(i) Who is the most influent project member?; (ii) Who is the project member who most give an opinion during the team meetings?; (iii) When you are having difficulty in your task, whom do you ask for help?;* and *(iv) Who is the most capable person to solve a conflict when it arises?*. Also, two PMO managers from both organizations as well as one software development functional manager's assessor from Organization A were interviewed since they were mentioned by the SPMs during the interviews, thus representing a sample of stakeholders. A total of thirty five participants were interviewed in this phase of the research, described in Appendices E and F.

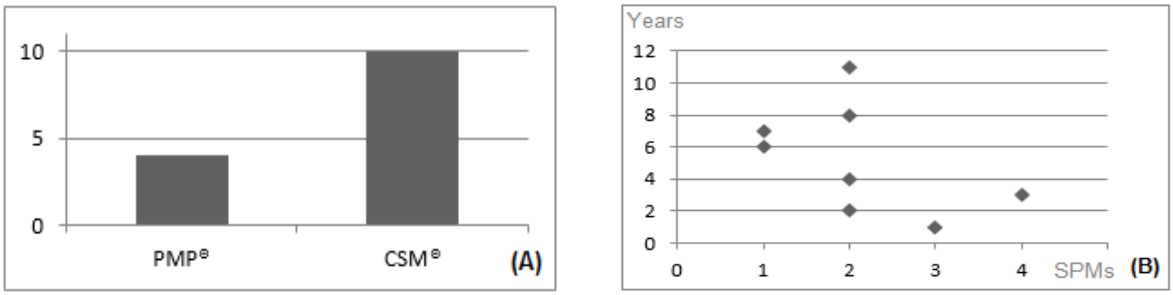
3.4.2 INTERVIEWS

The interviews were carried out at the organizations' own facilities during the period described in Figure 10. All the audio time totaled 30 hours and 46 minutes (or 399 pages), from which 25 hours and 48 minutes (or 302 pages) corresponding to the interviews with the SPMs. Considering the seventeen SPMs, fifteen software engineers, two PMO managers and one software development functional manager's assessor, we conducted 50 interviews, since each SPM was interviewed twice.

As shown in Figure 11a, from the seventeen SPMs interviewed, four SPMs were PMP® (Project Management Professional) and ten were CSM® (Certified Scrum Master). The former is an internationally recognized professional designation offered by the PMI (Project Management Institute) based on the PMBOK (Project Management Body of Knowledge) and the latter is a certification for Scrum Master, who acts as a facilitator for a product development team using the Scrum methodology and allows the team to self-organize and make changes quickly by managing the process for how information is exchanged. Although the Organization C has a more evident agile culture than Organization A, the majority of the CSMs were from Organization A, which can be interpreted as the importance given by the SPMs to the agile practices despite the more rigid structure of the organization.

Figure 11b shows the distribution of the sample according to the years managing projects in the organization.

Figure 11. Information about the participants



3.4.3 OBSERVATIONS AND DOCUMENT ANALYSIS

The observations, as well as the document analysis, were conducted only in the large Brazilian governmental organization with its permission. Due unauthorized access to places and events in the organization as well as confidentially issues, these data collection methods were not used in the large Brazilian private organization.

Although the perceptions we were investigating are difficult to observe, in parallel to the interviews, we participated in some meetings with the SPMs and stakeholders, including members from the support departments, in order to observe how decisions were made. Complete and detailed notes about the individual and collective actions of the respondents were registered during the observations as well as significant processes occurring in the environment. Also, some documents such as scope and change request documents, risks analysis and lessons learned recorded in the project management tool adopted by the organization were analyzed to deepen the understanding from the interviews.

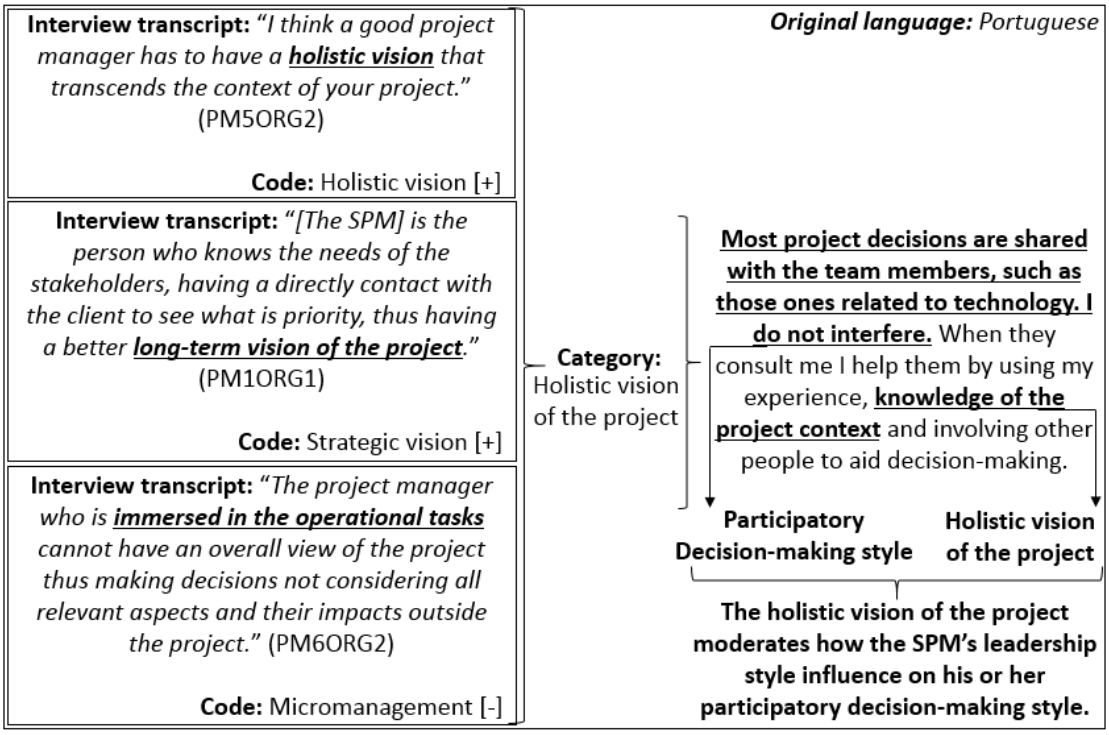
3.5 ANALYZING DATA

The objective of the qualitative analysis is to consolidate, reduce, and interpret data obtained from various sources and make sense of them (MERRIAM, 2009). It involves labeling and coding all data in order to identify similarities and differences to describe the phenomenon under study. Data analysis was performed in parallel with data collection, in incremental and iterative steps, as recommended by Merriam (2009).

We followed the guidelines provided by Strauss and Corbin (2014) to code, categorize, and synthesize data, towards the construction of a central story that explains the project managers' perceptions about how they make decisions in software projects. The data analysis and synthesis were supported by ATLAS.ti[1].

Data analysis began with the open coding of the transcripts. Post formed codes were constructed as the coding progressed and were attached to particular pieces of the text. Then, the codes arising from each interview were constantly compared to codes in the same interview and from other interviews. From the constant comparisons of the codes, we grouped them into categories that represent factors related to decision-making in software project management. As the process of data analysis progressed, relationships among categories were built. Finally, core categories were chosen according to their general explanatory power, propositions emerged, and a narrative was created to describe the central story. These steps are illustrated in Figure 12.

Figure 12. Building codes, categories and relationships.



In qualitative studies, the researcher is the primary instrument of data collection and analysis. In order to make explicit the researcher's assumptions,

[1] http://atlasti.com/

worldview, values and his path to define this research, a background description is available in Appendix A.

3.6 ENFOLDING THE LITERATURE

Following the guidelines of Eisenhardt (1989), after completing the data analysis and shaping initial hypothesis, we looked at the literature to sharpen construct definitions and generalizability and raise the theoretical level. We contrasted and compared our results with the naturalistic decision models and with the findings from the systematic literature review in Section 5.4.

3.7 REACHING CLOSURE

Throughout the iterations of data collection from the two rounds of interviews with the SPMs and subsequent analysis, during the second phase of the research conducted in Organization A and C, we checked for theoretical saturation (EISENHARDT, 1989). At this point, we consolidated the results and used member checking technique to validate the findings, improving accuracy, credibility, and internal validity of our interpretations (HARPER and COLE, 2012).

We submitted a questionnaire through Google Forms® to the fifteen SPMs from Organization A and C who were interviewed twice to evaluate their level of agreement with our interpretation of the data (see Appendix D). We received six responses, three from each organization, through which the SPMs demonstrated an agreement with the findings.

3.8 ETHICS

In order to meet the ethical requirements of this type of research, we obtained the approval of the organizations to carry out the research. Each participant was given an explanation about the research and their rights to guarantee the confidentiality of the data provided, the anonymity of the participant, and the right to withdraw from the research at any moment (MERRIAM, 2009). All invited individuals freely agreed to participate, and no participant withdrew from the research. Each one authorized through a specific question during the interviews about his or her agreement to participate in this research.

Each participant was first contacted in advance, and each interview occurred in a private meeting room in each organization. All the audio of the interview sessions was recorded with the consent of the participants and was transcribed verbatim.

3.9 THREATS TO VALIDITY AND RELIABILITY

The validity and quality of a research project require a verification of its reliability to minimize the subjectivity and bias from the researchers (RUNESON and HOST, 2008). In this research, we provided a rich description of the research method, the context in which the research was performed, and the results themselves. Second, we sampled the participants to achieve maximum variation since this would help to provide richer data and a more robust resulting theory. We addressed the threats to validity and reliability of our results from the three perspectives proposed by Merriam (2009):

- **Credibility:** the central problem is how to provide evidence that the findings are credible as the data is presented. To increase credibility, we used triangulation by having data collected from participants with different roles and by using multiple data collection techniques inside each case. We then used member checking with a sample of SPMs to avoid misinterpretations of what participants said.
- **Consistency:** an important question in qualitative research is whether the findings are consistent with the data collected. To increase consistency, we used triangulation in data collection and analysis inside each case. We also kept research diaries and process logs that can be used as audit trails by external reviewers.
- **Transferability:** it is a common understanding in qualitative research that generalization of research findings should be performed by the reader or user of the study. In this sense, reader or user can decide to what extent the findings can be applied to other situations. The possibility of transferability to another setting is enhanced by the maximum variation in the sample, whether it be the sites selected or the participants interviewed, and by the use of rich, thick description of the settings and participants of the study, as well as a detailed description of the findings with adequate

evidence presented in the form of quotes from participant interviews, field notes, and documents.

Since the research design was explained, the next chapter presents the findings about the perceptions of SPMs about cognitive biases in software projects by shedding light on the causal factors of SPMs' cognitive biases and how they deal with them, including techniques and tools they use to minimize the cognitive biases' adverse effects.

4 An Exploratory Study on Cognitive Biases in Software Project Management

In many cases, the problems involve a great variety of factors to be considered when a decision has to be made. When people think consciously, they can focus on only a few things at once (DIJKSTERHUIS et al., 2006). The more factors involved in the analysis, the more difficult it is to make a logical choice. In this way, a project manager will manage a project based on how he or she perceives the project.

Decision makers are known to rely on a few judgmental rules, or heuristics, to simplify complex decision situations. Although these “rules of thumb” are often necessary and useful, they also introduce cognitive biases that can lead to severe and systematic errors in decision making (KAHNEMAN et al., 1982). Thus, cognitive biases can be viewed as a negative consequence of adopting heuristics.

Kahneman (2011) emphasizes that people cannot rely on intuition in the absence of stable regularities in the environment. The opportunity for professionals to develop intuitive skills depends primarily on the quality and speed of the feedback, as well as sufficient opportunity to practice. If the environment is sufficiently regular and one who judges has a chance to learn about their regularities, the associative machinery will recognize situations and generate fast and accurate decisions. In this case, the intuitions are more reliable. Otherwise, in a less regular environment, the judgment heuristics are invoked, with a predisposition to reject options that lack the attributes people value. The world in people's heads is not an accurate model of reality; people's expectations about the frequency of events are distorted by the preponderance and emotional intensity of the messages to which they are exposed.

Simon (1957) suggested the concept of bounded rationality, that is, humans have a limited mental capacity and cannot directly capture and process all of the world's complexity. Instead, people construct a simplified model of reality and then use this model to come up with judgments. Although we behave rationally within the model, it does not necessarily represent reality. According to Hogarth (1987), given

the limited human information-processing capacity, we are necessarily dependent upon the use of operations that simplify judgmental tasks and reduce mental effort. In the hasty search for solutions, it is hard for project managers to have this sensibility, and thus, making them susceptible to cognitive biases.

In most research on biases, stimuli are not selected randomly but are designed to maximize the chance of detecting suboptimal processes (LOPES, 1988). Subjects are also selected non-randomly (i.e., they are typically students) and do not represent the range of experience ordinarily found in a domain. Christensen-Szalanski (1986) has argued that researchers should provide domain-specific measures of the importance of bias, and estimates of its prevalence in a domain.

The naturalistic point of view does not wholly banish the idea that errors occur when people make decisions or even the idea that those errors are systematic. In this perspective, biases represent a failure of metacognitive processes that facilitate problem recognition and retrieval of appropriate solutions, that monitor for potential problems in a decision process, and that verify and revise proposed solutions (COHEN, 1993b).

Decision-making is a skill that can be improved with experience and training (HASTIE and DAWES, 2001) and thus project managers can learn and teach themselves on how to make better choices by overcoming common mental traps. In this sense, it is important to shed light on causal factors of SPMs' cognitive biases, eliciting common tools and techniques used to minimize the cognitive biases' adverse effects (CUNHA et al., 2014, 2015a, 2015b, 2015c).

4.1 CONDUCTING THE EXPLORATORY STUDY

According to Tversky and Kahneman (1974), the cognitive biases can be classified into: (i) behavioral biases, (ii) perceptual biases, (iii) probability and belief biases, (iv) social biases, and (v) memory biases. Since there are many cognitive biases in the literature, eight cognitive biases were selected for the purpose of this study based on the researcher's experience monitoring software projects as PMO manager. These cognitive biases are described in Table 4.

Table 4. Description of the cognitive biases

Cognitive Bias	Description
Anchoring bias *(iii)*	The human tendency to rely intensively on a trait or piece of information without making sufficient adjustments.
Exposure effect *(v)*	The human tendency to like something simply because it is familiar.
Hindsight bias *(v)*	Human tendency to be unable to reconstruct past states of knowledge or beliefs that changed later.
Halo effect *(ii)*	The human tendency to evaluate a particular item that may interfere in other thus contaminating the final result.
Planning fallacy *(iii)*	The human tendency to underestimate the duration of the project´s activities.
Sunk-cost fallacy *(i)*	The human tendency to keep an action running even knowing that the expected results will not be achieved and that the cost that has already been spent cannot be recovered.
Availability-related bias *(iii)*	The human tendency to rely on rare events based on how easy an example can be remembered.
Parkinson´s law effect *(i)*	The human tendency to procrastinate the execution of activities until the end date originally agreed.

As stated earlier, seven SPMs from a large Brazilian governmental organization and three SPMs from a small Portuguese private organization were interviewed. During the interviews, for each bias, after presenting its description, the following questions were asked to the SPMs: "*Q1. Have you ever experienced a situation related to this bias in the context of project management?*" and "*Q2*. *If so, describe the situation and actions that were taken.*".

The thematic analysis of individual responses was performed by using two complementary techniques: (i) Strategic Options Development and Analysis approach (EDEN and ACKERMANN, 1998) for the creation and treatment of concepts maps, which includes aggregating and clarifying the concepts and its relations, and (ii) triangulation technique as a way to prevent the influence of individual analysis based on interviewer-researcher's personal opinion (NORTHCUTT and MCCOY, 2004). The analysis of the semi-structured interviews was conducted by the following three steps:

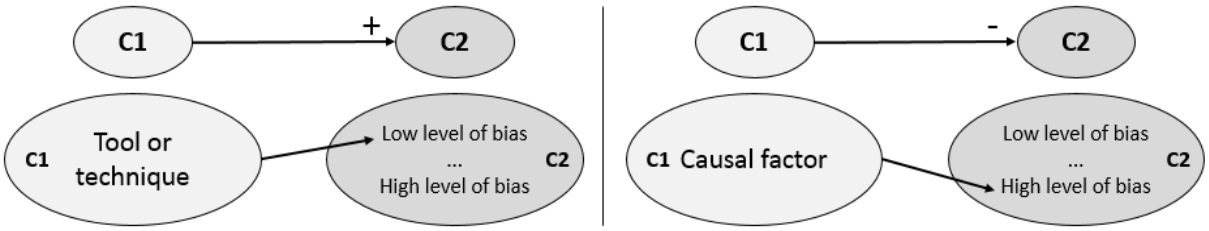
- **Grouping the responses for each question:** As a starting point of creative thinking, all responses to each question were grouped to extract

information about causal factors, tools and techniques, with the objective of building a map with all the concepts (or constructs).

- **Discussion of initial concepts map:** During the triangulation process, the concepts map was discussed with the software project managers to review it by including, aggregating or disaggregating the concepts. This process was facilitated by a second researcher in Organization A.
- **Validation of the consolidated concepts map:** After the interactions from the previous step, an updated concepts map was obtained with the contributions of each software project manager, thus resulting in a consolidated concepts map.

In order to facilitate the visualization of the concepts map, it was divided into four maps with two cognitive biases in each one. The concepts related to each cognitive bias consist of two poles: the main pole (first sentence) and the opposite one. In this case, the symbol "..." is read "instead of". The arrows indicate the direction of the connection of concepts. A positive sign (+) at the end of the arrow indicates that the origin of the arrow leads to the first pole of the bias, while a negative sign (-) at the end of the arrow indicates the origin of the arrow leads to the second pole of bias. In summary, the tools and techniques are related to the first pole (low occurrence of bias) and the causal factors to the second pole (high occurrence of bias), as illustrated in Figure 13. The tag "[B, P]" indicates that the concept was identified by SPMs from both organizations; the tag "[B]" indicates that the concept was identified by SPMs from the Brazilian organization; and the tag "[P]" indicates that the concept was identified by SPMs from the Portuguese organization.

Figure 13. Causal relationships in the concepts maps



4.2 ANCHORING AND HINDSIGHT BIAS

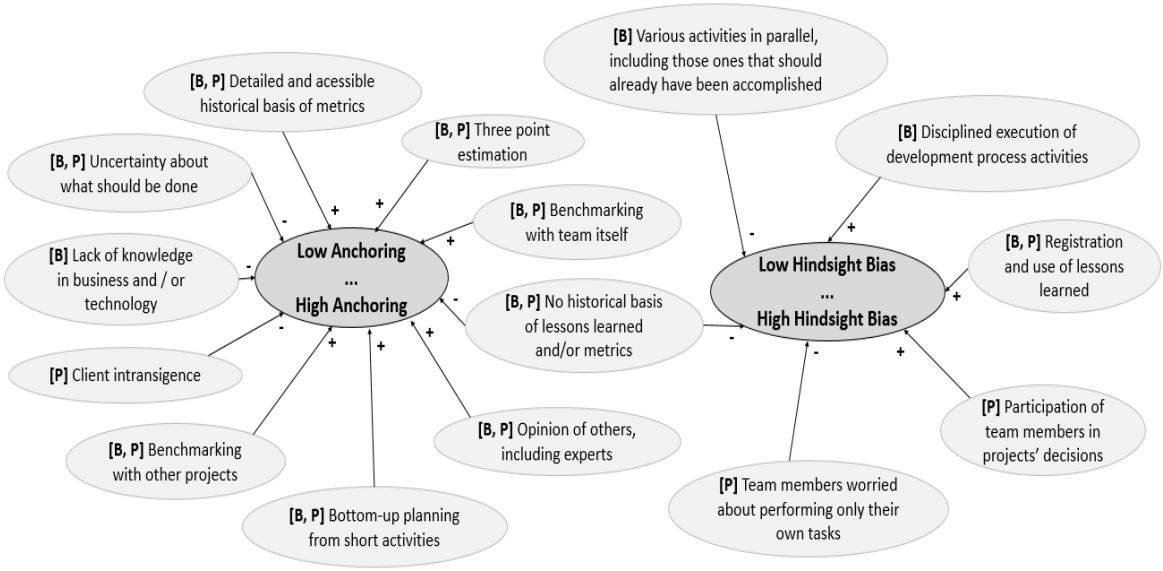
Anchoring and adjustment is a psychological heuristic that influences the way people intuitively assess probabilities. According to this heuristic, people start with an implicitly suggested reference point and make adjustments to it to reach their estimate. A person begins with a first approximation (anchor) and then makes incremental adjustments based on additional information. These adjustments are usually insufficient, giving the initial anchor a large amount of influence over future assessments.

When referring to anchoring bias, all project managers from both organizations described situations about time estimation. According to them, uncertainty about what should be done, including the required process' tasks, and the absence of a historical basis collaborate for anchoring initial estimate. The Brazilian SPMs also mentioned the lack of knowledge in business or technology and the Portuguese SPMs emphasized the client intransigence. This last causal factor was associated with the fact that the clients are used to anchor their deadlines based on their own, without considering technical aspects, giving much more work to the project managers to make a realistic plan.

In order to minimize its effects, an alternative presented was detailing the development process activities that led to such estimate so that can be questioned and discussed. Other techniques presented are related to benchmarking the estimates of the most critical activities using data from the team members and from the other projects, which requires an organizational historical basis and culture in measurement and analysis (JONES, 2008).

The SPMs also mentioned the three-point estimation technique (PMI, 2013), which provides an expected duration of activities and clarify the range of uncertainty around the expected duration by considering an optimistic, pessimistic and most likely view. The opinion of others was considered essential through knowledge sharing with team members, other project managers, the Project Management Office (PMO), and so on. This socialization process is characterized by social interaction through which tacit knowledge is transferred and shared in face-to-face meetings (NONAKA and TAKEUCHI, 1995). The concepts related to anchoring are illustrated in Figure 14.

Figure 14. Concepts map of anchoring and hindsight bias



Hindsight bias, also known as the knew-it-all-along effect or creeping determinism, is the inclination after an event has occurred, to see the event as having been predictable, despite having been little or no objective basis for predicting it. It is a multifaceted phenomenon that can affect different stages of designs, processes, contexts, and situations. Hindsight bias may cause memory distortion, where the recollection and reconstruction of content can lead to false theoretical outcomes.

When referred to hindsight bias, as illustrated in Figure 14, the lack of historical basis of lessons learned including what went right and wrong was considered as causal factor by SPMs from both organizations. This issue is reported by some authors, as the difficulty in storing information that can be retrieved easily (PEMSEL and WIEWIORA, 2013) and that is systematically organized (BARCLAY and OSEI-BRYSON, 2010). The Portuguese SPMs emphasized the concentration of team members only on their own tasks, without a holistic view of the project, which leads them to reclaim when something fails. In this sense, an approach to control this bias was forcing their participation on project's important decisions, making them feel responsible for the whole product.

The Brazilian SPMs also mentioned the performing of various activities in parallel, including those that should have already been accomplished, which generates confusion about what should have been done at the time. They mentioned the discipline about the sequence in conducting the development process activities as an approach to minimize the adverse effect of this cognitive bias. Both

organizations also cited the registration and use of lessons learned in the case they include contextual information to justify the decision made at some point of the time.

4.3 EXPOSURE EFFECT AND AVAILABILITY-RELATED BIAS

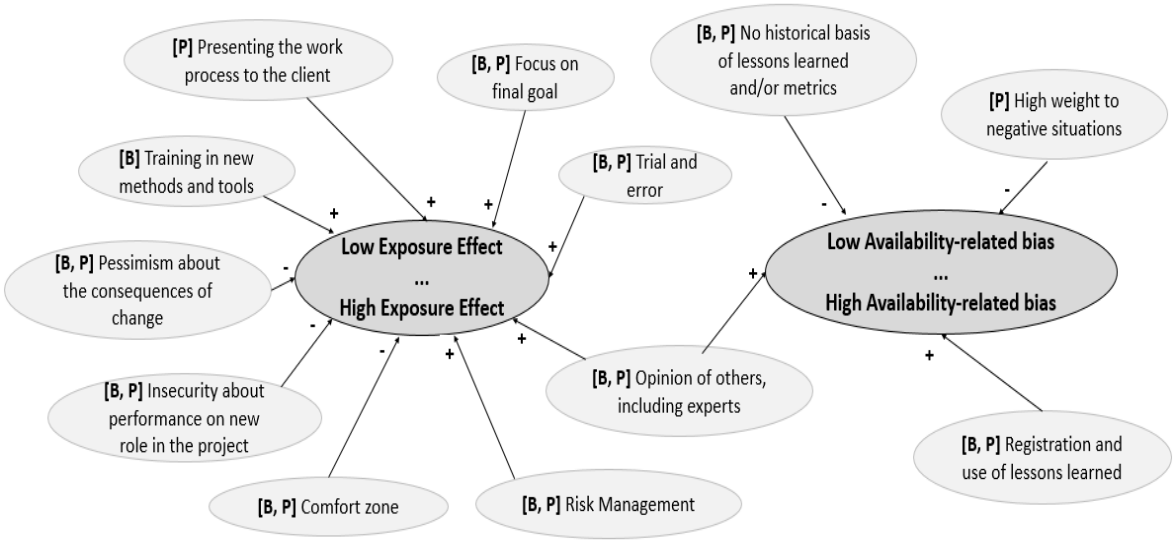
The exposure effect is a psychological phenomenon by which people tend to develop a preference for things merely because they are familiar with them. In social psychology, this effect is sometimes called the familiarity principle.

Regarding exposure effect, the project managers mentioned causal factors, tools, and techniques they use to deal with it in their teams. Comfort zone, pessimism about the consequences of change and insecurity about performance on the new role in the project, because he or she is already recognized in his or her current function, were indicated as causal factors by SPMs from both organizations. To overcome this limitation, the trial and error through execution of pilot tasks or elaboration of concept proofs was referred as an alternative to review the new approach either concerning to role changes in teams, use of new technology or new development method, with the possibility of the rollback, if necessary.

The SPMs also emphasized the necessity to focus on the final goal, in which the SPM has a major role for motivation, emphasizing the benefits of change, focusing on the learning process, and managing the potential problems related to changes in form of risks. Project risk management is an important aspect of project management. According to the PMI (2013, p. 310), project risk is defined as "*an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project´s objectives such as scope, schedule, cost, and quality*". Risk management is one of the ten knowledge areas in which a project manager must be competent.

The opinion of others was referred to provide an outside view of the project team, which increases the credibility of change. The capacitation of team members in the new methods and tools was considered necessary by the Brazilian SPMs while presenting the work process to the clients, making them comfortable with it, was mentioned by the Portuguese SPMs. The concepts related to the exposure effect are illustrated in Figure 15.

Figure 15. Concepts map of exposure effect and availability-related bias



The availability heuristic is a mental shortcut that relies on immediate examples that come to a given person's mind when evaluating a specific topic, concept, method or decision. The availability heuristic operates on the notion that if something can be recalled, it must be important, or at least more important than alternative solutions which are not as readily recalled. Subsequently, under the availability heuristic, people tend to weigh their judgments toward more recent information, making new opinions biased toward that latest news.

Regarding availability-related bias, as shown in Figure 15, the lack of historical basis was also referred as a causal factor by the SPMs from both organizations. Accordingly, the regular recording of lessons learned during the project was considered essential, not only at the end of the project. More important than knowledge storage is how it is stored. In this sense, the Project Management Office (PMO) aims to have an important role (DESOUZA and EVARISTO, 2006). The opinion of others once again was presented as important. The Portuguese SPMs also emphasized the high emphasis that is usually given to negative situations, even if there are much more positive situations influencing the decisions.

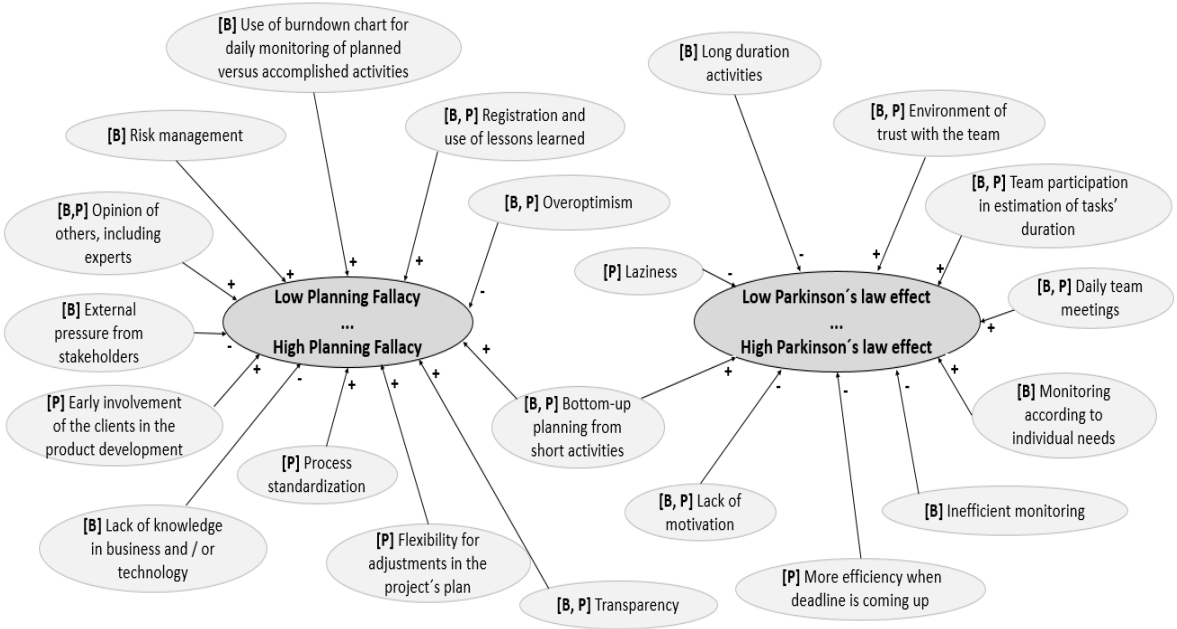
4.4 PLANNING FALLACY AND PARKINSON'S LAW EFFECT

The planning fallacy is a phenomenon in which predictions about how much time will be needed to complete a future task display an optimism bias, thus underestimating the required time.

When referring to the planning fallacy, the overoptimism to meet the stakeholder expectations were mentioned by the SPMs from both organizations as one of the factors causing this bias. The Brazilian SPMs also mentioned external pressure from stakeholders and lack of knowledge in business or technology. In this case, the use of burndown chart for daily monitoring of planned versus accomplished activities was referred to by them, which facilitates the identification of possible deviations and on decision making about time. Such practices are common in agile processes (SCHWABER, 1997). In this sense, as well as in other biases, risk management proved to be essential.

The Portuguese SPMs complemented the list of methods to minimize the adverse effects of this bias by including the early involvement of the clients in the product development, flexibility for adjustments in the project's plan, and process standardization. The SPMs from both organizations emphasized the opinion of others, such as the participation of project´s stakeholders in planning, ensuring transparency and consensus, the bottom-up planning from short activities and registration and use of lessons learned. The concepts related to the planning fallacy are illustrated in Figure 16.

Figure 16. Concepts map of planning fallacy, and Parkinson´s law effect



Parkinson's law effect indicates that work expands so as to fill the time available for its completion. Lack of motivation was suggested as a causal factor of

Parkinson's law effect by the SPMs from both organizations. As illustrated in Figure 16, the Brazilian SPMs pointed out the long duration of the tasks and the inefficient monitoring as causal factors while laziness and better efficiency when the deadline is coming up were cited by the Portuguese SPMs.

In addition to bottom-up planning from short activities, lasting between one and three days, the SPMs from both organizations indicated team participation in the estimation of tasks' duration, daily team meetings and the creation of an environment of trust with the team as good alternatives to minimize the negative effects of this bias. These practices are referred in the literature about agile methodologies (SCHWABER, 1997). The Brazilian SPMs also emphasized that monitoring activities should be conducted according to the individual needs.

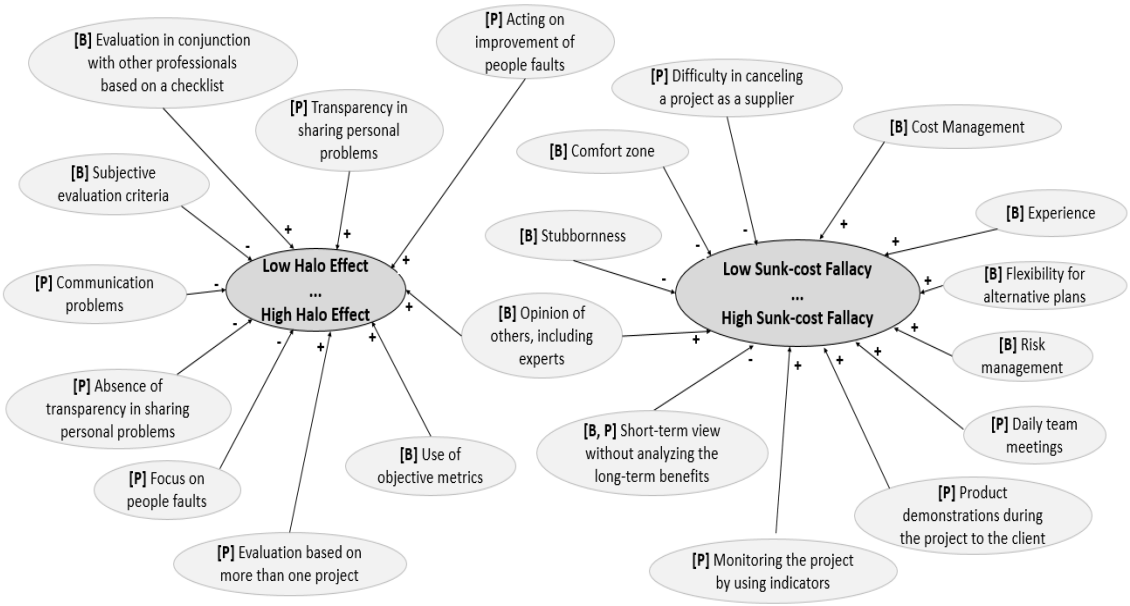
4.5 HALO EFFECT AND SUNK-COST FALLACY

The halo effect is a cognitive bias in which an observer's overall impression of a person, company, brand, or product influences the observer's feelings and thoughts about that entity's character or properties.

When questioned about halo effect, the Brazilian SPMs mentioned the use of subjective evaluation criteria as a causal factor, which gives rise to the judgment resulting from the first impression. The Portuguese SPMs complemented by emphasizing communication problems, the focus on people faults, and the absence of transparency in sharing personal problems. This last one referred to when the employee's productivity is affected by personal problems, such as divorce or death of a relative.

In order to minimize the negative effects of this bias, the Brazilian SPMs suggested the evaluation of an artifact or team member together with other professionals based on a checklist so everyone can have a clear idea of the items to be evaluated. The need to consider the opinion of others, from inside or outside the project and the use of objective metrics, whenever possible (JONES, 2008) were also indicated. The Portuguese SPMs also pointed out the evaluation of a team member based on more than one project, the focus of SPMs on improvement of the people faults and the transparency in sharing personal problems with the whole team. The concepts related to the halo effect are illustrated in Figure 17.

Figure 17. Concepts map of halo effect, and sunk-cost fallacy



The sunk cost fallacy is the tendency for humans to continue investing in something that clearly isn't working. Because it is human nature to want to avoid failure, people will often continue spending time, effort or money to try and fix what is not working instead of cutting their losses and moving on.

When referred to sunk cost fallacy, as shown in Figure 17, the short-term view without analyzing the long-term benefits was pointed out by the SPMs from both organizations as a causal factor. In this case, considering scenarios in which the advantages of an immediate change were proved, it was preferred to extend it despite the immediate cost and the time required for the change to be implemented. Some cases related to changing technology and refactoring software code were mentioned, thereby increasing the cost of future change. In other cases, the organization can have implicit benefits of a project, not related to the monetary aspects, which make it continues.

The Brazilian SPMs pointed out the comfort zone and stubbornness inherent to some SPMs or stakeholders as causal factors. The Portuguese SPMs also mentioned the difficulty to cancel a project as a supplier, who depends on the client to make the decisions. Being flexible to alternative plans, which requires experience from the project manager, and opinion of others, including experts, once again was considered important by the Brazilian SPMs to provide an outside view from the project. They also emphasized risk and cost management. The Portuguese SPMs

complemented the list by including daily team meetings and product demonstrations during the project to the client.

4.6 CLOSING REMARKS

The consolidated concepts map based on the interviews in both organizations is composed of twenty-four unique causal factors and thirty-two unique techniques to minimize the negative effects of the studied cognitive biases. Although the Brazilian organization uses a more formal process based on PMBOK (PMI, 2013) and RUP (KRUTCHEN, 2000), the SPMs used some agile practices as any type of organization can practice it without interfering in the organizational procedures. In the Portuguese organization, which is small and from the private sector, the process is based on agile practices (SCHWABER, 1997).

Some of techniques mentioned to minimize the negative effects of cognitive biases were related to agile practices as the use of burndown chart for daily monitoring of planned versus accomplished activities, bottom-up planning from short activities, daily team meetings, flexibility for adjustments in the project´s plan, environment of trust with the team, and product demonstrations during the project to the client.

The opinion of others was the alternative mentioned to reduce the majority of biases: anchoring, halo effect, availability-related bias, planning fallacy, sunk-cost fallacy and exposure effect. Although the project manager is responsible for making final project decisions, it shows a concern to consider opinions of others, such as consultants, Project Management Office members, other project managers and the project team itself with the objective of obtaining a better base for their decisions and not depositing all confidence in their own experience. The most mentioned causal factors were related to the absence of a historical basis. The difficulty in storing information that is systematically organized and that can be retrieved easily is one of the most problems in knowledge management in project´s context (BARCLAY and OSEI-BRYSON, 2010; PEMSEL and WIEWIORA, 2013).

This research aimed to understand how SPMs from two organizations interpret their experiences managing software projects, shedding light on cognitive biases. The SPMs from Brazil and Portugal that composed the sample of this study were

important to diversify the points of view based on different contexts in order to elaborate a consolidated concepts map.

The findings showed an initial picture of the influence of cognitive biases on SPMs' decisions and suggested that we needed a more grounded understanding of the mechanisms of decision-making, described in the next chapter.

5 Shaping the Theory

Decision-making in the complex global business environment is increasingly challenging and vulnerable to unforeseen circumstances. It is also vitally important to every aspect of business, especially project management, which involves making a multitude of decisions every day about priorities, approaches, resources, and timelines (PMI, 2015).

Researchers have tried to understand how people differ in arriving at a choice (EPSTEIN et al., 1996), how satisfied people are with their choice (CROSSLEY and HIGHHOUSE, 2005), and how people arrive at good decisions (FRANKEN and MURIS, 2005). According to Hunt et al. (1989), the decisions made by individuals are recognized as being affected by three sets of factors: decision features, situational factors, and individual differences. In software projects, understanding how project managers arrive at good decisions is useful to provide guidelines to eliminate potential errors in judgment.

In the next sections, we present our findings on SPMs' decision-making styles as well as what factors influence this phenomenon from their practical perspective. Some factors are triangulated based on interviews with team members, PMO and functional managers (see Appendix G), observations, document analysis and the findings from the previous exploratory study on cognitive biases. Based on data analysis, the relationships among the grounded factors were drawn, thus building the hypotheses that communicate the particular view of this phenomenon. Finally, those hypotheses were combined in order to build the central story that explains decision-making in software project management.

5.1 WHAT ARE THE SOFTWARE PROJECT MANAGERS' DECISION-MAKING STYLES?

When a diverse group works on a complex problem, people's views vary widely across many parameters: goals, priorities, problem definition, critical success factors, options for action, resources needed, and so on. The way people react in a particular decision context is related to his or her **decision-making style**.

Based on data from interviews, all five styles defined by Scott and Bruce (1995) were identified, as described in Table 5. The decisions made by the SPMs are mostly based on their tacit knowledge, rather than analytical decision-making models, as stated by the naturalistic decision-making models described in section 2.2.1. Influenced by the level of uncertainty inherent to the software development context (MARINHO et al., 2014), the SPMs do not seek for optimal solutions, but usually the first workable option, as described by the satisficing model proposed by Simon (1956), which defines that satisfactory alternatives which exceed some minimally acceptable criteria are selected. Those characteristics are related to the intuitive and spontaneous styles. Depending on the decision complexity, the SPMs consider the pros and cons (i.e., the advantages and disadvantages of each option before make a sensible decision). However, it is not usually supported by analytic models. The avoidant style is related to deferring commitment, which is a practice that comes from Lean (POPPENDIECK and POPPENDIECK, 2006) and means waiting until the last acceptable moment to make a decision when there is enough information to make the decision.

From all the decision-making styles, the most mentioned by the SPMs was the dependent style, which is related to the participatory decision-making by producing meaningful, integrated, and broadly supported solutions to problems through the involvement of the team members and stakeholders. In this context, the facilitator's job is to support everyone to do their best thinking by encouraging full participation, promoting mutual understanding, fostering inclusive solutions, and cultivating shared responsibility (KANER, 2014).

In a participatory group, in order to reach a sustainable agreement, members have to understand and accept the legitimacy of one another's needs and goals. The inclusive solutions take advantage of the truth held not only by the person who is most influential and powerful but also the truth held by all the team members. In this scenario, the members recognize that they must be willing and able to implement the proposals they endorse, so they make every effort to give and receive input before making final decisions. They also assume responsibility for designing and managing the thinking process that will result in a good decision.

When the group's facilitator is also the group's leader, he or she has to retain the mindset of a leader and thus be responsible for clarifying his or her own thinking

and communicating it effectively. On the other hand, she or he has to adopt the mindset of a facilitator and thus care about helping the group do its best thinking. It requires a focus on supporting others to develop their lines of thought.

This perspective on project manager's role is in line with the growing body of research which suggest that project manager's assumption as being expert instead of facilitator, expecting people to follow orders rather than encouraging participation, is not appropriate to all situations (POLLACK, 2007). Some authors (HALL et al., 2003) links low levels of participation to project failure.

This participatory decision-making style does not mean that SPMs do not have to take responsibility for the projects decisions. Otherwise, the project manager is seen as acting promptly and promoting a sense of urgency in the team, taking responsibility for actions and the consequences of their decisions, even when they are made in accordance with the stakeholders. It is related to "organizing with cooperation" cited by Hauschildt et al. (2000) or "teamwork and cooperation" as described by Dainty et al. (2005). This characteristic was emphasized by the software engineers.

Table 5. Interviewees' quotes about SPMs' decision-making styles

SPMs' decision-making styles		
Dependent (Participatory) style	***"Acho que uma decisão hoje até pra ter um efeito maior precisa ser muito bem estudada [...] Não é pegar um papel e calcular alguma coisa, é compartilhar as opiniões com as outras áreas pra ver o que todo mundo acha."***	***"Normalmente eu procuro fazê-los refletir se a decisão que eles tomaram tá correta com perguntas. Muitas vezes eu nem sei a resposta mas o fato de você fazê-los refletir sobre as decisões faz com que ou eles consolidem a decisão que foi tomada ou mudem de ideia."***
	English: *"I think that, in order to a decision has a good effect, it needs to be studied very well [...] It is not the case of picking up a paper and calculating something, but sharing opinions with the stakeholders to figure out what everyone thinks."* (PM7ORG1)	English: *"Normally I try to make them reflect if the decision they made is correct by questioning them. I often do not know the response but the fact that you make them think about the decisions it makes them confirm the decision or change their mind."* (PM5ORG2)

SPMs' decision-making styles (Continuation)		
Rational style	***"[Antes de tomar a decisão] foi feita uma lista de prós e contras, essa lista foi discutida até a gente chegar numa reunião e ver se tínhamos alguma forma de operar nesse cenário."*** English: *"[Before making a decision] we listed the pros and cons and discussed until we get to a meeting and figure out if we had any way of operating in this scenario."* (PM1ORG2)	"***Uma análise simples de prós e contras. Não é tão estruturada. Se eu for por esse caminho vou ter esse benefício e se for outro vai ter aquele.***" English: "*A simple analysis of pros and cons. It is not so structured. If I choose this way, I would have this benefit. Otherwise, I would have another benefit.*" (PM4ORG2)
Avoidant style	***"Eu prefiro evitar ou adiar tomar uma decisão quando nós não precisamos daquela decisão agora [...] Se eu posso, vou aguardar pra tomar uma decisão com base em mais fatos."*** English: *"I prefer to avoid, or postpone making a decision when we do not need that decision immediately […] If it is possible, I will wait to make a decision based on more information." (PM2ORG2)*	"***Às vezes tem situação em que você espera um pouco e outros caminhos aparecem. As coisas meio que se resolvem naturalmente, sem você ter que se desgastar***." English: "*Sometimes there is a situation in which you wait a little bit, and the things are made clear. The problems are resolved naturally, without you having to worry about.*" (PM4ORG2)
Intuitive style	***"A gente já teve aqui, processo estruturado de tomada de decisão, mas hoje em dia acho que é mais pelo feeling e experiência."*** English: *"We've had a structured decision-making process, but I think the decisions are usually made by using intuition and experience.*" (PM6ORG2)	"***Nesse processo de CMMI [nível 3] tinha um pra tomada de decisão [...] Eu não cheguei a usar isso muito intensamente, acho que usei uma vez ou outra perdida e isso perdeu força [...] então acho que o que o conhecimento tácito é mais relevante e pertinente no nosso dia a dia.***" English: "*In this CMMI process [level 3] there was one specifically for decision-making [...] I did not use it intensely. I think I used it once or twice, and it fell into disuse [...] so I believe that tacit knowledge is more relevant and pertinent in our day-to-day work.*" (PM4ORG2).
Spontaneous style	"***A gente precisa fazer a roda girar, mesmo que não seja a melhor decisão [...] e você sempre tem a oportunidade de mais à frente de corrigir, mudar o rumo [da ação].***" English: "*We need to make things happen, even if it is not the best decision [...] and later you will always have the opportunity to correct it, or change the course [of action].*" (PM5ORG2)	"***Olhar pra um problema e resolver, não de maneira ótima, mas de maneira eficaz.***" English: "*Looking at a problem and solving it, not optimally, but effectively.*" (PM2ORG2)

5.2 WHAT FACTORS AFFECT SOFTWARE PROJECT MANAGERS' DECISION-MAKING PROCESS?

The following subsections present the grounded factors that influence the SPM's decision-making process, which are grouped into situational and individual factors. The emerged consequences of the participatory decision-making style, which is related to the dependent style defined by Scott and Bruce (1995) are also presented. During the interviews, the SPMs emphasized the consequences when there is an involvement of the team members and stakeholders when making important decisions.

5.2.1 SITUATIONAL FACTORS

The following situational factors were identified: client involvement, iterative planning, continuous feedback, knowledge sharing initiatives, SPM's autonomy (composed by the process development flexibility), task complexity, and team members' technical capacity.

Client involvement

Every software project must be developed with the end user in mind, as it is the end user who will be using the product and benefiting from it. If the product is not developed according to the requirements, wishes and specifications of the user, the project will certainly fail. Lack of **client involvement** is one of the top reasons for software project failures (VISKOVIC et al., 2008).

If the software is not accepted by the users, it is not enough to finish the project on time and on budget. One of the main characteristics of agile software development is the active and continuous participation and involvement of the clients throughout the project, which leads to building the right product and to satisfied clients (KOSKELA and ABRAHAMSSON, 2004). This factor was pointed out by SPMs from both organizations as exemplified in Table 6. Also, the software engineers mentioned it as one of the most essential factors in project decisions.

Table 6. Interviewees' quotes about Client involvement

Client involvement	
"[Para tomar decisões] é importante que o cliente esteja muito bem próximo, que acredite na gente, e tenha essa transparência porque o resultado final depende dele também."	***"O cliente se sente fazendo parte da equipe e ele se sente alimentado com as coisas que acontecem. Então ele não é o cara que eu peço e espero, não. Ele participa. Então isso faz diferença [nas decisões]."***
English: *"[In order to make decisions] it is important that the clients get involved and believe in us, and they must be transparent because the success of the project depends on them too."* (PM4ORG2)	English: "*The client feels part of the team, and he feels fed up with the things that happen. So he's not the guy I ask and wait, no. He participates. So it makes a difference [in decisions]."* (PM5ORG2)
"Muitas vezes o projeto pode até empacar, porque você simplesmente não tem capacidade de tomar uma decisão sem que o cliente diga: é por aí"	"***Ele [o cliente] é um cara que ajuda muito a nível de negócio [...] É um cara que tá a frente do negócio, decidindo junto com a gente.***"
English: *"Often the project's performance can even decrease because you just don't have the ability to make a decision without the customer say: go ahead."* (PM9ORG1)	English: "*He [the customer] is a guy that helps a lot in terms of project's scope [...] He is a guy who is on the frontline of the business, deciding along with us.*" (PM8ORG1)

Iterative planning

As defined by agile methods (WILLIAMS and COCKBURN, 2003), **iterative planning** aims to establish time boxes to develop workpieces providing immediate feedback from the stakeholders. Adopting an iterative and incremental development approach is a fundamental change in working practices, which requires a progressive and adaptive approach to be taken to the management of the project.

The iterative development provides a platform for continuous process improvement by responding proactively to the lessons learned, as exemplified through the excerpts presented in Table 7. Although training in new processes and supporting tools is necessary, it is not sufficient and is often overemphasized at the expense of informal experiential learning, which is possible through software development in shorter time boxes. The advantage of this approach is that people learn by doing (BENJAMIN, 1984), thus influencing on feedbacks of early decisions made during the beginning of the iteration. This factor was reinforced by some software engineers.

Table 7. Interviewees' quotes about Iterative planning

Iterative Planning	
"Você aceita que não sabe muito sobre aquilo, toma decisões imperfeitas no começo e vai corrigindo e ajustando [ao longo das iterações]." English: *"You agree that you don't know very much about it, you make imperfect decisions at the beginning, and correct and adjust them [along the iterations]"* (PM2ORG2)	"***Com esse tipo de planejamento, a gente consegue aprender com os erros. Então a cada iteração você tenta ver os erros.***" English: "*With this kind of planning, we can learn from the mistakes. So every iteration you try to correct the mistakes.*" (PM6CS1)
"A gente trabalha mesmo com sprints, iterações fixas, o que aumenta bastante a previbilidade de algo que não é previsível [...] o bom de métodos ágeis é que você tem uma sprint normalmente pra descobrir se foi boa ou ruim." English: *"We work with sprints, fixed iterations, which significantly increases the predictability of something that is not predictable [...] One of the benefits of agile methods is that you have an interaction to find out whether it is progressing or not."* (PM1ORG2)	***"Com sprints fechadas você consegue fazer com que, periodicamente, você tenha um feedback da equipe, PO, cliente. Ter essa capacidade de melhoramento a cada iteração, isso é maravilhoso. Tomei uma decisão errada, mas na outra [iteração] vou mudar tal coisa, melhorando isso ou aquilo."*** English: "*Working with fixed sprints you can, periodically, get feedback from your team, the PO, the client. The improving capacity at each iteration is excellent. I made a wrong decision, but in the other [iteration] I will change that thing, improving this or that.*" (PM10ORG1)

Continuous feedback

The decision task is not a matter of making a single choice at one point in time but rather involves a whole series of actions or decisions, each of which affects the external environment or the decision maker's understanding of it in ways that influence the decisions that are made subsequently. Payne et al. (1993) suggested that, in some cases, decision strategies may be constructed step by step in the course of the decision maker's interaction with a problem. In such an incremental and iterative process, decision makers utilize feedback from previous cognitive actions to make local decisions about what to do next.

The dynamic environments of software projects rely on feedback from initial guesses, additional redundant clues, and opportunities for subsequent correction. Due to the uncertainty inherent in software projects (MARINHO et al., 2014), the SPMs focus on making, monitoring and adjusting decisions in a **continuous feedback**, as exemplified through the excerpts presented in Table 8. When there is

no feedback regarding whether or not predicted events occur, a consistent decision maker should not be calibrated. Noble (1989), Klein (1989), and Connolly (1988) stipulate that goals change as a function of feedback on the nature of the situation and the consequences of one's actions.

Table 8. Interviewees' quotes about Continuous feedback

Continuous feedback	
"Você tá numa sala escura e tá com um revolver com 6 balas e tem um alvo. Não sabe onde vai atirar. É mais ou menos uma decisão em que você não tem tanta informação... mas você vai e dá o primeiro tiro, e aí a bala vai clarear um pouco a sala e aí você já começa a verificar... E à medida que você vai atirando, você vai direcionando e consegue achar o alvo." English: *"You're in a dark room with a gun, six bullets, and a target. You don't know where you will shoot. It is like a decision that you don't have much information... You give the first shot, and the bullet will light a little bit the room in order to verify the target... As long as you shoot, you will adjust until finding the target."* (PM6ORG1)	***"Eles [membros da equipe] têm essa abertura, eles que me cobram, eles que dizem: 'não era pra ter sido feito assim, era pra ter sido feito assado'."*** English: *"I have an open posture [to my team members], they charge me, they say: 'it hadn't be done like this, it had to be done like that."* (PM1ORG1)
"***Você tem o retorno daquilo ali rapidamente... você consegue direcionar de forma mais sensata e tomar as decisões se você receber aquele feedback mais rápido."*** English: *"You have the return of that quickly... You can direct more wisely and make decisions if you receive feedback in a short time."* (PM9ORG1)	"***Eu sei que a gente decidiu ir por aqui, mas os feedbacks estão dizendo que a gente não devia ter ido por aqui. Vamos voltar pra outra solução? Aí é construtivo."*** English: "*I know that we decided it, but the feedbacks are saying that we should not have come here. Let's go back to another solution? It is constructive."* (PM2ORG2)

Knowledge sharing initiatives

The SPMs emphasized that effective **knowledge sharing initiatives** within and between projects is essential to avoid the risk of repeating the same mistakes (SCHINDLER and EPPLER, 2003). After-action reviews, short meetings aimed at evaluating performance in the midst of the action, postmortem analysis, as well as informal meeting with other more experienced project managers were pointed out as ways for SPMs to learn immediately from both successes and failures, as described through the excerpts in Table 9.

While the concept of capturing lessons learned is widespread and appreciated by organizations, it is often still performed poorly due to time, resource and incentive constraints (WILLIAMS, 2008). The SPMs from both organizations pointed out the inefficiency of historical data from projects, which can be explained by their tendency to give lower priority to everything that does not directly contribute to their project. The results are aligned with Pemsel and Wiewiora (2013) whose research indicated that lessons learned databases contained large amount of information that was not systematically organized and, as a consequence, they were underutilized and most SPMs did not make use of them as a source of knowledge in future projects.

The SPMs mentioned that, day-by-day, it was more important to share tacit knowledge through different types of socialization than access stored documents. Tacit knowledge can be defined as skills, ideas and experiences that people have in their minds and are, therefore, difficult to access because it is often not codified and may not necessarily be easily expressed (NONAKA and TAKEUCHI, 1995). With tacit knowledge, people are not often aware of the knowledge they possess or how it can be valuable to others. Effective transfer of tacit knowledge generally requires extensive personal contact, regular interaction, and trust (GOFFIN and KONERS, 2011). The PMO managers reinforced their role in promoting knowledge sharing between the SPMs through periodic meetings.

Table 9. Interviewees' quotes about Knowledge sharing initiatives

Knowledge sharing initiatives	
"A gente tem espaços na empresa que favorecem a troca de experiência e conhecimento [...] Esses momentos são extremamente ricos porque a gente aprende com a experiência dos outros." English: *"We have moments in the organization aiming to promote the experience and knowledge sharing [...] These moments are extremely important because we learn from the experience of others."* (PM5ORG2)	***"No dia a dia de trabalho é muito mais difícil consultar esse tipo de documento [de lições aprendidas] do que trocar uma ideia com um colega."*** English: *"In the daily work it is unusual to access this type of document [of lessons learned], instead of sharing an idea with a colleague."* (PM7ORG1)

Knowledge sharing initiatives (Continuation)	
"Eu me apoio muito nas experiências dos colegas. A gente almoça junto, conversa bastante, troca informações sobre como foi endereçado algo. Com base no que você tá ouvindo, você calibra e procura ver como você vai tratar a sua situação." English: "*I support myself in my colleagues' experience. We have lunch together, talk quite often, share information about how something was addressed. Based on what you're listening, you calibrate and seek how you will treat your situation.*" (PM1ORG2)	"***Na hora que você precisava coletar informação [nos documentos de lição aprendida], ela não servia porque faltavam detalhes importantes pra poder montar contexto e sem isso você não conseguia extrair informação [para decisão]."*** English: "*By the time you need to collect information [in the lessons learned documents], it was useless because it lacked important details about the context, and without context, you could not extract information [to a decision]."* (PM5ORG2)

Autonomy

The organizational structure is an environmental factor and ranges from functional to project-based, with a variety of matrix structures in between: weak, balanced, or strong (PMI, 2013). The balanced matrix organization recognizes the need for project managers, but it does not provide them with full authority.

Many companies base their organizational structures on various functional areas, creating departments around these functions and assigning responsibilities according to employees' job titles and experience. A functional organizational structure groups employees by various skills and expertise, such as software architecture, database, quality assurance, and so on. The Organization A has about 4000 professionals, with 10.5% responsible for software project development. The rest of the employees are located in the financial, human resource, infrastructure, and others departments. The Organization C has about 500 professionals, 85% were part of the technical workforce working in software projects and 15% allocated to administrative tasks.

Depending on how the organization's departments are structured, the project manager must align the project milestones and dependencies with the functional departments. Although the project manager is primarily responsible for the project outcomes, the involvement of such areas is a manner of sharing responsibility for project decisions in technical subjects in which the project manager and team members has little or no knowledge as well as to gaining their support in performing some project tasks. In a context in which those departments support multiple projects

at the same time, considering that those department's members are not formally allocated in the project, not all of them will attend the projects at the expected time, thus compromising the project manager's expectations. Therefore, the project managers should consider the norms and procedures of each department before making a decision. Besides the organizational structure, the organizational culture affects the way people and groups interact with each other, with clients, and with stakeholders. According to Ravasi and Schultz (2006), the organizational culture is a set of shared assumptions that guide what happens in organizations by defining appropriate behavior for various situations.

Based on the perceptions of the SPMs from the government organization, the lack of **autonomy** caused by the balanced matrix structure impacts negatively on decision-making because the other departments' members may have not the same engagement as the project team members because they are not formally allocated in the project. Each functional department has its corresponding priorities, which sometimes are not aligned with the project's priorities. Because the SPMs have no authority over such departments, it can impact the project planning. In the project-based organization, however, as the workforce is concentrated in projects, with just a few support departments, the SPMs had autonomy to make decisions. This difficulty was also emphasized by the software engineers from Organization A. It was also identified through analysis of change request and lessons learned documents as well as observations of the meetings with the SPMs and stakeholders, including members from the support departments.

Among the functional departments, the Project Management Office (PMO) is an organizational entity with responsibilities related to the centralization and coordination of projects under its domain. It is a management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques (PMI, 2013). SPMs from both organizations pointed out their importance to aid administrative decisions.

The SPM's autonomy is also related to the **development process flexibility**. Flexibility is defined as an individual's or an organization's ability to be proactive and adaptable (JONES, 2005) and as the capacity to change and to adapt to challenging environments (GEORGSDOTTIR and GETZ, 2004). When referring to the development process, it considers the autonomy of the SPM and team members to

make changes in how the tasks will be performed, what are the tools that will be used, how the change requests will be treated, and so on, based on the projects' characteristics. The Organization A has a more structured development process that has to be executed by all the projects with a little level of openness to modification, while in Organization C there is a high level of openness to adapt the development process. Some software engineers from Organization A pointed out that the process rigidity hinders creativity and innovation. The excerpts that justify these factors are presented in Table 10.

Table 10. Interviewees' quotes about SPM's Autonomy

SPM's Autonomy	
"***O gestor [de projeto de software] aqui não tem muita força em outras áreas. A gente tem muita dependência com o restante da empresa... é o principal ponto que a gente sofre hoje em dia [...] A gente não tem força pra interferir no trabalho dessas outras equipes da empresa. Vai da boa vontade do pessoal.***" English: "*The [software project] manager here has no power over the other areas. We have a lot of dependence on the rest of the organization ... It is the main problem that we suffer today […] We have no power to interfere in the work of these other departments' members. It depends on their willingness."* (PM4ORG1)	"***Então no meu caso essa flexibilidade é fantástica porque eu tenho nas minhas reuniões de kickoff quando a gente tá iniciando os projetos uma liberdade muito grande de tentar modelar o processo de desenvolvimento de acordo com que o cliente quer e com o que eu acho que é adequado."*** English: "*So in my case this flexibility is fantastic because when we are initiating a project, during the kickoff meetings, I have a very great freedom to try modelling the development process according to what the client wants and what I think is appropriate.*" (PM1ORG2)
"***Geralmente a gente faz o planejamento, chega em um momento a demanda da respectiva área tem outra prioridade e a gente acaba enfrentando um atraso em virtude disso [...] Seria mais fácil como gestor uma autonomia maior na tomada de determinadas decisões.***" English: "*Usually we plan, but when we need a service from the respective department, it has another priority and we end up facing a delay. [...] It would be easier if we have more autonomy to make certain decisions.*" (PM7ORG1)	"***A empresa tá 100% engessada para mudança, essa é uma das coisas que mais dificultam a gestão [do projeto]. Quando você recebe uma mudança, em vez de você ter uma liberdade para decidir como implementar aquela mudança de forma melhor possível, você fica extremamente pressionado a não mudar. E se mudar, que seja no menor tempo e impacto possíveis.***" English: *"The organization is 100% averse to change, that's one of the things that hinder the [project] management. When you receive a change request, instead you have a freedom to decide how to implement this change in best possible way, you are extremely pressed not to change. And if change, make it possible through the shortest time a low impact."* (PM9ORG1)

SPM's Autonomy (Continuation)	
"O PMO da gente tem um portfólio grande de serviços que oferece ao gerente, especialmente na parte burocrática." English: *"The PMO has a portfolio of services available to the project managers, especially when dealing with bureaucratic subjects."* (PM1ORG2)	***"Por já ter um processo bem definido, já ter os critérios que a gente deve seguir, quando abrir uma SM, se é melhor fechar, se é melhor suspender... isso tudo eu acho que o escritório orienta muito bem."*** English: *"Considering the well-defined process and the criteria which we have to attend when deciding about suspend or close a project, as well as formalize a change request, I think the PMO support us very well."* (PM2ORG1)

Team members' technical capacity

Also, the **team members' technical capacity** were pointed out as an important factor because the SPMs are not focused on operational tasks, thus delegating some decisions, as exemplified through the excerpts in Table 11. Since the SPMs have to focus on managerial decisions, the software engineers emphasized the importance of their technical capacity to support the SPMs.

Table 11. Interviewees' quotes about Team members' technical competence

Team members' technical competence	
"***A equipe técnica bem qualificada me dá bastante tranquilidade pra tomar decisões baseadas na informação que eles me passam.***" English: "*A qualified technical team makes me feel comfortable to make decisions based on the information they give to me.*" (PM4ORG2)	"***Você ter uma equipe proficiente não faz com que você tome melhores decisões em relação ao que fazer, mas favorece que você tome melhores decisões sobre o como fazer.***" English: "*Having proficient team members doesn't influence in decisions about what to do, but favors in making decisions about how to do.*" (PM2ORG2)
"Já tive projetos com equipe pouco experiente, a gente ficou meio perdido, sobre qual decisão tomar [...] Quando a gente tem na equipe pessoas com experiência do produto, na parte de implementação, facilita pra tomar decisão." English: *"I worked in projects with inexperienced team members, we got a little lost on what decision to make [...] When we have members with experience on the product, on how to implement, it makes easy to make decision."* (PM5ORG1)	***"Quando menor a senioridade da sua equipe, maior sua influência em decisões [...] Eu percebo que quando você tem uma equipe mais madura você compartilha mais do que influencia [nas decisões]."*** English: *"The lower the seniority of the team, the greater is your influence on decisions. […] I came to realize that when we have a more mature team, you share more decisions instead of me influencing [the decisions]."* (PM5ORG2)

Task complexity

From the SPMs' perspective from both organizations, a simple decision involves the absence of uncertainty caused by the knowledge gained on the domain of the decision. Also, it involves only team members and has low-impact consequences on the project.

On the other hand, the complexity of a decision is related to its impact on the project and on the organization. It is related to the involvement of various stakeholders to reach a consensus and a high level of uncertainty. Also, the SPMs from both organizations emphasized the complexity of decisions when they impact on people. Therefore, the **task complexity** influences in how the SPMs make decisions. The characteristics of both simple and complex decisions are exemplified through the excerpts in Table 12.

Table 12. Interviewees' quotes about Task complexity

Task complexity	
"É uma decisão que você sabe muito bem o que fazer, como fazer. Não causa impacto em nenhum agente externo, nem viola nenhum compromisso assumido." English: *"It is a decision where you know exactly what to do and how to do it. It does not impact on any external stakeholder, nor violate any agreement."* (PM2ORG2)	***"Uma decisão trivial é aquela que depende apenas de mim ou da equipe."*** English: "*A simple decision is one that depends only on me or the team.*" (PM3ORG1)
"***Decisão mais complexa pra mim é aquela que não envolve somente eu e a equipe, envolve também outras áreas [...] Quando isso acontece é mais difícil porque nem todos levam na mesma prioridade a decisão tomada e acaba gerando problemas [...] Quando há incertezas de todos os lados [...] é mais complicado de tomar decisão.***" English: "*For me,* a *complex decision is one that does not only involve my team and me, but also other departments [...] When it happens it is more difficult because not all of them take the same priority on the decision and ends up creating problems [...] When there is uncertainty from all sides [...] it is more difficult to make a decision.*" (PM5ORG1)	***"[...] têm outras decisões que eu acho que fica mais complexa pelo aspecto da questão humana [...]***" English: "[...] *there are other decisions that I think are more complicated by the human aspects [...]"* (PM5ORG2)

Task complexity (Continuation)	
*"**Uma decisão complexa pra mim envolve vários fatores e ela pode causar um impacto muito grande [no projeto].**"* English: "For me, a *complex decision involves many factors and can cause a huge impact [on the project].*" (PM6ORG1)	"***Eu acho que as mais difíceis de tomar são aquelas que envolvem as pessoas, tanto o cliente como o time.***" English: "*I think the most difficult decisions are those involving people, both the client and the team members."* (PM4ORG2)

5.2.2 INDIVIDUAL FACTORS

The following individual factors were identified: SPM's leadership style, SPM's experience, which is composed by the project management experience and employment time in the organization; SPM's knowledge, formed by SPM's technical capacity and knowledge on business domain; and SPM's skills, which are composed by the holistic vision of the project, transparent communication, negotiation capacity, organizational ability, interpersonal relationship, and proactive risk management.

Leadership style

Two **leadership styles** have been extensively investigated over the years: transactional leadership and transformational leadership (AVOLIO and BASS, 2004). In certain circumstances, both styles have been exhibited by a given leader in varying degrees over time.

According to Bass (1985), transactional leaders builds the foundation for relationships between leaders and followers in terms of clarifying responsibilities, specifying expectations and tasks requirements, negotiating contracts and providing recognition and rewards in exchange for the expected performance (LIU et al., 2011). The transactional leader usually operates to guarantee that subordinates will work according to the existing culture as opposed to change it. Such leaders pay close attention to deviations, irregularities, and mistakes in order to take action and make corrections. They also operate with an inclination to avoid risk and focus on time constraints, standards, and efficiency (BASS, 1985). These leaders deal with deviations using hard criticism, which can result in followers taking the leader's desired pathway of approaching problems instead of trying new ways to address the challenges and improve the results (LEE, 2008).

On the other hand, the transformational leader raises associates' level of awareness of the importance of achieving valued outcomes and the strategies for reaching them (BURNS, 1978). They also encourage followers to transcend their self-interest for the sake of the team or organization. Furthermore, they encourage the followers' needs to higher levels in such area as achievement, autonomy, and affiliation, which can be both work related and non-work related (BURNS, 1978). According to Bass and Avolio (1995), transformational leaders encourage others to both develop and perform beyond standard expectations.

The SPMs from both organizations presented a transformational leadership style when they demonstrated trust with team members by delegating some decisions and creating a learning environment where it is possible to make mistakes, as exemplified through the excerpts in Table 13.

Table 13. Interviewees' quotes about SPM's leadership style

SPM's leadership style	
"***Eu acredito que a decisão tenha que ser dada pela equipe, eu delego a decisão para eles, mas me colocando também como membro da equipe***." English: "*I believe that the decision has to be made by the team, I delegate the decision for them, but also including me as a team member."* (PM3ORG1)	"***Deixo muito as decisões técnicas nas mãos da equipe. Dou um voto de confiança a eles, eu compro a ideia deles.***" English: "*I delegate the technical decisions to my team members. I give them a vote of confidence. I support their idea."* (PM8ORG1)
"Em geral a gente trabalha pra fortalecer esse time pra que ele consiga tomar decisões, fluir, sem tanta dependência do gestor." English: "*In general, we work to strengthen this team so that they can make decisions by themselves, without so dependence with the project manager.*" (PM4ORG2)	***"Eu procuro muito criar um ambiente onde esteja tudo bem cometer erros [...] Toda vez que eles te dão uma má notícia, você briga com eles e aí eles não te dão mais más notícias até que elas já tão além do controle."*** English: *"I try to create an environment where it is okay to make mistakes […] If every time your team gives you bad news, you criticize them, they will not give you the bad news until they are out of control."* (PM1ORG2)

Experience

Research on expert problem solving has shown that a significant aspect of what specialists do when functioning in their everyday complex environments is to use their experience to size up the situation, determine if a problem exists, and, if so,

whether and how to act upon it (CHI et al., 1988). Experience enables a person to seek information that will be helpful in coping with the situation and to generate a limited set of plausible options, rather than wasting time on low-payoff leads.

Experts in a field can look at a situation and quickly interpret it using their highly organized base of relevant knowledge. The identification of situation type carries with it retrieval of one or more action alternatives that constitute appropriate responses. The RPD model (KLEIN, 1989) asserts that experienced decision makers can identify a reasonably good option as the first one they consider rather than generating many options. The **SPM's experience** was pointed out as an impacting factor in decision-making being composed of **project management experience** and **employment time in the organization**, as described through the excerpts presented in Table 14. The latter is especially important in organizations structured with many functional departments, each one responsible for specific tasks in the projects, as in Organization A. These two factors were reinforced by the software engineers, PMO managers, and the functional manager's assessor.

Table 14. Interviewees' quotes about SPM's experience

SPM's experience	
"***[Quando tenho que tomar decisões que envolvem outros departamentos] Eu já sei com quem falar, como lidar com as pessoas. A gente sabe que uma é diferente da outra, então você tem que ter um jeito pra falar com um, falar com outro.***" English: "*[When I have to make a decision that involves other departments] I already know who to talk to, and how to deal with them. We are aware that everyone is different, so we have to know the way to speak to each other.*" (PM6ORG2)	"***Muitas vezes a gente já viu em outros projetos [...] vamo tomar isso aqui porque esse outro caminho a gente tem esse problema ou esse outro.***" English: "*Often we have experienced in other projects [...] Let's do it because of this other option we have this or that problem.*" (PM4ORG1)
*"**Na minha vida o que fez diferença foi ter experiência, de errar um bucado e aprender com esses erros.**"* English: *"What makes the difference in my life is having experience, by making mistakes and learning from them."* (PM2ORG2)	"***Tudo que a gente viveu gera um histórico de conhecimento [...] e ai sem dúvida isso faz a diferença na hora que você vai tomar uma decisão.***" English: "*Everything we experienced generates a base of knowledge […] so there is no doubt that it will make a difference when you make a decision.*" (PM5ORG2)

Knowledge

The **technical capacity** of the SPMs was pointed out as important in order to he or she better argue with the team members, although it was not a consensus among the interviewed SPMs. Some of them claimed that it only offered a perception about the activities to enhance their ability to ask the right questions, making the team members reflect on their decisions. Others SPMs, however, considered it necessary in making technical decisions or, at least, having a close support to the team members, mainly when they are novice. This scenario can be explained by the individual background of each SPM, where some have a high technical skill while others do not have. Besides the technical capacity, the **knowledge on business domain** was also mentioned by the SPMs, and confirmed by some software engineers, thus complementing the **SPM's knowledge** necessary to make or support decisions, as described through the excerpts presented in Table 15.

Table 15. Interviewees' quotes about SPM's knowledge

SPM's knowledge	
"***Eu acho que essa conversa de que o gestor de projeto pode ser um cara que não conhece nada do assunto [técnico] que tá sendo tratado, que projeto é uma coisa genérica (...) Acho isso uma furada, as pessoas têm que entender, até pra debater com as pessoas.***" English: "*I think that the story the project manager can be a person who does not know anything about the [technical] subjects which are being discussed, thus having only general knowledge on project management, it is not true, since we need some technical knowledge to discuss with the project team members.*" (PM4ORG1)	"***Talvez esse conhecimento [obtido desempenhando outros papéis no projeto] me ajude a trabalhar com mais empatia. Entender o que é um dia de codificação, talvez me torne mais flexível a entender um determinado cenário.***" English: "*Maybe the knowledge [from performing other project roles] helped me gain more empathy. Understanding what a coding day is perhaps makes me more flexible in understanding a certain scenario.*" (PM1ORG2)
*"**Eu conheço muito bem o negócio, conheço como tá estruturado o projeto. É uma bagagem que me permite tomar decisões de forma mais acertada e com mais confiança.**"* English: *"I know very well the project's business, I know how the project is structured. It's a piece of knowledge that makes me make accurate decisions with more confidence."* (PM6ORG1)	"***Acho que isso [experiência em outros papéis] me agregou também tecnicamente pra ao escutar aquilo, poder me comunicar bem e até influenciar as decisões dos membros da equipe.***" English: "*I think it [experience performing other project roles] made me better technically to when listening something from the team members, communicate well and even influence their decisions.*" (PM3ORG1)

Skills

The number of studies into the role of the project manager as well as the project manager's impact on the outcome of the project has increased in the recent years (TURNER and MÜLLER, 2006). In parallel with the academic research, professional organizations, including the Project Management Institute (PMI) and the International Project Management Association (IPMA) have also developed standards about project manager competences: the Project Management Competency Development Framework (PMCD) (PMI, 2007) and the IPMA Competence Baseline (ICB3) (IPMA, 2006).

Recently, several studies that focus on the less tangible leadership and interpersonal skills have appeared (KEIL et al., 2013; NAPIER et al., 2009). Gemünden (2014) showed a clear decline of planning and controlling themes and a rise of topics related to the human side of project management. Among the several skills needed by SPMs to better manage a project, some of them relate directly to making effective decisions. The SPMs pointed out six skills: the holistic vision of the project, transparent communication, negotiation capacity, organizational ability, proactive risk management, and interpersonal relationship. The excerpts from the interviews that justify them are presented in Table 16.

The **holistic vision of the SPMs** enables their understanding of the entire project from a comprehensive analysis of the parties and the interaction between them. The SPMs should look increasingly to the whole to include factors that the team members usually not perceive as they are concentrated in individual tasks. On the other side, micromanagement is a management style whereby a manager closely observes or controls the work of subordinates or employees. Often, this excessive obsession with the minutest of details causes a failure in the ability to focus on the major details, impacting of the proactive perception of the consequences of some decisions.

The importance of the SPM's holistic vision of the project was mentioned by some software engineers in order to make the team members know what have to be exposed or not based on the context into which the project is inserted. A PMO manager and the functional manager's assessor reinforced the need for understanding the project's purpose for the organization.

The **transparent communication** is one key element which has to be applied effectively throughout a project's lifecycle from the beginning until the end and was mentioned by the SPMs as necessary in decision-making. Transparency communication begets trust, and that trust creates an environment in which people are more likely to be honest, share ideas and knowledge, and collaborate towards common goals. In a transparent and accountable environment, employees are not afraid of retaliation or punishment. As a result, they are willing to point out problems they discover before the problems escalate into major issues. Although not everyone can be included in every decision, the SPM should explain clearly why upper-level decisions were made when team members cannot be involved. Sharing as much information as possible with them about how and why certain decisions are made helps ensure team members' future decisions are in line with the project's objectives.

The transparent communication was emphasized by the software engineers. Some argued the importance to involve not only the experienced members but also the less experienced members in project meetings in order to get all the team members involved in the decisions. Also, they pointed out the importance of not hiding information from the client since it can have a bad consequence in the future. This skill was also pointed out by a PMO manager and the functional manager's assessor.

It is inevitable that conflict and disagreement will arise as the differing needs, aims and beliefs of people are brought together. Without **negotiation capacity**, such conflicts may lead to argument and resentment resulting in one or all of the parties feeling dissatisfied or uncompromising with the decision. The point of negotiation is to try to reach agreements without causing future barriers to communications. It is essential for everybody involved to keep an open mind in order to achieve an acceptable solution. Any agreement needs to be made perfectly clear so that both sides know what has been decided.

The SPM's **organizational ability** was pointed out as an important factor since managing and keeping track of projects, tasks, and people are essential to succeeding and making effective decisions. If the information about the project's schedule, budget, scope, quality, and so on, are not updated, there is a greater chance of making an improper decision or beyond the required time. The organizational ability was pointed out by one software engineer since it make

possible the SPM to plan and organize the project in order to define what should be done at each moment without get overloaded. A PMO manager emphasized the organizational ability through planning in order to be preventive in relation to the threats and opportunities.

The project manager is responsible for keeping himself and all the project team members working proactively and alert to risks. According to PMI (2013), a project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. Strategies to manage those negative effects typically include avoiding the threat, reducing the negative effect or probability of the threat, transferring all or part of the threat to another party, and even retaining some or all of the potential or actual consequences of a particular threat. Although there is a vast literature on risk management focusing on its quantitative aspects (MCNEIL, 2015), the SPMs usually manage the risks in a qualitative way. By exercising **proactive risk management**, the SPMs can achieve a comfort level within the project events and by coming up with alternative risk management strategies, they are more likely to circumvent obstacles and make effective decisions. This factor was reinforced by a PMO manager and the functional manager's assessor.

The SPMs pointed out the importance of building and maintaining good relations with the team members and stakeholders. The high quality of **interpersonal relationship** facilitates interpersonally oriented behavior that contributes to the accomplishment of project objectives. These include encouraging cooperation, consideration of others, and building and mending relationships. The possibility of disagreements over the accomplishment of a task as well as interpersonal incompatibilities are likely to decline. When a SPM has a good relationship with all the stakeholders, they are likely to motivate them to work hard and participate in decisions and be committed to them. The importance of this skill was confirmed by some software engineers and was also identified in the meetings with the SPMs and stakeholders, including members from the support departments.

Table 16. Interviewees' quotes about SPM's skills

SPM's skills		
Holistic vision of the project	"***Eu acredito que a visão sistêmica, a visão integrada do todo, dos impactos das coisas, das interdependências entre as coisas, ter essa visão muito clara na cabeça pra tomada de decisão.***" English: "*I believe that the systemic vision, the integrated vision of the whole, the impact and interdependence between things place a very clear vision in mind for decision-making.*" (PM1ORG1)	"***Aquele que tá somente com a lupinha ali mergulhado no operacional e não consegue ver o todo (...) Muitas vezes ele vai tomando decisão dentro da lupinha, não consegue ver o que tá fora.***" English: "*One who is only looking at the operational details does not see the whole project (…) Many times he makes decisions only at that level, and doesn't pay attention to what is happening at other levels.*" (PM6ORG2)
Transparent communication	"***Como eu tomo decisões em conjunto com os times das coisas dos projetos, a gente tem que alinhar bem as expectativas, as coisas têm que tá claras pra todo mundo. Isso é influência da boa comunicação.***" English: "*Since I make decisions together with my teams about the projects, we have to align expectations, so everything has to be clear to everyone. This is influenced by good communication.*" (PM4ORG2)	"***Porque se você tem uma comunicação fluida e transparente dentro do projeto, você permite que as pessoas conheçam você melhor (...). Quando eu insiro [a equipe] no contexto e eu observo como as pessoas se posicionam, isso me ajuda e ajuda as pessoas que trabalham comigo a tomar aquela decisão.***" English: "*Because if you have a fluid and transparent communication within the project, you allow people to know you better (...). When I include [the team] in the context and I notice how people position themselves, it helps me and helps people who work with me to make that decision*." (PM5ORG2)
Negotiation capacity	"***Eu meramente pego as coisas que são restritivas da organização, coloco isso pra eles [membros da equipe] de uma forma adequada, recebo o impacto de volta e tento negociar com a direção. Sou um cara do meio, um 'middleware' que une essas duas coisas.***" English: "*I merely picked up the things that are restrictive from the organization, put it to them [team members] in a proper way, I get the feedback and try to negotiate with the top managers. I stay in the middle in this relation, a 'middleware' that joins these two things.*" (PM1ORG2)	"***Eu sou muito sensível às demandas, aos pedidos dos clientes. O que procuro fazer é colocar em uma balança e equilibrar a relação pra que nem sempre seja o melhor para o time e nem sempre seja só o melhor para o cliente***." English: "*I am very sensitive to the demands of the clients. What I try to do is to manage the situation not always to be the best for the team and not always to be the best for the client*." (PM2ORG2)

SPM's skills (Continuation)		
Organizational ability	"***A partir do momento que você tá organizado, você normalmente tem as informações pra poder tomar a decisão.***" English: "*From the moment that you are organized, you usually have the information to be able to make a decision.*" (PM3ORG2)	"***Numa determinada situação ele tá tão desorganizado que a tomada de decisão dele é complicadíssima, e você aumenta muito os pontos de tomada de decisão.***" English: "*In a given situation he's so disorganized that his decision-making is very complicated, and you increases the number the decisions points.*" (PM8ORG1)
Proactive risk management	"***A gente tá tomando essa decisão, que é a decisão mais factível, mas não é a ideal. (...) Por que ela não é ideal? Porque ela tem o risco 'x'. Então vamos ver se a gente consegue mitigar o risco, se não a gente vai ter que partir pra outro caminho.***" English: "*We're making this decision, which is the most feasible decision, but it is not ideal. (...) Why is it not ideal? Because it has a risk. So let's see if we can mitigate the risk, otherwise, we'll have to make another decision.*" (PM5ORG2)	"***O processo não é tão formal do ponto de vista de ter auditoria de riscos, mas há identificação, avaliação e, nem sempre quantitativa, mas sempre qualitativa. Em relação aos riscos mais importantes, sempre há um planejamento de resposta.***" English: "*The process is not so formal in order to the risks be audited, but we identify and evaluate them, not always quantitatively, but always qualitatively. When regarding the most significant risks, there is always a response planning.*" (PM2ORG2)
Interpersonal relationship	"***Se você não tem uma boa relação com sua equipe, não adianta, você pode tomar a decisão que for, o pessoal pode até lhe boicotar.***" English: "*If you do not have a good relationship with your team, you can make any decision, the team members can even boycott it.*" (PM2ORG2)	"***Se foi você quem decidiu aquilo sozinho e depois o problema estourou e você não tem o relacionamento bacana [com os membros da equipe], eu acho que depois se você precisar de hora extra, por exemplo, eles não vão responder bem.***" English: "*If you decided alone, a problem arises and you do not have a good relationship [with the team members], if you need them working overtime, for example, I think they will not respond well."* (PM4ORG1)

5.2.3 CONSEQUENCES

Among the decision-making styles, the participatory decision-making style was the only one to which we could associate the following consequences based on the interviews: team members' commitment, SPM's decision regret, and SPM's cognitive biases.

Team members' commitment

The depth of the **commitment of team members** to work together effectively to accomplish the goals of the team is a critical factor in team success, which is gained through their involvement in project decisions. Meyer and Allen (1991) conceptualized the nature of commitment into three components: (i) continuance, which is related to the awareness of costs associated with leaving; (ii) normative, which is related to the feeling of obligation to remain with the team; and (iii) affective, which is related to the emotional attachment, identification, and involvement with the team.

Because this research concentrates on work teams, just normative and affective commitment could be found based on data extracted from the interviews. Some researchers have found that these components of commitment are positively related to performance and satisfaction in organizations and teams (BECKER et al., 1996). As stated by the SPMs from both organizations, shared responsibility in order to make participatory decision-making is essential to obtain the team members commitment to the project, as well as to establish an atmosphere of trust, as exemplified through the excerpts in Table 17. The SPMs characteristic of being dictatorial and centralizing the decision-making was pointed out as a negative element of the SPMs, impacting on the team members' commitment. The software engineers also reinforced their commitment when they are involved in decisions, since they feel part of the solution, thus having a better contribution to the quality of the products.

Table 17. Interviewees' quotes about Team member's commitment

Team member's commitment	
*"**Quando todo mundo vê que todos participaram daquela decisão, o compromisso é maior do que se eu chegar e dizer 'é assim'. Pode haver muito mais resistência.**"*	*"**Prefiro avaliar com a própria equipe qual a melhor alternativa. Por mais que eu pense um pouco diferente eu vou seguir o que a equipe quer fazer, porque é uma forma de ela se comprometer com aquilo.**"*
English: *"When everyone realizes that all team members participated in that decision, the commitment is greater than if I make the decision by myself. There may be much more resistance."* (PM9ORG1)	English: *"I prefer to assess with the team members what is the best alternative. Even if I think a little bit different I will do what the team members want to do, because it is a way they get committed."* (PM7ORG1)

Team member's commitment (Continuation)	
*"**Acho que a principal força motriz do projeto é a equipe. Se você não tá acompanhando como tá o sentimento da equipe, não tá fazendo com que ela participe da tomada de decisão (...) eles simplesmente vão trabalhar mais devagar e provavelmente vai gerar alguma consequência.**"* English: *"I think the project's main force is the team. If you're not paying attention to the team members' behavior, and not involving them in decision-making (...) they will simply work slowly, thus impacting on the projects' results."* (PM7ORG2)	"***Confiar nas pessoas é algo muito bom. Mesmo que eu tome uma decisão errada, se foi em comum acordo com eles, eles serão meu principal suporte pra gente partir na direção do que vai ajustar."*** English: "*Trusting in people is very good. Even if I make a wrong decision, but it was made in accordance with them, they will be my principal support in order to adjust it.*" (PM1ORG2)

Decision regret

Normative models of decision theory generally refer to decision-making quality as been achieved through a logical and rational decision process in which the pros and cons of all possible options are weighed, and the best option is selected. Milkman et al. (2009), however, suggested that a good decision can be indicated by satisfaction with one's choice when reflecting on it. According to the authors, a good decision is one that the decision-maker regards as the right choice even after some time has passed, which is related to the decision regret.

Regret is the negative emotion experienced when learning that an alternative course of action would have resulted in a more favorable outcome. The theory of regret aversion or anticipated regret (LOOMES and SUGDEN, 1982) proposes that when facing a decision, individuals may anticipate the possibility of feeling regret after the uncertainty is resolved and thus incorporate in their choice their desire to eliminate or reduce this possibility. The participatory decision-making style was pointed out as minimizing **decision regret of SPMs**, as described in Table 18.

Table 18. Interviewees' quotes about SPM's decision regret

SPM's decision regret	
*"**Eu acho que o fato de não tomar uma decisão sozinho [faz com que não me arrependa]. Geralmente eu tomo uma decisão com o apoio de alguém.**"* English: *"I think that is because I usually do not make decisions alone [I don't feel regretful]. I usually make decisions with someone else's support."* (PM7ORG1)	"***Como foi acordado, como tava todo mundo ciente, todo mundo concordou com aquilo, então não há esse arrependimento.**"* English: "*As it was agreed, everybody was aware and agreed with that, there is no regret*." (PM5ORG1)
*"**Normalmente a gente joga pra equipe quais são as opções que a gente tem. A partir do momento que a gente tá bem confiante que uma é a decisão a ser tomada, então a gente aposta todas as fichas naquela dali. Não fico me culpando ou pensando: 'como seria se fosse com essa outra?'"*** English: "*Usually we inform the team members what are the options we have. From the moment we're pretty confident what is the decision to be made, we go ahead. I don´t stay blaming myself or thinking: 'what the results would be if we decided differently?'*" (PM3ORG1)	"***É muito raro [me arrepender da decisão] porque nem sempre eu tomo sozinha, muito raro. Eu não me lembro, assim, de uma decisão que eu tenha tomado em projeto e que tenha me arrependido.***" English: "*It is very rare [the decision regret] because I do not always make decisions alone, it is very rare. I do not remember a decision I have made and I felt regretful."* (PM2ORG1)

Cognitive biases

According to Klein et al. (1993), a decision bias is not a lack of knowledge, a false belief about the facts, or an inappropriate goal; nor does it necessarily involve lapses of attention, motivation, or memory. Rather, a decision bias is a systematic flaw in the internal relationships among a person's judgments, desires, and choices.

From the naturalistic perspective, an unquestioning acceptance of the relevance of classical normative standards is untenable, because real-world decision makers appear to use qualitatively different types of cognitive processes and representations. In a continuous environment, iterated adjustments may move assessments progressively closer to the normative target through relies on feedback from initial guesses, additional redundant clues, and opportunities for subsequent correction. In this sense, the effects of multiple players and multiple constituencies may offset the effects of individual errors in a similar manner.

The identification of the factors related to **cognitive biases** was not straightforward in this research's phase. As the axial coding evolved, we noticed that some practices and attitudes were related to those identified during the exploratory study on cognitive biases.

Although the project manager is responsible for making final project decisions, the findings presented in Chapter 4 shows a concern of the SPMs to consider opinion of others, such as consultants, PMO members, the team members, and other project managers aiming to obtain a better base for their decisions and not depositing all confidence in their own experience, which aims to minimize the negative effects of some cognitive biases, such as anchoring, halo effect, availability-related bias, planning fallacy, sunk-cost fallacy and exposure effect (CUNHA et al., 2014, 2015a, 2015b, 2015c). Based on some excerpts, such the ones described in Table 19, the participatory decision-making aims to uncover new situations that were not though of by the SPM, thus minimizing the negative impact of such biases.

Table 19. Interviewees' quotes about SPM's cognitive biases

SPM's cognitive biases	
"[Quando questionado por algum stakeholder] minha resposta é sempre 'me dá um tempinho pra eu analisar internamente com o time'. Isso me causa sempre bons resultados, porque muitas vezes o time traz a coisa em uma perspectiva que eu não tinha analisado." English: *"[When questioned by a stakeholder] I ask to be given time to internally analyze with my team. This always causes good results, because the team members bring a perspective I had not considered."* (PM2ORG2)	"***Ás vezes a gente consegue mudar a estimativa, mudar o planejamento baseado nesse tipo de questionamento. Eu me posiciono como se fosse um cliente, questionando o porquê de algumas coisas.***" English: "*Sometimes we can change the task estimates and the plans based on this type of questioning. I stand, like a client, questioning things.*" (PM4ORG2)

5.3 RELATING FACTORS AND BUILDING HYPOTHESES

The next step in the data analysis was drawing relationships among the factors grounded in the data, thus building the hypotheses that communicate a particular view of the phenomenon.

In a scenario where the locus of decision-making moves from the project manager to the software development team, and the decision-making process changes from individual and centralized to shared and decentralized (PARK and LEE

2014), the SPMs' role is focused in questioning by promoting reflection by the team members and stakeholders. The SPMs from both organizations demonstrated trust with team members by delegating some decisions and creating a learning environment where it is possible to make mistakes. In this sense, the leadership style influences how the decisions are made. It is in line with the growing body of research which suggest that project manager's assumption as being expert instead of facilitator, expecting people to follow orders rather than encouraging participation, is not appropriate to all situations (POLLACK, 2007). Therefore:

Hypothesis 1: ***The SPM's leadership style influences their participatory decision-making style.***

According to Bjørnson and Dingsøyr (2008), there is a need to not focus exclusively on explicit knowledge, but also on tacit knowledge. As stated by the SPMs, the lessons learned and stored in documents were rarely used. Instead, they focused on tacit knowledge sharing with the team members and colleagues from other projects when making decisions.

Due to the uncertainty and dynamism inherent to software projects, the SPMs focus on making, monitoring and adjusting decisions, which need a constant feedback through client involvement as well as iterative planning. As stated by Williams and Cockburn (2003), the agile methodologies are developed to embrace, rather than reject, higher rates of change. In this scenario, feedback loops constitute the core element. The knowledge sharing initiatives, continuous feedback, client involvement, and iterative planning represent instrumental elements that aim to enhance the SPM's knowledge.

The experience of the SPMs, which includes their employment time in the organization and their project management experience influence the decisions made during the projects. This result is aligned with the experiment conducted by Huff and Prybutok (2008) which showed that experience in project management related to the subject area has a significant influence on the decisions. Also, the SPM's knowledge on business domain and technical aspects, thus enhancing his or her ability to facilitate decision-making. Therefore:

Hypothesis 2: ***The SPM's experience, formed by project management experience and employment time in the organization, and the SPM's***

knowledge, formed by technical capacity and knowledge on business domain, moderates how the SPM's leadership style influences on his or her participatory decision-making style.

The organization structure interferes in project management by limiting the autonomy given to the SPMs to make decisions. Because not all the workforce is dedicated to the project, the SPMs can face problems of lack of commitment and priority problems, thus impacting on decision-making. Also, the autonomy of the SPM and team members influence in how the tasks will be performed, what are the tools that will be used, how the change requests will be treated, and so on, based on the projects' characteristics. Those factors moderate how the SPM's leadership style influences their participatory decision-making style. Therefore:

Hypothesis 3: ***The SPM's autonomy, which includes the development process flexibility, moderates how the SPM's leadership style influences on his or her participatory decision-making style.***

According to the SPMs, while a simple decision involves the absence of uncertainty and is in the scope of the team members, a complex decision is related to the involvement of various stakeholders to reach a consensus and a high level of uncertainty. In this sense, the task complexity moderates how the SPM's leadership style influences their participatory decision-making style. Therefore:

Hypothesis 4: ***The task complexity moderates how the SPM's leadership style influences on his or her participatory decision-making style.***

The SPMs pointed out that a qualified technical team makes them feel comfortable to make decisions based on the information they give. Having team members with high technical capacity influence in decisions, mainly those related to how the things should be done. When the team members are novice, the SPM has a higher influence on decisions, thus impacting on the way decisions are made. Therefore:

Hypothesis 5: ***The team members' technical capacity moderates how the SPM's leadership style influences on his or her participatory decision-making style.***

Among the several skills needed by SPMs to better manage a project, some of them are directly related to decision-making. The SPMs pointed out six skills: the

holistic vision of the project, transparent communication, negotiation capacity, organizational ability, proactive risk management, and interpersonal relationship. The holistic vision of the project was pointed out as being important by the SPMs because it allowed them to bring other factors not initially considered by the team members and other stakeholders when making decisions. The transparent communication creates an environment of trust in which people are more likely to share ideas and knowledge. The negotiation capacity is important to try to reach agreements without causing future barriers to communications thus impacting on future decisions. The SPM's organizational ability refers to manage and keep updated track of projects, tasks, and people in order to make decisions based on the largest possible amount of information. By exercising proactive risk management, the SPMs are more likely to identify possible obstacles preventively and make effective decisions. Finally, when a SPM has a good relationship with all the stakeholders, they are likely to motivate them to work hard and participate in decisions and be committed to them. Therefore:

Hypothesis 6: ***The SPM's holistic vision of the project, transparent communication and negotiation capacity, organizational ability, proactive risk management, and interpersonal relationship moderates how the SPM's leadership style influences on his or her participatory decision-making style***.

As stated by the SPMs from both organizations, shared responsibility to make participatory decision-making is essential to obtain the team members commitment to the project, as well as to establish an atmosphere of trust. The SPMs characteristic of being dictatorial and centralizing the decision-making was pointed out as a negative element of the SPMs, impacting on the team members' commitment. Because this research concentrates on work teams, just normative and affective commitment could be found based on data extracted from the interviews. The depth of their involvement influences their commitment to work together to accomplish the project goals. Therefore:

Hypothesis 7: ***The SPM's participatory decision-making style influences positively the team members' commitment to the project.***

The emotions have a powerful impact in decision-making by shaping individual's behavior. Therefore, no decision theory could be complete without taking their role into account (MARCATTO and FERRANTE, 2008). According to the authors, individuals typically experience feelings of happiness after having made a

decision that leads to a good outcome and tend to experience negative and even painful feelings when wishing better decision could be made. Decision regret is the negative emotion experienced when learning that an alternative course of action would have resulted in a more favorable outcome. A good decision, therefore, can be indicated by satisfaction with one's choice when reflecting on it. The participatory decision-making, considering the involvement of the team members and stakeholders when making complex decisions, was pointed out as a factor that minimizes the decision regret of the SPMs. Therefore:

Hypothesis 8: ***The SPM's participatory decision-making style influences negatively the SPM's decision regret.***

Also, the participatory decision-making through which the SPM promotes reflections tends to minimize the possibility of a decision be made based on a recent event in the mind of an individual (availability-related bias) or relying too heavily on the first piece of information offered (anchoring), thus influencing on effective decisions. In addition to those cognitive biases, as presented in Chapter 4, the opinion of others, which is related to the participatory decision-making style, was the alternative mentioned to reduce the majority of biases, including the halo effect, planning fallacy, sunk-cost fallacy and exposure effect. Therefore:

Hypothesis 9: ***The SPM's participatory decision-making style influences negatively the SPM's cognitive biases.***

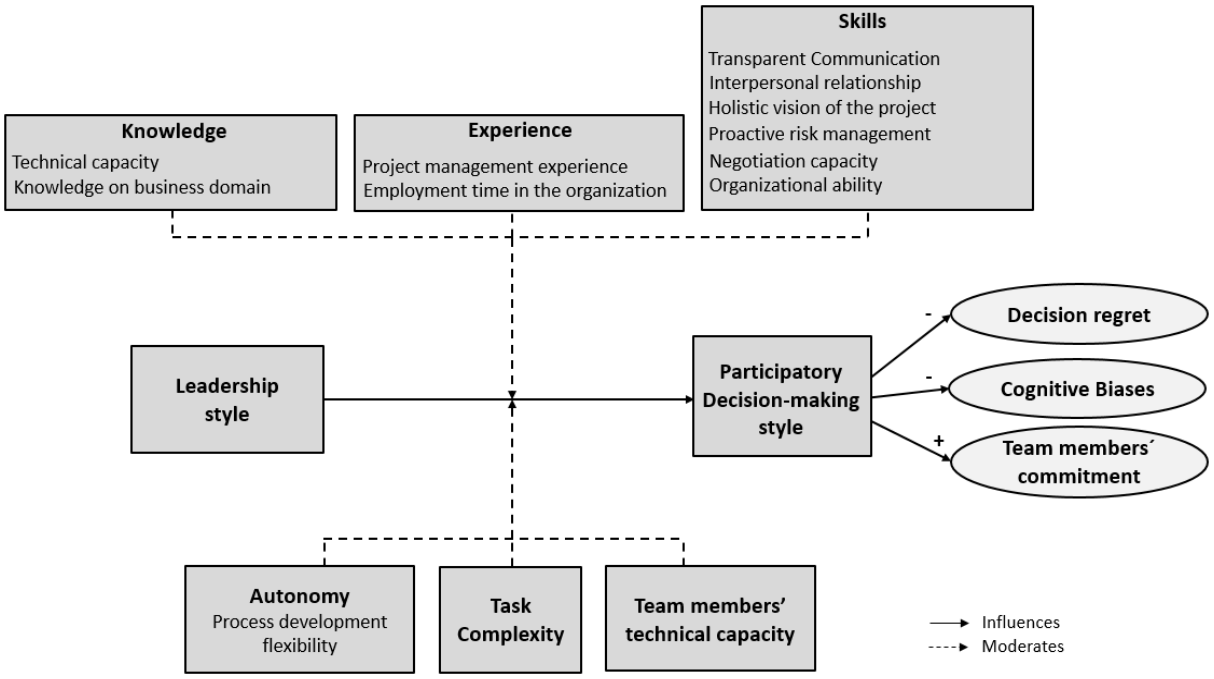
In short, decision-making in software project management is usually based on looking for the first workable option rather than trying to find the best possible option. In this process, the experience of the SPMs, which includes their employment time in the organization and their project management experience, as well as their knowledge on business domain and technical capacity, moderates how decisions are made. When involving the team members, the previous experience, and available knowledge are essential to ask questions to promote reflection of the group.

The SPMs' leadership style influences how the decisions are made by trusting in team members and delegating some decisions, thus creating a learning environment where it is possible to make mistakes. It is in line with the project manager's assumption that being expert instead of facilitator, expecting people to follow orders rather than encouraging participation, is not appropriate to all situations.

This facilitation capacity in participatory decision-making is impacted by the organization structure because it can limit the autonomy of the SPMs, including the flexibility given by the organization to adapt the development process to the project's characteristics. The relation between the SPM's leadership style and his or her participatory decision-making style is influenced by his or her holistic vision of the project, transparent communication and negotiation capacity, organizational ability, proactive risk management, and interpersonal relationship.

The SPMs focus on knowledge sharing with the team members and colleagues from other projects. Constant feedback aims to minimize the uncertainty inherent to software projects, which can be obtained through the client involvement as well as iterative planning. The involvement of team members in participatory decision-making is influenced by their technical competence as well as the task complexity. The participatory decision-making style has a positive impact on team members' commitment to the project as well as promotes reflections on the entire group involved in each decision, thus minimizing the decision regret and cognitive biases. The central story that explains decision-making in software project management is illustrated in Figure 18.

Figure 18. Substantive Theory of Decision-Making in Software PM



5.4 ENFOLDING THE LITERATURE

Traditionally, the researches focusing on how decisions ought to be made, and how they can be improved are based on analytical models (VIRINE and TRUMPER, 2008). However, in naturalistic settings, making decisions is a process of constructing and revising situation representations as much as a process of evaluating the merits of potential courses of action. The ill-structured problems; uncertain dynamic environments; shifting, ill-defined, or competing goals; action/feedback loops; time stress; high stakes; multiple players; and organizational goals and norms, all of them characteristics of a naturalistic setting, are directly related to the software project context.

In the following subsections, the naturalistic decision-making models and the findings from the systematic literature review are analyzed in light of our substantive theory.

5.4.1 NATURALISTIC DECISION-MAKING MODELS

Through SPM's experience managing other projects, they are able to decide what to do by observing that the current situation is similar to other previously observed situations, and that actions that worked in those situations may also work in the new one, as stated by Noble's model of situation assessment (NOBLE, 1989). This conclusion is in line with Klein's model of Recognition-Primed Decisions (KLEIN, 1989), which indicates that proficient decision makers rarely compare among alternatives. Rather, actions are selected from an action queue and the first one evaluated is that rated as the most typical response in the particular situation. In general, it is accomplished by a criterion of dominance, as defined by Montgomery's dominance search model (MONTGOMERY, 1983), through which the SPMs states the main objective to be accomplished when making decisions.

According to Beach and Mitchell's Image Theory (BEACH and MITCHELL, 1987), decisions are constrained by decision makers' values and knowledge, which includes decision maker's principles, concrete goals, and plans and tactics to achieve that goal. As well as the SPM's experience, the SPM's knowledge was an essential factor pointed out by SPMs when making decisions, composed of their technical capacity and knowledge on business domain. Depending on the SPM's leadership

style, decisions can be made by himself or through the involvement of the team members.

According to the Pennington and Hastie's model of explanation-based decisions (PENNINGTON and HASTIE, 1988), decision makers begin their decision process by constructing a causal model to explain the available facts. Through tacit knowledge sharing, the SPMs compare the available options with those that worked well in previous projects managed by other SPMs, making sufficient adaptions considering the current context. The matching and reassessment of those decisions are based on an argument way, as defined by Lipshitz's model of argument-driven action (LIPSHITZ, 1989).

According to Hammond's cognitive continuum theory (HAMMOND, 1988), the cognitive processes that guide decision making can be located on a cognitive continuum which ranges between intuition and analysis, influenced by the task characteristics. In our substantive theory, the task complexity moderates how the decisions are made considering the participation of the team members and stakeholders. Rasmussen's model of cognitive control (RASMUSSEN, 1983) emphasized the appropriateness of knowledge-based behavior in novel situations, which requires a deeper understanding of the nature of the situation and explicit consideration of objectives and options, which is facilitated through the involvement of team members considering the SPM's participatory decision-making style. Due to the uncertainty inherent to software projects, a continuous feedback is important to reassess the early decisions, emphasized by Connolly's model of decision cycles (CONNOLLY, 1988), which stated the cyclical interplay between situation assessment, evaluation of alternatives, and action through continuous feedback.

In sum, the naturalistic models pointed out the importance of experience, knowledge and continuous feedback in decision-making as well as in our substantive theory.

5.4.2 FINDINGS FROM THE SYSTEMATIC LITERATURE REVIEW

In the context of software projects, many authors pointed out the need for a culture of openness and a certain amount of shared decision making (ROSE et al., 2007; DRURY et al., 2012; TAYLOR and WOELFER, 2011; MEDINA and FRANCIS, 2015). According to the authors, the SPMs have to take active responsibility for

problems and the consequences of their decisions as well as listen to project members' views and involving them in decisions.

The participation of engaged developers ensures good decisions, which is related to the SPM's transformational leadership style to build a sense of ownership of the project among the team members. Pan et al. (2004), Pan (2006), and Newman and Sabherwal (1996) pointed out the importance of the creation of psychological safety for project members, either by removing barriers to change or by eliminating the threat inherent in past failures. It is related to the transformational leadership style when the SPMs demonstrated trust with team members by delegating some decisions and creating a learning environment where it is possible to make mistakes.

Moe et al. (2012) emphasized the need for a shift from rational to naturalistic decision-making through the development of shared mental models between the team members and stakeholders, reinforced by daily meetings as important for preventing decision-hijacking, which is related to the SPM's transparent communication throughout the project. The importance of the competences associated with communication decisions were also addressed by Dillon and Taylor (2015).

Although the participatory decision-making has been proved useful, McAvoy and Butler (2009) and Coyle et al. (2013) found that cohesive teams could exhibit problems such as groupthink. In this sense, the project managers have to take on the role of devil's advocate in the decision-making process, by encouraging the generation of new ideas from each team member during decision, and ensuring such decisions are evaluated and communicated effectively within the team. These characteristics are related to the SPMs' participatory decision-making style through which he or she ask questions to the group to make them reflect about the decisions.

In our substantive theory, project planning based on iterations influences on feedbacks of early decisions made during the beginning of the iteration. Drury-Grogan and Orla (2013) stated that iteration duration could place pressure on teams to make decisions quickly, which can impact on the rational way they are made. The authors also pointed out the importance of team member's experience. Drury-Grogan (2014) suggest that the teams have to learn all the technical competences required rather than splitting the work across teams which creates scheduling and

dependency issues, which influence on the SPM's autonomy to make decisions when he or she depends on services from different departments.

In sum, the transformational leadership style influences the way the SPMs make decisions through the involvement of the team members and stakeholders. Our substantive theory reinforces the movement from the locus of decision-making from the project manager to the software development team. In this context, an important role of the SPM during the management of the project is the facilitation of how the team members and stakeholders will achieve the project outcomes through shared and decentralized decision-making, which requires the skills identified in our substantive theory.

5.5 IMPLICATIONS FOR PRACTICE

Through the understanding of how SPMs make decisions based on how they interpret their experiences in the workplace, it is possible to focus on those elements that decrease the SPM's decision regret and cognitive biases as well as increase the team members' commitment to the project, thus influencing on the effectiveness of project management.

Based on the soft skills identified as essential to decision-making throughout the projects, there is a need for training courses on project management focusing on a more practical approach based on those skills rather than only on processes, techniques, and tools. The implications for practice in the workplace are explained below:

Mentoring

The SPM's experience and knowledge were presented as important factors influencing decisions along the projects, and, in some cases, more important than tools and techniques to support decision-making. In this sense, it is important that senior SPMs support novice SPMs through a mentoring process by a series of time-limited, confidential, one-on-one conversations and other learning activities (SWAP et al., 2001). The mentor may help the person being mentored develop specific job skills or leadership capacities.

A novice project manager benefits from a mentoring relationship because he has someone with greater knowledge and experience to turn to for advice. While a mentor will not do the SPM's job for him, the mentor may demonstrate a task, guide the SPM through solving a problem, or critique the SPM's work. Some of mentoring activities are:

- Spending time discussing how the SPM dealt with a challenging situation, followed by a brainstorm of alternate ways to overcome that challenge;
- Rolling play how to address a challenging situation to practice skills, such as in an upcoming interaction that the SPM is unsure about or would like guidance for;
- Inviting the SPM to sit in on a mentor’s meeting that will give him or her an opportunity to learn or network;
- Observing the SPM in a meeting or presentation and give him or her feedback on his or her performance;
- Discussing the SPM's strengths, ways he or she can further develop these skills, and potential problems that can result from over-reliance on them;
- Discussing the SPM's weaknesses, ways he or she can strengthen his or her skills in these areas, and the potential advantages they can offer;
- Talking about the types of people the SPM finds most difficult to work with, and strategies for more effective interactions with them.

Communities of Practice

In a socio-technical approach to knowledge process, communities of practice can be considered as social enablers. The Communities of Practice (CoPs) are groups of people informally bound together by shared expertise and passion for a joined enterprise (WENGER, 2008). The participation in CoPs can be seen as an essential process of learning, thus being relevant to tacit knowledge sharing between SPMs.

Communities develop their practice through a variety of methods, including: problem solving, requests for information, seeking the experiences of others, reusing assets, coordination and synergy, discussing developments, visiting other members,

mapping knowledge and identifying gaps. A necessary component is that members share an interest in a specific domain. In this sense, the CoPs can be formed by those SPMs that work with the same client, technology, process, and so on. Since CoPs are informal and self-organizing by nature, members are empowered to design the type and frequency of interactions that best meet the need of the community, and must give attention to the following actions:

- Interacting and engagement in shared activities, helping each other, and sharing information with each other. Relationships are built to enable them to learn from each other;
- Developing a shared repertoire of resources which can include stories, helpful tools, experiences, stories, and ways of handling typical problems. This kind of interaction needs to be developed over time according to the needs and characteristics of the group.

Brokering activities

Brokering activities, in turn, are social processes with the broker participating in the interactions and establishing connections between communities by introducing elements of one practice into another (BROWN and DUGUID, 1998). As responsible for supporting all projects of an organization, the PMO can act as knowledge broker by disseminating the lessons learned from tacit knowledge sharing initiatives instead of focusing most on explicit knowledge management. Effective knowledge brokers have to be capable of translating, coordinating and aligning different perspectives (PAWLOWSKI and ROBEY, 2004).

The main goal of the knowledge broker is to promote evidence-informed decision-making (LOMAS, 2007). Knowledge brokers as facilitators of knowledge transfer are actors who provide connections between communities of practice, transfer elements of one practice into another, enable coordination, and create new opportunities for learning (WENGER, 2008). The PMO, as a knowledge broker, needs:

- To cross social boundaries to access information and knowledge held within different projects and departments that are characterized by distinct

mindsets and attitudes, and also by different ways of processing knowledge;

- To integrate and translate the acquired knowledge in order to effectively transfer it in terms of the SPM's perspective;
- To engage in mediation activity between projects and create opportunities for communication mechanisms to emerge between SPMs and as a result facilitate knowledge transfer between them.

Shared mental models

Shared mental models represent knowledge held in common by members that lets them understand tasks and relationships among tasks, and coordinate their actions and interactions. If a team has established a shared mental model, members can anticipate one another’s needs and adjust work strategies in accordance with team or task changes (DINGSØYR et al., 2016). Since software development depends on team members’ ability to acquire, communicate, and use relevant knowledge, it is crucial that the SPMs:

- Create an environment of trust with team members by delegating some decisions. Trust is established when each team member feels important and part of the team. When team members feel everyone is pulling together to accomplish a shared vision, rather than a series of personal agendas, trust results;
- Create a learning environment where it is possible to make mistakes. If one makes a mistake in a certain situation, one will remember about how something does not work. Thus the same kinds of mistakes will not be repeated.

6 Conclusions and Future Works

Software projects involve dealing with trade-offs between characteristics, preferences and quantities while maintaining a balance between requirements, expectations, perceptions, opportunities, and risks. The primary challenge of project managers is to achieve all project goals and objectives while honoring the preconceived constraints, such as scope, time, quality and budget.

Due to the contestation in recent years by both practitioners and academics of the functionalist/positivist goal of disseminating “best practice” in project management to masses of practitioners, the development of an explicit theoretical basis for project management has been pointed out as one of the most crucial issues in the development of the profession. Also, it provides the opportunity to understand the assumptions which underpin practice.

This research aimed to understand how software project managers make decisions by how they interpret their experiences in the workplace when making decision, and what are the antecedents and the consequences of their decisions. The choice of the epistemological position (interpretative), ontological (constructivist) and methodological (qualitative) to analyze the phenomenon also gave to this research a novelty character regarding the way to address the problem.

In the first phase of this research, through an exploratory study based on semi-structured interviews with seven SPMs from a large Brazilian governmental organization and with three SPMs from a small Portuguese private organization, eight cognitive biases were considered in order to shed light on how the SPMs deal with them. The opinion of others was the alternative mentioned to reduce the majority of biases: anchoring, halo effect, availability-related bias, planning fallacy, sunk-cost fallacy and exposure effect.

Although the project manager is responsible for making final project decisions, it showed a concern to consider the opinion of others, such as consultants, PMO members, team members, and other project managers with the objective of obtaining a better base for their decisions and not depositing all confidence in their own experience. The findings showed an initial picture of the influence of cognitive biases

on SPMs' decisions and suggested that we needed a more grounded understanding of the mechanisms of decision-making. Therefore, a broader research protocol based on semi-structured interviews was carried out with eleven SPMs within a large Brazilian governmental organization and with six SPMs within a large Brazilian private organization in order to understand the phenomenon of decision-making in software project management.

The findings indicate that the SPMs usually look for the first workable option rather than try to find the best possible option. When involving the team members and stakeholders, the previous experience, and available knowledge are essential to ask questions to promote reflection of the group. The former is gained through their employment time in the organization and their experience managing projects, and the latter consists of knowledge on business domain and technical capacity.

The SPMs' leadership style moderates how the decisions are made by trusting in team members and delegating some decisions, thus creating a learning environment where it is possible to make mistakes. The facilitation capacity in participatory decision-making is impacted by the organization structure because it can limit the autonomy of the SPMs, including the flexibility given by the organization to adapt the development process to the project's characteristics. The relation between the SPM's leadership style and his or her participatory decision-making style is influenced by his or her holistic vision of the project, transparent communication and negotiation capacity, organizational ability, proactive risk management, and interpersonal relationship.

The SPMs focus on knowledge sharing with the team members and colleagues from other projects instead of the extensive use of explicit documents to gain information to make decisions. The constant feedback aims to minimize the uncertainty inherent to software projects, which can be obtained through the client involvement as well as iterative planning. Also, the involvement of team members in participatory decision-making is influenced by their technical competence. The participatory decision-making style has a positive impact on team members' commitment to the project as well as promotes reflections on all the group involved in each decision, thus minimizing the decision regret and cognitive biases.

The feedback provided by some SPMs at the end of the interviews showed their interest in the evaluation of the decision-making process from this perspective, a

subject not yet studied in their training courses in project management. Since the SPMs tend to use decision-making strategies that make effective use of their substantive knowledge and processing capacity, decision aiding and training should be targeted at strengthening the decision maker's preferred approach to a problem rather than replacing it altogether.

Future works

Based on the research method as well as the findings from this research, the following future works were defined:

Replication in other contexts

Replications play a key role in Empirical Software Engineering by allowing the community to build knowledge about which results or observations hold under which conditions (SHULL et al., 2008). In terms of external validity, replications help researchers show that experimental results are not dependent on the specific conditions of the original study. In terms of internal validity, replications also help researchers show the range of conditions under which experimental results hold.

A replication that produces results that are similar to those of the original experiment on which it was based is just as useful to the community as a replication that produces results that are different from those of the original experiment. Therefore, replicating this research in other types of organizations and from different countries may contribute to construct a more grand theory.

Competency model

A competency model is a framework for defining the skill and knowledge requirements of a job and it is widely used in business for defining and assessing competencies within organizations in both hard and soft skills.

The elements identified in our substantive theory can be organized in a competency model, such as SWECOM (IEEE, 2014), ICB3 (IPMA, 2006), and PMCD (PMI, 2007), with a focus on decision-making in software project management, including the skills and work activities for each skill in order to give an structured view of the findings for practitioners.

Project Governance

In a recent systematic review on project governance, Biesenthal and Wilden (2014) suggested that additional research contexts are needed to progress project governance research, particularly including contexts in which projects are more transient, more agile and, therefore, less driven by structured approaches. Project governance is an overarching business function in project-based organizations (PMI, 2013) and provides a framework for organizational processes, decision-making models, and project management tools, which support the successful delivery of projects, programs and portfolios.

The common conception of program management as an extension or variant of project management, and therefore endowed with the same rationalist, instrumental underpinnings, has been reviewed and questioned (PELLEGRINELLI, 2011). Also, there is a movement towards behavioral and organizational viewpoints in portfolio management that embrace the dynamic and complex nature of practice and context (GERALDI, 2008). Therefore, it is necessary an understanding of how the program and portfolio managers make decisions by how they interpret their experiences in the workplace when making a decision as well as how they interact with each one and facilitate genuinely effective cooperation and shared learning between project managers.

References

ARGYRIS, C., and SCHÖN, D. **Theory in Practice - Increasing Professional Effectiveness**. [S.l.]: Jossey-Bass, 1974.

AVOLIO, B., and BASS, B. **Multifactor Leadership Questionnaire: manual and sampler set**, Third Edition, Mind Garden, 2004.

BANA e COSTA, C. A. e VANSNICK, J. C. **MACBETH - An interactive path towards the construction of cardinal value functions**, International Transactions in Operational Research, Vol. 1, No. 4, pp. 489-500, 1994.

BARCLAY, C., and OSEI-BRYSON, K. **An exploration of knowledge management practices in IT projects: A case study approach**, Proceedings of the 16th Americas Conference on Information Systems, pp. 368-378, 2010.

BARCLAY, S., BEACH, L. R., and BRAITHWAITE, W. P. **Normative models in the study of cognition**. Organizational Behavior and Human Performance, Vol. 6, pp. 389-413, 1971.

BARRY, E.; KEMERER, C.; SLAUGHTER, S. **Environmental volatility, development decisions, and software volatility: A longitudinal analysis**. Management Science Vol. 52, No. 3, p. 448-464, 2006.

BASILI, V. R. **Applying the goal/question/metric paradigm in the experience factory. Software quality assurance and measurement: a worldwide perspective**. London: International Thomson, 1996.

BASS, B. M. **Leadership and performance beyond expectations**, New York: Collier Macmillan, 1985.

BASS, B. M., and AVOLIO, B. J. **MLQ, Multifactor Leadership Questionnaire, 2nd ed**. Redwood City, CA: Mind Garden, 1995.

BATEMAN, T. S., and ZEITHAML, C. P. **The psychological context of strategic decisions: a model and convergent experimental findings**, Strategic Management Journal, Vol. 10, pp. 59-74, 1989.

BEACH, L. R., and MITCHELL, T. R. **Image theory: Principles, goals and plans**. Acta Psychologica, Vol. 66, pp. 201-220, 1987.

BEACH, L. R., CHRISTENSEN-SZALANSKI, J., and BARNES, V. **Assessing human judgment: Has it been done, can it be done, should it be done?** In G. Wright & P. Ayton (Eds.), Judgmental forecasting (pp. 49-62). New York: Wiley & Sons, 1987.

BECKER, T. E., BILLINGS, R. S., EVELETH, D. M. and GILBERT, N. L. **Foci and bases of employee commitment: implications for job performance**, Academy of Management Journal, Vol. 39 No. 2, pp. 464-80, 1996.

BENJAMIN, S., **Bloom's Taxonomy of Educational Objectives**, Boston: Allyn and Bacon, 1984.

BERGER, J. O. **Statistical Decision Theory and Bayesian Analysis - Second Edition**, Springer-Verlag. New York, USA, 1985.

BIESENTHAL, C., and WILDEN, R. **Multi-level project governance: Trends and opportunities**, International Journal of Project Management, Vol. 32, pp. 1291-1308, 2014.

BJØRNSON, F. O., and DINGSØYR, T. **Knowledge Management in Software Engineering: A Systematic Review of Studied Concepts and Research Methods Used**, Information and Software Technology, Vol. 50, p 1055-1168, 2008.

BOURGAULT, M.; DROUIN, N.; HAMIL, E. **Decision making within distributed project teams: An exploration of formalization and autonomy as determinants of success**. Project Management Journal (Special PMI Research Conference Ed.), Vol. 39, No. S1, pp. S97-S100, 2008.

BREHMER, B. **Strategies in real-time dynamic decision making**. In R. Hogarth (Ed.), Insights in decision making: A tribute to Hillel J. Einhorn (pp. 262-279). Chicago: University of Chicago Press, 1990.

BRETT, J. M. **Negotiating globally: How to negotiate deals, resolve disputes, and make decisions across cultural boundaries**. San Francisco: Jossey-Bass, 2001.

BROWN, J. S. and DUGUID, P. **Organizing knowledge**. California Management Review, Vol. 40, No. 3, pp. 90-111, 1998.

BUKSZAR, E., and CONNOLLY, T. **Hindsight bias and strategic choice: some problems in learning from experience**, Academy of Management Journal, Vol. 31, pp. 628-641, 1998.

BURNS, J. **Leadership**, New York, NY: Harper & Row, 1978.

CHAPMAN, C.; WARD, S. **Managing project risk and uncertainty: A constructively simple approach to decision making**. Hoboken, NJ: John Wiley & Sons, 2002.

CHI, M. T. H., GLASER, R., and FARR, M. J. **The nature of expertise**. Hillsdale, NJ: Erlbaum, 1988.

CHOO, C. W. **The knowing organization: how organizations use information to construct meaning, create knowledge, and make decision. 2nd Edition**, Oxford, UK: Oxford University Press, 2006.

CHRISTENSEN-SZALANSKI, J. J. J. **Improving the practical utility of judgment research**. In B. Brehmer, H. Jungermann, P. Lourens, & G. Sevan (Eds.), New directions for research in judgment and decision literature. North Holland: Elsevier, 1986.

CICMIL, S.; WILLIAMS, T.; THOMAS, J.; HODGSON, D. **Rethinking Project Management: Researching the actuality of projects**. International Journal of Project Management, Vol. 24, pp. 675-686, 2006.

CLARKE, N., **Projects are emotional: how project managers' emotional awareness can influence decisions and behaviours in projects**, International Journal of Managing Projects in Business, Vol. 3, pp. 604-624, 2010.

CLELAND, D.; IRELAND, L. **Project manager's handbook: Applying best practices across global industries**. New York: McGraw-Hill Professional, 2007.

COHEN, M. S. **Three Paradigms for Viewing Decision Biases**, pp 36 - 50. In Klein, G. A., Orasanu, J. M., and Calderwood, R. Decision Making in Action: Models and Methods, New Jersey: Ablex Publishing Corporation, 1993.

COHEN, M. S. **The Naturalistic Basis of Decision Biases**, pp 51 - 99. In Klein, G. A., Orasanu, J. M., and Calderwood, R. Decision Making in Action: Models and Methods, New Jersey: Ablex Publishing Corporation, 1993b.

CONNOLLY, T. **Hedge-clipping, tree-felling, and the management of ambiguity**. In M. B. McCaskey, L. R. Pondy, & H. Thomas, (Eds.), Managing the challenge of ambiguity and change. New York: Wiley, 1988.

COSTA, H. R.; BARROS, M., O.; TRAVASSOS, G., H. **Software Project Risk Evaluation Based on Specific and Systemic Risks** in: Proceedings of the 16th International Conference of Software Engineering and Knowledge Engineering, 2004.

CRESWELL, J. W. **Qualitative Inquiry & Research Design: choose among five approaches**. Thousand Oaks (California): Sage, 2013.

CROSSLEY, C., and HIGHHOUSE, S. **Relation of job search and choice process with subsequent satisfaction**. Journal of Economic Psychology, Vol. 26, pp. 255-268, 2005.

CUNHA, J. A. O. G., and MOURA, H. P. de **Project Management in Light of Cognitive Biases: A Cross-case Analysis of IT Organizations from Brazil and Portugal**. Proceedings of the 12th International Conference on Information Systems and Technology Management (CONTECSI), São Paulo, Brazil, pp. 2591-2607, 2015b.

CUNHA, J. A. O. G., and MOURA, H. P. de **Towards a Substantive Theory of Project Decisions in Software Development Project-Based Organizations: A Cross-Case Analysis of IT Organizations from Brazil and Portugal**. Proceedings of the 10th Iberian Conference on Information Systems and Technologies (CISTI), Aveiro, Portugal, pp. 154-159, 2015c.

CUNHA, J. A. O. G., da SILVA, F. Q. B., MOURA, H. P., and VASCONCELLOS, F. J. S. **Decision-Making in Software Project Management: A Qualitative Case Study of a Private Organization**, Proceedings of the 9th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), Austin, USA, pp. 26-32, 2016a.

CUNHA, J. A. O. G., da SILVA, F. Q. B., MOURA, H. P., and VASCONCELLOS, F. J. S. **Towards a Substantive Theory of Decision-Making in Software Project Management: Preliminary Findings from a Qualitative Study**, Proceedings of the Empirical Software Engineering and Measurement (ESEM), Ciudad Real, Spain (to be published), 2016b.

CUNHA, J. A. O. G., DIAS, J. L., CUNHA, L. M., MOURA, H. P. **Melhoria de Processos de Software sob a Perspectiva dos Vieses Cognitivos: Uma Análise de Múltiplos Casos**, Anais do XI Simpósio Brasileiro de Sistemas de Informação (SBSI), Goiânia, Goiás, pp. 259-266, 2015a.

CUNHA, J. A. O. G., MOURA, H. P., and VASCONCELLOS, F. J. S. **Decision-Making in Software Project Management: A Systematic Literature Review**, International Conference on Project Management (PROJMAN), Porto, Portugal (to be published), 2016c.

CUNHA, J. A. O. G., VIGLIONI, T., THOMAZ, J., and MOURA, H. **Project Management in light of Cognitive Biases: A Public Sector IT Organization Case**. Proceedings of the 10th European Conference on Management, Leadership and Governance (ECMLG), Zagreb, Republic of Croatia, pp. 50-58, 2014.

DAINTY, A., CHENG, M., and MOORE, D. **A comparison of the behavioural competencies of client-focused and production-focused project managers in the construction sector**. Project Management Journal, Vol. 36, No. 1, pp. 39-48, 2005.

DAS, T. K., and TENG, B. **Cognitive Biases and Strategic Decision Processes: An Integrative Perspective**, Journal of Management Studies, Vol. 36, No. 6, pp. 757-778, 1999.

DE FINETTI, B. **Foresight: Its logical laws, its subjective sources**. English translation. In H. E. Kybert, Jr. & H. E. Smokler (Eds.), Studies in subjective probability. New York: Wiley, 1964. (Original work published 1937).

DESOUZA, K., and EVARISTO, J. **Project management offices: A case of knowledge-based archetypes**, International Journal of Project Management, Vol. 26, No. 5, pp. 414-423, 2006.

DIJKSTERHUIS, A., and BAS, M. W.; NORDGREN, L. F.; van BAAREN, R. B. **On making the right choice: The deliberation-without-attention effect**, Science, Vol. 311, p. 1005-1007, 2006.

DILLON, R. L.; TINSLEY, C. H. **How near-misses influence decision making under risk: A missed opportunity for learning**. Management Science, Vol. 54, No 8, pp. 1425-1440, 2008.

DINGSØYR, T., FÆGRI, T. E., DYBÅ, T., HAUGSET, B., and LINDSJØRN, Y. **Team Performance in Software Development: Research Results versus Agile Principles**, IEEE SOFTWARE, pp. 106-110, 2016.

Driver, M. J., Brousseau, K. E., & Hunsaker, P. L. **The dynamic decision maker**. San Francisco: Jossey-Bass Publishers, 1993.

EDEN, C., and ACKERMANN, F. **Making strategy: The journey of strategic management**, London: SAGE publications, 1998.

EILON, S. **Management control**. Oxford, UK: Pergamon Press, 1979.

EINHORN, H. J., and HOGARTH, R. M. **Behavioral decision theory: Processes of judgment and choice**. Annual Review of Psychology, Vol. 32, pp. 53-88, 1981.

EINHORN, H. J., and HOGARTH, R. M. **Judging probable cause**. Psychological Bulletin, Vol. 99, pp. 3-19, 1986.

EISENHARDT, K. M. **Building Theories from Case Study Research**. The Academy of Management Review, Vol. 14, No. 4, pp. 532-550, 1989.

EPSTEIN, S., PACINI, R., DENES-RAJ, V., and HEIER, H. **Individual differences in intuitive experiential and analytical-rational thinking styles**. Journal of Personality and Social Psychology, Vol. 71, pp. 390-405, 1996.

ESPINOSA, J. A.; SLAUGHTER, S. A.; KRAUT, R. E.; HERBSLEB, J.D. **Familiarity, complexity, and team performance in geographically distributed software development**. Organization Science, Vol. 18, No. 4, pp. 613-630, 2007.

FRANKEN, I., and MURIS, P. **Individual differences in decision-making**. Personality and Individual Differences, Vol. 39, pp. 991-998, 2005.

GALOTTII, K.M., CINER, E., ALTENBAUMER, H.E., GEERTS, H.J., RUPP, A., and WOULFE, J. **Decision-making styles in a real-life decision: Choosing a college major**. Personality and Individual Differences, Vol. 41, pp. 629-639, 2006.

GATI, I., LANDMAN, S., DAVIDOVITCH, S., ASULIN-PERETZ, L., and GADASSI, R. **From career decision-making styles to career decision-making profiles: A multidimensional approach**. Journal of Vocational Behavior, Vol. 76, pp. 277-291, 2010.

ALLINSON, C. W., and HAYES, J. **The Cognitive Style Index: A measure of**

intuition-analysis for organizational research. Journal of Management Studies, Vol. 33, pp. 119-135, 1996.

GEMÜNDEN, H. G. **Project management as a behavioral discipline and as driver of productivity and innovations**. Project Management Journal, Vol. 45, No. 6, pp. 2-6, 2014.

GEORGSDOTTIR, A. S., and GETZ, I. **How flexibility facilitates innovation and ways to manage it in organizations**. Creativity and Innovation Management, Vol. 13, No. 3, pp. 166-175, 2004.

GERALDI, J. G. **The balance between order and chaos in multi-project firms: a conceptual model**, International Journal of Project Management, Vol. 26, pp. 348-356, 2008.

GLASER, B. G., and STRAUSS, A. L. **The discovery of grounded theory: Strategies for qualitative research**. New York: Aldine, 1967.

GOFFIN, K., and KONERS, U. **Tacit Knowledge, Lessons Learnt, and New Product Development**. Journal of Product Innovation Management, Vol. 28, No 2, pp. 300-318, 2011.

GRECO, S., FIGUEIRA, J., EHRGOTT, M. **Multiple criteria decision analysis**. Springer's International series. 2005.

GUTIERREZ, E., SANDSTROM, O., JANHAGER, J., and RITZEN, S. **Innovation and decision making: Understanding selection and prioritization of development projects**. Proceedings of the 4th IEEE International Conference on Management of Innovation and Technology, pp. 333-338, 2008.

HALL, M., HOLT, R., and PURCHASE, D. **Project sponsors under new public management: lessons from the frontline**. Int J Proj Manage, Vol. 21, pp. 495-502, 2003.

HAMILTON, K., SHIH, S., and MOHAMMED, S. **The development and validation of the rational and intuitive decision styles scale**. Journal of Personality Assessment, 2016.

HAMMOND, K. R. **Judgment and decision making in dynamic tasks**. Information and Decision Technologies, Vol. 14, pp. 3-14, 1988.

HANSSON, S. O. **Decision Theory: A Brief Introduction**, 1994. Available at www: <people.kth.se/~soh/decisiontheory.pdf>. Accessed on 2015-05-13.

HARPER, M., and COLE, P. **Member Checking: Can Benefits Be Gained Similar to Group Therapy?** The Qualitative Report, Vol. 17, No. 2, pp. 510-517, 2012.

HARREN, V.A., **A model of career decision making for college students**. Journal of Vocational Behavior, Vol. 14, pp. 119-133, 1979.

HASTIE, R., and DAWES, R. **Rational Choices in an Uncertain World**, Thousand Oaks, CA: Sage Publications, 2001.

HAUSCHIDT, J., KEIM, G., and MEDCOF, J. W. **Realistic criteria for project manager selection and development**. Project Management Journal, Vol. 31, No. 3, pp. 23-33, 2000.

HOGARTH, R. M. **Judgement and choice: The psychology of decision (2nd ed.)**. Oxford, England: John Wiley & Sons, 1987.

HOGBERG, O.; ADAMSSON, A. **A Scandinavian view of project management**. International Journal of Project Management, Vol. 1, No. 4, pp. 216-219, 1983.

HOPPLE, G. W. **Decision aiding dangers: the law of the hammer and other maxims**, IEEE Transactions on Systems, Man, and Cybernetics, Vol. 16, No. 6, pp. 948-963, 1986.

HUFF, R. A., and PRYBUTOK, V. R. **Information Systems Project Management Decision Making: The Influence of Experience and Risk Propensity**. Project Management Journal, Vol. 39, No. 2, pp. 34-47, 2008.

HUNT, R. G., KRZYSTOFIAK, F. J., MEINDL, J. R., and YOUSRY, A. M. **Organizational Behavior and Human Decision Processes**, Vol. 44, No. 3, pp. 436-453, 1989.

HUSSEY, J. M.; HALL, S. E. **Managing global development risk**. Boca Raton, FL: Auerbach Publications, 2007.

IEEE, **Software Engineering Competency Model (SWECOM)**, IEEE Computer Society, 2014.

IPMA, **ICB - IPMA Competence Baseline, Version 3.0**, International Project Management Association, 2006.

ISO/IEC ISO/IEC 12207:2008 **Systems and software engineering - Software life cycle processes**, Geneve: ISO, 2008.

ISO/IEC ISO/IEC 15504-2: **Information Technology - Process Assessment - Part 2 - Performing an Assessment**, Geneve: ISO, 2003.

JONES, C. **Applied Software Measurement: Global Analysis of Productivity and Quality**, Third Edition, NY: McGraw-Hill, 2008.

JONES, C. B. **Behavioral flexibility in primates: Causes and consequences**. New York: Springer-Verlag, 2005.

KAHNEMAN, D. **Thinking, Fast and Slow**, NY: Ed. Farrar, Straus and Giroux, 2011.

KANER, S. **Facilitator's Guide to Participatory Decision-Making, Third Edition**. John Wiley & Sons, 2014.

KEENEY, R. L. **Decision analysis: An overview**. Operations Research, Vol. 30, pp. 803-838, 1982.

KEENEY, R. L., and RAIFFA, H. **Decisions with multiple objectives: Preferences and value tradeoffs**. New York: Wiley & Sons, 1976.

KEIL, M., LEE, H. K., and DENG, T. **Understanding the most critical skills for managing IT projects: A Delphi study of IT project managers**. Information & Management, Vol. 50, No. 7, pp. 398-414, 2013.

KEIL, M., LI, L., MATHIASSEN, L., and ZHENG, G. **The influence of checklists and roles on software practitioner risk perception and decision-making**, Journal of Systems and Software, Vol. 81, No. 6, pp. 908-919, 2008.

KIRKWOOD, C. W. **Strategic Decision Making - Multiobjective Decision Analysis with spreadsheets**, Duxbury Press, Belmont, CA, 1997.

KLEIN, G. A. **Recognition-primed decisions**. In W.B. Rouse (Ed.), Advances in man-machine system research (Vol. 5, pp. 47-92). Greenwich, CT: JAI Press, 1989.

KLEIN, G. A., ORASANU, J., and CALDERWOOD, R. **Decision Making in Action: Models and Methods**. Ablex, 1993.

KOSKELA J., and ABRAHAMSSON, P. **On-Site Customer in an XP Project: Empirical Results from a Case Study**, In Software Process Improvement, Springer Berlin, pp. 1-11, 2004.

KRISHNAN, V., and ULRICH, K. **Product development decisions: A review of the literature**. Management Sciences, Vol. 47, No. 1, pp. 1-21, 2001.

KRUTCHEN, P. **The Rational Unified Process: An Introduction, Second Edition**, Boston, MA: Addison-Wesley Longman Publishing Co, 2000.

LANT, T. K., MILLIKEN, F. J., and BATRA, B. **The role of managerial learning and interpretation in strategic persistence and reorientation: an empirical exploration**, Strategic Management Journal, Vol. 13, pp. 585-608, 1992.

LEE, J. **Effects of leadership and leader-member exchange on innovativeness**. Journal of Managerial Psychology, Vol. 23, No. 6, pp. 670-87, 2008.

LEE, W. **Decision theory and human behavior**. New York: Wiley & Sons, 1971.

LENBERG, P., FELDT, R., and WALLGREN, L. G. **Behavioral software engineering: A definition and systematic literature review**, The Journal of Systems and Software, No. 107, pp. 15-37, 2015.

LEYBOURNE, S. **Project management and high-value superyacht projects: an improvisational and temporal perspective**, Project Management Journal, Vol. 41, pp. 17-27, 2010.

LIPSHITZ, R. **Converging themes in the study of decision making in realistic settings**. In G. A. Klein, J. Orasanu, R. Calderwood, & C. E. Zsambok (Eds.), Decision making in action: Models and methods (pp. 103–137). Norwood, NJ: Ablex, 1993.

LIPSHITZ, R. **Decision making as argument driven action**. Boston: Boston University Center for Applied Social Science, 1989.

LIU, J., LIU, X., and ZENG, X. **Does transactional leadership count for team innovativeness?: The moderating role of emotional labor and the mediating role of team efficacy**, Journal of Organizational Change Management, Vol. 24, No. 3, pp. 282-298, 2011.

LOMAS, J. **The in-between world of knowledge brokering**, BMJ: British Medical Journal, Vol. 334, No 7585, pp. 129-132, 2007.

LOO, R. **A psychometric evaluation of the General Decision-Making Style Inventory**. Personality and Individual Differences, Vol. 29, pp. 895-905, 2000.

LOOMES, G. and SUGDEN, R. **Regret theory: An alternative theory of rational choice under uncertainty**, Economic Journal, Vol. 92, No. 4, pp. 805-824, 1982.

LOPES, L. L. **The rhetoric of irrationality**. Madison, WI: University of Wisconsin, 1988.

LUNDIN, R. A.; SÖDERHOLM, A. **A theory of the temporary organization**, Scandinavian Journal of Management, Vol. 11, No. 4, pp. 437-455, 1995.

MANN, L., BURNETT, P., RADFORD, M., and FORD, S. **The Melbourne Decision Making Questionnaire: An instrument for measuring patterns for coping with decisional conflict**. Journal of Behavioral Decision Making, Vol. 10, No. 1, pp. 1-19, 1997.

MARCATTO, F., and FERRANTE, D. **The Regret and Disappointment Scale: An instrument for assessing regret and disappointment in decision making**, Judgment and Decision Making, Vol. 3, No. 1, pp. 87-99, 2008.

MARCONI, M. A.; LAKATOS, E. M. **Fundamentos de Metodologia Científica**, 7 Edição, São Paulo: Editora Atlas, 2010.

MARINHO, M., SAMPAIO, S., LIMA, T., and MOURA, H. **A Systematic Review of Uncertainties in Software Project Management**. International Journal of Software Engineering and Applications, Vol. 5, No. 6, 2014.

MCBRIDE, T. **The mechanisms of project management of software development**, Journal of Systems and Software, Vol. 81, No. 12, pp. 2386-2395, 2008.

MCLEOD, L., DOOLIN, B., and MACDONELL, S. G. **A perspective-based understanding of project success**, Project Management Journal, Vol. 43, pp. 68-86, 2012.

MCMANUS, J. **A stakeholder perspective within software engineering projects**. Proceedings of the IEEE International Engineering Management Conference, Vol. 2, pp. 880-884, 2004.

MCNEIL, A. J., FREY, R., and EMBRECHTS, P. **Quantitative Risk Management: Concepts, Techniques and Tools**. United Kingdom: Princeton University Press, 2015.

MERRIAM, S. B. **Qualitative Research: a Guide to Design and Implementation**, San Francisco, CA: Jossey-Bass, 2009.

MESSERSCHMITT, D. G. **Marketplace issues in software planning and design**. IEEE Software, Vol. 21, No. 3, pp. 62-70, 2004.

MEYER, J. P., and ALLEN, N. J. **A three-component conceptualization of organizational commitment**, Human Resource Management Review, Vol. 1, No. 1, pp. 61-89, 1991.

MILKMAN, K. L., CLOUGH, D., and BAZERMAN, M. H. **How can decision making be improved?** Perspectives on Psychological Science, Vol. 4, pp. 379-383, 2009.

MONTGOMERY, H. **Decision rules and the search for a dominance structure: Towards a process model of decision making**, In P. Humphreys, O. Svenson, & A. Vari (Eds.), Advances in psychology. Amsterdam: North-Holland, 1983.

MÜNCH, J.; HEIDRICH, J. **Software project control centers: concepts and approaches**, Journal of Systems and Software, Vol. 70, No. 1-2, pp. 3-19, 2004.

MYERS, I. B. **Introduction to Type: A description of the theory and applications of the Myers-Briggs type indicator**, Consulting Psychologists Press, Palo Alto Ca., 1962.

MYERS, M. D. **Qualitative Research in Information Systems**, MIS Quarterly, Vol. 21, No. 2, pp. 241-242, 1997.

MYERS, W. **An Assessment of the Competitiveness of the United States Software Industry**. IEEE Computer, pp. 81-92, 1985.

NAPIER, N. P., KEIL, M., and TAN, F. B. **IT project managers' construction of successful project management practice: A repertory grid investigation**. Information Systems Journal, Vol. 19, No. 3, pp. 255-282, 2009.

NENKOV, G. Y., INMAN, J. J., and HULLAND, J. **Considering the future: The conceptualization and measurement of elaboration on potential outcomes**. Journal of Consumer Research, Vol. 35, pp. 126-141, 2007.

NGUYEN, T. N. **A decision model for managing software development projects**, Information & Management, Vol. 43, No. 1, pp. 63-75, 2006.

NISBETT, R. E., KRANTZ, D. H., JEPSON, C., and KUNDA, Z. **The use of statistical heuristics in every day inductive reasoning**. Psychological Review, Vol. 90, No. 4, pp. 339-363, 1983.

NOBLE, D. **Application of a theory of cognition to situation assessment**. Vienna, VA: Engineering Research Associates, 1989.

NONAKA, I., and TAKEUCHI, H. **The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation**, United Kingdom: Oxford University Press, 1995.

NORTHCUTT, N., and MCCOY, D. **Interactive qualitative analysis: a systems method for qualitative research**, Thousand Oaks, CA: SAGE Publications, 2004.

ORASANU, J., and CONNOLLY, T. **The reinvention of decision making**, pp 3 - 20. In Klein, G. A., Orasanu, J. M., and Calderwood, R. Decision Making in Action: Models and Methods, New Jersey: Ablex Publishing Corporation, 1993.

PARK, J. G., and LEE, J. **Knowledge sharing in information systems development projects: Explicating the role of dependence and trust**, International Journal of Project Management, Vol. 32, pp. 153-165, 2014.

PAWLOWSKI, S. D. and ROBEY, D. **Bridging user organizations: knowledge brokering and the work of information technology professionals**, MIS Quarterly, Vol. 28, No. 4, pp. 645-672, 2004.

PAYNE, J. W. **Task Complexity and Contingent Processing in Decision Making: An Information Search and Protocol Analysis**, Organizational Behavior and Human Performance, Vol. 16, pp. 366-387, 1976.

PAYNE, J. W., BETTMAN, J. R., and JOHNSON, E. J. **The Adaptive Decision Maker**, Cambridge University Press: Australia, 1993.

PELLEGRINELLI, S. **What's in a name: Project or programme?**, International Journal of Project Management, Vol. 29, pp. 232-240, 2011.

PEMSEL, S., and WIEWIORA, A. **Project management office a knowledge broker in project-based organisations**, International Journal of Project Management, Vol. 31, No. 1, pp. 31-42, 2013.

PENNINGTON, N., and HASTIE, R. **Explanation-based decision making: Effects of memory structure on judgment**. Journal of Experimental Psychology: Learning, Memory, & Cognition, Vol. 14, No 3, pp. 521-533, 1988.

PMI, **Project Manager Competency Development Framework – Second Edition**, Project Management Institute, 2007.

PMI, Project Management Institute **A guide to the project management body of knowledge (PMBOK® guide) - Fifth edition**, Newtown Square, 2013.

PMI, **Capturing the Value of Project Management through Decision Making**, 2015.

POLLACK, J. **The changing paradigms of project management**. International Journal of Project Management, Vol. 25, pp. 266-274, 2007.

POLLACK-JOHNSON, B., and LIBERATORE, M. J. **Incorporating quality considerations into project time/cost tradeoff analysis and decision making**. IEEE Transactions on Engineering Management, Vo. 53, No 4, pp. 534-542, 2006.

POPPENDIECK, M., and POPPENDIECK, T. **Implementing Lean Software Development: From Concept to Cash**. Boston: Addison-Wesley Professional, pp. 32-33, 2006.

POWER, D. J., SHARDA, R., and BURSTEIN, F. **Decision support systems**. John Wiley & Sons, 2015.

RASMUSSEN, J. **Skill, rules and knowledge: Signals, signs, and symbols, and other distinctions in human performance models**. IEEE Transactions on Systems, Man and Cybernetics, Vol. 3, pp. 257-266, 1983.

RAVASI, D., and SCHULTZ, M. **Responding to organizational identity threats: Exploring the role of organizational culture**. Academy of Management Journal, Vol. 49, No. 3: pp. 433-458, 2006.

REMEYI, D., WILLIANS, B., MONEY, A., and SWARTZ, E. **Doing Research in Business and Management: an Introduction to Process and Method**, London: Sage Publications, 2000.

RUHE, G. **Software Engineering Decision Support. A new paradigm for learning Software organizations**, In Proc. 4th Workshop on Learning Software Organizations, Chicago, 2003.

RUNESON, P. and HOST, M. **Guidelines for conducting and reporting case study research in software engineering**. Empirical Software Engineering, Vol. 14, No. 2, pp. 131-164, 2008.

RUS, I., and COLLOFELLO, J. S. **A Decision Support System for Software Reliability Engineering Strategy Selection**. In: Proceedings of the 23rd Annual International Computer Software and Applications, Scottsdale, pp. 376-381, 1999.

SAATY, T. L. **Decision making with the analytic hierarchy process**, Int. J. Services Sciences, Vol. 1, No. 1, pp.83-98, 2008.

SAKTHIVEL, S. **A decision model to choose between software maintenance and software redevelopment**, Journal of Software Maintenance: Research and Practice, Vol. 6, No. 3, pp. 121-143, 1994.

SANDBERG, J. **The constructions of social constructionism**. In S.-E. Sjöstrand, J. Sandberg, & M. Tyrstrup (Eds.), Invisible management: The social construction of leadership. London: Thomson, 2001.

SAUER, C., REICH, B. H. **Rethinking IT project management: Evidence of a new mindset and its implications**, International Journal of Project Management, Vol. 27, pp. 182-193, 2009.

SAUNDERS, M., LEWIS, P., and THORNHILL, A. **Research Methods for Business Students, 4th Edition**, Pearson Education Limited, 2009.

SAVAGE, L. J. **The Foundations of Statistics**. New York, Wiley, 1954.

SCHINDLER, M., and EPPLER, M. J. **Harvesting project knowledge: a review of project learning methods and success factors**, International Journal of Project Management, Vol. 21, No. 3, pp. 219-228, 2003.

SCHMIDT, J. B.; MONTOYA-WEISS, M. M.; MASSEY, A. P. **New product development decision-making effectiveness: Comparing individuals, face-to-face teams, and virtual teams**. Decision Sciences, Vol. 32, No. 4, pp. 575-600, 2001.

SCHOEMAKER, P. J. H. **Experiments on Decisions under Risk: The Expected Utility Theorem**, Martinus Nijhoff Publishing, Boston, 1980.

SCHWABER, K. **SCRUM Development Process**, Proceedings of the 10th Annual ACM Conference on Object Oriented Programming Systems, Languages, and Applications, pp. 117-134, 1997.

SCHWANDT, T. A. **Three epistemological stances for qualitative inquiry**. In Denzin, N., and Lincoln, Y. (Eds.), Handbook of qualitative research. Thousand Oaks, California: Sage Publications, pp. 189-213, 2000.

SCHWARTZ, B., WARD, A., MONTEROSSO, J., LYUBOMIRSKY, S., WHITE, K., and LEHMAN, D. R. **Maximizing versus satisficing: Happiness is a matter of choice**. Journal of Personality and Social Psychology, Vol. 83, No. 5, pp. 1178-1197, 2002.

SCOTT, S. G., and BRUCE, R. A. **Decision-making style: The development and assessment of a new measure**. Educational and Psychological Measurement, Vol. 55, No. 5, pp. 818-831, 1995.

SEI **CMMI for Development (CMMI-DEV), Version 1.3, Technical Report CMU/SEI-2010-TR-033**. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 2010.

SHULL, F. J., CARVER, J. C., VEGAS, S., and JURISTO, N. **The role of replications in empirical software engineering**. Empirical Software Engineering, Vol. 13, No. 2, pp. 211-218, 2008.

SIEBERT, J., and KUNZ, R. **Developing and Validating the Multidimensional Proactive Decision-Making Scale**. Special Issue Behavioral Operations Research in European Journal of Operational Research, Vol. 249, No. 3, pp. 864-877, 2016.

SIMON, H. A. **Models of Man: Social and Rational**, New York: John Wiley & Sons, 1957.

SIMON, H. A. **Rational Choice and the Structure of the Environment**. Psychological Review, Vol. 63, No. 2, pp. 129-138, 1956.

SIMON, H. A. **The New Science of Management Decision (3rd revised edition; first edition 1960)** Prentice-Hall, Englewood Cliffs, NJ, 1977.

SLOVIC, P., FISCHHOFF, B., and LICHTENSTEIN, S. **Behavioral decision making**. Annual Review of Psychology, Vol. 28, pp. 1-39, 1977.

SMALL, J., and WALKER, D. **The emergent realities of project praxis in socially complex project environments**, International Journal of Managing Projects in Business, Vol. 3, pp. 147-156, 2010.

SOFTEX **Guia de Implementação – Parte 5: Fundamentação para Implementação do Nível C do MR-MPS-SW**, 2013.

STRAUSS, A. and CORBIN, J. **Basics of Qualitative Research Techniques and Procedures for Developing Grounded Theory (4th edition)**. Sage Publications: London, 2014.

SVEJVIG, P., and ANDERSEN, P. **Rethinking project management: A structured literature review with a critical look at the brave new world**, International Journal of Project Management, Vol. 33, No. 2, pp. 278–290, 2015.

SWAP, W., LEONARD, D., and MIMI SHIELDS, L. A. **Using mentoring and storytelling to transfer knowledge in the workplace**. Journal of management information systems, Vol. 18, No. 1, pp. 95-114, 2001.

THOMAZ, J. P. C. F. **O Apoio à Tomada de Decisão na Avaliação do Desempenho de Pessoas: Contributos para o Processo de Decisão Militar em Tempo de Paz**, PhD Thesis, Instituto Superior Técnico, Universidade Técnica de Lisboa, 2005.

TURNER, J. R., and MÜLLER, R. **Choosing appropriate project managers: Matching their leadership style to the type of project**. Newtown Square, PA: Project Management Institute, 2006.

TURPIN, S. M., and MARAIS, M. A. **Decision-making: Theory and practice**. Orion, Vol. 20, No. 2, pp. 143-160, 2004.

TVERSKY, A. **Elimination by aspects: A theory of choice**. Psychological Review, Vol. 79, No. 4, pp. 281-299, 1972.

TVERSKY, A., and KAHNEMAN, D. **Judgment under Uncertainty: Heuristics and Biases**, Science, New Series, Vol. 185, No. 4157, pp. 1124-1131, 1974.

VIRINE, L., and TRUMPER, M. **Project decisions: the art and science**, USA: Management Concepts Press, 2008.

VISKOVIC, D., VARGA, M., and CURKO, K. **Bad practices in complex IT projects**, ITI 2008 – 30Th International Conference On Information Technology Interfaces, p. 301, Publisher Provided Full Text Searching File, EBSCOhost, 2008.

VON NEUMANN, J. and MORGENSTERN, O. **Theory of games and economic behavior**. Princeton, NJ: Princeton University Press, 1947.

WANG, J., and LIN, Y. I. **A fuzzy multicriteria group decision making approach to select configuration items for software development**, Fuzzy Sets and Systems, Vol. 134, No. 3, pp. 343-363, 2003.

WARKENTIN, M., MOORE, R. S., BEKKERING, E., and JOHNSTON, A. C. **Analysis of systems development project risks: An integrative framework**. ACM SIGMIS Database, Vol. 40, No. 2, pp. 8-27, 2009.

WENGER, E. **Communities of Practice - Learning, Meaning and Identity**, Cambridge University Press, New York, 2008.

WILLIAMS, L. and COCKBURN, A. **Agile software development: it's about feedback and change**. IEEE Computer, Vol. 36, No. 6, pp. 39-43, 2003.

WILLIAMS, T. **How Do Organizations Learn Lessons From Projects - And Do They?** IEEE Transactions on Engineering Management, Vol. 55, No. 2, pp. 248-266, 2008.

WINTER, M., SMITH, C., MORRIS, P., and CICMIL, S. **Directions for future research in project management: The main findings of a UK government-funded research network**, International Journal of Project Management, Vol. 24, pp. 638-649, 2006.

WOHLIN, C. and AURUM, A. **Towards a decision-making structure for selecting a research design in empirical software engineering**, Empirical Software Engineering, Vol. 20, No 6, pp. 1427-1455, 2014.

ZAKAY, D. **The role of personal tendencies in the selection of decision-making strategies**. The Psychological Record, Vol. 40, No. 2, pp. 207-213, 1990.

SLR: List of Primary Studies

[PS07] TAYLOR, H., **An examination of decision-making in it projects from rational and naturalistic perspectives**, Proceedings of the Twenty Eighth International Conference on Information Systems, 2007.

[PS11] DRURY-GROGAN M. L., and O'DWYER, O. **An investigation of the decision-making process in agile teams**, International Journal of Information Technology & Decision Making, Vol. 12, No. 6, pp. 1097-1120, 2013.

[PS15] MOE, N. B., AURUM, A., and DYBÅ, T. **Challenges of shared decision-making: A multiple case study of agile software development**, Information and Software Technology, Vol. 54, No. 8, pp. 853-865, 2012.

[PS16] MOLOKKEN-OSTVOLD, K. and HAUGEN, N. C. **Combining Estimates with Planning Poker - An Empirical Study**, Software Engineering Conference, ASWEC, pp. 349-358, 2007.

[PS19] PALACIOSA, C. C., SOTO-ACOSTAC, P., and GARCÍA-CRESPOA, A. **Decisions in software development projects management. An exploratory study**. Behaviour & Information Technology, Vol. 32, No. 11, 2013.

[PS21] PAN, G. S. C., PAN, S. L., and FLYNN, D. **De-escalation of commitment to information systems projects: a process perspective**, The Journal of Strategic Information Systems, Vol. 13, No. 3, pp. 247-270, 2004.

[PS22] NEWMAN, M., and SABHERWAL, R. **Determinants of Commitment to Information Systems Development: A Longitudinal Investigation**, MIS Quartely, Vol. 20, No. 1, 1996.

[PS31] DILLON, S. and TAYLOR, H. **Employing Grounded Theory to Uncover Behavioral Competencies of Information Technology Project Managers**. Proj Mgmt Jrnl, Vol. 46, pp. 90-104, 2015.

[PS43] COYLE, S., CONBOY, K., and ACTION, T. **Group Process Losses in Agile Software Development Decision Making**, International Journal of Intelligent Information Technologies, Vol. 9, No. 2, 2013.

[PS47] KORZAAN, M., and MORRIS, S. A. **Individual characteristics and the intention to continue project escalation**, Computers in Human Behavior, Vol. 25, No. 6, pp. 1320-1330, 2009.

[PS48] TESSEM, B **Individual empowerment of agile and non-agile software developers in small teams**, Information and Software Technology, Vol. 56, No.8, pp. 873-889, 2014.

[PS53] AL-ANI, B., and REDMILES, D. **Investigating Decision Making Processes in Distributed Development Teams: Findings of a Comparative Empirical Study**, Fourth IEEE International Conference on Global Software Engineering, Limerick, pp. 51-60, 2009.

[PS60] TAYLOR, H. and WOELFER, J. P. **Leadership Behaviors in Information Technology Project Management: An Exploratory Study**, 44th Hawaii International Conference on System Sciences, Kauai, pp. 1-10, 2011.

[PS62] ROSE, J., PEDERSEN, K., HOSBOND, J. H., and KRÆMMERGAARD, P. **Management competences, not tools and techniques: A grounded examination of software project management at WM-data**, Information and Software Technology, Vol. 49, No. 6, pp. 605-624, 2007.

[PS64] DRURY, M., CONBOY, K., and POWER, K., **Obstacles to decision making in Agile software development teams**, Journal of Systems and Software, Vol. 85, No. 6, pp. 1239-1254, 2012.

[PS70] DRURY-GROGAN, M. L. **Performance on agile teams: Relating iteration objectives and critical decisions to project management success factors**, Information and Software Technology, Vol. 56, No. 5, pp. 506-515, 2014.

[PS86] PAN, G. **The Hidden Dilemmas in Software Development Project Decisionmaking: Persist or Desist?**, Proceedings of the Tenth Pacific Asia Conference on Information Systems, pp. 1159-1171, 2006.

[PS96] MCAVOY, J., and BUTLER, T. **The role of project management in ineffective decision making within Agile software development projects**, European Journal of Information Systems, Vol 18, pp. 372-383, 2009.

[PS106] MEDINA, A. and FRANCIS, A. J. **What Are the Characteristics That Software Development Project Team Members Associate With a Good Project Manager?**. Proj Mgmt Jrnl, Vol. 46, pp. 81-93, 2015.

Academic productions and awards

Full papers

CUNHA, J. A. O. G., MOURA, H. P., and Vasconcellos, F. J. S. **Decision-Making in Software Project Management: A Systematic Literature Review**, Procedia Computer Science, Vol. 100, pp. 947-954, 2016.

CUNHA, J. A. O. G., da SILVA, F. Q. B., MOURA, H. P., and Vasconcellos, F. J. S. **Towards a Substantive Theory of Decision-Making in Software Project Management: Preliminary Findings from a Qualitative Study**, Proceedings of the 10th ACM/IEEE Empirical Software Engineering and Measurement (ESEM), Article no. 20, Ciudad Real, Spain, 2016.

CUNHA, J. A. O. G., da SILVA, F. Q. B., MOURA, H. P., and Vasconcellos, F. J. S. **Decision-Making in Software Project Management: A Qualitative Case Study of a Private Organization**, Proceedings of the 9th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), Austin, USA, pp. 26-32, 2016.

CUNHA, J. A. O. G., and MOURA, H. P. de **Towards a Substantive Theory of Project Decisions in Software Development Project-Based Organizations: A Cross-Case Analysis of IT Organizations from Brazil and Portugal**. Proceedings of the 10th Iberian Conference on Information Systems and Technologies (CISTI), Aveiro, Portugal, pp. 154-159, 2015.

CUNHA, J. A. O. G., and MOURA, H. P. de **Project Management in Light of Cognitive Biases: A Cross-case Analysis of IT Organizations from Brazil and Portugal**. Proceedings of the 12th International Conference on Information Systems and Technology Management (CONTECSI), São Paulo, Brazil, pp. 2591-2607, 2015.

CUNHA, J. A. O. G., DIAS, J. L., CUNHA, L. M., MOURA, H. P. **Melhoria de Processos de Software sob a Perspectiva dos Vieses Cognitivos: Uma Análise de Múltiplos Casos**, Anais do XI Simpósio Brasileiro de Sistemas de Informação (SBSI), Goiânia, Goiás, pp. 259-266, 2015.

CUNHA, J. A. O. G., VIGLIONI, T., THOMAZ, J., and MOURA, H. **Project Management in light of Cognitive Biases: A Public Sector IT Organization Case**.

Proceedings of the 10th European Conference on Management, Leadership and Governance (ECMLG), Zagreb, Republic of Croatia, pp. 50-58, 2014.

CUNHA, J. A. O. G., and MOURA, H. **Project Management Office: The State of the Art based on a Systematic Review**. Proceedings of the 10th European Conference on Management, Leadership and Governance, Zagreb, Republic of Croatia, pp. 41-49, 2014.

CUNHA, J. A. O. G., FIGUEIREDO, J., MATOS, F., and THOMAZ, J. **Knowledge Management on PMO's Perspective: A Systematic Review**. Proceedings of the 15th European Conference on Knowledge Management, Santarém, Portugal, pp. 233-241, 2014.

Doctoral Symposium

CUNHA, J. A. O. G., and MOURA, H. P. **A Substantive Theory of Project, Program, and Portfolio Decisions in Software Development Project-Based Organizations**. 12th International Conference on Information Systems and Technology Management (CONTECSI), São Paulo, Brazil, 2015.

CUNHA, J. A. O. G., and MOURA, H. P. **Towards a Theory of Project Decisions in Software Development Project-Based Organizations**. 10th European Conference on Management, Leadership and Governance (ECMLG), Zagreb, Republic of Croatia, 2014. [**PhD Research Certificate of Merit**].

APPENDIX A – RESEARCHER BACKGROUND

I have a bachelor degree in Computer Science at the Federal University of Paraíba in 2005 where I worked on research projects related to the Brazilian digital television standard. I initiated the master's degree in Computer Science at the Federal University of Pernambuco in 2006, through which I could deepen my knowledge in software engineering. My research area was related to productivity in software project teams. Throughout the course, I had the opportunity to learn techniques related to multicriteria decision analysis and propose an evaluation model of software project teams' productivity based on a multicriteria approach.

At the end of the first half of the master program, in 2006, I started working at DATAPREV, the Social Security Technology and Information Organization from Brazil. During this period, traveling back and forth between João Pessoa - PB and Recife - PE was a routine. Since I concluded the master program in 2008, I decided to focus on practical experience, since my experience up to there was as an intern in some organizations. From 2008 to 2011 I worked on several projects in DATAPREV and performed different roles, such as coder, requirements analyst and project manager. In early 2012 I started working as the Project Management Office (PMO) manager of one of the organization's software development units. For two years (march 2012 to march 2014) I conducted activities related to project management in the PMO, such as the definition and improvement of the project management methodology; participation in the implementation of some agile initiatives; coordinating a project program, and promoting courses and events to incentive knowledge sharing. In early 2012 I also started the doctoral program with the incentive of the organization.

Based on my experience in the PMO, I firstly decided to investigate as my doctoral proposal one of the problems experienced in practice coordinating the PMO. One of the primary need was the effective support from the PMO to project managers in project planning and monitoring, supporting them in complex decisions. In this sense, the initial research question was "*How do PMOs can aid decision-making of*

software project managers?". This question guided the first step of the research plan in the Centro de Estudos de Gestão do Instituto Superior Técnico da Universidade de Lisboa from march to december 2014. In order to better understand the state of the art on PMO, a systematic literature review was conducted, and, based on its results and conversations with practitioners and professors in different conferences around Europe, I started to reflect on the real contribution of the research.

From the experience and knowledge obtained during these studies on PMO, I started to analyze the decision-making process through a new perspective, from a PMO model based on knowledge management and decision-making techniques, following a positivist paradigm, to the research of the reality of project managers to understand how they make decisions in practice, following an interpretive paradigm.

This doctoral thesis is the result of several reflections based on academic and practical experiences, including discussions with practitioners and academics from Brazil and Europe.

APPENDIX B – SYSTEMATIC LITERATURE REVIEW PROTOCOL

The research method used is based on a systematic review to do a comprehensive and unbiased search distinguished from a traditional review of the literature. The process covered the phases of a systematic review, resulting in a thematic map with its respective synthesis. Each step and their outcomes are shown in Figure 19.

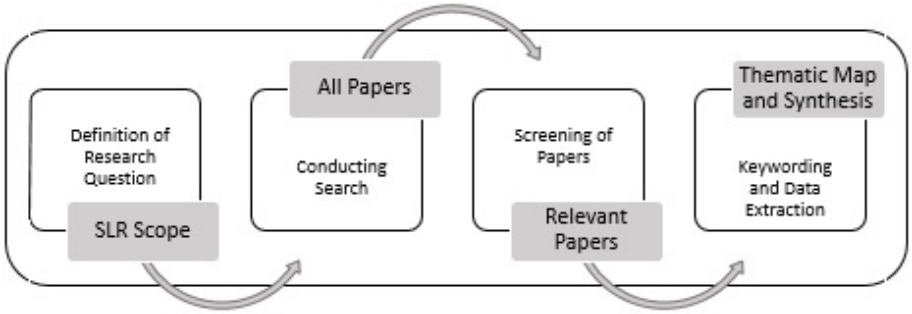


Figure 19. SLR's research method

Definition of research questions and searching for primary studies

Research questions provide the guidance for the review. Building from the aim of this study, the primary research question was "*How do software project managers make decisions?*". The primary studies were identified by using the search string shown below, which is composed by general keywords related to "*software project management*" and "*decision-making*" in order to identify as many relevant primary studies as possible. The term "*cognitive bias*" was also included since it is directly related to the phenomenon studied.

("software" OR "information technology" OR "information system" OR "information systems") AND ("team leader" OR "team leaders" OR "project manager" OR "project managers" OR "project management") AND ("cognitive bias" OR "cognitive biases" OR "decision making" OR "decision-making")

The search process was conducted through an automatic search in the following five search engines: ScienceDirect, Scopus, Wiley, IEEE Xplore, and ACM

Digital Library. Since the term “*naturalistic decision-making*” is not common in the project management and software engineering literature, we did not restrict the main question. As the term “*decision-making*” is related to many areas, this initial step yielded 19000 papers, including papers related to decision-making from a normative theory perspective.

Screening of papers, Keywording and Data Extraction

The screening of papers was initially based on the title. After the papers had been identified, we eliminated duplicated ones that were obtained in more than one search engine. In some cases, the abstracts were also read. This initial screening resulted in 109 selected papers. All inclusion and exclusion criteria are resumed in Table 7. In this step, besides the inclusion criterion, it was applied only the first exclusion criterion.

Table 20. SLR's inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Papers describing empirical studies regarding decision-making in software project management from a naturalistic perspective published up to February 2016	1. Keynotes, white papers, in-progress papers, abstracts, book's chapters and dissertations. Papers not published in English. Secondary and tertiary studies;
	2. Papers describing empirical studies regarding decision making in project management, but not focused on software context;
	3. Papers describing empirical studies with students as participants;
	4. Papers describing empirical studies in decision making from a normative perspective.

The second, third and fourth exclusion criteria were applied during the full reading of papers, resulting in 19 papers listed in “SLR: List of Primary Studies” section. Most of the papers (74%) were obtained from journals and 89% of them were published in the last ten years. The thematic analysis method was used to synthesize the data extracted from the primary studies.

APPENDIX C – INTERVIEWS SCRIPT

PART A - INTRODUCTORY PRESENTATION

The presentation, objective of the interview, related research projects, introduction, and identification of the interviewee sections were presented by the same way for the software project managers, team members, and project stakeholders.

Apresentação
[Presentation]

- Auto-apresentação
  [Self-presentation]
- Agradecimento ao participante
  [Thank the participant]
- Permissão para gravar o áudio da entrevista
  [Ask for permission to record the interview audio]

Objetivo da Entrevista
[Objective of the interview]

O objetivo desta pesquisa é entender aspectos relacionados ao estilo de tomada de decisão de gerentes de projeto de software.
[This research aims to understand the aspects related to decision-making style of software project managers.]

Sobre os projetos de pesquisa
[Talk about the related research project]

- Falar sobre os grupos de pesquisa vinculados a esta pesquisa
  [Talk about the research groups linked to this research.]

Introdução
[Introduction]

Todas as informações fornecidas nesta entrevista serão tratadas como confidenciais. Apenas a equipe de pesquisa terá acesso às informações fornecidas. Em particular, nenhuma pessoa direta ou indiretamente ligada a sua empresa terá acesso às informações fornecidas nesta entrevista e em nenhuma outra fase da pesquisa. O conteúdo das entrevistas será utilizado apenas para fins da pesquisa acadêmica, não tendo assim nenhuma influência na avaliação do funcionário no desempenho

das suas atividades na organização. A entrevista será gravada para posterior documentação.
[All information provided in this interview will be treated as confidential. Only the research team will have access to the information provided. In particular, no person directly or indirectly linked to your organization will have access to the information presented on this interview and in any other phase of the research. The content of the interviews will be used only for the purposes of academic research, thus have no influence on employee performance evaluation in carrying out hit/her activities in the organization. The interview will be recorded for documentation.]

Ao final da pesquisa, os dados serão publicados em eventos de natureza acadêmica, mas os nomes das pessoas envolvidas serão omitidos nas respectivas publicações.
[At the end of this research, the data will be published in academic nature events, but the names of the people involved will be omitted in the respective publications.]

Sua participação nesta pesquisa é voluntária e você pode decidir não participar ou se retirar da
pesquisa a qualquer momento. Caso você decida não participar, não receberá nenhuma sanção
ou penalidade. Você concorda em participar desta pesquisa?
[Your participation in this research is voluntary and you can decide not to participate or withdraw from the research at any time. If you decide not to participate, you will not receive any sanction or penalty. Do you agree to participate in this research?]

Identificação do entrevistado
[Identification of the Interviewee]

- As informações a seguir serão utilizadas caso a equipe de pesquisa precise entrar em contato com você no futuro para esclarecimentos sobre a entrevista. Por favor, diga seu nome e e-mail.
  [The following information will be used if the research team need to contact you in the future to clarify the interview. Please tell me your name and e-mail]

PART B - INTERVIEW SCRIPTS

ROTEIRO DA ENTREVISTA #1 COM GERENTES DE PROJETO DE SOFTWARE
INTERVIEW SCRIPT #1 FOR SOFTWARE PROJECT MANAGERS

Q1. [**Background**] Fale um pouco de você: sua formação, idade, trajetória profissional.

- Sondagem: *Quais funções você exerceu em projetos de software? Onde você mais gostou de trabalhar? Por quê? Onde você menos gostou de trabalhar? Por quê?*

[Q1. Tell me a little about yourself: your background, age, professional career.]
[Probe: What functions you discharged in software projects? What was the most striking in each experience? Where did you most like to work? Why? Where did you least like to work? Why?]

Q2. [**Background]** O que o levou a trabalhar como gerente de projetos de software?

- Sondagem: *Qual foi o melhor projeto em que já trabalhou? Por que? Como você se sentia nesse projeto? E o contrário, qual foi o pior projeto em que já trabalhou? Por que? Como você se sentia nesse projeto?*

[Q2. Talk about your experience as software project manager. If you prefer, focus on the most significant projects.]
[Probe: What was the best project you have ever worked? Why? How did you feel working in this project? Otherwise, what was the worst project you ever worked? Why? How did you feel working in this project?]

Q3. [**Background**] Há quanto tempo você trabalha nesta empresa?
[Q3. How long have you worked for this organization?]

Q4. [**Experience**] O que o levou a trabalhar nesta empresa?

- Sondagem: *Comparado com outras empresas em que trabalhou, como se sente nesta?*

[Q4. What led you to work here?]
[Probe: Compared to other organizations in which you worked, how do you feel working in this organization?]

Q5. [**Experience**] Como a empresa está estruturada a nível de projetos?
[Q5. How is your organization structured in terms of projects?]

Q6. [**Feeling**] Como você se sente atualmente trabalhando como gerente de projetos de software?

- Sondagem: *Comparado com outras funções, como você avalia o seu trabalho como gerente de projetos de software? Mais/menos estressante, divertido, significativo, etc.*

[Q6. How do you feel currently working as software project manager?]
Probe: Compared to other areas, how do you evaluate your job as software project manager? More/less stressful, fun, meaningful, etc.]

Q7. [**Opinion**] O que a sua organização oferece ou faz para estimular o bom gerenciamento dos projetos?

- Sondagem: *Quais planos, incentivos, eventos etc a organização promove para estimular o gerenciamento de projetos?*

[Q7. What does your organization offer or do to stimulate good project management?]
[Probe: What plans, incentives, events, etc. does the organization promote to stimulate the project management discipline?]

Q8. [**Opinion**] Qual a relação dessas ações para a melhoria das decisões tomadas pelos gerentes de projeto de software?
[Q8. What is the relationship of these actions in order to improve the decisions made by the software project managers?]

Q9. [**Opinion**] O que a sua organização faz (e/ou que não deveria fazer) que dificulta o bom gerenciamento dos projetos?

- Sondagem: *Quais planos, incentivos, eventos etc a organização realiza que tem o efeito inverso no bom gerenciamento de projetos?*

[Q9. What does your organization do that difficult the project management?]
[Probe: What plans, incentives, events, etc. does the organization promote that have the reverse effect on good project management?]

Q10. [**Opinion**] De que forma tais ações dificultam a tomada de decisão pelos gerentes de projeto de software?
[Q10: How these actions difficult the decision-making by software project managers?]

Q11. [**Experience**] Fale sobre o projeto em que trabalha atualmente.
- Sondagem: *Quais são os objetivos e metas? Quais são os principais desafios da sua equipe?*
[Q11: Tell me about the project you work.]
[Probe: What are the objectives? What are the main challenges of your project?]

Q12. [**Feeling**] Como você se sente em trabalhar nesse projeto?
[Q12: How do you feel working in this project?]

Q13. [**Experience**] Descreva em detalhes como é um dia de trabalho típico seu.
[Q13: Tell me in details how is a typical day for you.]

Q14. [**Experience**] Quais são as principais dificuldades que vocês enfrentam no projeto em que trabalha?
- Sondagem: *Restrições de tempo, recursos de equipe, conhecimento dos membros e a natureza mutável do ambiente. O que você faz para lidar com tais dificuldades?*
[Q14: What are the main difficulties you face in working on the project?]
[Probe: Time, staff resources, and expertise of the members constraints as well as the changing nature of the environment. How do you do to deal with these difficulties?]

Q15. [**Opinion**] Como você definiria uma decisão complexa?
- Sondagem: *Dentre as atividades do seu dia a dia, quais envolvem decisões complexas?*
[Q15: How would you define a complex decision?]
[Probe: Considering your daily activities, which ones involve complex decisions?]

Q16. [**Opinion**] Como você definiria uma decisão trivial?
- Sondagem: *Dentre as atividades do seu dia a dia, quais envolvem decisões triviais?*
[Q16: How would you define a trivial decision?]
[Probe: Considering your daily activities, which ones involve trivial decisions?]

Q17. [**Background**] Descreva a equipe do projeto.
- Sondagem: *Como sua equipe de trabalho está organizada?*
[Q17: Describe you project team.]
[Probe: How is you project team organized?]

Q18. [**Feeling**] Como você acha que sua equipe se sente em relação à sua atuação como gestor do projeto?

- Sondagem: *Quais são os principais comentários da equipe a respeito deste projeto? O que você considera como justificativa para os comentários negativos? O que você considera como justificativa para os comentários positivos?*
  [Q18: What do you think your project team feels about your performance as software project manager?]
  [Probe: What are the main comments from your project team about you? How do you explain the negative comments? How do you explain the positive comments?]

Q19. [**Experience**] Qual influência você exerce nas decisões tomadas pelos membros da equipe?

[Q19: What is your influence on the decisions made by the project team members?]

Q20. [**Experience**] Qual a influência da equipe nas decisões do projeto?

[Q20: What is the influence of project team members on project decisions?]

Q21. [**Background**] Descreva os principais stakeholders do projeto.

- Sondagem: *Como eles estão organizados?*
  [Q21: Describe the main project stakeholders.]
  [Probe: How are they organized?]

Q22. [**Feeling**] Como você acha que os stakeholders se sentem em relação à sua atuação como gestor do projeto?

- Sondagem: o *Quais são os principais comentários dos stakeholders a respeito deste projeto? O que você considera como justificativa para os comentários negativos? O que você considera como justificativa para os comentários positivos?*
  [Q22: What do you think the project stakeholders fees about your performance as software project manager?]
  [Probe: What are the main comments from your project team about you? How do you explain the negative comments? How do you explain the positive comments?]

Q23. [**Experience**] Qual influência você exerce nas decisões tomadas pelos stakeholders?

[Q23: What is your influence on the decisions made by the project stakeholders?]

Q24. [**Experience**] Qual a influência dos stakeholders nas decisões do projeto?

[Q24: What is the influence of project stakeholders on project decisions?]

Q25. [**Experience**] Em que situações você prefere evitar tomar uma decisão?

[Q25: In which situations do you prefer avoid making decision?]

Q26. [**Feeling**] Com que frequência você se arrepende de decisões?

[Q26: In which frequency do you repent making decisions?]

Q27. [**Feeling**] Como você se sente quando a ação tomada surtiu o efeito esperado?
[Q27: How do you feel when the action taken has had the desired effect?]

Q28. [**Feeling**] Como você se sente quando a ação tomada não surtiu o efeito esperado?
[Q28: How do you feel when the action taken has not had the desired effect?]

Q29. [**Feeling**] Que tipo de decisão você se sente mais à vontade para tomar?
- Sondagem: *Em quais áreas de conhecimento? Por que?*
[Q29: What kind of decision do you feel more comfortable to make?]
[Probe: In which knowledge areas? Why?]

Q30. [**Feeling]** Que tipo de decisão você se sente menos à vontade para tomar?
- Sondagem: *Em quais áreas de conhecimento?*
[Q30: What kind of decision do you feel less comfortable to make?]
[Probe: In which knowledge areas? Why?]

Q31. [**Opinion]** Como você descreveria um colega que desempenha bem a sua função como gerente de projetos de software?
[Q31: How would you describe a colleague who has a good performance as a software project manager?]

Q32. [**Opinion]** Dentre as características citadas quais são essenciais para um bom tomador de decisão?
[Q32: Among the characteristics mentioned, which ones are essential for a good decision maker?]

Q33. [**Opinion**] De que forma você acha que tais características impactam no desempenho do projeto?
[Q33: How do you think these characteristics impact on project performance?]

Q34. [**Opinion**] Como você descreveria um colega que desempenha mau a sua função como gerente de projeto de software?
[Q34: How would you describe a colleague who has a bad performance as a software project manager?]

Q35. [**Opinion**] Dentre as características citadas quais influenciam um mau tomador de decisão?
[Q35: Among the characteristics mentioned, which ones influence a bad decision maker?]

Q36. [**Opinion**] De que forma você acha que tais características impactam no desempenho do projeto?
[Q36: How do you think these characteristics impact on project performance?]

Q37. [**Opinion**] Qual a relação da experiência em outras funções na sua capacidade de tomar decisões como gestor de projeto?
[Q37: What is the relationship between your experience performing other roles when making decisions as software project manager?]

Q38. [**Feeling**] Como você avalia seu desempenho como gestor de projetos?

- Sondagem: *O que mais influencia esse desempenho? O que pode ser feito para melhorar?*

  [Q38: How do you evaluate your performance as software project manager?]
  [Probe: What most influence this performance? What can be done to improve?]

Q39. [**Feeling**] Como você avalia o seu desempenho como tomador de decisão?

- Sondagem: *O que mais influencia esse desempenho? O que pode ser feito para melhorar?*

  [Q39: How do you evaluate your performance as a decision maker?]
  [Probe: What most influence this performance? What can be done to improve?]

Q40. Você gostaria de adicionar alguma informação ou observação que não foi perguntada, mas que você considera importante para a avaliaçao do processo decisório de gerentes de projeto de software?

[Q40: Would you like to add some information or observation that was not asked, but that you consider important for the evaluation of the decision-making process of software project managers?]

Q41. Por favor, faça uma avaliação de dois pontos fortes e dois pontos fracos desta entrevista.

[Q41: Please, tell me two strengths and two weakness of this interview?]

ROTEIRO DA ENTREVISTA #2 COM GERENTES DE PROJETO DE SOFTWARE
INTERVIEW SCRIPT #2 FOR SOFTWARE PROJECT MANAGERS

Q42. [**Background**] Você continua gerenciando o(s) mesmo(s) projeto(s) que você estava gerenciando quando a primeira entrevista foi realizada?

[Q42: Are you managing the same project(s) you were managing when the first interview was conducted?]

Q43. [**Experience**] Como você coleta informações para tomada de decisão?

- Sondagem: *O que você faz para verificar a confiabilidade das informações antes de tomar uma decisão?*

[Q43. How do you collect information to make decision?]
[Probe: What do you do to verify the reliability of the information before making a decision?]

Q44. [**Opinion**] Para você, é mais importante que o objetivo seja alcançado independente de como?

[Q44. For you, is it more important that the goal is achieved regardless of how?]

Q45. [**Opinion**] De que forma a autonomia influencia na tomada de decisão?

[Q45. How does autonomy influence on decision-making?]

Q46. [**Opinion**] De que forma o compartilhamento do conhecimento influencia na tomada de decisão?

[Q46. How does knowledge sharing influence on decision-making?]

Q47. [**Opinion**] De que forma a experiência gerenciando projetos influencia na tomada de decisão?

- Sondagem: *De que forma a experiência atuando em outros papeis influencia na tomada de decisão? E o tempo de trabalho na organização?*

[Q47. How does experience managing projects influence on decision-making?]
[Probe: How does experience performing other project roles influence on decision-making? What about the employment time in the organization?]

Q48. [**Feeling**] Como você se sente como responsável pelas decisões do projeto?

- Sondagem: *Como você se sente nas situações de pressão ao tomar uma decisão?*

[Q48. How do you feel as responsible for the project decisions?]
[Probe: How do you feel in pressure situations to make a decision?]

Q49. [**Feeling**] Como você se sente em decisões que envolvem muito esforço cognitivo?

- Sondagem: *Como se sente caso não encontre uma alternativa rapidamente?*

[Q49. How do you feel when making decisions involving much cognitive effort?]
[Probe: How do you feel if you do not find an alternative quickly?]

Q50. [**Experience**] Como você lida com incertezas ao tomar uma decisão?

[Q50. How do you deal with uncertainty when making a decision?]

Q51. [**Experience**] Com que frequência você confia em seu instinto/sentimento na tomada de decisão?

- Sondagem: *Você acredita na primeira coisa que vem à mente?*

[Q51. How often do you trust in your instinct/feeling when making decision?]
[Probe: Do you believe in the first thing that comes to your mind?]

Q52. [**Experience**] Como você explora as opções antes de tomar uma decisão?

- Sondagem: *Define e prioriza critérios? Usa técnicas de compensação? Prós e contras?*

[Q52. How do you explore the options before making a decision?]
[Probe: Do you define and prioritize criteria? Do you use compensation techniques? Pros and cons?]

Q53. [**Experience**] Você fica repensando sobre as outras alternativas por um tempo?

[Q53. Do you rethink about the other alternatives for a while?]

Q54. [**Experience**] Você continua a procurar opções mesmo que exista uma que atenda às necessidades mínimas?

[Q54. Do you continue to look for options even if there is one that meets the minimum requirements?]

Q55. [**Opinion**] De que forma a capacidade de negociação influencia na tomada de decisão?

- Sondagem: *Como você lida com conflitos ao tomar uma decisão?*

[Q55. How does negotiation capacity influence on decision-making?]
[Probe: How do you handle with conflicts when making a decision?]

Q56. [**Opinion**] De que forma a comunicação influencia na tomada de decisão?
[Q56. How does communication influence on decision-making?]

Q57. [**Opinion**] De que forma a personalidade influencia na tomada de decisão?
[Q57. How does personality influence on decision-making?]

Q58. [**Opinion**] De que forma ter uma visão sistêmica influencia na tomada de decisão?
[Q58. How does systemic vision influence on decision-making?]

Q59. [**Opinion**] De que forma o envolvimento do cliente influencia na tomada de decisão?
[Q59. How does client involvement influence on decision-making?]

Q60. [**Opinion**] De que forma a competência técnica da equipe influencia na tomada de decisão?
[Q60. How does team member's technical capacity influence on decision-making?]

Q61. [**Experience**] Você usualmente espera algo acontecer pra decidir ou tomar a iniciativa?

- Sondagem: *Você tende a se adaptar às circunstâncias do que mudá-las ao tomar uma decisão?*

[Q61. Do you usually wait for something to happen or take the initiative when making a decision?]
[Probe: Do you tend to adapt yourself to the circumstances rather than changing them when making a decision?]

Q62. [**Experience**] Ao tomar uma decisão, você foca mais nos possíveis resultados positivos ou negativos?

- Sondagem: *Como você se sente sobre a possibilidade de a decisão dar errado?*

[Q62. When making a decision, do you focus on the possible positive or negative results?]
[Probe: How do you feel about the possibility of the decision go wrong?]

Q63. [**Opinion**] De que forma o gerenciamento de riscos influencia na tomada de decisão?

- Sondagem: *Você tenta se antecipar as consequências das suas decisões?*

[Q63. How does risk management influence on decision-making?]
[Probe: Do you try to anticipate the consequences of your decisions?]

Q64. [**Opinion**] De que forma o planejamento iterativo influencia na tomada de decisão?
[Q64. How does iterative planning influence on decision-making?]

Q65. [**Opinion**] De que forma ser organizado influencia na tomada de decisão?
[Q65. How does the organization capacity influence on decision-making?]

Q66. [**Opinion**] Quão satisfeito você está com a forma como você decide?
[Q66. How satisfied are you on how you decide?]

ROTEIRO DA ENTREVISTA COM MEMBROS DA EQUIPE DE PROJETO
INTERVIEW SCRIPT FOR PROJECT TEAM MEMBERS

Q1. [**Background**] Fale um pouco de você: sua formação, há quanto tempo está na empresa, qual sua função atual e há quanto tempo está na função atual.
[Q1. Tell us a little about yourself: your formation, for how long do you work in this organization, what is your current role and for how long are you performing this role.]

Q2. [**Background**] Fale sobre suas atividades no projeto atual.
[Q2. Talk about your activities in the current project.]

Q3. [**Experience**] Quais são as principais dificuldades que você enfrenta no projeto em que trabalha?
[Q3: What are the main difficulties you face in working on the project?]

Q4. [**Experience**] Qual sua influência nas decisões tomadas ao longo do projeto?
[Q4: What is your influence on project decisions?]

Q5. [**Experience**] Qual a influência do gerente de projeto em suas decisões?
[Q5: What is the influence of the software project manager on your decisions?]

Q6. [**Opinion**] Quais são as características do seu gerente de projeto que o faz ser um bom tomador de decisão?
[Q6: What are the characteristics of your software project manager that makes him or her a good decision maker?]

Q7. [**Opinion**] O que poderia ser feito de forma diferente no seu projeto para que melhores decisões fossem tomadas?
[Q7: What could be done differently in your project in order to better decisions be made?]

Q8. [**Opinion**] Você gostaria de adicionar alguma informação ou observação que não foi perguntada, mas que você considera importante para a avaliaçao do processo decisório de gerentes de projeto de software?

[Q8: Would you like to add some information or observation that was not asked, but that you consider important for the evaluation of the decision-making process of software project managers?]

ROTEIRO DA ENTREVISTA COM STAKEHOLDERS DO PROJETO
INTERVIEW SCRIPT FOR PROJECT STAKEHOLDERS

Q1. [**Background**] Fale um pouco de você: sua formação, há quanto tempo está na empresa, qual sua função atual e há quanto tempo está na função atual.

[Q1. Tell us a little about yourself: your formation, for how long do you work in this organization, what is your current role and for how long are you performing this role.]

Q2. [**Background**] Fale sobre suas atividades na função atual.

[Q2. Talk about your activities in your current position.]

Q3. [**Experience**] Quais são as principais dificuldades que você enfrenta nos projetos que acompanha?

[Q3: What are the main difficulties you face when monitoring the projects?]

Q4. [**Experience**] Qual sua influência nas decisões tomadas ao longo dos projetos?

[Q4: What is your influence on projects decisions?]

Q5. [**Experience**] Qual a influência dos gerentes de projeto em suas decisões?

[Q5: What is the influence of the software project managers on your decisions?]

Q6. [**Opinion**] Quais são as características dos gerentes de projeto que os fazem ser bons tomador de decisão?

[Q6: What are the characteristics of software project managers that makes them a good decision maker?]

Q7. [**Opinion**] O que poderia ser feito de forma diferente pelos gerentes de projeto para que melhores decisões fossem tomadas?

[Q7: What could be done differently by the software project managers in order to better decisions be made?]

Q8. [**Opinion**] Você gostaria de adicionar alguma informação ou observação que não foi perguntada, mas que você considera importante para a avaliaçao do processo decisório de gerentes de projeto de software?

[Q8: Would you like to add some information or observation that was not asked, but that you consider important for the evaluation of the decision-making process of software project managers?]

APPENDIX D – MEMBER CHECKING QUESTIONNAIRE

#	Afirmação *	Concordância
1	O estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Não Concordo nem Discordo ( ) Discordo Parcialmente ( ) Discordo Totalmente
2	A experiência do gerente de projeto, formada pela experiência gerenciando projetos e pelo tempo de trabalho na organização, assim como o conhecimento do gerente de projeto, formado pelo conhecimento técnico e do negócio, moderam como o estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	
3	O feedback contínuo, infuenciado pelo envolvimento do cliente e pelo planejamento iterativo, estão positivamente relacionados com o conhecimento do gerente de projeto na tomada de decisão.	
4	O compartilhamento de conhecimento dentro e entre projetos está positivamente relacionado com o conhecimento do gerente de projeto na tomada de decisão.	
5	A autonomia do gerente de projeto, que inclui a flexibilidade do processo de desenvolvimento, modera como o estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	
6	A complexidade da tarefa modera como o estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	
7	A capacidade técnica dos membros de equipe modera como o estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	
8	A visão sistêmica do projeto, a comunicação transparente, a capacidade de negociação, a capacidade de organização, o gerenciamento proativo dos riscos e o relacionamento interpessoal moderam como o estilo de liderança do gerente de projeto influencia no seu estilo de tomada de decisão participativo.	
9	O estilo de tomada de decisão participativo influencia positivamente no comprometimento do time no projeto.	
10	O estilo de tomada de decisão participativo influencia negativamente no arrependimento de decisões pelo gerente de projeto.	
Comments:		

* The hypothesis related to cognitive biases was not included in the member-checking questionnaire since they were indirectly evaluated in the second phase of the research. This hypothesis was confronted and confirmed through the exploratory study of the first phase of the research.

APPENDIX E – THE GOVERNMENT ORGANIZATION

Organization description

The Brazilian public organization was founded in 1974 and provides information technology solutions for the improvement and implementation of social policies of the Brazilian State. The organization has a computational and logistical capacity to host, maintain, manage, protect information, and also to analyze and classify data, provide consulting services, and support the development of projects. The management processes broadly followed the PMBOK guide and, at the moment of the research, the use of agile management practices was starting. The organization's structure is distributed throughout Brazil with five departments responsible for software development. At the time of this research, the organization had about 4000 professionals, with 10.5% responsible for software development. The rest of the employees are located in the financial, human resource, infrastructure, and others departments.

Participants' profiles

PM1ORG1: Project Manager, Female, 32 years old, M.Sc. in Computer Science. She is CSM certified. She works in the organization for 6 years and managed a project for 1 year. She has also experience as system analyst. (*Interview audio time: 58' 06"*).

PM2ORG1: Project Manager, Female, M.Sc. in Computer Science. She is CSM certified. She works in the organization for 17 years, 3 years of which managing projects. She has also experience as web developer and system analyst. (*Interview 1 audio time: 77' 59"; Interview 2 audio time: 47' 16"*).

PM3ORG1: Project Manager, 34 years old, Male, MBA in Project Management. He is PMP and CSM certified. He works in the organization for 9 years, 7 years of which managing projects. He has also experience as web developer and system analyst. (*Interview 1 audio time: 61' 15"; Interview 2 audio time: 28' 58"*).

PM4ORG1: Project Manager, 28 years old, Male, M.Sc. in Computer Science. He is CSM certified. He works in the organization for 6 years, 1 year of which managing projects. He has also experience as web developer and system analyst. (*Interview 1 audio time: 70' 48"; Interview 2 audio time: 39' 46"*).

PM5ORG1: Project Manager, 31 years old, Male, MBA in Project Management. He is CSM certified. He works in the organization for 9 years, 2 years of which managing projects. He has also experience as system analyst and web developer. (*Interview 1 audio time: 48' 48"; Interview 2 audio time: 34' 27"*).

PM6ORG1: Project Manager, Male, M.Sc. in Computer Science. He is CSM certified. He works in the organization for 6 years, 1 year of which managing projects. He has also experience as system analyst and web developer. (*Interview 1 audio time: 59' 27"; Interview 2 audio time: 30' 52"*).

PM7ORG1: Project Manager, 27 years old, Male, B.Sc. in Computer Science. He is CSM certified. He works in the organization for 3 years, 2 year of which managing projects. He has also experience as web developer. (*Interview audio time: 59' 59"*).

PM8ORG1: Project Manager, Male, B.Sc. in Computer Science. He is PMP and CSM certified. He works in the organization for 9 years, 8 year of which managing projects. He has also experience as system analyst and web developer. (*Interview 1 audio time: 66' 38"; Interview 2 audio time: 35' 56"*).

PM9ORG1: Project Manager, 35 years old, Male, MBA in Project Management. He is CSM certified. He works in the organization for 9 years, 3 year of which managing projects. He has also experience as system analyst. (*Interview 1 audio time: 59' 46"; Interview 2 audio time: 35' 07"*).

PM10ORG1: Project Manager, 34 years old, Male, B.Sc. in Computer Science. He works in the organization for 8 years, 6 year of which managing projects. He has also experience as web developer. (*Interview 1 audio time: 53' 08"; Interview 2 audio time: 32' 03"*).

PM11ORG1: Project Manager, 40 years old, Male, MBA in Project Management. He is CSM certified. He works in the organization for 8 years, 3 year of which managing

projects. He has also experience as system analyst (*Interview 1 audio time: 56' 12"; Interview 2 audio time: 55' 43"*).

STK1ORG1: PMO Manager, Female, B.Sc. in Computer Science and Civil Engineering. She is CSM certified. She works in the organization for 8 years, 2 of which managing the PMO. (*Interview audio time: 16' 50"*)

STK2ORG1: Software development functional manager's assessor, Male, M.Sc. in Computer Science. He is PMP and CSM certified. He works in the organization for 8 years, 4 of which in actual role. (*Interview audio time: 28' 23"*)

SWE1ORG1: Software engineer, Female, M.Sc. in Software Engineering. She works in the organization for 10 years performing different roles, including quality assurance. Currently, she works as requirement analyst. (*Interview audio time: 16' 02"*)

SWE2ORG1: Software engineer, Male, B.Sc. in Computer Science. He works in the organization for 5 years, 4.5 of which working in the same project business. (*Interview audio time:* 11' 03'')

SWE3ORG1: Software engineer, Female, B.Sc. in Telematics. She works in the organization for 9 years, 2 of which in the same project business. (*Interview audio time: 13' 26"*)

SWE4ORG1: Software engineer, Female, M.Sc. in Computer Science. She works in the organization for 8 years, 4 of which working in the same project business. He has experience as project manager and currently she works as requirements analyst. (*Interview audio time: 18' 40"*)

SWE5ORG1: Software engineer, Male, B.Sc. in Web Development. He works in the organization for 4 years, all of them in the same project business. He is the technical leader of the project. (*Interview audio time: 16' 04"*)

SWE6ORG1: Software engineer, Male, M.Sc. in Computer Science. He works in the organization for 7 years, 3 of which working in the same project business. He has experience as project manager and currently he works as the technical leader of the project. (*Interview audio time: 15' 24"*)

SWE7ORG1: Software engineer, Male, B.Sc. in Software Engineering. He works in the organization for 5 years, all of them in the same project business. Currently, he works as requirement analyst. (*Interview audio time: 20' 03"*)

SWE8ORG1: Software engineer, Male, B.Sc. in Software Engineering. He works in the organization for 8 years, 4 of which working in the same project business. He is the technical leader of the project. (*Interview audio time: 20' 43"*)

SWE9ORG1: Software engineer, Male, M.Sc. in Computer Science. He works in the organization for 8 years, 3 of which working in the same project business. He is the technical leader of the project. (*Interview audio time: 22' 05"*)

APPENDIX F – THE PRIVATE ORGANIZATION

Organization description

The Brazilian private and non-profit software development organization, established in 1994, has units in three states of Brazil. It operates in many different areas, such as: information technology, telecommunications, industrial automation, solutions for the public sector, and, by providing support services, workforce supply for third-parties, development of software and hardware products, software factories, product certification tests, and research and development of innovative technologically products. The project-based organization was assessed as SW-CMMI level 3. The management processes broadly followed the PMBOK guide and SCRUM agile management practices. At the time that this research was carried out, the organization had about 500 professionals, 85% were part of the technical workforce and 15% allocated to administrative tasks.

Participants' profiles

PM1ORG2: Project Manager, 41 years old, Male, MBA in Business Management. He is PMP and CSM certified. He works in the organization for 3 years, all of them managing projects. He has 20 years of experience managing projects. (*Interview 1 audio time: 76' 41"; Interview 2 audio time: 43' 22"*)

PM2ORG2: Project Manager, Male, M.Sc. in Computer Science. He works in the organization for 4 years, all of them managing projects. He has 10 years of experience managing projects. (*Interview audio 1 time: 56' 31"; Interview 2 audio time: 36' 02"*)

PM3ORG2: Project Manager, Male, B.Sc. in Computer Science. He works in the organization for 11 years, all of them managing projects. He has 17 years of

experience managing projects. (*Interview audio 1 time: 58'50''; Interview 2 audio time: 49' 33''*)

PM4ORG2: Project Manager, 34 years old, Female, B.Sc. in Computer Science. She works in the organization for 10 years, 4 of which managing projects. She has experience as coder and technical leader. (*Interview audio 1 time: 50' 19''; Interview 2 audio time: 28' 46''*)

PM5ORG2: Project Manager, Female, B.Sc. in Computer Science. She works in the organization for 9 years, 8 of which managing projects. She has experience as coder. (*Interview audio 1 time*: 47' 34''; Interview 2 audio time: 22' 41'')

PM6ORG2: Project Manager, Female, M.Sc. in Computer Science. She is CSM certified. She works in the organization for 15 years, 11 of which managing projects. She has experience as coder and business analyst. (*Interview 1 audio time: 45' 41''; Interview 2 audio time: 20' 45''*)

STK1ORG2: PMO Manager, Female, M.Sc. in Computer Science and Civil Engineering. She works in the organization for 19 years performing different roles, such as coder and project manager. She works as PMO manager for 3 years. (*Interview audio time: 15' 26''*)

SWE1ORG2: Software engineer, Male, B.Sc. in Computer Science. He works in the organization for 4 years. He is the technical leader of the project. (*Interview audio time: 21' 02''*)

SWE2ORG2: Software engineer, Male, M.Sc. in Computer Science. He works in the organization for 5 years. He is the technical leader of the project. (*Interview audio time: 20' 38''*)

SWE3ORG2: Software engineer, Male, M.Sc. in Software Engineering. He works in the organization for 10 years. He is the technical leader of the project. (*Interview audio time: 09' 52''*)

SWE4ORG2: Software engineer, Male, B.Sc. in Computer Science. He works in the organization for 10 years, 5 of which in the same project business. (*Interview audio time: 12' 14''*)

SWE5ORG2: Software engineer, Male, M.Sc. in Software Engineering. He works in the organization for 5 years working on several technologies. (*Interview audio time: 09' 05"*)

SWE6ORG2: Software engineer, Male, B.Sc. in Computer Science. He works in the organization for 5 years. He is working on his second project in the organization. (*Interview audio time: 12' 53"*)

APPENDIX G – Excerpts from the Interviews for Triangulation

The excerpts from the interviews with the software engineers, PMO and functional managers are presented in Table 21. They reinforce some of the categories identified from the interviews with the software project managers.

Table 21. Excerpts from the interviews for triangulation

Dependent (Participatory) style	
*"**O gerente do meu projeto é bem democrático. Ele gosta de decidir em conjunto.**"* English: *"My project manager is very democratic. He decides together with us."* (SWE3ORG1)	"***O gerente de projeto é uma pessoa que escuta muito e acaba que as decisões são tomadas em conjunto, a equipe inteira (...) Não há muita imposição não.***" English: "*The project manager is a person who listens a lot and ends up making decisions together with the whole team (...) There is not much imposition.*" (SWE4ORG1)
Client involvement	
*"**Nas reuniões, tanto na daily com o cliente quanto na gerencial semanal a gente tá sempre reavaliando e tendo feedback do resultado do que a gente tá fazendo.**"* English: "*Both in the daily meetings with the client and in the weekly managerial meetings we are always re-evaluating and having feedback of the results of what we are doing.*" (SWE2ORG2)	"***Envolver o cliente 100% na tomada de decisão. Ele é bem participativo e isso facilita o andamento do projeto e o acompanhamento dele.***" English: "*To fully involve the client in the project decisions. He is very participative and it facilitates the progress of the project and its control.*" (SWE3ORG2)
Iterative planning	
*"**Quanto à tomada de decisões de projeto, [o planejamento iterativo] ajuda o gerente a ter uma visão mais clara das atividades que ainda tão faltando.**"* English: "*When making project decisions, [the iterative planning] helps the project manager to get a clearer picture of the activities that are still in progress.*" (SWE6ORG1)	"***Eu acho que dependendo de como andam as sprints, elas vão dar um feedback ou positivo ou negativo, pra gente dar continuidade por um caminho ou por outro no decorrer do projeto.***" English: "*I think that depending on how the sprints are going, they will support a positive or negative feedback. So we can decide to continue in one way or another during the project.*" (SWE6ORG2)

Knowledge sharing initiatives (Continuation)
*"**A gente tem um modelo, onde a gente levanta, por exemplo, boas práticas que acontecem. Aquele momento é um momento rico, onde você como gestor tá compartilhando [conhecimento] com outros gestores de projetos.**"* English: "*We have a model through which we indicate, for example, good practices of the projects. That is a rich moment, where you as a project manager shares [knowledge] with other project managers.*" (STK1ORG2)
Autonomy
*"**A gente dá bastante autonomia pra o gestor, pra lidar com as decisões dentro da organização, dentro do seu projeto.**"* English: "*We give a lot of autonomy to the project manager to deal with the decisions within the organization and within his project.*" (STK1ORG2) "***A gente tem alguns problemas em relação às áreas parceiras da empresa. Pra desenvolver o projeto a gente depende de outras áreas, e os cronogramas, os processos não são casados.***" English: "*We have some problems with our partner departments. During the project we depend on other departments, and their schedules and processes do not match with our plans.*" (SWE4ORG1)
Development process flexibility
"Os processos em si da empresa mesmo, eles impedem muito a gente a ter uma flexibilidade maior pra inovar, pra melhorar alguma coisa. É muita rigidez, muito protocolo, muito documento pra ser assinado." English: "*The processes of the organization prevent us from having a greater flexibility to innovate, to improve something. It's a lot of rigidity, a lot of protocol, a lot of documents to be signed.*" (SWE8ORG1)
Team members' technical capacity
*"**Acho que eu influencio nas decisões relacionadas ao produto em si. Como eu conheço o produto há mais tempo, eu conheço um pouco dos problemas que a gente já teve.**"* English: "*I think I influence in the decisions related to the product. Since I've known the product for a long time, I know a little of the problems we've had.*" (SWE4ORG1) "***No viés técnico, por tá desde o começo do projeto e ter conhecimento maior nas tecnologias, consigo ver qual é o problema que algumas pessoas não conseguem ver.***" English: "*On the technical side, since I work from the beginning of the project and have a greater knowledge in the technologies, I can see what the problem that some people cannot see is.*" (SWE1ORG2)

Project management experience (Continuation)	
*"**Quando o gestor de projetos é maduro e tem uma certa experiência, ele adquire diversos artifícios que ele consegue utilizar para tomar suas decisões.**"* English: "*When the project manager is mature and has a certain experience, he acquires a variety of tools that he can use to make his decisions.*" (STK1ORG1)	"***Eu entendo que alguns gerentes de projeto, por já ter uma experiência na gestão de projetos, sabem quais são os principais riscos, já sabe quem são as pessoas que ele vai entrar em contato, e a forma de mitigar o risco de forma mais apropriada.***" English: "*I understand that some project managers, since they have an experience in project management, they know what the main risks are, they know who the people to get in touch with, and the way to mitigate the risk more appropriately.*" (STK2ORG1)
Employment time in the organization	
*"**Vejo que ele tem bastante conhecimento das caixinhas da empresa, sabe bem a quem se reportar caso dê algum problema. Acho que isso é legal, na hora de tomar decisão.**"* English: "*I see that he has a lot of knowledge of the organization structure, he knows who to report if he has any problem. I think this is cool when it comes to making decisions.*" (SWE2ORG1)	
Knowledge on business domain	
*"**Quanto mais domínio [no negócio] vc tiver, melhor vc vai tomar decisão.**"* English: "*The more knowledge [on business domain] you have, the better you will make a decision.*" (SWE6ORG2)	
Holistic vision of the project	
*"**Geralmente acontece muito de eu tomar uma decisão sozinha, sem consultá-la e depois ela [a gerente de projeto] vem e muda aquela decisão, pelo domínio que ela tem do todo. Então, muitas vezes eu não consigo ter a visão do todo e acabo tomando uma decisão errada.**"* English: "*Usually I make a decision on my own, without consulting her and then she [the project manager] comes and changes that decision, since she knows the whole project. So often I cannot get the whole view and I end up making a wrong decision.*" (SWE1ORG1)	"***Além do aspecto do planejamento, ele [o gerente de projeto] precisa aumentar um pouco a visão dele. A visão em relação ao seu papel na instituição, ao papel do projeto no contexto da empresa.**"* English: "*Beyond the planning aspect, he [the project manager] needs to increase his vision in relation to its role in the organization, and the role of the project in the context of the organization.*" (STK2ORG1)

Transparent communication (Continuation)	
*"**Normalmente as comunicações, todos recebem ao mesmo tempo. Isso ajuda na tomada de decisão, né? A gente tem conhecimento do que tá acontecendo pra opinar daquela forma.**"* English: "*Usually all team members receive the project information at the same time. This helps in decision making, right? We know what's happening to think and give an opinion.*" (SWE2ORG1)	"***Ele sendo um bom comunicador, ele [gerente de projeto] já consegue 50% do objetivo de ser gestor do projeto. Ele conseguir se comunicar bem, ele vai se relacionar bem com as áreas, vai adquirir facilidades para negociar suas aquisições e vai conseguir motivar a equipe.***" English: "*Being a good communicator, he [project manager] achieves 50% of the goal of being a project manager. If he is able to communicate well, he will relate well to the departments, he will acquire facilities to negotiate his acquisitions and will be able to motivate the team members.*" (STK1ORG1)
Organizational ability	
*"**Quando você consegue se planejar, mesmo que seja com uma coisa que você não tenha muita visão do futuro, mas você sabe que tem aquela necessidade, é mais fácil [para tomar decisões].**"* English: "*When you can plan, even if it's something you do not have much of a vision of the future, you know you have that need, it's easier [to make decisions].*" (STK1ORG1)	
Proactive risk management	
*"**Hoje em dia, a principal causa raiz de problemas de projetos que eu acompanho são problemas de planejamento. Não existem riscos que não podem ser contornados, quem vem e impactam o projeto.**"* English: "*Nowadays, the main root cause of the problems of the projects I monitor is related to planning problems. There are no risks that cannot be circumvented, which comes and impacts the project.*" (STK2ORG1)	
Interpersonal relationship	
*"**É importante conhecer as pessoas, se relacionar bem com elas e conhecer o potencial das pessoas.**"* English: "*It is important to know the people, to relate well to them and to know their potential.*" (SWE4ORG1)	"***A relação individual impacta. [É importante] manter uma boa relação com o time, com os indivíduos. A gente acabava trabalhando com mais naturalidade, expondo até os problemas pequenos.***" English: "*The individual relationship impacts. It is important to maintain a good relationship with the team, with the individuals. We ended up working more naturally, exposing even small problems.*" (SWE2ORG2)

Commitment of team members (Continuation)	
*“**Eu acredito que quando as pessoas se sentem parte da solução, se sentem importantes naquele processo de construção de um produto, elas se comprometem mais, e, consequentemente elas vão contribuir mais com a qualidade final do produto.**”*	“***A equipe se sente envolvida e a gente consegue até um comprometimento maior de todo mundo. O cara diz: ‘Eu ajudei na decisão, e eu disse que eu conseguia cumprir até tal dia. Não foi alguém que chegou e disse: ‘Daqui a um mês, tu tem que entregar isso aqui’.***”
English: “*I believe that when people feel part of the solution, they feel important in that process of building a product, they are more committed, and consequently they will contribute more to the final quality of the product.*” (SWE1ORG1)	English: “*The team members feel involved and we can even get a bigger commitment from everyone. The guy says: 'I helped in the decision, and I said I could finish it until that day. It was not someone who came and said: 'In a month, you have to deliver it'.*” (SWE8ORG1)