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Hard and Soft Paradigm Analysis in Knowledge Creation Projects: an Aeronautical Certification Case

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ABSTRACT

Knowledge creation projects are essential for today's business. It is common to observe in these projects, in all their dimensions, the presence of the uncertainty factor. Effectively, managing uncertainties is seen nowadays as a necessary condition for project success. This article aimed to present a study on the intensity that the hard and soft paradigms appear in knowledge creation projects and, consequently, identify the levels of uncertainty presented in its projects. To make this study possible, we adopted the hard and soft analysis framework. A case study on knowledge creation, managed by the aeronautical certification department of EMBRAER S.A, was analyzed under the aspects of this framework. It was expected, as a result of this study, to empirically validate the concepts about the uncertainty levels presented in projects of this nature.

Keywords: Aeronautical certification; Knowledge creation; Project management; Uncertainty; Hard, Soft.

INTRODUCTION

Projects are different. Therefore, they have different levels of uncertainty (Shenhar 2001). Some have characteristics that involve a higher level of uncertainty, such as subjectivism, social approach, focus on learning, qualitative aspects, innovation, etc. Other ones present aspects with lower level of uncertainty, such as objectivism, scientific approaches, focus on results, clear objectives, quantitative aspects, routine tasks, etc. (Crawford and Pollack 2004). According to Atkinson *et al.* (2006), Domingos (2020) and Shenhar *et al.* (2020), uncertainty management is seen as a necessary condition for effective project management. The sources of uncertainty are wide ranging and have a fundamental effect on projects and project management.

In knowledge creation projects, it is possible to note the presence of high levels of uncertainty (Chagas Jr. and Campanario 2014). In these projects, it is observed that the complexity of the human factors to be managed is much higher compared to other data/information management projects (Davenport *et al.* 1998).

Considering the appropriate scope for uncertainty management, it is useful to characterize the range of project types in terms of the scope of uncertainty involved (Shenhar and Dvir 2010; Shenhar *et al.* 2020). The conventional management approach works very well for projects with clear and tangible goals and low participation, but it does not work so well for projects with

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ambiguous, intangible goals and high participation (Barnard 1938; Atkinson *et al.* 2006; Pollack 2007; Shenhar and Dvir 2010; Gustavsson and Hallin 2014).

In the project management literature, there are some types of categorization system proposed (Crawford *et al.* 2005; Niknazar and Bourgault, 2017). For this study, the hard and soft analysis framework developed by Crawford and Pollack (2004) was adopted, since this framework is effective in identifying the levels and sources of uncertainty in projects (Domingos 2020). A case study on knowledge creation, managed by the aeronautical certification department of EMBRAER S.A., was analyzed under the aspects of this framework.

The main contribution of this paper is to improve knowledge of uncertainties in value/knowledge creation projects, based on the hard and soft aspects. The aims of this research were to present a study on the intensity that the hard and soft paradigms appear in knowledge creation projects and, consequently, identify the levels of uncertainty presented in its projects.

This article is structured as follows: the next section presents the main points concerning the literature review. Then, the methodology is explained. After that, the case study conduction analysis is described. The two last sections discuss the results and, finally, present the conclusions.

LITERATURE REVIEW

The literature review includes some concepts about knowledge creation projects, uncertainty management in projects, hard and soft paradigms in projects and hard and soft analysis framework (categorization system).

Knowledge creation projects

Abstract, intangible, and unpredictable are some characteristics of knowledge creation projects. According to Atkinson *et al.* (2006), Shenhar and Dvir (2010), and Green and Sergeeva (2019), there is a need to rethink the project management model, making room for projects with intangible value/benefits because projects with these characteristics have guided organizations nowadays.

According to Davenport *et al.* (1998), knowledge creation projects have ambiguous goals that are difficult to measure. For Green and Sergeeva (2019), the difficulty in determining the value created for this type of project is that it involves abstract aspects that are continuously molded over the time, so the final judgment depends on alignment between the different stakeholder's point of view. Another difficulty with measuring the value created by these projects is to associate how much the project results contribute to the success of the organization (Goldoni and Oliveira 2006).

Crawford and Pollack (2004) and Azim *et al.* (2010) state that projects with ambiguous and intangible goals are very dependent on stakeholder's participation, reactions, and interactions, thus making these interdependencies difficult to model and unpredictable, which increase the project uncertainty. On the other hand, the authors explain that negotiation and consensus-building among stakeholders make the objectives clearer as the project progresses, so the uncertainty regarding the goal clarity decreases.

The Project Management Institute (PMI 2017) also states that projects that have high levels of unpredictability require stakeholders' engagement and participation to reduce project-inherent uncertainties. On the other hand, Domingos (2015; 2020) warnes that projects of this nature have a higher challenge, compared to other projects, to keep people engaged as the project doesn't directly contribute to the organization's income.

Finally, Atkinson *et al.* (2006), Crawford *et al.* (2006) and Gillier *et al.* (2015) argue that the traditional project management approach based on control and predictability tends to inhibit learning, innovation, and creativity. Therefore, projects that seek to create knowledge and/or intangible values need a flexible and engaging structure and motivational factors to create, share and use knowledge.

Uncertainty management in projects

Atkinson *et al.* (2006) and Perminova *et al.* (2008) state that, at first, the views on uncertainty in projects were reduced to risk management. However, over the years, it was possible to see that project uncertainties go far beyond a series of possible events that can impact performance from the project. According to the authors, the sources of uncertainty are not limited to potential events, and include lack of information, ambiguity, specific characteristics of the project parts, subjectivism, social approach, focus on

learning, qualitative aspects, innovation, among others. The effective project management involves understanding these sources of uncertainty and identifying appropriate management strategies (Ward and Chapman 2008).

Atkinson *et al.* (2006) and Pollack (2007) warn that the traditional project management approach does not address the fundamental sources of uncertainty, particularly in projects with predominant soft characteristics in which flexibility and tolerance to lack of information are required.

Atkinson *et al.* (2006) state that the project management community has noted the need to pay more attention to the development of more dynamic project management processes associated with value creation, knowledge management, and building an appropriate organizational culture to work with high levels of uncertainty.

In that direction, Shenhar and Dvir (2010) developed a new project management approach based on a flexible, adaptive, and success-oriented framework. The authors named this approach adaptive project management. The adaptive project management view is receptive to the change and inherent uncertainties of some projects, according to Pollack (2007).

Shenhar and Dvir (2010) draw parallels between adaptive project management and traditional project management concerning its principles. Table 1 details this comparison.

Table 1. Traditional project management vs. adaptive project management.

Project approach	Traditional project management	Adaptive project management
Goal	Satisfy the triple constraint	Get business results
Plan	Activities performed according to planning and triple constraint	Organization and process to achieve business results
Planning	Only once at the beginning of the project	Plan at the beginning and replan when necessary
Management approach	Rigid, focused on the initial plan	Flexible, variable, adaptive
Work	Predictable, linear, and simple	Unpredictable, uncertain, non-linear, complex
Ambient effect	Minimum. No effect after project launch	Affect the project throughout the execution
Control	Keep things on track	Adjust the plan according to the changes
Distinction	All projects are the same	Projects are different
Managerial style	Unique size	Adaptive approach. One size does not fit all

Source: Shenhar and Dvir (2010).

Hard and soft paradigms in projects

Project management literature understands that the terms hard and soft are two distinct paradigms, each of which involves particular values, ways of seeing the world, and different practical approaches (Pollack 2007).

According to Pollack (2007) and Mateo *et al.* (2017), hard approaches are rooted in positivist, reductionist, and realistic philosophy, emphasizing the pursuit of objective knowledge, while soft approaches are rooted in constructive and interpretive schools of thought, emphasizing the intersubjective creation of knowledge.

Crawford and Pollack (2004) and Carvalho and Rabechini Jr. (2011) explain that hard projects are stand-alone projects that have well-defined and tangible goals and measurable success. On the other hand, soft projects are not predefined. Conversely, they are open to the discussion along their life cycle with high participation and influence from the stakeholders. The authors also point out that a project can have, at the same time, both hard and soft aspects that can change over the life cycle.

According to Crawford and Pollack (2004) and Mateo *et al.* (2017), the main differences between the hard and soft paradigms in projects are presented in Table 2.

Table 2. Differences between the hard and soft paradigm in projects.

Subject	Hard	Soft
Issues	Time Cost Quality	Community perception Environmental impacts Legal acceptability Social and political impacts
Approaches	Scientific Objective	Social Subjective
Methods	Rooted in positivist and realistic philosophies, emphasizing the search for objective knowledge	Rooted of constructivist and interpretive thoughts, emphasizing the intersubjective creation of knowledge
Research intentions	Optimization, problem solving	Consensus between the stakeholder's interests. Problem construction
Management	Rational decision-making process	Effort to maintain relationships

Source: Crawford and Pollack (2004) and Mateo *et al.* (2017).

Crawford and Pollack (2004), Atkinson *et al.* (2006) and Ward and Chapman (2008) explain that projects with predominantly soft aspects exhibit high levels of uncertainty and ambiguity, and, as projects assume softer characteristics, the importance of stakeholders as contributing to the project uncertainty increases. This uncertainty and ambiguity manifest as follows: multiple and at the same time conflicting interpretations, lack of stakeholder understanding or misinterpretation of project problems and/or outcomes.

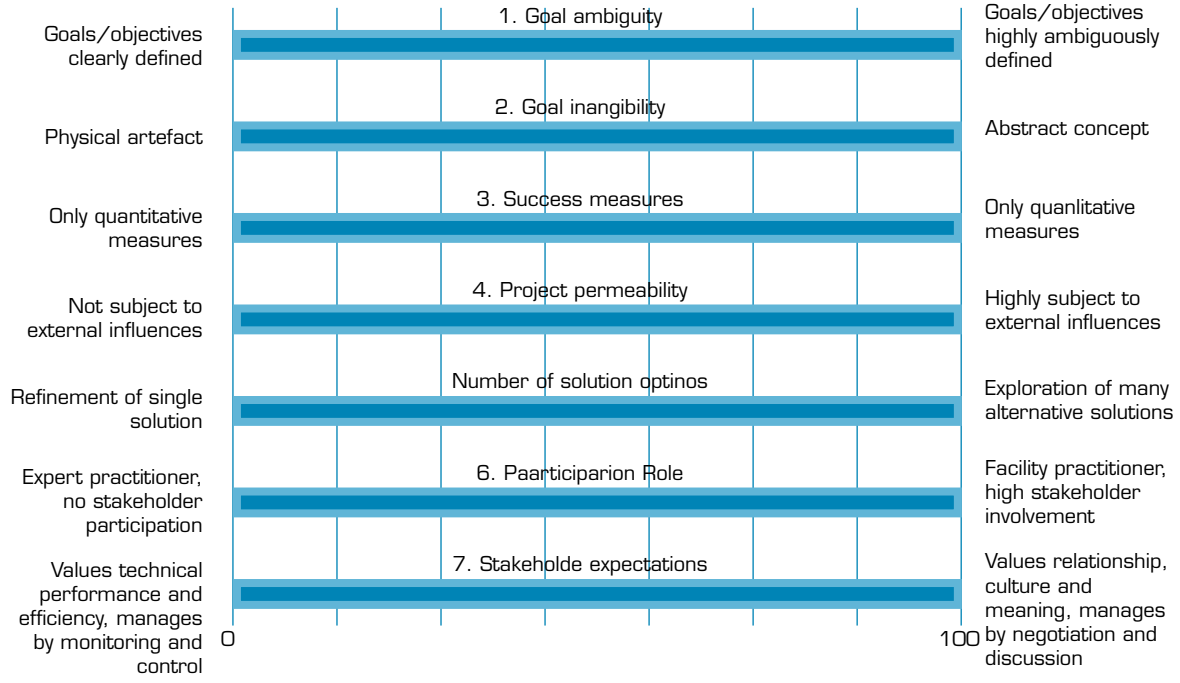
Particularly, soft characteristics related to the dimensions of goal ambiguity, project permeability, number of solution options, stakeholder participation and expectations require a carefully designed uncertainty management process that effectively involves key project stakeholders (Ward and Chapman 2008).

Gustavsson and Hallin (2014) also warn about the inappropriate use of the hard and soft paradigms when considering paradigms as dichotomies. According to the authors, a dichotomy not only reinforces the separation between two opposing sides, but also establishes a hierarchy between them, in which one of the opposites is superior to the other. In accordance with Crawford and Pollack (2004), Gustavsson and Hallin (2014) and Mateo *et al.* (2017), the hard and soft paradigms do not constitute a dichotomy. On the contrary, they are complementary. While the hard approach works well for project dimensions with low uncertainty, the soft approach works best for project dimensions with high uncertainty.

Analysis framework for project categorization based on hard and soft paradigms

To analyze a project from the hard and soft aspects, Crawford and Pollack (2004) developed an analysis framework containing seven dimensions. According to the authors, such framework is a categorization scheme for structuring discussion on influential aspects of projects, facilitating project evaluation and the transfer of lessons learned into practice. The framework also has a predictive application, helping with resources, planning, and guiding the use of management approaches. Figure 1 presents the analysis framework based on the hard and soft paradigms.

It is observed in Fig. 1 that there are two ends: 0 and 100. On this scale, 0 represents ultimately hard and 100 represents ultimately soft. For this research, we chose to adopt the nomenclature adapted by Domingos (2019; 2020), which changes the description of the first two dimensions in relation to the initially proposed by Crawford and Pollack (2004). Instead of "goal clarity", the first dimension was called "goal ambiguity". As it is more intuitive, this term was adopted to make the idea that goals become clearer when the dimension "goal ambiguity" is closer to the 0 value end. Following the same logic, the second dimension was called "goal intangibility", instead of "goal tangibility"", as initially proposed by Crawford and Pollack (2004).



Source: Crawford and Pollack (2004).

Figure 1. Depiction of the hard and soft dimensions framework.

The dimensions shown in Figure 1 were attributed to seven dichotomies, which follow:

- Goal ambiguity: how clearly defined the projects goals and objectives are. If the project goals/objectives are clear to the project manager and to the team, this dimension tends to be harder. However, if the project goals/objectives are still ambiguous, unstable and they can change over the project life cycle, this dimension tends to be more soft;
- Goal intangibility: how tangible the project goals and objectives are. If the goals/objectives are presented more abstractly, this dimension has a softer aspect. On the other hand, if the objectives are presented more physically, this dimension has a harder aspect;
- Project permeability: this dimension addresses how affected the project objectives, process and results are by factors out of the project control. It is related to changing boundaries and permeable interfaces in project management;
- Number of solution options: soft projects have many possible solution options, while hard projects have a strong convergence towards a single solution for the project. Hard methods focus on efficient delivery, while soft methods focus on discussing and studying alternative options;
- Participation and practitioner role: if there is strong participation with effective involvement of relevant stakeholders and the professional expertise is facilitation, this dimension has a softer aspect, but, otherwise, team members are seen as experts in their clearly defined role fields, the dimension looks harder. Under the hard paradigm, a specialized approach may encourage faster project completion, but increases the risk of ignoring potential innovation and stakeholder input. The soft paradigm involves a participatory, collaborative, facilitative approach in which many viewpoints are required on many issues. Thus, a participatory approach may take longer, but it is appropriate for situations in which it is necessary to consider multiple perspectives considering the stakeholders' interest necessary for the project execution;
- Success measures: the hard aspect of this dimension is focused on data and quantitative measures, and the soft aspect of this dimension is related to qualitative measures. As presented by Crawford and Pollack (2004), the quantitative measurement cannot analyze all aspects of reality, since quantity does not capture interpretation, attitude, or morality;
- Stakeholders' expectations: if the project's assumption is to not consider stakeholders' expectations, this dimension has a harder aspect. However, if the project considers stakeholders' expectations, this dimension has a softer aspect.

According to Howell *et al.* (2010), it is noticeable that all factors associated with the soft side of the project management are a measure in some way of uncertainty.

METHODOLOGY

The methodology involved studying, reading, researching, interviews, demonstration exercises and qualitative analysis to interpret the results. This is a descriptive, exploratory, and qualitative research (Ketokivi and Choi 2014). The case study was the research method used to test the hypotheses regarding the research questions (Yin 2001). In conducting the case study, interviews were held with the project manager, who was the only stakeholder active throughout the project's life cycle. To direct the interview, a questionnaire was developed, based on the hard and soft framework analysis. The next section of this article registers the compilation of data collected in the interviews.

The case study was conducted in the following way: The authors applied the hard and soft analysis framework in the case study in order to identify and monitor, throughout the project's life cycle, the intensity with which the hard and soft paradigms appear. First, the analysis framework was applied at the beginning of the project. Based on the identified levels of uncertainty, the project manager adopted management approaches to reduce the uncertainty such as risk, communication, and stakeholders' expectations management. At the end of the project, the analysis framework was applied again in order to analyze the project evolution in terms of levels of uncertainty. It was possible to compare the presence of these paradigms at the beginning and at the end of the project.

The case study is a knowledge creation project conducted in the certification department of EMBRAER S.A. The company is one of the world's largest aircraft manufacturers, focusing on specific market segments in commercial aviation, executive aviation and defense and security (Chagas Jr. *et al.* 2017; EMBRAER, 2021).

CASE STUDY CONDUCTION

Case study description

The project aimed to harmonize the knowledge of the people involved in the certification process regarding the showing of compliance with design requirements for an aeronautical product. This knowledge creation would be made possible through the development of an aeronautical certification process manual/guide. The knowledge recorded in a database, which composed this manual, was generated through meetings in which groups of five to 10 people discussed the proposed requirement and registered the harmonized knowledge on an internal portal accessible to all. Thus, the created knowledge was shared with the other employees in the department. The group members alternated according to the requirement to be discussed. Personal experience was the criterion for choosing the member. At the end of each study, the participating group presented the result of the harmonization orally to the other employees of the department.

Hard and soft paradigms analysis: aeronautic certification case

The case study was assessed considering the hard and soft project analysis framework attributes. The summary of this analysis is presented:

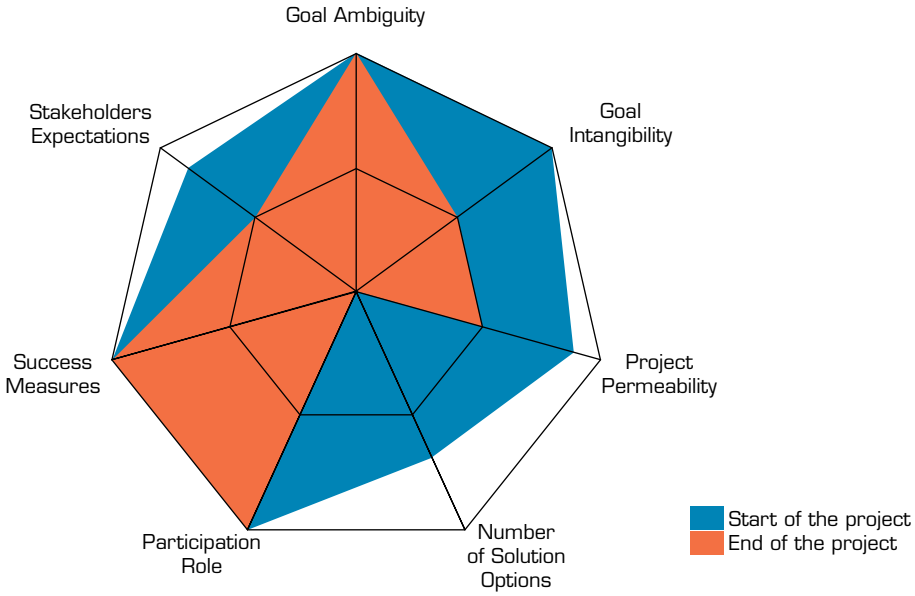
- Goal ambiguity: creating or harmonizing knowledge is an ambiguous goal as there are difficulties in quantitatively measuring the result. Additionally, considering it is a project whose focus is learning, it is not possible to state that this goal will remain the same throughout the life cycle of the project. Therefore, the soft paradigm was very evident in this dimension of the project, from the beginning to the end;
- Goal intangibility: there are high levels of uncertainty in this dimension considering the ambiguity of the goal of the project. If the goal is not specific, how to know it is tangible? Also, the project is highly participatory, which increases the risk to tangibility. Throughout the project, the uncertainty regarding tangibility was reduced. However, it was present until the end. The soft paradigm was more present at the beginning than at the end of the project;
- Project permeability: the project is considered permeable since it is a knowledge creation project, whose central focus is learning and do not directly contribute to the company revenue. It was a challenge to keep people's engagement. The nature

of the project was unable to prevent more urgent priorities from diverting sources originally dedicated to the knowledge creation project. Based on this scenario, the project manager adopted some managing approaches, such as risk management and communication plans, which resulted in reduction of uncertainty in this dimension. The soft paradigm was more present at the beginning than at the end of the project;

- Number of solution options: the manual was the solution defined at the beginning of the project. However, there were several ways to reach this solution. Initially, an unlimited group of people with or without experience was suggested to discuss the requirements. However, in the end, it was decided to limit the scope of the discussion groups to a limited number of people, as each should have experience. Also, it was thought to make a manual in the Word format, then it was thought in Excel format and, finally, it was decided for an HTML system inside the department's official website. The soft paradigm was more present at the beginning of the project;
- Participation and practitioner role: highly participatory project. Debates, different points of view and teamwork were essential factors for the construction of the manual. The manager acted as a facilitator during the discussions, and, for the proper management of the team, a communication plan was developed between the interested parties. The soft paradigm was very evident in this dimension of the project, from the beginning to the end;
- Success measures: the success measure of the project is related to the creation/harmonization of the knowledge of the people involved in the certification process. Therefore, it is a subjective/qualitative measure that involves interpretation of the people involved. The soft paradigm was very evident in this dimension of the project, from the beginning to the end;
- Stakeholders' expectations: the success of the project was directly related to meeting the expectations of the interested parties, especially the most influential ones. Managing expectations was one of the main tasks performed by the project manager. Before starting the project, the manager conducted interviews with each stakeholder to register and manage their expectations, interests, and requirements. The soft paradigm was more present at the beginning than at the end of the project.

RESULTS AND DISCUSSION

As shown in Fig. 2, it was possible to monitor the behavior of the case study project, throughout its life cycle, identifying the levels of uncertainty presented by it.



Source: adapted from Crawford and Pollack (2004).

Figure 2. Hard and soft map: aircraft certification case.

The result of the study, illustrated in Figure 2 by the hard and soft map, confirms Davenport *et al.* (1998), Goldoni and Oliveira (2006), Ward and Chapman (2008), Azim *et al.* (2010), Domingos (2015) and Green and Sergeeva (2019) understood the characteristics present in knowledge creation projects. The soft paradigm presented itself with greater intensity in the project compared to the hard paradigm. As the project evolved, the levels of uncertainty in some dimensions were reduced, due to the implementation of risk and stakeholders' expectations management. However, even so, the soft paradigm remained present from the beginning to the end of the project.

In the case study, it was observed that the language of knowledge creation projects was more abstract and invited debate by exposing the uncertainty of interested parties. The objective of "harmonizing knowledge" is ambiguous and difficult to measure, since it is a subjective measure. The ambiguity of the goal was present until the end of the project, which made the "measures of success" dimension also predominant soft. The only way to measure success was to face the inherent subjectivity of the project's characteristics. The manager then used individual interviews to obtain qualitative feedback from users regarding the success of the project.

The "goal intangibility" dimension, therefore, also had high degrees of uncertainty for two reasons: because the goal ambiguity and the complex methods. The methods used to achieve the objective are intense, such as consensus meetings between different points of view, and involve uncertainty about the diligent participation of those involved. The participation of the interested parties (teams of discussion groups, users of the manual and department leaders) is high, and their expectations are quite considered since they have high influence on the project. The project is vulnerable to external influences since its focus is knowledge, and not the generation of concrete results.

The case study confirmed the concepts presented in the literature review that knowledge creation projects have predominant soft aspects in their dimensions, thus presenting high levels of uncertainty. Projects with the same characteristics may require different management approaches compared to the traditional project management approach. Considering that the project goal is to create/harmonize knowledge, a flexible and more dynamic structure is desirable, and motivational factors for creating, sharing, and using knowledge are very important. Therefore, it is suggested to use the adaptive project management approach (Shenhar and Dvir 2010), to properly coordinate the inherent uncertainties of this type of project.

Additionally, it was possible to verify that the analysis framework based on the hard and soft aspects is a tool that positively influences the results of the projects, since characterizing projects in a hard/soft spectrum provides a reflection by the project manager on the appropriate choice of management approach based on the identified levels of uncertainty.

CONCLUSION

The main contribution of this research was to improve knowledge of uncertainties in value/knowledge creation projects, based on the hard and soft aspects. The research highlighted the effectiveness of the hard and soft framework analysis in identifying and managing project uncertainties. The case study compared the results of applying the hard and soft analysis framework at the beginning and at the end of the project–soft results implying broad analysis (high levels of uncertainty), and hard results implying tight focus (low levels of uncertainty). The research results show that value/knowledge creation projects have predominant soft characteristics in their dimensions and, therefore, require a carefully developed uncertainty management process.

Also, proper risk management and stakeholders' expectations tend to reduce the degree of uncertainty present in the project. For studies to be developed from this, it is suggested to complement this research with additional case studies, on knowledge/value creation, involving different organizations in the Brazilian aerospace sector or even in the international context. Furthermore, it is suggested to test the effectiveness of the hard and soft framework in meeting other purposes that were not explored in this article. The results of this research serve as a basis for these future studies that are necessary to deepen the knowledge about value creation projects and hard and soft framework analysis.

AUTHORS' CONTRIBUTION

Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Visualization, Writing – First Draft, Writing – Review and Editing: Domingos TRP, Chagas Junior MF.

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