Pontifícia Universidade Católica
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Marília Guterres Ferreira

Anticipating Change in Software Systems supporting Organizational Information Systems using an Organizational based Strategic Perspective

TESE DE DOUTORADO

Thesis presented to the Programa de Pós-Graduação em Informática of the Departamento de Informática, PUC-Rio as partial fulfillment of the requirements for the degree of Doutor em Ciências – Informática.

Advisor: Prof. Julio Cesar Sampaio do Prado Leite

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Abstract

Ferreira, Marília Guterres; Leite, Julio Cesar Sampaio do Prado (advisor). **Anticipating Change in Software Systems supporting Organizational Information Systems using an Organizational based Strategic Perspective.** Rio de Janeiro, 2016. 240p. DSc. Thesis – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Keeping organizations and their Software Systems supporting Organizational Information Systems (SSsOIS) aligned over time is a complex endeavour. We believe understanding the organizational dynamics of changes, and of the impacts these changes might cause, can support the evolution of SSsOIS. Yet, reasoning about the organizational changes in advance also supports the development of an SSsOIS more likely to be aligned to the dynamics of the organization. Based on it, we ground our work on strategic management theory, which reasons about possible futures of the organization and formulates strategies to achieve new goals in these possible futures. We propose to apply the outcomes of strategic management to prepare SSsOIS for the future, i.e. to prepare SSsOIS for these new requirements raised from the strategic plans. For this, we use scenario planning as a tool to support key people in the organization to think about multiple possible futures and plan strategies. In order to keep the strategic planning of the organization aligned to the SSsOIS, we propose an Organizational Dynamics-based Approach for Requirements Elicitation (ODA4RE) composed by a scenario-based strategic planning (SSP), organizational impact analysis (OIA), and validation of the likely SSsOIS' requirements (LSRV). OIA also introduces an organizational dynamics meta-model (ODMM) on which to base the reasoning, and an organizational dynamics questions set (ODQS) to explore likely organizational impacts. We evaluate our proposal in four empirical studies with different purposes: first in an academic organization in Rio de Janeiro to analyse specifically the SSP, second in a workshop to evaluate the ODMM's expressiveness, third in a Post Office branch in London to analyse OIA, and finally the entire approach at a Brazilian research university. Results show contributions towards SSsOIS' requirements evolution as they align with the organization plans.

Keywords

Software Evolution; Requirements Engineering; Strategic Management; Scenario Planning; Predictive Models; Contextual Scenarios; i*, Impact Analysis.

Resumo

Ferreira, Marília Guterres; Leite, Julio Cesar Sampaio do Prado. **Antecipando Mudanças em Sistemas de Software que suportam Sistemas de Informação Organizacionais usando uma Perspectiva Estratégica baseada em Organizações.** Rio de Janeiro, 2016. 240p. Tese de Doutorado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Manter as organizações e seus Sistemas de Software que apoiam os Sistemas de Informação Organizacional (SSsOIS, em inglês) alinhados ao longo do tempo é um empreendimento complexo. Acreditamos que a compreensão da dinâmica organizacional das mudanças, e dos impactos que essas mudanças podem causar, pode apoiar a evolução do SSsOIS. No entanto, o raciocínio sobre as mudanças organizacionais com antecedência também suporta o desenvolvimento de um SSsOIS mais propensos a serem alinhados com a dinâmica da organização. Com base nisso, fundamentamos nosso trabalho sobre a teoria da gestão estratégica, que raciocina sobre futuros possíveis da organização e formula estratégias para alcançar novas metas nesses futuros possíveis. Propomos aplicar os resultados da gestão estratégica para preparar SSsOIS para o futuro, ou seja, preparar SSsOIS para estas novas exigências levantadas a partir dos planos estratégicos. Para isso, usamos o planejamento de cenários como uma ferramenta para apoiar pessoas chave da organização a pensar em múltiplos possíveis futuros e planejar estratégias. A fim de manter o planejamento estratégico da organização alinhado ao SSsOIS, propomos uma Abordagem Dinâmica-Organizacional para a Elicitação de Requisitos (ODA4RE, em inglês) composta por um planejamento estratégico baseado em cenários (SSP, em inglês), análise de impacto organizacional (OIA, em inglês) e validação dos prováveis requisitos do SSsOIS (LSRV, em inglês). A OIA também introduz um meta-modelo de dinâmica organizacional (ODMM, em inglês) no qual basear o raciocínio, um conjunto de perguntas de dinâmica organizacional (ODQS, em inglês) para explorar possíveis impactos organizacionais. Avaliamos nossa proposta em quatro estudos de caso com diferentes propósitos: primeiro em uma organização acadêmica no Rio de Janeiro para analisar especificamente o SSP, segundo em um workshop para avaliar a expressividade do ODMM, terceiro em uma agência dos Correios em Londres para analisar a OIA e, finalmente, toda a abordagem em uma universidade de pesquisa brasileira. Os resultados mostram contribuições para evolução dos requisitos do SSsOIS conforme eles se alinham com os planos da organização.

Palavras-chave

Evolução de Software; Engenharia de Requisitos; Gestão Estratégica; Planejamento de Cenários; Modelos Preditivos; Cenários Contextuais; i*, Análise de Impactos.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

CMOC	Configuration Model of Organizational Culture
LMS	Learning Management Systems
LSRV	Likely SSsOIS' Requirements Validation
ODA4RE	Organizational Dynamics Approach for Requirements Elicitation
ODMM	Organizational Dynamics Meta-Model
ODQ	Organizational Dynamics Question
ODQS	Organizational Dynamics Questions Set
OIA	Organizational Impact Analysis
OIS	Organizational Information System
RE	Requirements Engineering
SADT	Structured Analysis and Design Techniques
SPE	Lehman's program types: *S*-type for Specification, *P*-type for Problem and *E*-type for Environmental/Evolving
SSP	Scenario-based Strategic Planning
SSsOIS	Software System supporting Organizational Information System

"Bem sei eu que tudo podes,
e que nenhum dos teus propósitos
pode ser impedido."
(Jó 42:2)

1
Introduction

In this chapter, we introduce the motivation of our work, the problem we address and our proposed solution. Following, we present related work and this thesis outline.

1.1.
Motivation

Managing software evolution is a challenging problem (SHI, WANG and LI, 2013). Software evolution is unavoidable, but it is a risky, complex, difficult, time-consuming, and costly process (LEHMAN and FERNANDEZ-RAMIL, 2006). Challenges lie in the difficulty of maintaining software systems aligned with new environmental requirements since organizations frequently evolve in order to maintain their marketplace competitiveness (THEVENET and SALINESI, 2007). Therefore, we must identify how to understand and anticipate some of the inevitable changes emerging from environment upon software lifetime (PFLEEGER, 2008) but existing requirements elicitation methods lack the ability to anticipate change (LIM and FINKELSTEIN, 2011). Being prepared and committed to this environmental evolution contributes to requirements evolution management success (LEHMAN and FERNANDEZ-RAMIL, 2006). Moreover, to be prepared and committed to evolution, we first need to think about the organizational future and analyse how it can influence both organizational goals and organizational information systems (OIS), more precisely, Software Systems supporting OIS (SSsOIS), which also must evolve.

In this setting, strategic management renders support to think towards and to plan organization's future (GATES, 2010). However, claiming that strategic investments in SSsOIS are essential to organizations' long-term survival is already regarded as a truism. Our point is, not only SSsOIS strategies should be aligned to high-level organizational goals (SOUSA and LEITE, 2014) but also SSsOIS-triggered strategic changes should be understood and identified in advance. While focus exists on the challenge of aligning organization's goals to SSsOIS capabilities, little is still known of how SSsOIS should successfully

address strategic changes. How to evolve SSsOIS to embrace organizational changes raised from strategic goals is a truly critical challenge within strategic SSsOIS development (ARVIDSSON, HOLMSTRÖM and LYYTINEN, 2014).

1.2. Problem Statement

Over time, SSsOIS present inconsistencies and lack of compliance with new environmental requirements in which it was deployed (LEHMAN, 1996), i.e. with business strategy, activities and business processes through which the organization intends to generate value (BLEISTEIN, COX, VERNER and PHALP, 2006).

In their research, McGee and Greer identified that software requirements with a higher level of business influence change more often and with a higher change cost only from changes coming from the domain of organization (domains of change are explained in Figure 5). Understanding the causes and consequences of changes can improve the process of change anticipation (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009).

On the above, we face the following challenges:

C1. How to support stakeholders to think about the future of the organization to anticipate SSsOIS' requirements changes?

C2. How to identify and understand likely impacts on the organization from changes influencing SSsOIS' requirements?

C3. How to understand the flow of impacts in the organization caused by one organizational change, in order to apply this knowledge to SSsOIS' requirements elicitation?

1.3. Proposed Solution

The purpose of our work is eliciting and understanding knowledge about organizational changes and impacts to support key people to make decisions on SSsOIS' requirements changes. For that, we propose an Organizational Dynamics Approach for Requirements Engineering (ODA4RE). It starts by the *Scenario-based Strategic Planning (SSP)*, a sub process grounded on *strategic management* and applying *scenario planning* to build future scenarios as

predictive models for SSsOIS evolution. Following, the sub process *Organizational Impact Analysis (OIA)* supports the understanding of the organization, to then reason on its dimensions and their relationships to elicit likely organizational impacts raised by organizational changes. For that matter, we ground this reflection on an Organizational Dynamics Meta-Model (ODMM), representing how organizational dimensions influence each other over time (DAUBER, GERHARD and YOLLES, 2012) and we elicit knowledge using an Organizational Dynamics Questions Set (ODQS). Finally, the sub process Requirements Validation (RV), in which elicited SSsOIS' requirements are validated by the most interested, the stakeholders.

Our intention is to go beyond evolving an SSsOIS by aligning it with organizational strategy, *in a reactive way*. We propose a *proactive* development on the issue of SSsOIS alignment with organizational strategy, supporting the strategic rationale for elicitation of SSsOIS requirements related to organizational strategy. In other words, we aim at supporting software evolution through a **proactive** alignment between SSsOIS and organizational strategy by the anticipation of organizational changes and consequent impacts influencing SSsOIS' requirements aroused by strategic initiatives.

1.4. Related Work

Works listed below are part of the foundation of this research and are briefly examined as follows. We have selected these works because they illustrate limitations associated to our objective:

Existing approaches to software evolution largely focus on software engineering artefacts and processes, and not so much on the dynamics of organizational environment. Shi and Wang work on predicting future requirement changes based on information from the evolution history. First, they define a number of metrics to characterize the evolution history of a product with multiple versions. Then, they apply this metrics to analyse the product updates history (SHI, WANG and LI, 2013). Our proposal bases software evolution on organizational evolution. For this, we use strategic planning to uncover future organizational objectives and organizational impact analysis to organizational key people to reason on organizational changes and impacts.

Many researches focus on eliciting SSsOIS` requirements from business processes disregarding their alignment to current organizational goals. In his research, Przybylek advocates the major reason for unsatisfactory information systems not fulfilling business needs is faulty requirements analysis. To work on the transition between business modelling and requirements gathering, he proposes an approach to integrate Requirements Engineering with Business Process Engineering and *derives system requirements based on business process models* (PRZYBYLEK, 2014). We propose to bring strategic planning to requirements engineering, intertwining these processes to foster understanding of strategic objectives of organization when engineering requirements.

Changes impacts are analysed only on SSsOIS' requirements disregarding likely impacts on the organization. In their work, Goknil, Kurtev, Berg, and Spijkerman use formalization of requirements relations and changes for propagating proposed changes and consistency checking of proposed changes in requirements models (GOKNIL, KURTEV, BERG and SPIJKERMAN, 2014). Our approach identify changes and promotes reasoning on it and its ripple effect[1] through the organization, benefiting the understanding on the relationship between organizational impacts and SSsOIS' requirements.

Besides the aforementioned researches, we were also inspired by the following ones:

In Macedo's Doctoral Thesis, they worked with Continuous Organizational Change and how to strategically deal with it using Knowledge Management support (MACEDO and LEITE, 2003). They propose architecture for corporate memory with emphasis on strategic issues, hence the name Strategic Corporate Memory - SCM, which takes into account the competitive situation of the global market. The architecture of SCM reflects their Organizational Baseline, which is the repository of knowledge that aims to meet this range of information needs, based on the business conceptual model. The modeling (abstraction) of the business model is conducted taking as inspiration the different approaches to strategic analysis, notably the visions of "positioning" and "emphasizing efficiency", therefore, using an integrated view of these proposals and enriched with an analysis of the processes and functions under a total quality orientation

[1] Ripple effect: the continuing and spreading results of an event or action.

and metaphors about the images of the organization. This work substantially contributes to our research in what concerns to the Organizational Aspects, as Strategic Planning and Continuous Change, and relating them to the development of SSsOIS.

Colette Rolland has been publishing insightful papers in the area of Requirements to Software Evolution for more than 20 years (COLETTE, SALINESI and ETIEN, 2004). In the year of 2006, Rolland, Salinesi and Etien came up with an Alignment and co-evolution Method (ACEM) (ETIEN, ROLLAND and SALINESI, 2006). They investigated the alignment between IT systems and the business they support; and how system evolves due to contextual forces. For the former, Rolland takes the position that intentional modelling can help resolving some of these issues. For the later, they propose a generic typology of gaps to facilitate a precise definition of change requirements, by means of modelling change as a set of gaps between the requirements specification of the current and the future system. Their work provides solid foundation for the co-evolution approach with regard to the interdependence between the organization and the IT system. Their contributions will guide how to apply intentional modelling to represent the organizational factors to IT systems. To align SSsOIS with a strategic level, Thevenet and Salinesi (THEVENET and SALINESI, 2007) have proposed the InStAl (Intention Strategic Alignment) method. This approach describes organizations' strategic objectives and their IS, for documenting and analysing strategic alignment, i.e. how IS contributes to strategic objectives satisfaction. The proposed method reuses organization documents as a basis for strategic alignment formalization. Their work focuses on strategic alignment, not on thinking about futures and preparing for requirements evolution like ours.

Bryl and Giorgini researched the growing involvement of humans and organizations in system structure and operation (BRYL, 2009b) (BRYL, GIORGINI and MYLOPOULOS, 2009). They argue that an interdisciplinary notion of a Socio-Technical System (STS) is the one that captures aspects as the organizational environment in which software operates, the software system itself, the related hardware components and human users. They address the problem of understanding the requirements of the STS software component and the way in which the structure of human and organizational activities is influenced by introducing technology. Then, they present a framework, which aims at supporting the design of STS, specifically the design of a network of inter-actor dependencies intended to fulfil a set of initial goals. The focus on the relationship between socio and technological aspects in the design of socio-technical systems

is the one applied in this Doctoral Research. However, they propose Requirements Engineering specifically to socio-technical systems and this Doctoral Research proposes Requirements Engineering to evolve SSsOIS.

Sousa and Leite (SOUSA and LEITE, 2014) address the alignment problem by proposing to model goals and processes in an integrated way, improving the traceability among strategic and operational layers. We propose to address the alignment problem by eliciting SSsOIS' requirements that support the organizational strategic objectives.

All aforementioned works have contributed to our research. From the literature review, we understand that little has been said about relating organizational strategic intents to SSsOIS preparation for software evolution.

1.5. Thesis Outline

The remainder of this thesis is structured as follows. Chapter 2 describes the research method we followed in this research. Chapter 3 explores the bases of this thesis being Software Evolution and Organizations. Chapter 4 introduces our proposal for eliciting SSsOIS' requirements originated by strategic changes. Chapter 5 presents four case studies we conducted to understand our proposal in context. Chapter 6 concludes with a summary of our thesis, main contributions and outlines future work.

2
Research Method

In this section, we present Groot's Empirical Cycle, and how our research progressed following this research model.

2.1.
Introduction

Our research seeks to elicit and understand knowledge from organizational key people being relevant to the respective SSsOIS' requirements. Because we work on the organization's context and with organization's key people, and combine theories from business management and requirements engineering, we followed a social science well known research model to conduct our work. More specifically, our research progressed according to the *Empirical Cycle* model, by Groo*t* (1969). Our research is empirical in the sense it is built by *gaining knowledge by means of direct or indirect observation or experience*. Empirical research uses empirical evidence, i. e. the record of one's direct observation or experiences. It may be analysed quantitatively or qualitatively in order for the researcher to build knowledge about the observed phenomena (GROOT, 1969) (WIERINGA, 2014).

Additionally, to build our research *basis* on how organizational evolution is linked to software evolution, we look into literature applying a *phased-literature review* (LISTON, 2016) intertwined with the empirical cycle. We used a phased-literature review because its first two phases are investigative and exploratory, to understand the area, converging to a more specific last two phases, to identify research opportunities, as showed in Figure 1. Each phase is led by a set of questions to be answered by literature review, as illustrated in next sections. In other words, we have built our research following Groot's empirical cycle, and when necessary, we support it with literature review, according to Liston's phased-literature review.

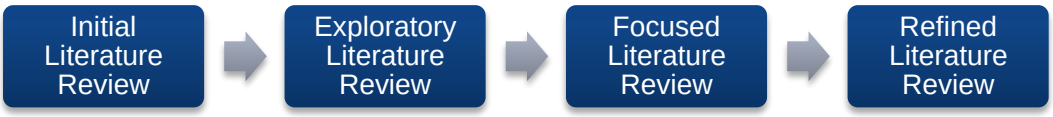


Figure 1: Phased-literature Review (LISTON, 2016)

2.2. Groot's Empirical Cycle

Adriaan de Groot postulates that empirical research is made on the empirical cycle, which represents a hypothetical-deductive research approach and consists of the following stages (GROOT, 1969), in Figure 2:

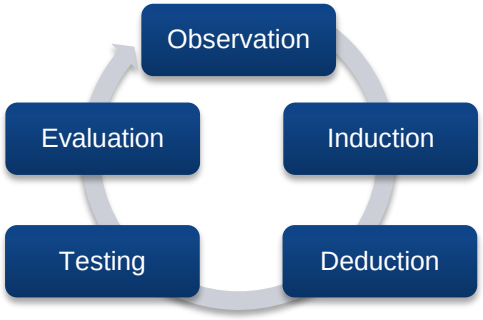


Figure 2: Empirical Cycle according to A. D. de Groot (GROOT, 1969)

As follows, we describe each phase of Groot's empirical cycle and in which of its phases we have applied the phased-literature review interweaved with it. We start conceptually describing the phases and then we tell the storyline of our research according to that phase, highlighting the outcomes of Groot's empirical cycle application.

2.2.1. Observation

Observation is the active acquisition of information from a primary source. In this phase, researchers *observe* a phenomenon in order to collect and organize empirical facts to form hypothesis (GROOT, 1969).

We belong to the Rio de Janeiro's Pontifícia Universidade Católica Requirements Engineering Group (RE Group - PUC-Rio), an academic research

group in Requirements Engineering, as well as of the Software Engineering Laboratory (LES-PUC-Rio), a laboratory of academic research applied to software solutions development for industry (FERREIRA and LEITE, 2013b). Some of this group's notable contributions are works related to Software Transparency (LEITE and CAPPELLI, 2010), Scenarios (LEITE, HADAD, DOORN and KAPLAN, 2000), Non-Functional Requirements (CHUNG and LEITE, 2009) and the Language Extended Lexicon (LEL) (LEITE and FRANCO, 1993). This group comprises a coordinator, professors, associate researchers, Ph.D. and Master students. All members research Software Engineering with emphasis on Software Requirements and Software Transparency. Concomitantly, they are developers in projects of software solutions development for companies, such as *Telefonica*, *Petrobrás*, *Brazilian National Government*, *Ancine (Brazilian National Cinema Agency)*, *Rio de Janeiro's state government,* performing roles as requirements engineers, architects, code developers and testers. This group combines experience in academy and in industry. Yet, in the group's context, several software systems have already been developed and are operating, namely *C&L*, *Lattes Scholar SimuLES*, *Lua-based Digital Library*, among others (SILVA, LEITE and BREITMAN, 2005).

Our research has been sparked by observations of real SSsOIS projects we have worked on as software developers in different roles. In these projects we have observed strategic changes raise organizational changes and consequent SSsOIS' requirements changes as a ripple effect. This is a common story happening in organizations. Our emphasis is, however, on the organizational context evolution process, not only on the context result. Consider the following *general motivating scenario* as an example to represent such projects.

> Organization "X" provides services for customers. The deployed SSsOIS controls customers', suppliers and employees' information; as well as information regarding post and other services. Currently, to have their requests fulfilled, customers join a queue to wait standing their turn to be served by staff at counters. In a strategic initiative to keep its competitiveness in the market, the organization decides on introducing a software system into customers' attendance process to improve customers' flow and queue efficiency. Now, we shall illustrate a deeper analysis of likely organizational changes impacts. One of the possible consequences is now customers are able to wait in order to be served comfortably sitting on couches. Then, organization notices the opportunity of displaying new products on shelves right in front of customers. In addition, for

better results, organization analyses the customers' profile to invest on products which address usual public needs. It so happens that this organization is commonly frequented by foreigners and the elderly. Thus, possible new products are souvenirs, travel items, post cards, collectibles, and tissues. Applying an even further analysis allows us to realize the opportunity for the organization to offer new services as well. For instance, bureau of change, immigration support and lottery, why not? All these new initiatives must be supported by SSsOIS and, subsequently bring impacts upon its requirements. Examples of possible SSsOIS' requirements changes are:

- expand target customers' profile (new business goal):
  - *RNF01. System shall be accessible to visually impaired customers (elderly);*
  - *RNF02. System shall be presented in English and Spanish;*
- automate process to allow customers to play lottery (new process):
  - *RF01. System shall register customer's lottery numbers;*
- maintain postcard's information (new product):
  - *RF02. System shall create, retrieve, update and delete postcard*;

And so on for each initiative. Organizational changes and impacts flow is depicted in Figure 3.

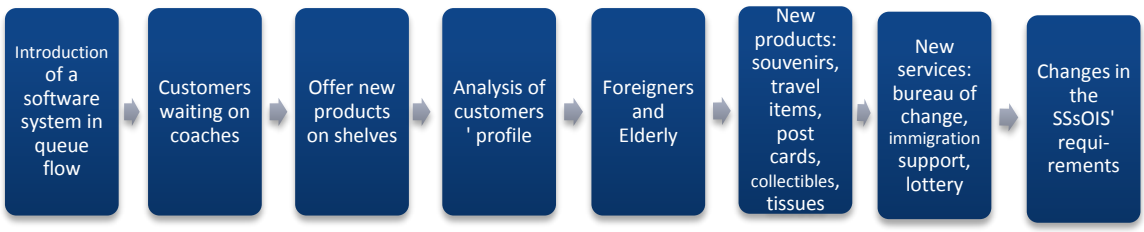


Figure 3: Organizational Dynamicity: Flow of organizational changes and impacts (An Example)

From *observation* of numerous software development projects from industry similar to the example, we have *collected a number of empirical facts* (EF), as stated below. They are the triggers for this research:

EF1. A relevant amount of SSsOIS development projects is in the nature of Software Evolution;

EF2. Frequently, projects to evolve software are complex, time-consuming, difficult, traumatic and costly;

EF3. Recurrently, these projects present similar SSsOIS' requirements changes to evolve their SSsOIS.

To elaborate on the third empirical fact observed (EF3), a number of generic examples of SSsOIS' characteristics changes (CC) are listed below:

CC1. Change system to automate new business goal;
CC2. Change system to automate new business process;
CC3. Change system to address new product sold by organization ;
CC4. Change system according to changes to regulation (for instance, a new law);
CC5. Change system to address organization's new department;
CC6. *Recode system into a modern programming language.*

To theoretically support our understanding of the empirical facts, we started an *initial literature review* on software evolution and organizations (MENS and DEMEYER, 2008) (SOMMERVILLE, 2011). Initial literature review is triggered by interest and curiosity and aims at identifying resources of information (LISTON, 2016), our goal at this moment.

2.2.2. Induction

Following, in the *induction* phase, researchers aim at explicitly specifying inferences based on the observed facts. *Inductive reasoning* derives general principles from specific observations (GROOT, 1969).

We have applied *inductive reasoning* on the collected empirical facts (EF) and SSsOIS' characteristics changes (CC) in order to comprehend the relationship between strategic changes and software evolution and form the basis for our research. As we can see, by analysing the motivating scenario and detailing EF3, SSsOIS' characteristics changes are derived from changes in the organization and one organizational change may bring up other organizational changes, like a ripple effect, a flow of organizational impacts and changes which may have impacts on the SSsOIS' requirements. Therefore, we formulate the following inferences (I):

I1. Some SSsOIS' requirements changes are originated from the environment dynamicity in which the software is deployed. Put differently, recurrent changes in organizational strategy, organizational structure, organizational behaviour or even marketplace raise SSsOIS' requirements changes as a consequence*;*

I2. Several of these SSsOIS' requirements changes can be anticipated in the software requirements engineering, thus, preparing in advance the SSsOIS for the future changes. In other words, if, during requirements engineering process, engineers have the time to *think ahead* about the organization in the future, and about organizational changes and consequent impacts, their conclusions can be useful for preparing the SSsOIS for possible requirements changes such as, for instance, preparing SSsOIS for the organization's new product and its intrinsic impacts*.*

2.2.3. Deduction

Deductive reasoning derives concrete deductions (GROOT, 1969). From the empirical facts (EF), inferences (I) and phased-literature review *answers*, we deducted a General Negative Hypothesis (GNH) on how strategic management theories and tools can be valuable to prepare SSsOIS for evolution.

Recapping, our previous two inferences state that (I1) a significant amount of SSsOIS' requirements changes are originated from the environmental dynamicity and (I2) SSsOIS' requirements changes can be anticipated during SSsOIS' requirements engineering if engineers reason about organizational evolution in advance (I2).

Accordingly, at this point, from observations, inductive reasoning and literature review, presented in detail in chapter 3, we understand that a way for organizations to prepare themselves for future is through strategic management.

A useful tool to support the strategic management process is scenario planning. Hence, we have formulated the following *general negative hypothesis (GNH):*

GNH1. SSsOIS' requirements changes originated by strategic initiatives cannot be anticipated.

This GNH may be decomposed in the two negative hypotheses (NH) below:

NH1. Organizational changes influencing SSsOIS cannot be anticipated by future scenarios.

NH2. Organizational changes and consequent impacts influencing SSsOIS cannot be anticipated by conceptual models' analysis.

We have then performed an *exploratory literature review* to identify topic research areas and respective gaps in software evolution relating to organizational evolution (LISTON, 2016). This literature review was triggered by the exploratory questions (EQ) below:

EQ1. How do SSsOIS evolve regarding the environment in which they are deployed?

EQ2. What kind of software change is related to organizational change?

EQ3. How to anticipate organizational changes which influence SSsOIS?

EQ4. Which organizational theories support preparation for the future?

The exploratory literature review findings based our approach to prepare SSsOIS' requirements for evolution and are shown in sections 3 and 4. Focused literature review outcomes are shown in section 1.4, presenting related research work with the instant work. To complete our phased-literature review, we performed a *refined literature review* by analysing, organizing, and documenting our findings. They are presented through chapters 3 and 4.

2.2.4. Testing

Next, in the *testing* phase, the hypothesis is *tested* by collecting new empirical data in order to examine whether it is provisionally supported, adjusted, or rejected. The observations collected in the testing phase can serve as new observations, explaining why the process is described as a cycle (GROOT, 1969).

We have tested our hypothesis using the testing strategy of case study in four real cases of SSsOIS evolution, with the participation of experienced organizational key people, software developers, and researchers, as described in chapter 5. These case studies are grounded on Easterbrook *et al.'s* and Runeson

and Höst's researches (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008) (RUNESON and HÖST, 2009). For these authors, a *case study* is a technique for detailed exploratory investigations, both prospectively and retrospectively, that may attempt to test theories or investigate contemporary phenomenon within its real-life context, using primarily qualitative analysis. They recommend using case studies to answer "how" and "why" questions; when there is a strong connection between context and the phenomena and they cannot be separated; when it is needed to know how context affects the phenomena and whether the proposed theory applies to a real world setting.

For Easterbrook, Singer, Store and Damian (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008), case studies can be exploratory or confirmatory case studies. Exploratory case studies investigate a phenomenon to derive hypotheses, build theories or come up with a model explaining the phenomena. Confirmatory case studies test existing theories or hypotheses (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008). In our research, we conducted 1 exploratory and 3 confirmatory case studies, as detailed in chapter 5.

A plan for a case study research should at least present the following elements (ROBSON, 2002):

- *Objective*: what is intended to be achieved;
- *The case*: what will be studied;
- *Theory*: frame of reference;
- *Research questions*: what is intended to know about;
- *Methods*: how data will be collected;
- *Selection strategy*: where data will be sought.

To address the overtime increasing lack of compliance between the SSsOIS and the organization in which it is deployed due to organizational evolution, we propose ODA4RE, detailed in chapter 4. ODA4RE aims at supporting organizational key people to think about multiple possible organizational futures (states of the organization in the future) and to make decisions on better management strategies and impacts on SSsOIS' requirements. The general hypothesis presents the core of our framework *(anticipation of organizational change influencing SSsOIS' requirements)* and was *tested* by applying our proposal in four real cases. This testing was also guided by the following Groot's Empirical Cycle testing-related questions (TQ):

TQ1. Does our approach anticipate possible organizational change?

TQ2. Does our approach support the preparation for requirements changes?

TQ3. What kind of software change does our approach allow anticipating?

2.2.5. Evaluation

Then, in the *evaluation* phase, researchers interpret the obtained results in terms of the hypothesis (GROOT, 1969).

To evaluate our approach, we have applied Questionnaires; a quantitative-qualitative methodology supported by observation of our proposal's application and semi-structured questions to collect data, with the case study participants. We have chosen a qualitative methodology because it leads to the possibility of reflection from the ones interacting, hence, generating awareness, one of the goals of our work. Participants' feedback is presented in chapter 5.

Questionnaires were constructed following Kitchenham and Pfleeger recommendations (KITCHENHAM and PFLEEGER, 2002). Questionnaire specification sent to participants included: the objective of the study; a description of the rationale for each question; and a description of the evaluation process.

In questionnaires, we have requested participants to asses elicited SSsOIS' requirements regarding qualities using a Likert scale. The qualities are based on Creativity studies, because, as in Creativity area, here we applied a process to elicit new SSsOIS' requirements or SSsOIS' requirements changes, hence we ask stakeholders to evaluate these according to their qualities (MAIDEN, KARLSEN, NEILL, ZACHOS and MILNE, 2010). In Creativity area, SSsOIS' requirements are assessed according to their *novelty* and *usefulness* (SVENSSON and TAGHAVIANFAR, 2015), and here, with a SSsOIS evolution perspective, we complemented SSsOIS' requirements assessment qualities as follows:

- ***Possible in short term:*** the requirement is possible to exist within the context of the group for a period of up to 2 years;
- ***Possible in long-term:*** the requirement is possible to exist within the context of the group after two years;

- ***New:*** the requirement is new to the group, elicited by the application of the method;
- ***Relevant:*** the requirement is important to the success of the group;
- ***Useful in short term:*** the requirement is useful for the group over a period of up to 2 years
- ***Useful in long-term:*** the requirement will only be useful for the group after 2 years.

In this research, we also consider as empirical evidence ***participants' discourse*** about ODA4RE strategy, as well as all participants' impressions and opinions expressed during the case studies.

A summary of our research methodology, based on Groot's Empirical Cycle, is depicted in Figure 4:

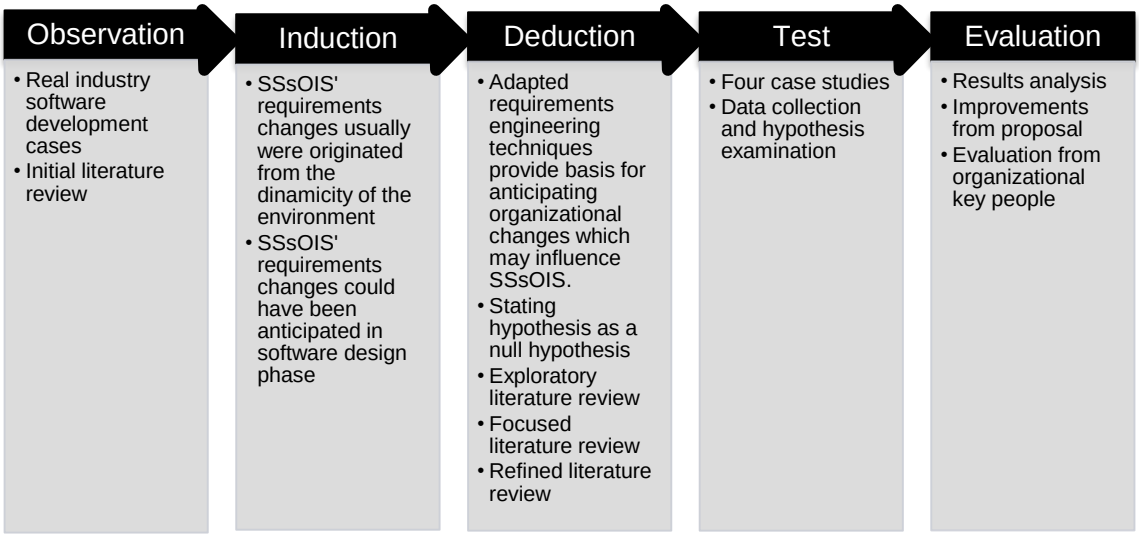


Figure 4: Summary of our Groot's Empirical Cycle- based approach (GROOT, 1969)

2.3. Final Remarks

In this chapter, we presented Groot's Empirical Cycle, the research model we followed to conduct our work. Our research was inspired by observations of real industry cases, in which we have participated. We noted a significant amount of SSsOIS' requirements changes come from organizational evolution and we

realized thinking ahead during requirements engineering would support anticipating these SSsOIS' changes. From these inferences, we deducted our GNH, which we tested through four case studies. Finally, results were evaluated by organizational key people, as described in chapter 5.

In next chapter, we present the literature review grounding our work.

3
Software Evolution and Organizations: A literature review

In this chapter, we present the conceptual basis on which this thesis was built. We introduce Software Evolution and important aspects we deal in this work. Then, we describe Strategic Management and Organizational Design, key theory to understand organizations, the context of SSsOIS. We finish this chapter by showing the two models that constitute the core of our thesis on organizational dynamics.

3.1.
Introduction

Successful software systems are constantly updated, refined, or altered due to evolving environment, requirements, technologies, and stakeholder knowledge. These repeated changes constitute software evolution and impact software production overall cost (RAJLICH, 2014). Answering exploratory questions (EQ) in section 2.2.3, to better describe how software systems evolve (*EQ1*), Lehman and Belady have formulated a series of laws, later called *Laws of Software Evolution* (LEHMAN, 1996) (BELADY and LEHMAN, 1976) (LEHMAN and FERNANDEZ-RAMIL, 2006) (COOK, HARRISON, LEHMAN and WERNICK, 2006) (LEHMAN and FERNANDEZ-RAMIL, 2001). These still-influential and continuously relevant laws also support different types of software changes (SOMMERVILLE, 2011). From all kinds of changes, our research focuses on *adaptive changes* (LIENTZ and SWANSON, 1980), i. e., changes in software requirements related to customer experience and environment (*EQ2*) (CHAPIN, HALE, KHAN , RAMIL and TAN, 2001). More specifically, we focus on how to anticipate likely changes on the organization that may have influence on the SSsOIS. For this, we based our research on organizational changes coming from Strategic Planning, since this is the area that supports planning and preparation for future (*EQ4*) [(NAG, HAMBRICK and CHEN, 2007) and triggered by McGee and Greer's *Change Source Taxonomy* (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009).

In addition, SSsOIS are strategic as far as they are used to implement strategic intent (ARVIDSSON, HOLMSTRÖM and LYYTINEN, 2014). Therefore, need exists to address software evolution with strategic management approaches. In the following sections, we provide an overview of the theoretical background that grounded this research on how to understand organizational changes arising from strategic planning, and then, gain insights and reason on them to evolve and manage SSsOIS.

3.2. Software Evolution

In this work, we shall use *software evolution* to refer to software systems dynamic behaviour as they are maintained and enhanced over their lifetimes (LEHMAN, 1996) (BELADY and LEHMAN, 1976) (LEHMAN and FERNANDEZ-RAMIL, 2006) (COOK, HARRISON, LEHMAN and WERNICK, 2006) (LEHMAN and FERNANDEZ-RAMIL, 2001); in other words, the study and management of the process of making changes to software overtime. Additionally, we shall use *maintenance* to denote software product modification following delivery to correct errors (SOMMERVILLE, 2011) (IEEE STD. 610.12-1990, 1991).

During a software process study, IBM researchers Lehman and Belady have led an investigation of OS/360 evolution and carried out several empirical studies (BELADY and LEHMAN, 1976). They characterized software evolution nature as an inevitable part of software lifecycle and formulated theories, labelled *laws of software evolution*. Albeit these laws were formulated in the 70's, they continue to be influential in the study of how and why software systems change over time, and they still bear meaning in an era of rapid change, ad hoc development practices, and wholesale reuse and adaption of third-party software assets (GODFREY and GERMAN, 2014).

Moreover, Lehman devised *SPE taxonomy* to explain why programs vary in their evolutionary characteristics. From software evolution perspective, Lehman realized programs are different, according to the objective they have been written to satisfy. Therefore, these can be described in three types (LEHMAN and FERNANDEZ-RAMIL, 2006) (GODFREY and GERMAN, 2014) (LEHMAN, 1996) (COOK, HARRISON, LEHMAN and WERNICK, 2006):

- ***S*-type** (*S* for Specification): programs are formally defined by being derivable from a static specification, and can be proven as either correct or not in a mathematical sense;
- ***P-type*** (P for Problem): programs attempt to solve problems which can be formally formulated, but which are not computationally affordable;
- ***E-type*** (E for Environmental/Evolving): programs embedded in real world situations, implementing an application in that environment and changing like the world.

Lehman has narrowed the application of laws to E-type programs because the evolutionary software behaviour was different in P- and S-types. E-type programs attempt to solve a problem that somehow involves people or the real world. In these systems, requirements change to reflect changing business needs. System evolution is essential for systems to provide business value (HERRAIZ, RODRIGUEZ and ROBLES, 2013) (SOMMERVILLE, 2011). Lehman's Laws of Software Evolution are presented in Table 1. The laws in bold, I, II, VI, VII and VIII, are those most related to this dissertation, because of the strong relationship between software evolution and organizational evolution.

Lehman's laws help elucidate future system evolution risks and can also be a guide to the ways system can evolve. In other words, once deployed, the system will be put under evolutionary pressure by the environment. Accurately predicting what this pressure will be is an improbable task, but it is possible to develop a system prepared for it. Therefore, it is more important to develop a system prepared for environmental evolution than to perfectly satisfy requirements in development time. In addition, once a system is deployed, developers should be prepared to its continuing change and growth, increasing complexity, declining quality and strong feedback relation to its environment (GODFREY and GERMAN, 2014). This evolution cycle between environment and software system demands software change and so Lehman's laws should be taken into account upon process planning (SOMMERVILLE, 2011).

Table 1: Laws of Software Evolution (COOK, HARRISON, et al., 2006)

Year	Name		Brief Description
1974	**I**	**Continuing Change**	**E-type systems must be continually adapted lest they become progressively less satisfactory.**
1974	**II**	**Increasing Complexity**	**As an E-type system evolves, its complexity increases unless work is done to maintain it or reduce it.**
1974	III	Self-regulation	E-type systems evolution process is self-regulating, with product and process measures distribution over time close to normal.
1980	IV	Organizational Stability Conservation	The average effective global activity rate in an evolving E-type stability system is invariant over a product's lifetime.
1980	V	Familiarity Conservation	During an evolving E-type system active life, successive releases average content is invariant.
1980	**VI**	**Continuing Growth**	**Functional E-type system content must be continually increased to maintain user satisfaction with system over its lifetime.**
1996	**VII**	**Declining Quality**	**Stakeholders will perceive an E-type system as having declining quality unless it is rigorously maintained and adapted to its changing operational environment.**
1974-1996	**VIII**	**Feedback system**	**The E-type systems evolution processes constitute multi-level, multi-loop, multi-agent feedback systems and must be treated as such for achieving significant improvement over any reasonable baseline.**

To increase change-mechanisms understanding and factors influencing these mechanisms, Mens (MENS, BUCKLEY, ZENGER and AWAIS, 2003) and Buckley (BUCKLEY, MENS, ZENGER, RASHID and KNIESEL, 2005) offer a software change taxonomy organized into the following logical groups: temporal properties (*when*), objects of changes (*where*), system properties (*what*) and change support (*how*). Complementary to their works, are the research works focused on change *purpose*, i. e., the *why*. In late 1970's, Lientz and Swanson presented a very high fraction of life-cycle costs that were being expended on maintenance. In this widely-cited survey, repeated by others in different domains, the authors categorised maintenance activities into three classes (LIENTZ and SWANSON, 1980) (BENNETT and RAJLICH, 2001):

- **Adaptive**: encompasses changes needed as a consequence of some mutation in the environment in which system must operate;
- **Perfective**: refers to changes originating from user requests;
- **Corrective**: includes all changes made to fix software errors.

From these, around 75% of maintenance effort is expended on *adaptive* and *perfective* changes (LIENTZ and SWANSON, 1980) (BENNETT and RAJLICH, 2001). Empirical studies propose more objective and finer granularity recognition of types of software and software maintenance as actually done, constructed by observation of activities, artefacts, and comparison between before-and after-software documentation (CHAPIN, HALE, KHAN , RAMIL and TAN, 2001) (BENNETT and RAJLICH, 2001) (CANFORA and CIMITILE, 2000).

Chapin *et al.*'s finer grained classification of software change types helps to better apprise which specific types of changes to address by organizing such changes into clusters. These clusters refer to where changes were made, that is:

- In the **support interface cluster,** software is used only for reference, i. e. software is not changed;
- In the **documentation cluster,** non-code documentation is changed;
- In the **software properties cluster,** software code is changed; and
- In the **business rules cluster** customer-experienced functionalities are changed.

In other words, changes are made in collection of system characteristics apparent to customer (CHAPIN, HALE, KHAN , RAMIL and TAN, 2001).

Our work proposes tackling **business rules cluster** changes. This cluster consists of three types of activities: *reductive*, *corrective,* and *enhancive*. *Reductive type* restricts or reduces customer-experienced functionality, and involves limiting or eliminating a number of business rules from the implemented system. *Corrective type* fixes customer-experienced functionality, implicates in refining and rendering implementation of the existing business rules more specific to handle exceptions and mishandled cases better. *Enhancive type* replaces, adds to, or extends the customer-experienced functionality; it implements changes and additions to the software-implemented business rules. These three types of activities are the most frequent and most significant in software evolution, and, generally depend on other clusters' activities. Default type activity

in this cluster is *enhancive*. Further details of this classification are presented in (CHAPIN, HALE, KHAN , RAMIL and TAN, 2001).

With the intent of better understanding causes and effects of software requirements changes, McGee and Greer provide a generic software change *source* taxonomy, which sets forth distinction among factors contributing to software requirements *uncertainty* and *triggers* to change (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009). According to their research, software changes stem from the following domains:

- *Solution*: Change accommodating new technical requirements, design improvement, solution elegance. Technical answer to the problem;
- *Specification*: Change to requirements specification related to established problem, ambiguity resolution, inconsistency, increasing understanding;
- *Vision*: Change to the problem to be solved, product direction and priorities, stakeholder involvement, process change;
- *Organization*: Change strategic direction, customer organization considerations, political climate;
- *Market*: Differing costumer needs, government regulations.

These domains present increasing and decreasing characteristics, as shown by the arrows in Figure 5. McGee and Greer argue that requirements presenting a higher level of business novelty change more frequently and with a higher change cost only from changes coming from the domain of *organization*. Yet, they infer that in addressing organization change, there is increased certainty that novel requirements meet business needs, and as a result are less prone to other types of changes. Their work shows that higher cost and value changes originate more often from *organization* and *vision* domains. These changes are also usually related to stakeholders and considered less controllable than changes arising directly from specification or solution sources (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009). *Change Source Taxonomy* itself is presented in Table 2.

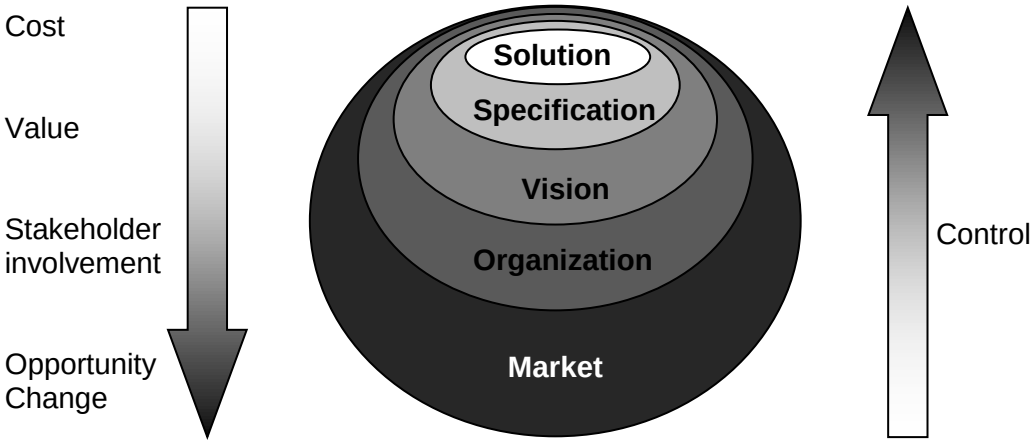


Figure 5: Requirements Change Taxonomy (MCGEE e GREER, 2012) (MCGEE e GREER, 2010) (MCGEE e GREER, 2009)

3.3. Strategic Field

Strategic management concept is built on six elements: strategic management deals with (1) major intended and emerging initiatives formulation and implementation , (2) taken by general managers (3) on behalf of owners, (4) involving resources utilization (5) enhancing organization's performance (6) in their external environments (NAG, HAMBRICK and CHEN, 2007). That is, strategic management provides complete direction to the organization and involves specifying an organization's objectives, developing policies and plans for reaching such objectives, and then allocating resources to implement these plans (HILL and JONES, 2012). Following this, strategy is defined as determination of an organization's basic long-term goals, and adoption of courses of action and allocation of resources necessary for achieving these goals (CHANDLER, 1962). In addition, strategic management is often described as involving two major processes: strategy formulation and implementation. In practice, the two processes are iterative, each offering input to the other (MINTZBERG and QUINN, 1996).

On the one hand, the formulation process is known as strategic thinking: it comprises the "articulation of options" (CONWAY, 2004). Strategic thinking is defined as a mental or thinking process applied by an individual in the context of achieving success in game or other endeavours. As a cognitive activity, it produces thought. When applied to an organizational setting, strategic thinking focuses on finding and developing organizational opportunities and creating

dialogue about organizational direction, aiming at creating competitive advantage for a firm or organization (LIEDKA, 1998). Strategic thinking can be an individual process, as well as a collaborative process, among key people who can positively alter an organization's future. When carried out in-group, strategic thinking may create more value by enabling a proactive and creative dialogue, where individuals gain other people's perspectives on critical and complex issues. This is regarded as a benefit in highly competitive and fast-changing business settings (SAHAY and AMITABH, 2012).

Conversely, the implementation process is known as strategic planning: it is the “actions generation” (CONWAY, 2004). Strategic planning comprises the process of defining an organization’s plans for achieving its mission. An organizational strategy is a derived approach to achieving such mission. The product of a strategic planning effort is usually a document, the strategic plan. This elaborates high-level strategy and articulates the elements influencing this strategy – a full description of organization’s environment and intentions (GATES, 2010) (CASSIDY, 2006). Strategy is directional in nature; although present situation descriptions and analysis are included, a strategic plan does not merely endorse the status quo, it directs change of some kind (CASSIDY, 2006).

Both strategic management and strategy itself involve strategic planning and strategic thinking concepts (CHANDLER, 1962) (MINTZBERG and QUINN, 1996). Successful strategies cannot be only analytically planned but rather emerge in a process involving creativity, intuition and learning, such as strategic thinking (BRANDS, WULF and MEISSNER, 2013). Creative strategic thinking comprises the basis for successful strategy creation, although it cannot be simply applied to practice without an effective set of tools and strategy frameworks. In this context, strategic planning is considered as one of the most important processes and comes to complement strategic thinking (RIGBY and BILODEAU, 2007). The latter brings flexibility and openness, thereby bestowing responsiveness and improvisation to the dynamic, complex and volatile environment. The former put these innovative strategies in practice (BRANDS, WULF and MEISSNER, 2013). In other words, strategic thinking is creative, divergent, and synthetic while strategic planning is conventional, convergent, and analytical (LIEDKA, 1998). Once strategic thinking is employed, it provides values to the planning process itself; nonetheless, strategic planning is still required for effective strategic work (GATES, 2010). To sum up, strategic thinking and planning are distinct, but interrelated and complementary thought processes

which must sustain and support one another for effective strategic management (GRAETZ, 2002).

Nevertheless, there is still a need for a synthesis combining strategic thinking flexibility and openness with strategic planning application-orientation. This synthesis is fulfilled with the integration of *scenario planning* to this combination (BRANDS, WULF and MEISSNER, 2013).

Scenarios were first applied as a military planning tool in World War II. After the war, Herman Kahn introduced scenario planning to the civilian domain (GATES, 2010). The main scenario planning goal lies in developing different possible views of future states and thinking through their effects in the organization (BRANDS, WULF and MEISSNER, 2013). That is, the aim of this technique is not to accurately predict the future but rather help managers develop better strategies by overcoming thinking limitations, and prepare organizations for possible eventualities, making them more flexible and more innovative (BRANDS, WULF and MEISSNER, 2013) (AMER, DAIM and JETTER, 2013). Scenario planning forces key people to acknowledge future uncertainty and think about multiple options to achieve organizational objectives once the future scenario comes (BRANDS, WULF and MEISSNER, 2013). The value of scenario planning does not lie so much in scenario construction itself but in discussing consequences for the organization (BISHOP, HINES and COLLINS, 2007).

Several different approaches exist to scenario planning and the academic works most often cited are those by van der Heijden (2005), Shoemaker (1995) and Schwartz (1996). Approaches vary in their details but a comparative analysis reveals in general these scenario-building techniques emphasize the following phases, based on Heijden (2005), Shoemaker (1995), Schwartz (1996) Amer, Daim and Jetter (2013), Wulf, Meißner and Stubner (2010):

1. *Definition of scope:* In this phase, foundation for analysis and strategy definition phases is set. Specifies important issues for scenario planning project, such as time frame, analysis scope or participating team. This generates project common ground.
2. *Perception analysis:* Here, perception of the executives participating in scenario project is analysed by identifying the existing mental models and challenging them, including external opinions. This assumptions benchmarking against external perceptions allows for external interests and expectations perception, as well as for internal assumptions coming to a holistic view on possible future maps.

3. *Trend and uncertainty analysis:* In this phase, analysis is made of the most important industry trends and uncertain elements by identifying the foremost driving forces affecting the organization. These factors are prioritized by their degree of uncertainty and their importance and potential impact for the organization in order to identify the most crucial environmental drivers that the organization has to consider in its planning process.
4. *Scenario building*: The scenario planning core phase. The previously-identified environmental uncertainties are now converted into distinct scenarios describing different possible world future states. These basic scenarios are then complemented by other driving forces to create consistent and plausible future visions. Links between the present to these future stories can be pictured. This phase opens participants' future perceptions and sets the foundation for strategies definition to achieve organizational goals, the next phase.
5. *Strategy definition:* The organization tests, in this phase, the decisions or strategic options against multiple scenarios. This improves organizational strategies by making them more robust and applicable in several possible future situations. This phase prepares the organization for different strategic alternatives depending on how the future turns out to be.
6. *Monitoring:* Finally, several indicators are defined and then monitored to check whether strategic changes are needed or not. It is important to continuously assess the environment. The scenario planning process should be repeated in case of drastic changes.

Traditional scenario planning approaches, i.e. those presenting the aforementioned phases in one way or another, enable managers to plan strategies for multiple possible futures as well as allow integrating and aligning external and internal perspectives to challenge existing assumptions and mind-sets. This makes scenario planning a potential approach to serve as conceptual foundation for an integrative strategic management framework (BRANDS, WULF and MEISSNER, 2013).

In section 4.2, we describe our proposal on how strategic management theories can be structurally applied by scenario planning to prepare software requirements for organizational evolution and ensuing adaptive changes.

3.4. Organizational Design

Organization Design is the deliberate process of configuring *structures*, *processes*, *systems*, and *people practices* to create an effective organization capable of achieving the *business strategy*. One of the main drives of organizational design is to support the alignment of individual motivations with the organizational objectives and therefore enhance decision-making process. Furthermore, a well-designed organization assistances the collective work to accomplish complex purposes (KATES and GALBRAITH, 2010) (STEWART and ROGERS, 2012).

Organization design is a decision-making process and a common organizational design framework for decision-making has a number of benefits. Kates e Galbraith exemplify (2010):

- Supporting design decisions to be based on long term business strategy rather than the more explicit and immediate demands;
- Establishing a common language for objectively and impersonally debating and analysing alternatives;
- Providing a clear rationale for the alternatives considered and their implications as a basis for communication and successful change management;
- Enabling decision makers to evaluate outcomes, understand root causes, and make proper adjustments during implementations.

As follows, we present two frameworks for organizational design that grounded this thesis. Star Model, by Galbraith (1995) and Kates and Galbraith (2010), provides the initial five categories of organizational design policies, or *organizational dimensions*. The Configuration Model of Organizational Culture (CMOC), by Dauber, Gerhard and Yolles (2012), presents the *dynamic relationship* between two constructs helping to understand the flow of impacts of organizational change over time in an organization.

3.4.1. Galbraith's Star Model

Jay Galbraith's Star Model (GALBRAITH, 1995) is one of the most widely-used and accepted framework for organizational design. It has been used and refined over the past thirty years. This model relies on the five categories of

organizational design policies and is depicted in Figure 6 (STEWART and ROGERS, 2012) (KATES and GALBRAITH, 2010):

- *Strategy* is the organization's formula for success. Strategy sets the organization's direction and encompasses the organization's vision and mission, as well as its short and long term goals. It specifies goals and objectives to be achieved, specifically delineates the products or services to be provided, the market to be served, the value offered to the costumer, and the sources of competitive advantage. Traditionally, strategy is the *first* component of Star Model to be addressed.
    - *Capabilities* are the translation from strategy into design criteria. Put differently, organizational capabilities are the criteria used for organization design decisions and will differentiate the organization from competitors and support it execute its strategy. The organizational capabilities are the connection between the strategy and the organizational requirements necessary to the strategy to be implemented. They are unique, integrated combination of skills, processes, and human abilities; created by and housed within an organization, developed refined and protected internally. Capabilities differentiate the organization and provide competitive advantage. They are important to identify the many factors at which the organization has to be as good as its competitors and mainly the few where it truly needs to be better.

- *Structure* determines where formal power and authority are located. Together with strategy are the first design policies to be addressed through this model. Usually, organizations are designed around functions, products, geographies, or customers, and are then configured into a hierarchy for management and decision-making. The organizational structure is what is shown on a typical organizational chart. The structure sets out the hierarchical relationships, power distribution, and communication channels. The structure should at least nominally support the strategy to conduct how people should work in the organization.

- *Processes* are a series of connected activities through which information flows up and down and across the organization. In other words, business process is a collection of related, structured activities or tasks with interleaving decision points that produce a specific service or product for a particular set of customers.

- *Reward Systems* align individual behaviour and performance with organizational goals. And, metrics are the measures used to evaluate individual and collective performance. The reward system communicates to employees what are the organization's values, motivates employees and reinforces the behaviours that add value to the organization through salary, incentives, bonuses, stock, recognition, and benefits.

- *People Practices* are the people management policies for selection, staffing, training, and development that are established to help form the capabilities and mind-sets necessary to carry out the organization's strategy. People policies produce abilities and behaviours required by the strategy and structure of the organization, generating the skills and mind-sets necessary to implement the chosen direction. Transparency and open communication channels between employees and managers create an important foundation for all necessary competencies.

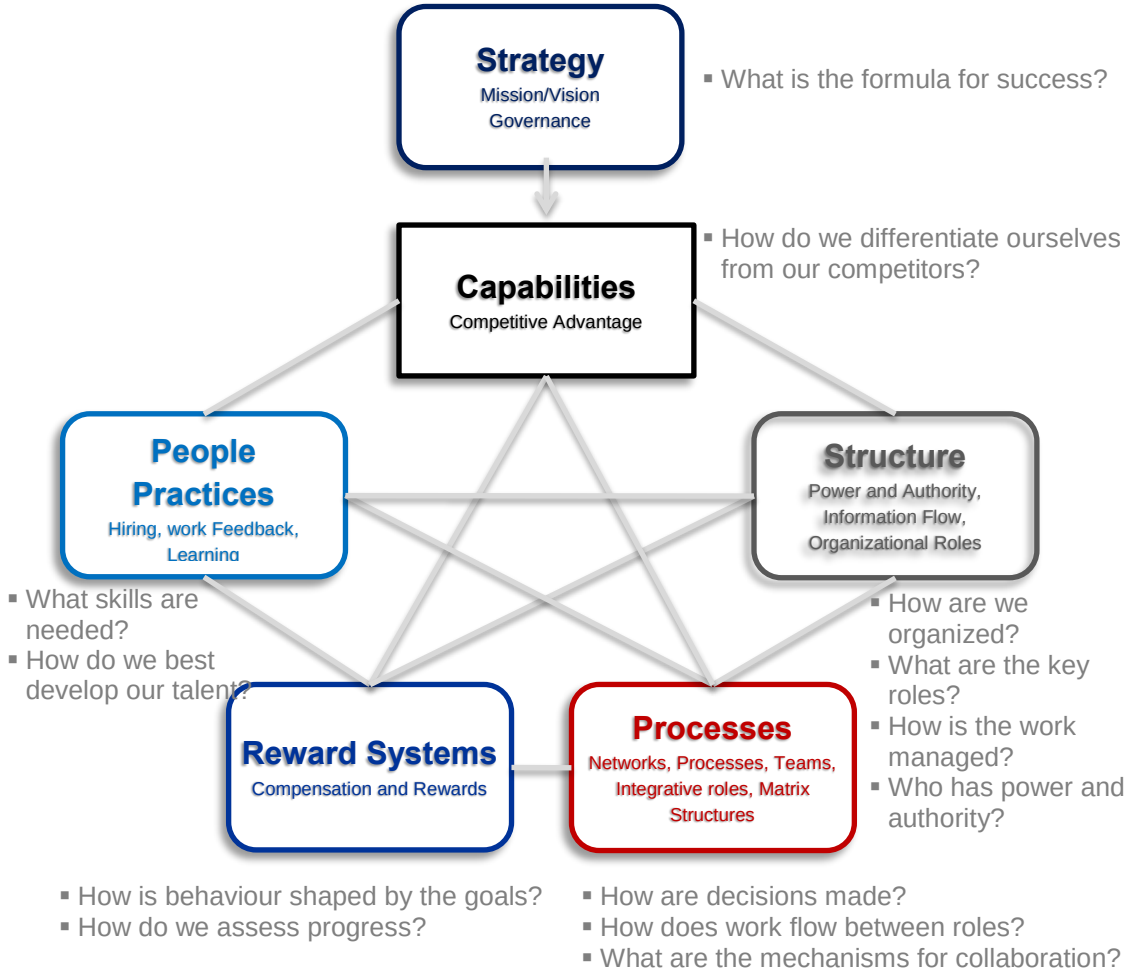


Figure 6 : Star Model (GALBRAITH, 1995)

These categories determine the organization's direction to follow, the decision-making power's location, the information's flow, the people's motivation to perform, and employee mind-set and skills. In other words, strategy drives structure; processes are based on structure, and structure and processes define the implementation of reward systems and people policies. This organizational dynamicity based on the organizational dimensions of Galbraith (1995) is illustrated in Figure 7.

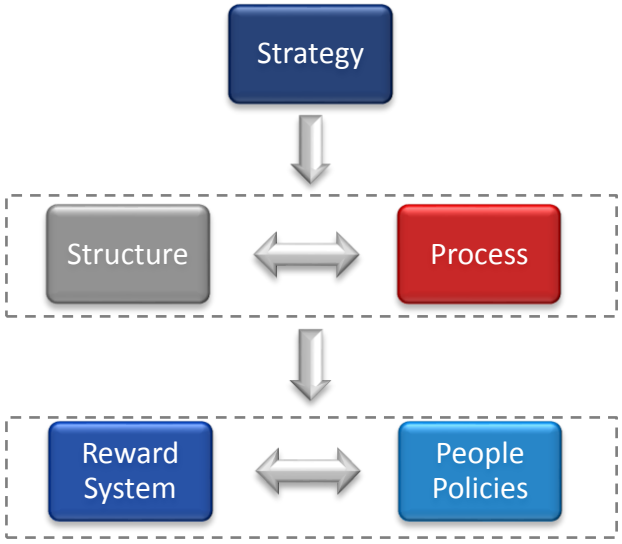


Figure 7: Direct Impact Relations between Organizational Dimensions (GALBRAITH, 1995)

The *organizational dynamicity* existing between organizational dimensions is explored in more detail in the following section.

3.4.2. A Configuration Model of Organizational Culture

Facing real industry cases involving strategic change and software evolution, we observe the need to understand the inherent effects of organizational change over time on causal relationships between organizational dimensions. From literature review, we have reached the *Configuration Model of Organizational Culture (CMOC)* (DAUBER, GERHARD and YOLLES, 2012), which explores *dynamic relationships* between organizational culture, strategy, structure and operations of an organization (internal environment) and maps interactions with the external environment (task and legitimization environment). CMOC is an evolution of prevailing widely recognized organizational models in the field of organization theory and culture theory (DAUBER, GERHARD and YOLLES, 2012).

In this context, organizational configuration is any *multidimensional collection* of conceptually distinct characteristics that commonly occur together. For instance, numerous dimensions of environments, industries, strategies, structures, processes, practices, technologies, groups, members, cultures, ideologies, beliefs, and outcomes cluster into configurations (also known as archetypes or gestalts) (MEYER, TSUI and HININGS, 1993). Accordingly, a

configuration model of organizational culture needs to accounts for the multidimensionality and complexity of organizations, which requires a multidisciplinary approach (DAUBER, GERHARD and YOLLES, 2012). Besides that, a configuration model of organizational culture should also be able to fully capture organizational dynamics or change and their adherent complexity, to at least indicate how and when certain variables change over time (PLOYHART and VANDENBERG, 2010).

CMOC distinguishes between *domain* and *process*. Whereas *domains* represent certain constructs, as strategy, structure, culture and so on, *processes* in CMOC link elements of a model to each other; that is, they clarify relationships between constructs (DAUBER, GERHARD and YOLLES, 2012).

Grounded on a large literature review, CMOC represents five domains of organizational culture, described as follows (SCHEIN, 1985) (HATCH and CUNLIFFE, 2006) (DAUBER, GERHARD and YOLLES, 2012):

1. Organizational Culture Dimension: value and belief system, capturing the underlying, unobservable assumptions of organizational behaviour; constitutes the basis for every organization;
2. Organizational Strategy Dimension: representing the overall orientation toward task achievement and impacts on structures and activities of an organization; provides rules, norms and regulations;
3. Organizational Structure Dimension: reflecting the effectuation of values and beliefs as norms, rules and regulations. This builds the referential frame for organizational processes and behaviour's patterns, and is aligned to a predefined strategy;
4. Organizational Operations Dimensions: organizational activities, operations, actions, that is, patterns of behaviour, as the observable manifestation of values, predefined strategies, and structures; and
5. External Environment Dimension: meant as an influential factor through evaluation processes on organizational culture and the internal environment of the whole organization at large.
    - 5.1. Market Dimension: all elements outside the organizational boundary to which the organization needs to adapt;
    - 5.2. Stakeholders Dimension: directly influencing organizational culture by bringing their own personalities and perceptions of social values, rules and norms.

The domains are systematically *connected* by well-defined processes, that is, feedback loops explaining *how* and *why* these organizational domains might change and impact each other (DAUBER, GERHARD and YOLLES, 2012). These processes are represented by arrows in CMOC, as depicted in Figure 8. Arrows from left-to-right represent the execution, implementation of the left dimension by the right one, and arrows from-right-to-left represent organizational learning or adjustment as processes of detecting and correcting errors. These linking dimensions processes are described below (DAUBER, GERHARD and YOLLES, 2012):

- Guidance, from Culture to Strategy dimension, is the process which guides and consequently changes the overall organizational strategy based on the value and belief system;

- Operationalization, from Strategy to Structure dimension, is the process that turns organizational strategies into action, generally known as “operationalization”, “implementation of strategies”, or “strategy doing”, unfold through organizational structures and organizational activities;

- Patterns of Behaviours, from Structure to Operations dimension, is the process that guides and provides rules for organizational behaviour. “Behaviour”, in this context, represents the observable outcome of “operationalizing” strategies;

- Action, from Operations to Market dimension, is the process which links the organization to its external environment as a *coupling* of organizational structures and operations;

- Legitimacy Management, from Operations to Stakeholders dimension, is the process of legitimizing the organization by, justifying its activities to and solving conflicting interests of several groups of stakeholders, as for instance, customers, shareholders, employees, suppliers and so on.

- Market Feedback, from Market to Operations dimension, is the process in which the market responds to organizational operations;

- Cultural Pressure, from Stakeholders to Operations dimension, is the process of stakeholders as an external environment changing the organization by their own cultural pressure;

- Performance Assessment, from Operations to Structure dimension, is the process of adapting organizational structure because of changes in organizational operations;

- Single-loop Learning, from Structure to Strategy dimension, refers to the process of detecting errors and adjusting existing strategies to meet new organizational requirements;

- Double-loop Learning, from Strategy to Culture dimension, by contrast, refers, to a more profound process of learning, where underlying organizational policies and objectives, that is, underlying assumptions are questioned and changed.

CMOC is elaborated in such a way that is confirms past empirical research and expands knowledge in different fields of organization research, such as, organizational culture, strategy-structure fit research, organizational behaviour, organizational learning and so on, reaching beyond existing culture models. Preceding recognized models are most of the time limited in their applicability in complex and dynamic scenarios, basically because they were not necessarily designed for such settings. CMOC provides new avenues for investigation into current and possibly future phenomena, which might be partly driven by factors in the past (DAUBER, GERHARD and YOLLES, 2012).

From this section on, we use the word *'flow'* instead of process to identify this concept of flow of effects between organizational dimensions in order to avoid misperception with the word *'process'* in the context of business.

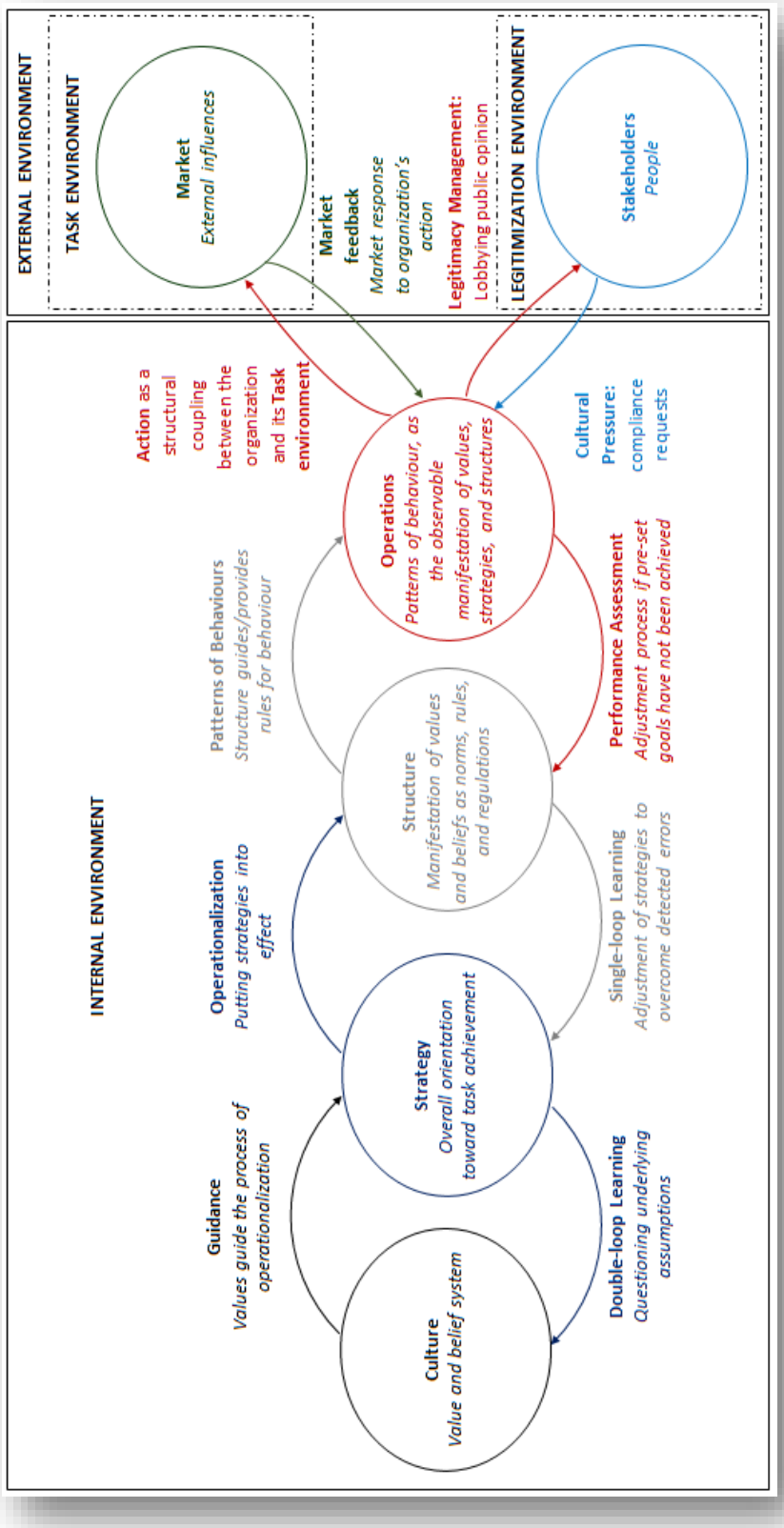


Figure 8: Configuration Model of Organizational Culture, adapted from (DAUBER, GERHARD e YOLLES, 2012)

3.5. Final Remarks

As Lehman and Belady postulated, Software is continuously evolving and there is an intrinsic relationship between software and the context in which it is deployed. Our study focus on SSsOIS and for this reason, to realize how SSsOIS may evolve, we need first to understand how the organization may evolve and consequent new requirements it will originate. After that, in this chapter, we presented Strategic Management, the theory guiding how one organization should evolve to achieve its objectives in future. To understand organizational dynamics, we use Galbraith's Star model, a well-accepted organizational model, and a Configuration Model for Organizational Culture, the model representing the dynamic flow of changes and consequent impacts within an organization.

In the next chapter, we present how we conflated this organizational theory aiming to enhance requirements' elicitation contributing to software evolution.

4
Eliciting SSsOIS' requirements originated from strategic changes – an Organizational Dynamics Approach for Requirements Elicitation (ODA4RE)

In this chapter, we present our Organizational Dynamics approach for Requirements Elicitation (ODA4RE).

4.1.
Introduction

ODA4RE's is an epistemic tool for the purpose of eliciting knowledge from organizational key people about organizational changes and impacts to support them to make decisions on SSsOIS' requirements evolution. From now on, we present ODA4RE using *SADT* (Structured Analysis and Design Techniques) as an activity model. This technique uses a hierarchical decomposition of activities with a top-down approach, wherein each new diagram, the activities of the previous level are decomposed into three to six others. Moreover, the boxes stand for *activities*, the left incoming arrows are *inputs* of these activities, the right outgoing arrows are *outputs*, the bottom incoming arrows are the *means*, *components,* or *tools* used, and the upper incoming arrows are the *controls* that influence the execution of the activity (ROSS and SCHOMAN, 1977). Figure 9 depicts *Level A-0* of ODA4RE.

Organizational knowledge is an input to the process because it is the basis for strategic planning, organizational changes and impacts identification, and this knowledge is evolved over ODA4RE application. Due to organizational knowledge evolution, it is also the feedback of some activities. Then, new SSsOIS' requirements are elicited according to the organizational knowledge evolution, and, after validation, current SSsOIS' requirements specification is adjusted to the new SSsOIS' requirements specification. These new SSsOIS' requirements refer to how the SSsOIS will support organizational strategic objectives, therefore

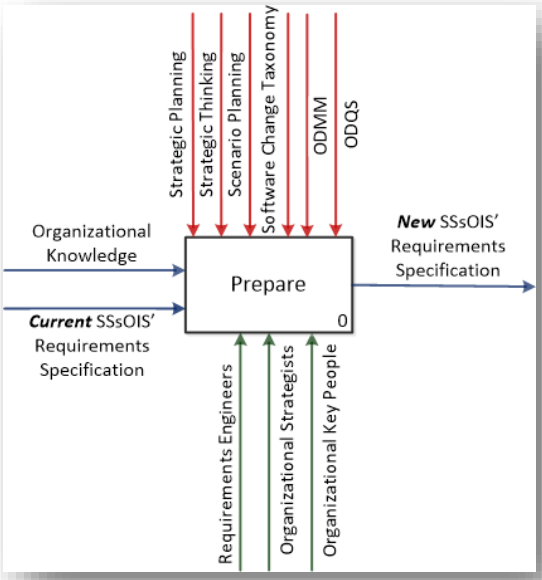


Figure 9: A-0 Prepare - ODA4RE

ODA4RE is decomposed in 3 sub process, shown in Figure 10. Respectively, Reflect corresponds to SSP, Analyse to OIA and Validate to LSRV. Each one is detailed in next sections.

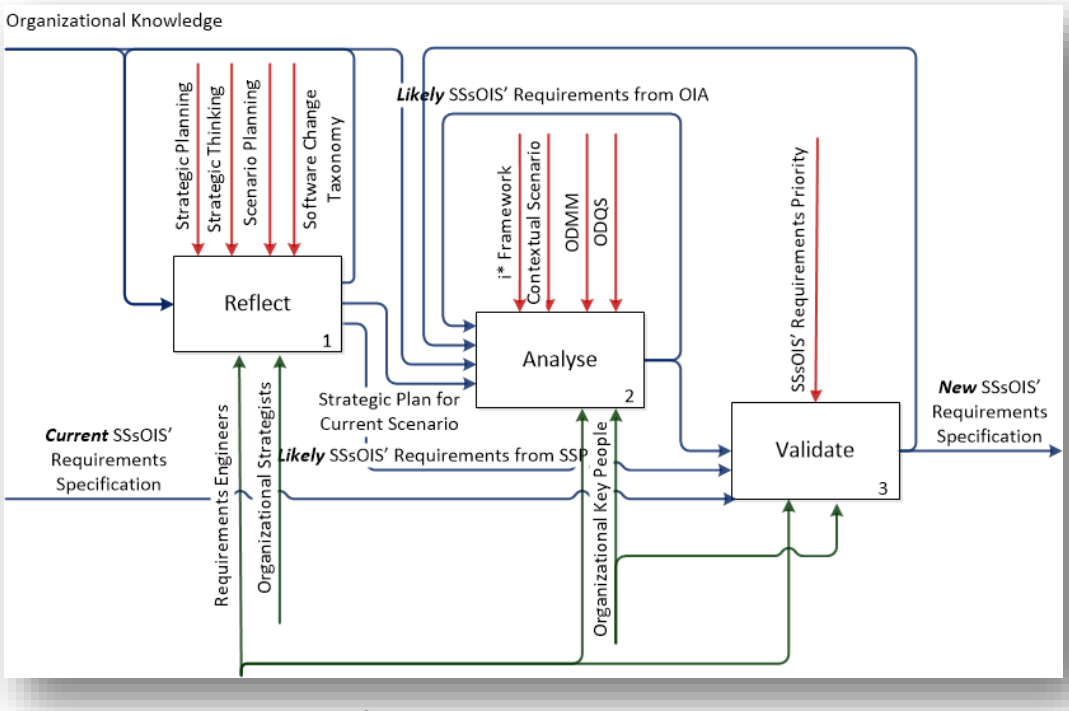


Figure 10: A0 Prepare - ODA4RE

4.2. Scenario-based Strategic Planning (SSP): Reflecting about multiple possible organizational future

First ODA4RE's sub process is *Scenario-based Strategic Planning (SSP)*. It aims at preparing SSsOIS for organizational evolution changes, by identifying possible organizational futures through a strategic perspective. For this, we have grounded our research on the six-phased traditional scenario planning processes designed from the most consolidated researches in scenario planning field, described in section 3.3 (HEIJDEN, 2005) (SCHWARTZ, 1996) (SHOEMAKER, 1995). To overcome the often-criticized complexity of grafting scenario planning approaches, we have been inspired by, and have also adapted the framework proposed by Brands, Wulf, Meißner (2013), explained in this section. Finally, to emphasize the organization and software evolution relationship, we have complemented our approach with Bush's findings about the applicability of scenario planning for SSsOIS' requirements engineering (BUSH and FINKELSTEIN, 2002) and McGee and Greer's Change Source Taxonomy (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009).

In other words, our SSP approach for preparing SSsOIS' requirements for organizational evolution involves the following: (a) identification of multiple possible organizational futures which could influence SSsOIS, and (b) support for SSsOIS preparation for possible requirements changes, achieved by the adaptation of the original framework (BRANDS, WULF and MEISSNER, 2013) with Bush's outcomes (BUSH and FINKELSTEIN, 2002) and McGee and Greer's Change Source Taxonomy (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009).

Identification of organizational changes bearing influence on SSsOIS is justified by basing strategic scenario construction on trends and uncertainties driving software change, according to Mcgee and Greer (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009). In addition, preparation for software changes is justified by expanding strategists' perceptions, challenging current assumptions and convictions, and committing key people to the intended SSsOIS' changes, consequences of future scenarios analysis (AMER, DAIM and JETTER, 2013). Below, we detail our SSP approach to software evolution based on strategic management, pictured in Figure 11. SSP is decomposed into three activities: Plan, Align, and Monitor. First activity, Plan, aims at strategically planning organization's future. The output is the

Organizational Strategic Plan and it is the income for aligning the SSsOIS to the organization, goal of subsequent activity, Align. The outcome comprises a General Strategic Plan, regarding Organizational Plan complemented by SSsOIS' strategies and Likely SSsOIS' requirements to support this general strategic plan. Finally, the goal of last activity, Monitor, is to monitor the present according to indicators and identify which of the future scenarios is approaching. After identifying the current scenario, the respective strategies should be implemented in the organization. In our approach, we propose then to analyse which organizational changes and impacts these strategies may rise, as explained in section 4.3, in order to prepare the SSsOIS by evolving it according to organizational evolution.

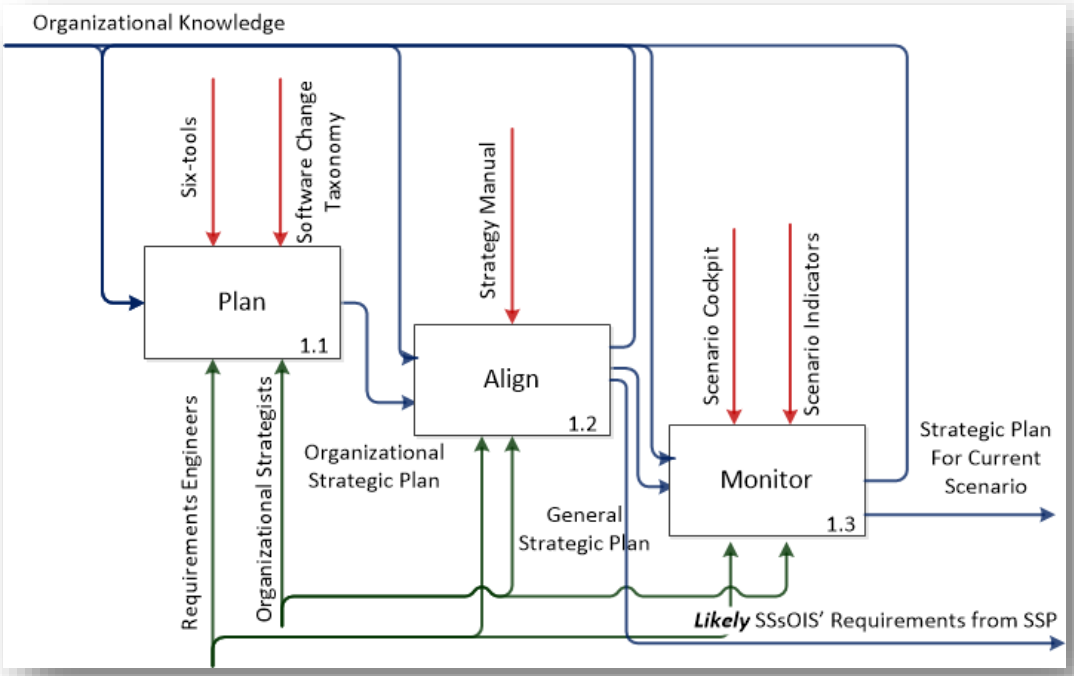


Figure 11: A1 Reflect - SSP

Activity 1.1 - Plan

This activity aims at strategically planning the organization's future. For that, we propose to build a common understanding about the organization and then to use scenario planning as a technique to deal with future uncertainty. Each Plan's activity in Figure 12 is described in detail as follows.

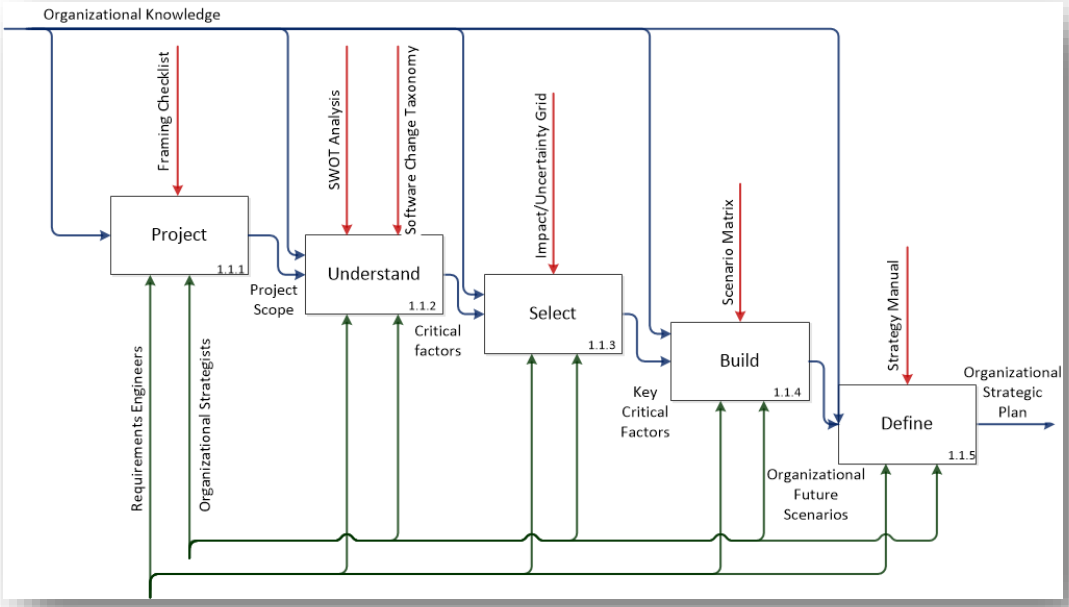


Figure 12: A11 Plan

Activity 1.1.1 – Project: Definition of Project Scope

First activity goal entails defining overall scope of strategic scenario-based software evolution project. For this purpose, we suggest the *Framing Checklist*, an awareness tool consisting of five simple questions, which need to be agreed upon before process start (BRANDS, WULF and MEISSNER, 2013). This Framing Checklist is presented in Figure 13:

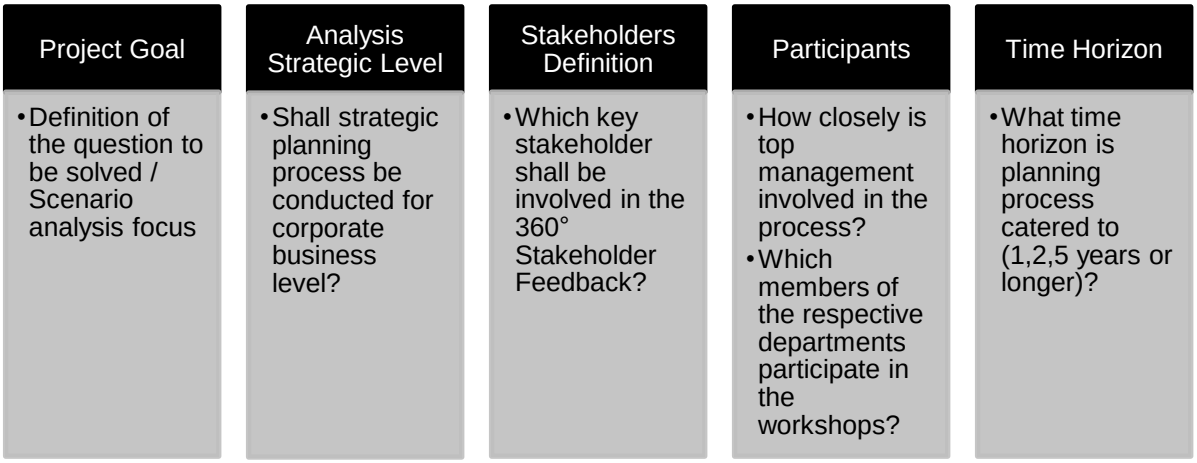


Figure 13: Framing Checklist (BRANDS, WULF e MEISSNER, 2013)

Activity 1.1.2 – Understand: Perception Analysis

This activity aims at arousing participants' awareness about the group as an organization and the software system as an SSsOIS. Expected result comprises identification of factors influencing software evolution related to the organization's future at the same time. This process is driven by four main goals:

1. Arousing organizational awareness;
2. Setting up a list of factors potentially influencing the organization's future. In our approach, we have used the Change Source Taxonomy proposed by McGee and Greer (MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009). The taxonomy, listed in Table 2, presents a direct relationship between software evolution and the organization. These factors can be complemented by other factors the organization finds relevant;
3. Evaluating listed factors according to their potential performance impact and their degree of uncertainty;
4. Comparing different stakeholders' groups perspectives concerning these influence factors.

Activity 1.1.3 – Select: Trend and Uncertainty Analysis

This activity aim is identifying important trends and critical uncertainties potentially having an impact on organizational future and influencing SSsOIS' evolution. In our approach, these factors are mostly derived from Change Source Taxonomy, in Table 2. To facilitate this activity, we recommend the *Impact/Uncertainty Grid,* a two-axis grid: potential performance impact and degree of uncertainty, as depicted in Figure 14 (HEIJDEN, 2005). It allows positioning all identified influencing factors according to their degrees in axis characteristics:

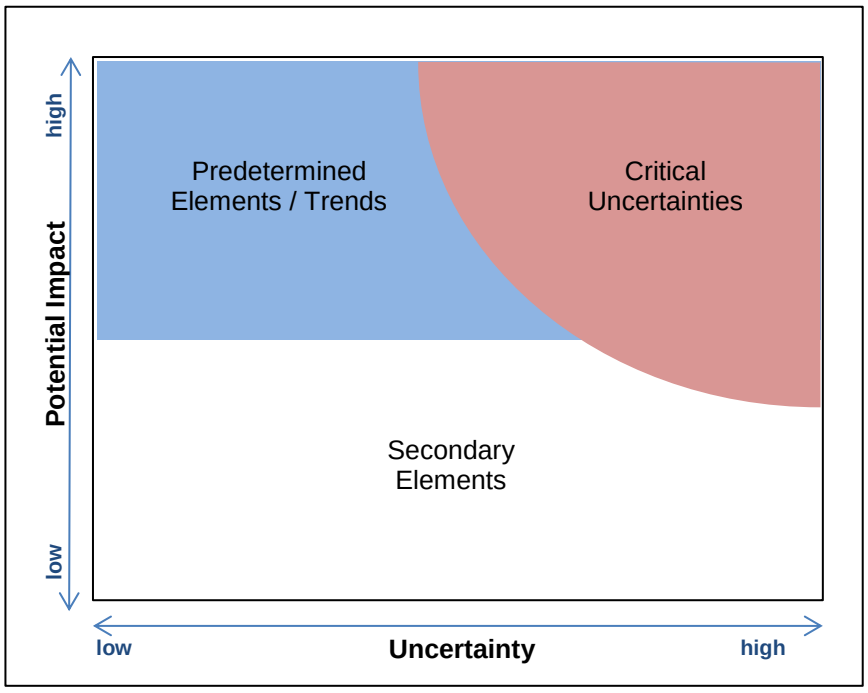


Figure 14: Impact/Uncertainty Grid (HEIJDEN, 2005)

Impact/Uncertainty Grid is divided into three sections:

- *Secondary elements:* factors that have a relatively low performance impact. They are not deemed further as part of the scenario planning process.
- *Trends:* factors having a comparatively high performance impact, being relatively predictable simultaneously. They are important for the scenario building in the following activity (SCHWARTZ, 1996).
- *Critical Uncertainties:* factors not only having a high performance impact, but for which also future development is rather uncertain. These form the Impact/Uncertainty Grid core comprising the approach major outcome.

This activity objective is identifying the two key driving uncertainties, with the highest impact and uncertainty degree to the organization. In our approach, we suggest using Table 2 as a trend and uncertainties source to keep organizational strategic planning aligned to SSsOIS' evolution, since these trend and uncertainties have indeed an influence on SSsOIS' requirements changes. Then, in the following activity, the key driving uncertainties will be combined 2x2 to build four future scenarios for the organization. Most researchers consider three to five scenarios appropriate to apply scenario planning, stimulate creativity, and deal with future uncertainty (AMER, DAIM and JETTER, 2013).

Table 2: Change Source Taxonomy
(MCGEE and GREER, 2012) (MCGEE and GREER, 2010) (MCGEE and GREER, 2009)

Change Domain	Trigger	Uncertainty
Market	• Change to Government Policy or Regulation • Changes to Market Demands • Response to Competitor	• Market Stability • Differing Customer Needs
Customer Organization	• Strategic Change • Company Reorganization • Political Climate Change • Customer Hardware/Software Change	• Customer's Business Environment Stability

Project Vision	• Business Process Change • Business Case Change • Cost/Schedule Overrun • New Opportunity • Stakeholder Representative Change • New Stakeholder Role • Participative Learning	• All Stakeholders Involved • Shared Product Vision Clarity • Unknown Customer Project Dependencies • All Stakeholders Identified • Degree of Change to Customers Workflow • Project Size • Novelty of Application • Stakeholder Agenda Synergy • Development Team Business Area Knowledge • Analyst Skill Experience
Requirements Specification	• Increased Customer Understanding • Private User Representative First Engagement • Increased Developer Understanding of Problem • Misunderstanding Resolution • Miscommunication Resolution • Incorrect Requirement Identified • Incorporation of Deferred Requirement	• Communication with Customer Availability • User Representatives Insufficient Sample • Communication Quality between Analyst/Customer • Analysis Techniques • Development Team Business Area Knowledge • Requirements Specification Quality • Analyst Skill/Experience • Development Team Stability • Development Team Communication Quality • Low Staff Morale • Incompatible Requirements • Logical Problem Complexity • Involved Customer's Problem Knowledge/Understanding • Involved Customer's IT Experience • Incorrect User Involved • Age of Requirements
Solution	• Technical Solution Understanding • New Tools/Technology (component) • Design Improvement/Solution Elegance	• Technical Uncertainty of Solution • Technical Complexity of Solution • COTS Stage

Activity 1.1.4 – Build: Scenario Building

This activity objective is identification and description of organization's multiple possible futures scenarios. Since future scenario construction is carried out by taking into account previous key uncertainties related to software change, these future scenarios are likely to bear influence on SSsOIS' evolution. This activity is supported by the *Scenario Matrix* tool, a visual aid and logical scenario baseline, useful for viewing and understanding scenarios in a logical *Scenario Matrix* relationship. At this instance, stakeholders are challenged to think widely, and produce storylines, with logical linearity, which, in its dynamics, illustrates driving forces plausible workings and interrelationships (HEIJDEN, 2005).

Having selected the previous activity's two most critical uncertainties, these serve as the matrix dimensions, being now further specified by working out outcomes for each scenario in greater detail. These can be combined in a 2 x 2 matrix, as illustrated in Figure 15. Two extreme values have to be defined for each scenario dimension. As a result, the matrix bears four quadrants reflecting four distinct future scenarios.

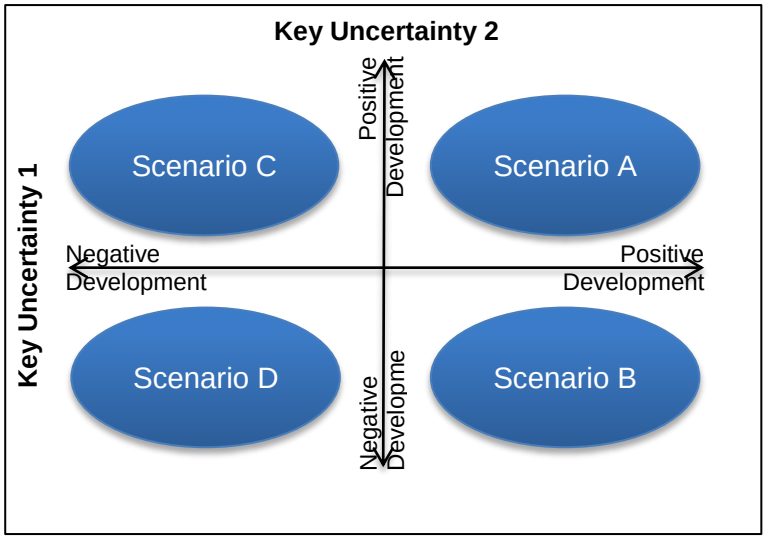


Figure 15: Scenario Matrix (HEIJDEN, 2005)

After determining these four scenarios based on the two scenario dimensions, next activity is describing such scenarios in further detail. The resulting four *Scenario Matrix* quadrants present four questions to participants derived from the combination of key driving factors two-by-two, for instance: *"What kind of world would it be if we had to deal with economic instability and bigger projects?"* These questions should be worked out in detail to ensure that understanding is shared. For example, writing key words characterizing each of

the four scenarios, causes, and effects. Trends and uncertainties from activity 1.1.3 may serve as cause and effects to develop a cause-effect chart. Next, participants creates a story of how current state reaches end state, through a series of events, each one leading to another over time, based on cause-and-effect chart (HEIJDEN, 2005). Finally, the scenarios are described in full detail.

Activity 1.1.5 – Define: Strategy Definition

This activity goal is both identifying new strategies applicable in one or several scenarios, and comparing existing strategies against future scenarios. This activity links thinking about the future to deriving concrete strategies and action plans. Brands, Wulf and Meißner (2013) suggest application of the *Strategy Manual* tool, consisting of the subsequent sub activities:

1. Structure strategy discussion around four important elements, to be determined for each scenario:
   1.1. Macro-environment developments;
   1.2. Competitors' and customers' behaviour;
   1.3. Own company intended positioning and competitive strategies;
   1.4. Value chain and action plans respective design.
2. Identify core strategy and complementary strategy options. First, based on the aforementioned elements, identify those shared by all scenarios. These common elements form the core strategy basis, possible to be immediately implemented since it is future developments independent. Then, all remaining strategy elements differing among scenarios form strategy options complementing core strategy. According to current environment state, some strategy options may be immediately executed; others may demand initial investment whereas remaining strategies may be implemented later. Growth potential value, insurance and learning are valuable to define potential investment size and timing;
3. Describe core strategy and complementary strategy options and milestones for these options execution in detail and compare them to existing strategies. This serves as basis for decision-making process on strategic change.

Strategy definition phase's outcome is a strategy applicable in all possible future scenarios, complemented by several strategy options satisfying the

requirements of each specific scenario. Increasing strategy alternatives number enables executives to react faster to environmental changes and to outpace competitors.

Activity 1.2 - Align

The goal of this activity is to align the SSsOIS to organizational strategies. Organizational knowledge evolved in this activity is a feedback to A11 Plan to update Organizational Strategic Plan with new knowledge. A12 Align activity is executed in parallel to A11 Plan activity to stimulate the definition of aligned strategies. It comprises the following activities, as shown in Figure 16:

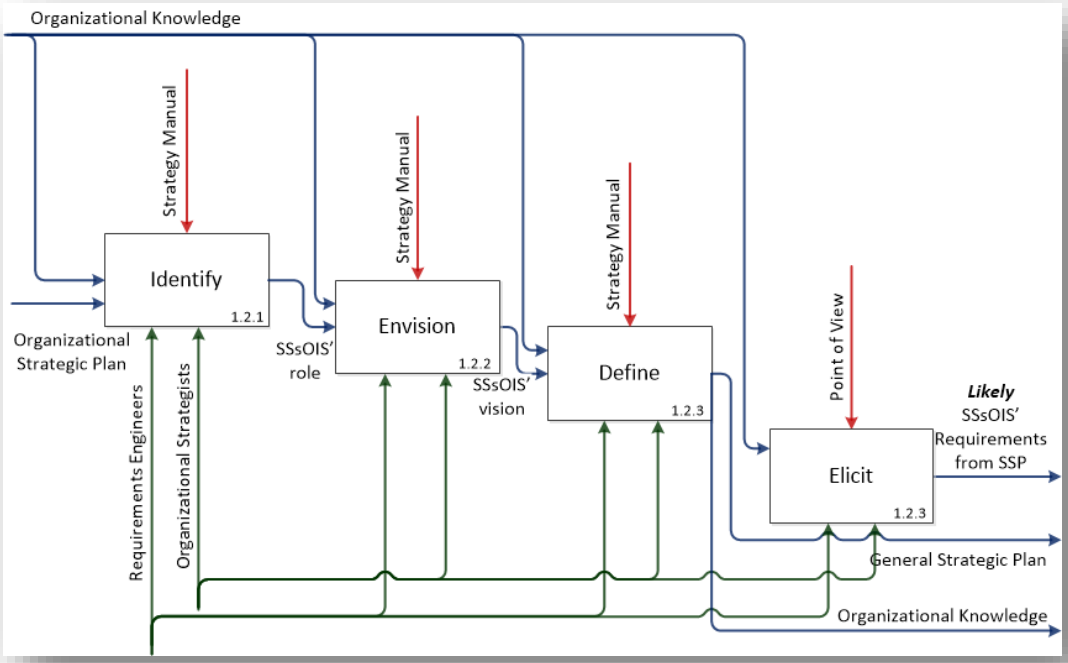


Figure 16: A12 Align

Activity 1.2.1 – Identify

This activity aims at identifying SSsOIS' role in the organization at the present moment. For this, this activity stablishes a common sense between key people and requirements engineers on the current SSsOIS' responsibilities in the organization.

Activity 1.2.2 – Envision

This activity aims at identifying SSsOIS' vision for the organization. In other words, ascertain on what is expected from SSsOIS in each of the previously described future scenarios. This activity's leading question is: "How will SSsOIS behave in each scenario?". More specifically, "How will the SSsOIS support our new strategies and goals?", "How are we going to use SSsOIS?" "How will each requirement be in each scenario for organization to achieve its objectives?". "How are we going to manage SSsOIS?" This activity may also question SSsOIS' requirements, though, it is not one prerequisite in this approach SSsOIS' requirements already being specified and known by participants;

Activity 1.2.3 – Define

This activity aims at identifying strategies to manage SSsOIS. It should be executed in parallel with activity 1.1.5, in Figure 12, i.e. at the same time, to each future scenario, defining strategies to manage the organization and the SSsOIS. Its output is a General Strategic Plan, comprising the Organizational Strategic Plan complemented by the SSsOIS' Strategic Plan.

Activity 1.2.4 – Elicit

Finally, requirements engineers should elicit SSsOIS' requirements necessary to support identified strategies from General Strategic Plan. The origin of the SSsOIS' requirement is a strategic goal and should be registered to keep traceability.

A12 Align activity's output is a General Strategic Plan, both for the Organization and for the SSsOIS; and *likely SSsOIS' requirements* elicited from organization's and SSsOIS' strategic plans. These likely SSsOIS' requirements will be later validated in LSRV sub process.

Activity 1.3 – Monitor

Last activity of A1 Reflect (SSP) aims at realizing whether the real world is moving into one of the created scenarios and then identify which particular complementary strategy option is more suitable to reality. Periodic benchmarking of created scenarios against current reality becomes mandatory for such purpose. Brands, Wulf and Meißner (2013) developed the three- activity tool Scenario Cockpit, as described below:

1. Define indicators for each scenario. These indicators can be directly derived from the cause-effect chart, in activity 1.1.3;
2. Determine indicators value ranges. These ranges will be benchmarked against indicators actual values to either identify which scenario is closest to the real-world development and which scenarios are still valid and plausible;
3. Constant monitor indicators. The results may serve as basis for decision-making process.

In Figure 17, we present an overview of our proposed scenario-based framework, adapted from (BRANDS, WULF and MEISSNER, 2013).

Our proposal objective is fostering organizational key people toward thinking about the organization's future and reason about consequent influence on SSsOIS; therefore, we have added the underlined points in Figure 17. We brought the context of SSsOIS to strategic planning by (a) linking trends and uncertainties impacting the organization to the sources of software change; (b) bringing SSsOIS strategic analysis as an activity to the process, and by (c) eliciting SSsOIS' requirements to support identified strategies.

Figure 17: Scenario-based framework for thinking about future aligning organization and SSsOIS, adapted from (BRANDS, WULF e MEISSNER, 2013)

4.3. Organizational Impacts Analysis (OIA): Analysing likely organizational changes and impacts

Second ODA4RE's sub process is *Organizational Impact Analysis (OIA).*It aims at supporting the elicitation of organizational changes and reasoning about potential impacts on and from both the organization and the SSsOIS. Hence, it is a *sequence of activities* assisted by the **Organizational Dynamics Meta-Model (ODMM)** and by the **Organizational Dynamics Questions Set (ODQS)**. These supporting tools were developed based on literature review, application in real cases, and recurrent refinements, as detailed in chapter 5. Specifically, ODMM and ODQS were created during a case study on Learning Management Systems at Universities, section 5.3, both posteriorly evaluated in the UK Post Office and PUC-Rio case studies, in sections 5.4.

4.3.1. Organizational Dynamics Meta-Model (ODMM)

The Organizational Dynamics Meta-Model (ODMM) originates from literature review and application on real cases. We have studied existing and respected organizational models from literature (GALBRAITH, 1995), extended them (SCHEIN, 1985) (HATCH and CUNLIFFE, 2006) (DAUBER, GERHARD and YOLLES, 2012), and conflated the prevailing organizational models. Then, we have modelled real cases we have worked in to elicit empirical knowledge, discussed current version with experts and refined the resulting model according to the new requirements of each of these iterations, as reported in chapter 5.

This model's main purpose is establishing a common foundation for key people to learn about and understand the organization, its *dimensions*, how they *connect* to each other and their internal *elements*. It presents the essential organizational elements to trigger reflection on that organizational dimension and then adapt it according to the current organizational context being examined. It is not intended to be complete, since this is impossible given the high complexity of organizations.

Initially, ODMM originates from a conflation of the Star Model by Galbraith (1995), which provides *organizational dimensions,* and the Configuration Model of Organizational Culture (CMOC) by Dauber, Gerhard and Yolles (2012), which provides *dynamic relationships* between these organizational dimensions, as explained in sections 3.4.1 and 3.4.2, respectively. From extensive literature

review and refinement by application in real cases, we identified *organizational elements* for each of the six organizational dimensions in ODMM.

ODMM's organizational dimensions, their organizational elements and dynamic relationships are depicted in Figure 18:

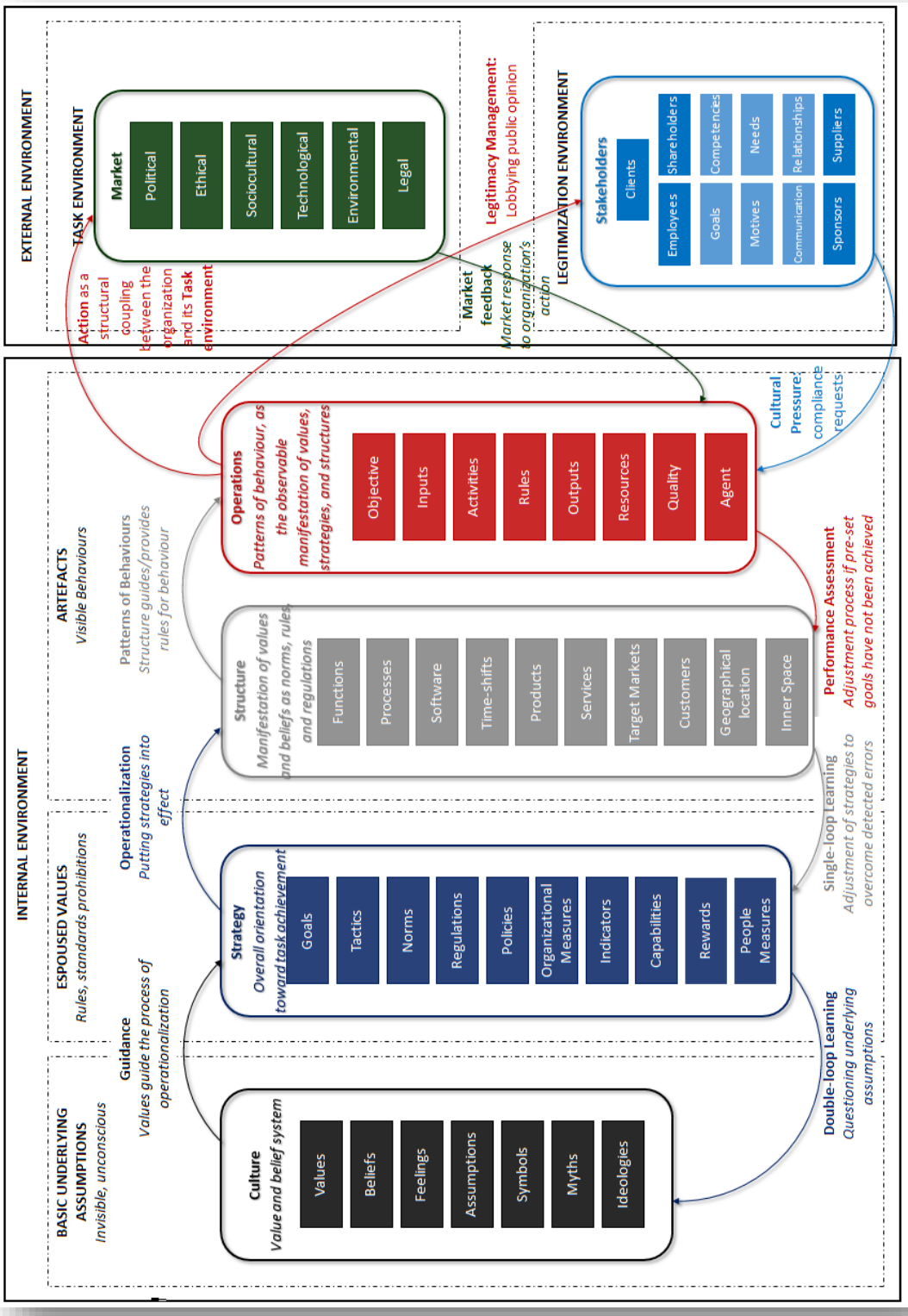


Figure 18: Organizational Dynamics Meta-Model (ODMM)

4.3.2.Organizational Dynamics Questions Set (ODQS)

The Organizational Dynamics Questions Set (ODQS), as the name says, is a set of 178 questions about organizational dynamicity. The ODQS's main goal is gathering information from key people about likely organizational impacts raised by organizational changes and from these ne identified likely organizational impacts identifying the need of SSsOIS' requirements changes. Otherwise stated, these 178 questions aim at gaining knowledge from key people about likely organizational changes and provoking insights on likely organizational impacts, which might affect current SSsOIS' requirements.

The ODQS was constructed based on how organizational changes might impact the organizational dimensions besides to their own organizational dimension. For this, based on ODMM, we elaborate a set of questions for each relationship among organizational dimensions (or flow), represented by the arrows in Figure 18. These questions are grounded on the likely impacts on *organizational elements* and organized in 10 sets, corresponding to the 5 *flows of impacts* (arrows left-to-right in Figure 18) and to the 5 *flows of adjustments* (arrows right-to-left in Figure 18) within the organizational dimensions. Thus, given one organizational change being analysed, we apply a particular set of questions to identify likely organizational impacts on each element of the following organizational dimension, then a next set of questions, corresponding to the same flow or to the next, and so on and so forth, deeper detailed in the next section. ODQS is presented in APPENDIX A.

4.3.3.Organizational Impacts Analysis (OIA) subprocess

The *Organizational Impacts Analysis (OIA)* corresponds to the second sub process in Figure 10. The overall goal of OIA is to elicit organizational knowledge to support key people to identify SSsOIS' requirements evolution by analysing and understanding likely organizational changes and likely organizational impacts. OIA's decomposition into activiites to achieve this overall goal is depicted in Figure 19.

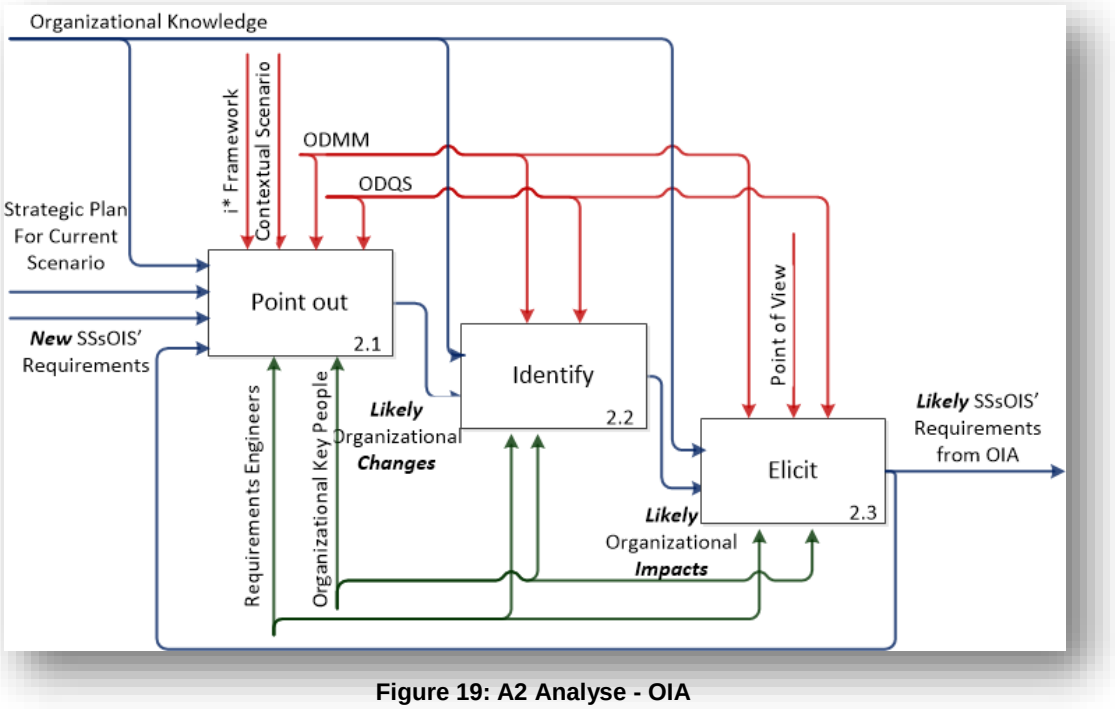


Figure 19: A2 Analyse - OIA

First activity 'Point Out' aims at *point out organizational changes* by stimulating *organizational awareness* in key people about likely organizational changes raised by strategic goals, by comparing current and future reality. For that, we have decomposed this activity in three sub activities, as presented in Figure 20. OIA starts by modelling the organizational context *as it is* at the present moment *(Organization As Is)* and *as it is going to be* following strategies presented in the General Strategic Plan *(Organization To Be)*. Both models are built using the i* framework or contextual scenarios language. The differences found by comparing models *as is* and *to be* are the ***likely organizational changes***.

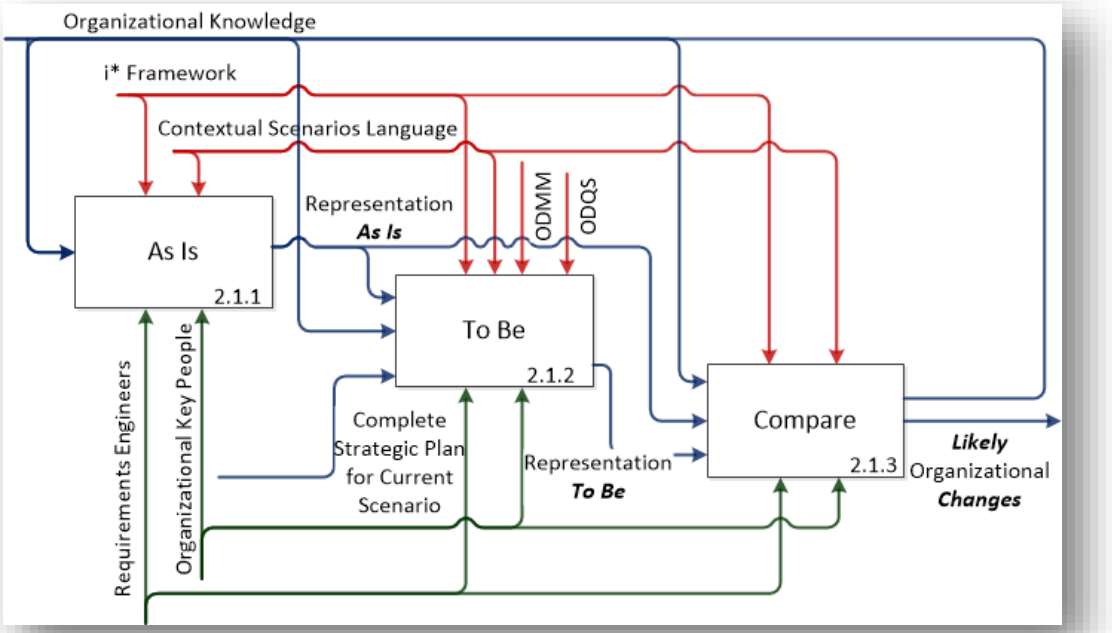


Figure 20: A21 Point Out

We use goal-oriented requirements engineering, specifically the i* framework, because it is suitable for modelling and analysis in requirements engineering, then we can model and understand stakeholders' underlying motivations for systems, dependencies, identify the relation between the system and the organizational and business context, clarify and capture organizational changes, impacts and requirements from the analysis (HORKOFF and YU, 2014).

In order to augment our knowledge, we also apply contextual scenario walkthroughs into the organizational *as is* and *to be* contexts with the purpose of analysing and capturing organizational changes. For that, we use *contextual scenarios* to describe the direct interactions between actors their selves and actors and systems. This description is made in natural language as a sequence of steps until the overall scenario's goal is achieved (LEITE, ROSSI, BALAGUER, MAIORANA, KAPLAN, HADAD and OLIVEROS, 1997) (POHL and HAUMER, 1997). The idea behind these contextual scenarios walkthroughs is that people are better at identifying facts of commission rather than omission. From this, scenario walkthroughs offer stakeholders support to think about most likely impacts of organizational changes. If the identified impact is relevant to the system being specified but not yet handled in the specification, then a potential requirement change has been identified, and it is suggested to the developers to

acquire and document the relevant requirements (ALEXANDER and MAIDEN, 2005).

Back to Figure 19, last activities, 2.2 and 2.3, aim at, by the end, identifying ***likely SSsOIS new requirements*** raised by the potential organizational changes identified from comparison both in the i* models and in the contextual scenarios. For that matter, OIA provides support for key people to identify *likely organizational changes* and consequent *likely organizational impacts*, and thus reason on how they may impact on SSsOIS' requirements.

OIA's activities in Figure 19 and Figure 20 are described as follows:

Activity 2.1 - Point out

To point out likely organizational changes, this activity is decomposed in 3 sub activities, in Figure 20:

Activity 2.1.1 - AS IS

Requirements engineers should model the organizational context according to current reality using i* and contextual scenarios language. i* helps to identify actors, dependencies, goals, softgoals, tasks and resources, closer to the Organizational Dimensions of Strategy, Market and Stakeholders. On the other hand, contextual scenarios assist to understand the sequence of organizational activities and the structure behind it, closer to the Organizational Dimensions of Patterns of Behaviours and Structure.

Activity 2.1.2 - TO BE

Requirements engineers should model the organizational context considering the strategies in the *Strategic Plan* as implemented. At this point, the modelling process may be assisted by ODMM and ODQS to identify changes between the 'as is' and 'to be' models. Main point of this activity is to understand the organizational differences between the contexts over time.

Activity 2.1.3 - Compare

From comparisons between either set of i* models or contextual scenarios, identify different elements or statements between each two set. Each different element or statement represents an organizational change and is an output of activity 2.1 in Figure 19.

For each organizational change (new element or new statement):

Activity 2.2 - Identify

To identify likely organizational impacts from the organizational changes from activity 2.1, we have decomposed activity 2.2 in 3 sub activity, as follows:

2.2.1 Identify the change's type:

(a) Key people should *decide on one* of the organizational changes previously identified. For that, key people may prioritize the organizational changes according to their own criteria, as relevance of the change to the organization, potential to spark new ideas, familiarity with the organizational change and so on and so forth;

(b) Based on ODMM, key people choose one *organizational dimension* that better fits the organizational change (Strategy, Structure, Operations, Market, Stakeholders or Culture);

2.2.2 Choose the flow of reasoning to follow: to stimulate key people to have a free flow of reasoning, they may choose from either to follow *flow of impacts* (arrows from left to right) or the *flow of adjustments* (arrows from right to left), according to their own insights regarding the ODMM.

2.2.3 Answer ODQS:

(a) Considering the change's type and the chosen flow of reasoning, participants then use the questions from the matching set in the ODQS to identify the likely organizational impacts.

(b) Apply the questions; annotate the organizational changes (the answers of the questions) and the organizational impacts following the flow of reasoning they came up.

Activity 2.3 - Elicit

Then, from the identification of likely organizational impacts, participants analyse the possible impacts on the SSsOIS' requirements. At this activity, requirements engineers should elicit SSsOIS' requirements to deal with the organizational impacts. The origin of the SSsOIS' requirement is an organizational impact and should be registered to keep traceability. This activity's

outcome is SSsOIS' requirements aligned to organizational changes and impacts.

Each cycle of *organizational questions - organizational answers* allows elicitation of SSsOIS' requirements, independently of the chosen flow of reasoning direction, since independently of the chosen flow, ODQS is eliciting the impact of one organizational dimension on other. The flow of reasoning can follow several flows of impacts and flow of adjustments since one change may bring numerous impacts in different organizational dimensions. The procedure can be ended at each *organizational questions – organizational answers – SSsOIS' requirements elicitation* cycle.

To organize elicited information, we used a table, following the template in Table 3. This table supports the rationale behind identifying impacts from organizational changes. To each likely organizational change, there are iterations of questions-answers-SSsOIS' requirements' sets. Dimension A Questions column represents questions from the organizational change's dimension. Next column is for the answers and Dimension A Impacts is for a further rationale on the impacts of the change. Finally, SSsOIS' requirements column is where elicited SSsOIS' requirements will be registered. The use of this table is represented in Table 20, Table 21, Table 28, and Table 29.

Table 3: Template to apply ODQS and ODMM

Context		**Direction of Flow**			
		Flow's name			
Contextual Scenario BEFORE	Contextual Scenario AFTER	Dimension A Questions	Dimension A Answers	Dimension A Impacts	SSsOIS' requirements

4.4.
Validating SSsOIS' requirements changes (LSRV)

Third ODA4RE's sub process is Likely SSsOIS' Requirements Validation (LSRV). It aims at validating previously elicited ***Likely SSsOIS New Requirements*** with organizational key people. The activities of this sub process are pictured in Figure 21 and described below:

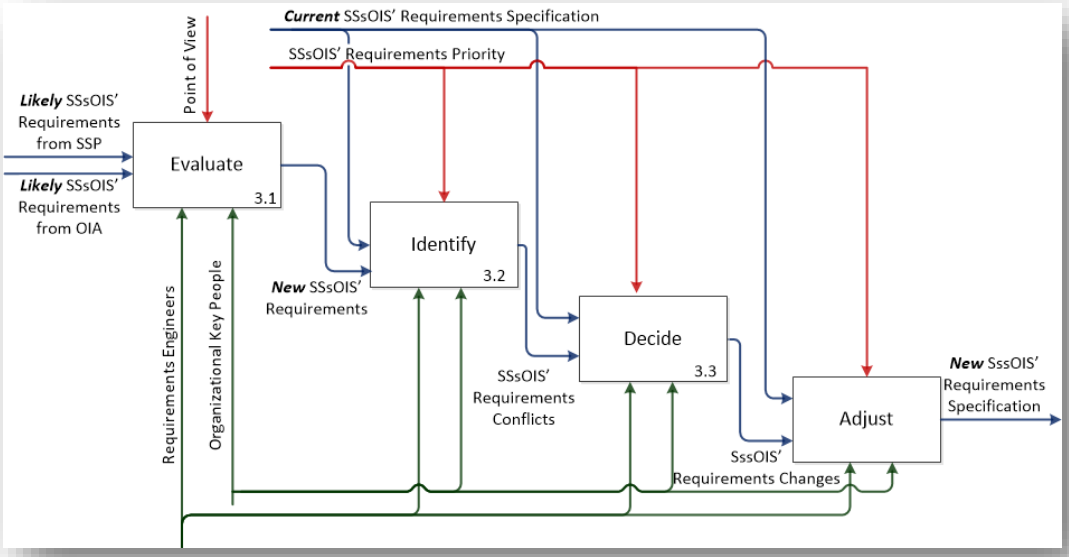


Figure 21: A3 Validate - LSRV

Activity 3.1 - Evaluate

First, resulting likely SSsOIS' requirements are validated by key organizational people. This activity outcome is the ***New SSsOIS' Requirements.***

Activity 3.2 – Identify

Second, organizational key people and requirements engineers compare current and new SSsOIS' requirements in order to identify conflicts between them. This activity's output is the detected SSsOIS' requirements conflicts.

Activity 3.3 - Decide

Then, according to the SSsOIS' requirements priority, organizational key people make decision on the detected SSsOIS' requirements conflicts regarding which of them are going to be adjusted, when (in a short or long term), how

(adding, deleting, merging, splitting,…). This activity's output is the decided SSsOIS' requirements changes.

Activity 3.4 - Adjust

Finally, according to the organizational key people's decisions, requirements engineers adjust current SSsOIS' requirements specification document.

By the end of the Likely SSsOIS' Requirement Validation process, the SSsOIS' requirements specification document is adjusted according to the decisions of organizational key people.

4.5. Final Remarks

In this chapter, we presented ODA4RE, an epistemic tool to elicit knowledge from organizational key people to identify, analyse, and understand organizational changes and impacts raised by strategic initiatives, and how they are likely to influence SSsOIS' requirements. To achieve this ultimate goal, ODA4RE comprises 3 main objectives: identify organization's strategic goals, so aligned with SSOIS; understand likely organizational changes and impacts; and, finally, elicit and validate SSsOIS' likely requirements with organizational key people. To support these main objectives, we proposed one sub process for each of them, being respectively SSP, OIA and LSRV. SSP is a Scenario-based Strategic Planning process, adapted with a taxonomy of software change sources to strategically plan on possible future organization's scenarios, and with an activity to reflect on SSsOIS' requirements demanded by organization's strategic goals on these scenarios. Next comes OIA, an Organizational Impact Analysis aiming at understanding likely organizational changes and impacts raised by strategic goals. For that, we based organizational key people rationale on an Organizational Dynamics Meta-Model (ODMM) and we elicit their knowledge applying the Organizational Dynamics Questions Set (ODQS). Finally, LSRV validates SSsOIS' requirements elicited from strategic goals, organizational changes and impacts with key organizational people.

In next chapter, we present four case studies in which we have evaluated ODA4RE.

5
Understanding Strategic Change Cases and their effects on SSsOIS' requirements – Four case studies

We conducted four case studies to evaluate ODA4RE's subprocess on eliciting knowledge and gaining a deeper understanding of organizational evolution and likely impacts on SSsOIS, described in this chapter.

5.1.
Introduction

In this chapter, we present four case studies we have carried out to evaluate ODA4RE partially or completely. We grounded our case studies on Easterbrook *et al.* (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008)*;* Runeson and Höst (RUNESON and HÖST, 2009), and Robson work (ROBSON, 2002), as detailed in section 2.2.4.

Each one of these case studies had a specific objective. Knowledge built from one was basis for the next and so on. First case study was conducted at a research group with the objective of evaluating SSP, first sub process of ODA4RE, with a posterior adapted LSRV, last sub process of our thesis. Second case study had the participation of academic experts to investigate how to represent organizational changes and impacts aroused from the deployment of a learning management system in their universities. Third case study was carried out at the UK Post Office aiming at evaluating OIA, second sub process of ODA4RE. Finally, last case study was performed at a Brazilian research university with the objective of evaluating ODA4RE as a whole process. Case studies are described in following sections.

We chose real cases for these case studies because they are real strategic initiatives in which known requirements engineering teams have actively worked before. These teams' identities will be kept secret in respect to their privacy. There are other advantages in using real cases. First, they are undoubtedly instances of a concrete strategic initiative, not a conjecture. Second, as the initiatives were carried out without using our proposal, differences between using it and not using it can be made clearer. And third, they gives us the opportunity to

see how ODA4RE can be used epistemically, i.e. as a means to build new knowledge and understanding, while generating new SSsOIS' requirements.

Case studies are reported as follows. All case studies' supporting files, namely meeting minutes, notes, models, data, are available online[2].

5.2. A case study at RE Group PUC-Rio - applying future scenarios as predictive models to software evolution cases (SSP)

In this section, we detail our first confirmatory case study to evaluate the application of SSP, the first process of our proposal, in Figure 10, and test the negative hypothesis NH1.

The case study plan is detailed in Table 4.

Table 4: RE Group' Case Study Plan

RE Group's Case Study Plan	
Objective	Investigate if SSP brings up new/future SSsOIS' requirements
The case	SSsOIS to support organizational dynamics existing in an academic group
Theory	•Strategic management (HILL and JONES, 2012); •Six tools for scenario-based strategic planning (BRANDS, WULF and MEISSNER, 2013); •Software Change Source Taxonomy (MCGEE and GREER, 2012).
Research question	*Q1: How SSsOIS' requirements can be anticipated?*
Data collection method	Observation of SSP process Questionnaire Semi structured interview Document analysis
Unit of Analysis	SSsOIS' requirements
Selection Strategy	Academic experts Experienced software developers (all roles)

[2] https://dl.dropboxusercontent.com/u/21614026/ThesisCaseStudies.rar

In section 4.2, we have proposed SSP, an operationalization for this “how” question (Q1), using strategic management theory and future scenarios as predictive models to reflect about multiple possible organizational futures, and, from these future scenarios, plan strategies and elicit SSsOIS’ requirements to support these strategies. These strategies will lead the organization to evolve in order to achieve its own future objectives. SSP, our operationalization, is elaborated on the assumption that SSsOIS’ requirements will change as the organization evolves itself, bringing about new SSsOIS’ requirements. This is our theory to be tested in this confirmatory case study. By the end, we have validated SSsOIS’ requirements elicited by SSP with stakeholders, the most interested people in these SSsOIS’ requirements, to check if SSP do elicit valid SSsOIS’ requirements, and as such be a valid operationalization to our research question.

First case study was conducted in our RE Group through personal meetings and email exchange to confirm what had been discussed. This team seeks to contribute to this research area’s evolution as well as to each one’s research in particular, forming an organization (a group of people with the same objective). One of the organization’s objectives is supported by *C&L* (Scenarios and Lexicon, in Portuguese) software. C&L is a software for editing symbols of any organization’s lexicon and describing scenarios. Moreover, this software provides for a collaborative environment where users can interact to develop, maintain, evolve and manage projects containing scenarios and lexicon symbols (SILVA, LEITE and BREITMAN, 2005). C&L also *supports development of* the group’s research itself, and, at the same time, *it is developed by* RE group’s research own team, thereby constituting a *symbiotic relationship* between the group and C&L.

5.2.1. Description

Our empirical evaluation description is detailed as follows, telling the story of what has been done through the process.

Sub process 1: Scenario-based Strategic Planning (SSP): Reflecting about multiple possible organizational future (Figure 11)

<u>Activity 1.1 Plan (Figure 12)</u>

Activity 1.1.1 – Project: Definition of Scope

Starting the process in our case study, the key stakeholders discussed about the Framing Checklist points Framing Checklist (Figure 13), the discussion results being presented in Figure 22:

Project Goal	Analysis Strategic Level	Stakeholders Definition	Participants	Time Horizon
• Anticipate possible future scenarios for the RE Group and define strategies based on these scenarios.	• *Business Strategic Unit* • Efficient use of resources • Competiti-veness	• Professors • Students • Researchers • C&L developers	• Members with more experience in the group	• 5-10 years

Figure 22: RE Group answers to the Framing Checklist

Activity 1.1.2 – Understand: Perception Analysis

In our case study, we have applied SWOT Analysis to make participants aware of the group as an organization. This is a structured planning method to highlight **s**trengths, **w**eaknesses, **o**pportunities, and **t**hreats involved in a business initiative. Business objectives are first identified, followed by external and internal favourable or unfavourable factors for organization to achieve said objectives (KING, 2004).

Participants, through discussions and analysis, have come to the following consensus, in Table 5:

Table 5: RE Group's organizational identity

Aspect	Description
Organizational Identity	
Field	*Research about Software Engineering with an emphasis on Software Requirements and Software Transparency.*
Target public	*Researchers, professors, students and practitioners interested in our research area.*
Mission	*Evolving research in our field contributing to researchers' qualification and development.*
Vision	*Being globally recognized and a centre for research and education in our field.*
Strategic Analysis	
Strengths	•*Qualified members;* •*Best Computer Science Department in Latin America;* •*Cooperative work;* •*One of the major research groups in area;* •*Own software.*
Weaknesses	•*General commitment with cooperative targets;* •*Funding to researchers;* •*Lack of support staff (lab technicians);* •*Management of the research;* •*Difficult to keep alumni;* •*Interaction with industry.*
Opportunities	•*Journals and conferences in the research area;* •*Demand for Software Transparency;* •*Demand for Software Engineering (Requirements);* •*Demand for Software Engineering Education (Requirements);* •*Growing Research and Development demand (field for the group);* •*Research edicts by government or industry;* •*Other Software Engineering groups (collaboration);* •*Own software C & L.*
Threats	•*Growing Research and Development demand (taking researchers from the group);* •*Other Software Engineering groups (competition);* •*Hasty understanding of Software Requirements meaning;* •*Hasty UML understanding and application;* •*Qualis CAPES (journals restriction, publications discouragement);* •*Lack of funding (few edicts);* •*Decrease in group members;* •*No framework exists for Lua language to date (one of the languages in which C&L is developed).*

Following that, the participants analysed Table 2 factors list. Under the different participants' perspectives, they have selected through discussions uncertainties and triggers with RE Group's highest impact. This list was also complemented by Table 2 critical factors. This step outcome was a list, presented in Table 6.

Table 6: Main trends, uncertainties, triggers and critical factors for RE Group

Domain	Trends or Uncertainties	Triggers or Critical Factors
Market	**Financial Opportunities**	•Government scholarships •Industry scholarships •Institution scholarships
	Research Field Stability	•New opportunities •Decline in interest from research community
	Publications	•Works acceptation score
	Concurrency	•Open data: new patterns •Other Software Engineering groups: new software technologies
	Assessment of the Institution	•Keeping best assessment •Decreasing assessment
Organization	**Group Stability**	•Leadership changes •Members cohesion •Increasing members number •Decreasing members number
Solution	**Technological Solutions**	•Technological infrastructure evolution used facing software and hardware evolution
	C&L	•Programming language stability (Lua, PHP) •Development support (framework)

Activity 1.1.3 – Select: Trend and Uncertainty Analysis

To identify RE group's two key uncertainties, participants first openly discussed the list in Table 2. Afterwards, to assess uncertainties without undue influence from each other, they privately listed on a piece of paper the two most critical uncertainties giving their impact and uncertainty. Then, the opinions on the papers were ranked in the Impact/Uncertainty Grid according votes on paper. Almost all participants voted on *Group Stability* as RE group's most critical

uncertainty. Secondly, comes *Financial Opportunities*. These key uncertainties were used in the ensuing step of this scenario-based approach to prepare SSsOIS for software evolution. These and other RE Group's key uncertainties are listed in Figure 23.

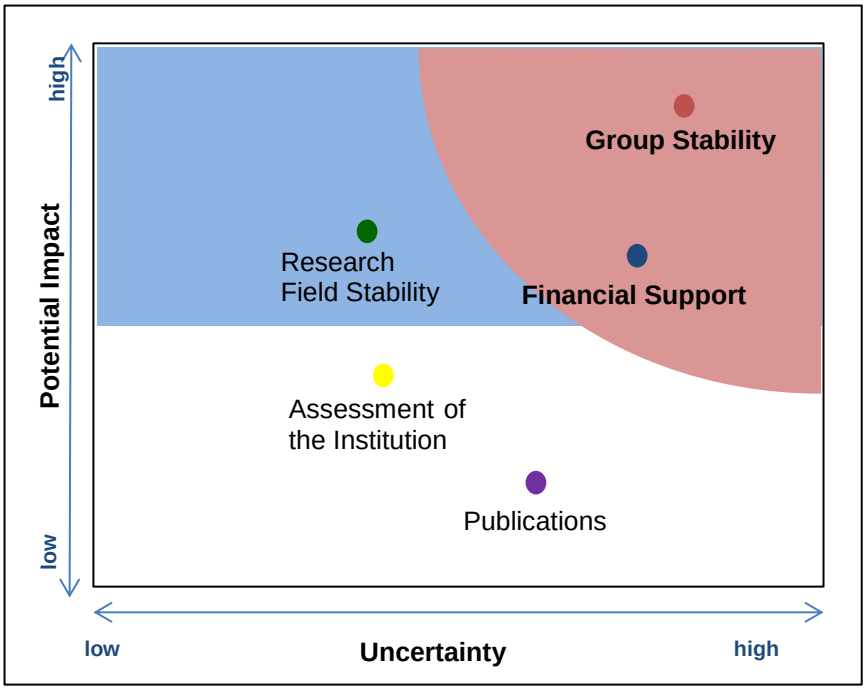


Figure 23: Impact/Uncertainty Grid for the RE Group

Activity 1.1.4 – Build: Scenario Building

Combining the key uncertainties of our case study, we have come to Scenario Matrix: *Group Stability x Financial Support,* in Figure 24.

The combination of the two dimensions of this matrix comprised four future scenarios of the RE Group, as follows:

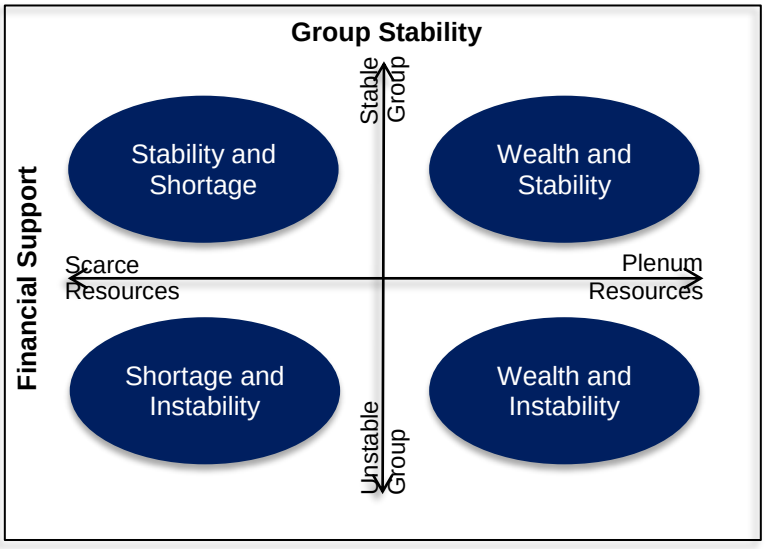


Figure 24: Scenario Matrix by RE Group

Group Stability x Financial Support

- *Shortage and Instability:* this is the worst possible future scenario. In this scenario, RE Group has no funding or stability at all. The few members that remain have to seek alternative financial forms, and leadership is also unstable. This causes a task overload which members have short extra time to perform. The consequence is less specialized responsibilities, fewer tasks accomplished by members, greater volume of individual work;
- *Stability and Shortage:* in this future scenario, although the group does not have any funding, it is a stable group, cohesive, with an appropriate number of members and its leadership is certain. Members still have to find an alternative financial source. In this world, as there are more members, more tasks are performed in group, more specialized responsibilities, and fewer tasks per person.
- *Wealth and Instability:* the RE Group in this future scenario has plenty of options of funding, from industry, government and the institution; conversely, it is an unstable group, disconnected, presenting an inappropriate leadership and number of members. This instability results in fewer tasks performed in general, less specialized responsibilities and more workload per person.
- *Wealth and Stability:* this combination yields the best future scenario, with no restrictions. In this future scenario, RE Group has funding and

stability. The group is sponsored by the government, the industry and the institution and has proper members and leadership. For being financed by the group, members can dedicate themselves exclusively to research for the organization intents. The group performs more tasks, more specialized responsibilities, and minor number of tasks per person.

Activity 1.1.5 – Define: Strategy Definition AND <u>Activity 1.2 – Align</u> (Figure 16)

This activity started, in the RE Group, with a discussion about RE Group future, taking into account the aforementioned elements. Thus, participants have identified general strategies applicable to all future scenarios related both to RE group and to C&L. These strategies bear in common focus on *quality*, both *process* and *product quality* aspects. These are listed in Table 7.

Table 7: RE Group's strategies applicable to all future scenarios

Aspects	RE Group	C&L
Goals	• Achieve global recognition as a research and education centre in Software Engineering with emphasis on Software Requirements and Software Transparency.	• Make C&L a robust tool, basis for Software Engineering with emphasis on Software Requirements and Software Transparency (tools, methods and support strategies). • Evolve C&L.
Strategies	• Obtain financial support • Attract new researchers • Foster cooperative work in group • Produce papers	• Expand knowledge base (e.g. source code); • Manipulate knowledge base; • Integrate with other tools (plug-ins) • Use C&L as a Lua-education tool
Actions	• Publicize group, its goals and results • Write publishable articles in vehicles indexed by Qualis CAPES • Submit research projects to financial edicts • Record group meetings • Control group meetings • Manage group meetings	• Attract undergraduate students to develop and evolve requirements • Produce tutorials about C&L • Encourage undergraduate students to research • Plan desired structure • Publicize C&L and its functionalities • Improve usability

In addition, to define each scenario strategies according to Scenario Matrix dimension, *Group Stability* is assessed regarding aspects of leadership, cohesion and number of members in the group, and *Financial Support* regarding government, industry and institution funding. Leading question in this discussion was, "*How to achieve RE Group's objectives in each scenario?*". The outcome of this discussion is shown in Figure 25.

By wondering about SSsOIS role in RE Group at the moment, participants agree even C&L contributes to RE Group's research, and it is an Information System in what concerns information management, however it is not a SSsOIS in what concerns managing information to the organizational decision-making process. Regarding this, requirements elicited are to a future SSsOIS and to C&L, according to future scenarios.

Then, participants reasoned about the SSsOIS' role in each of these future scenarios. Figure 26 shows the resulting strategies to manage the SSsOIS formulated by RE Group. Then, SSsOIS' requirements were elicited from the resulting Strategic Plan to a SSsOIS to be developed.

As follows, we list general SSsOIS new requirements originated from Table 7. These requirements are in "High Level Requirements". Initially, we have focused on functional requirements. In time to come, these requirements will be elaborated in a lower level of abstraction as well as non-functional requirements will be elicited.

Group Meetings

FR01: SSsOIS shall maintain group meetings, keeping data as for example, date, time, local, participants, topics, subjects, issues to be solved, log and so on.

FR02: SSsOIS shall produce reports on groups meetings, as for example, subjects discussed, frequency of subjects being discussed, issues solved, pending issues; members attending the meeting, frequency of members, and so on.

FR03: SSsOIS shall manage tasks to be performed by RE Group's members.

Figure 27 shows SSsOIS' requirements in each future scenario. These SSsOIS' requirements originate from Figure 25 and Figure 26. Requirements identified by FR are for SSsOIS e by EVOL are for C&L.

Activity 1.3 – Monitor

This activity is still in execution in our case study. The case study indicators are *leadership, number of RE Group members, financing value (in Brazilian currency)* and *Likert scale to represent RE Group's cohesion*. Those indicators are constantly monitored and according to their range, respective identified strategies are implemented.

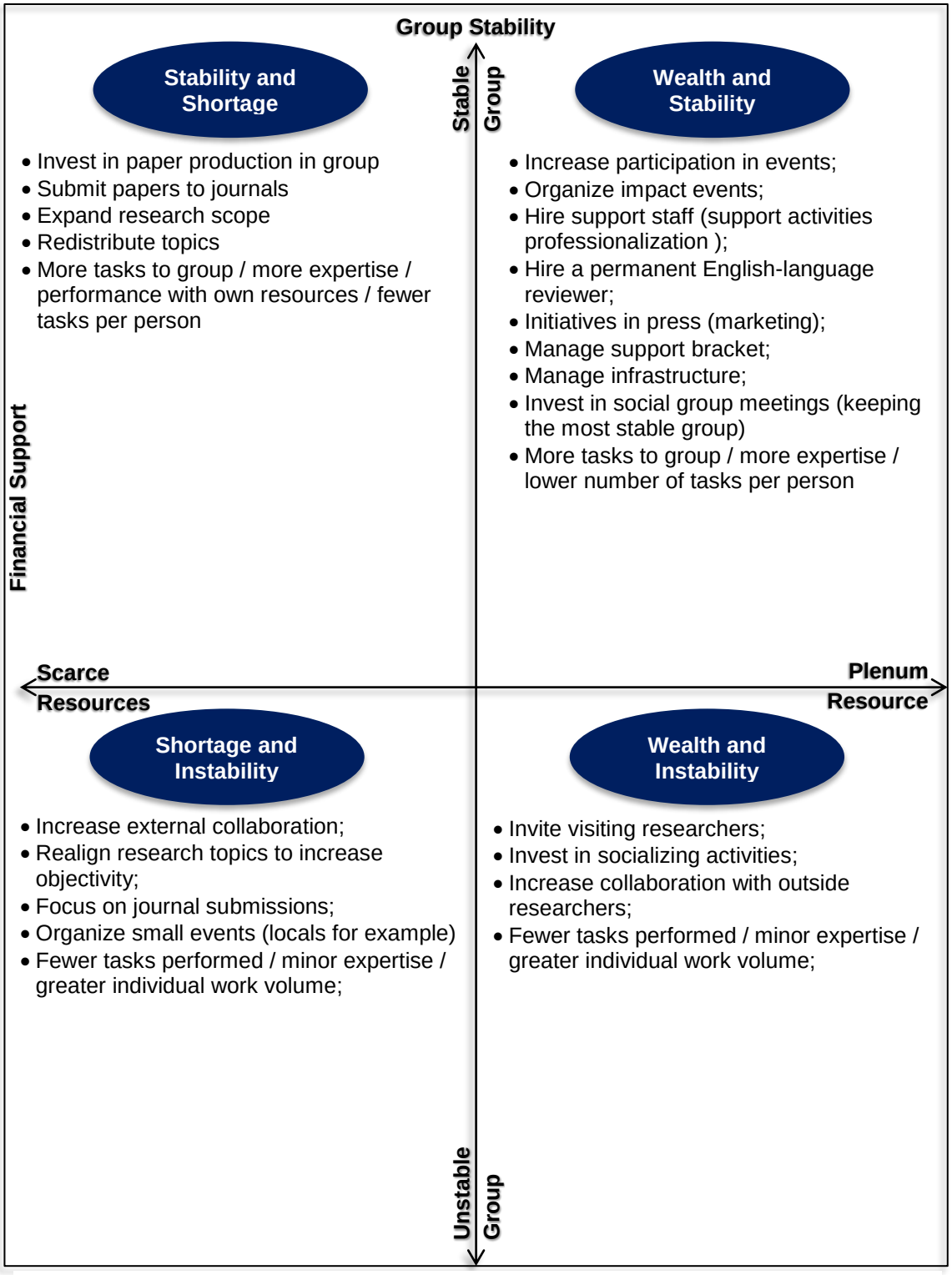


Figure 25: RE Group Strategies applicable to each scenario

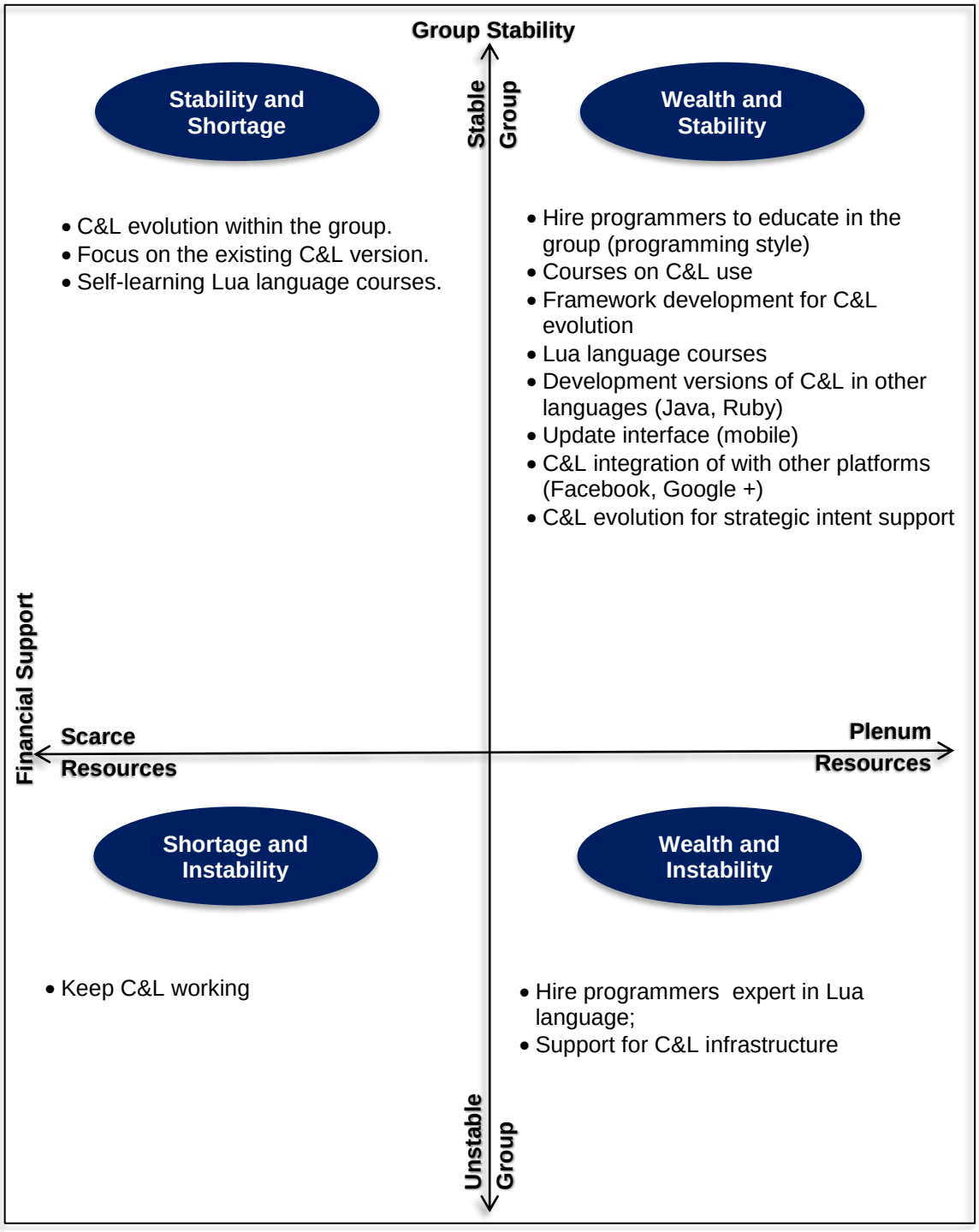


Figure 26: C&L-related Strategies in each scenario

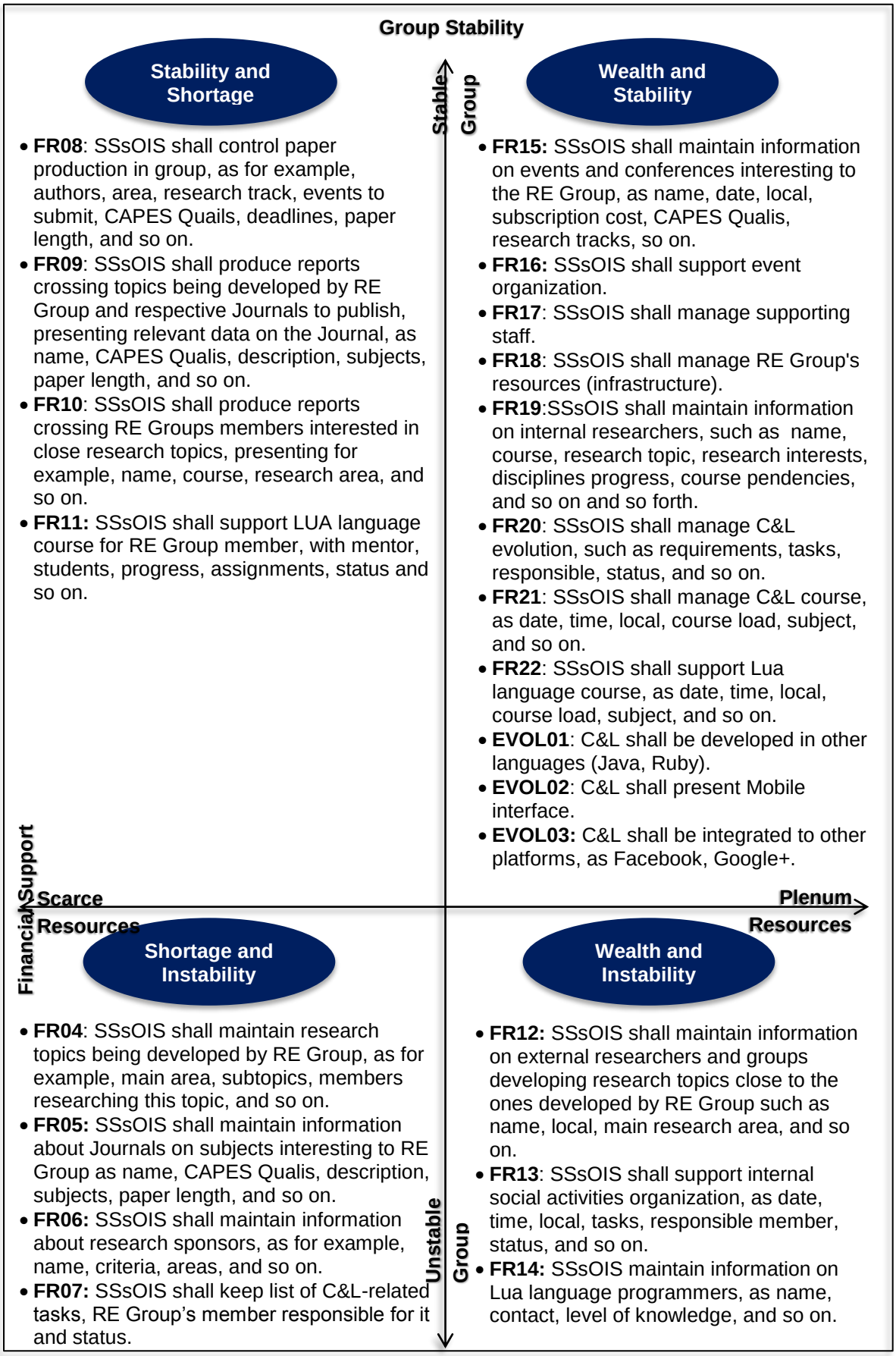


Figure 27: High level SSsOIS' requirements examples to each RE Group's future scenario

Sub process 3: Validating SSsOIS' requirements changes (LSRV) (Figure 21)

Finally, we have made a SSsOIS' requirements validation with RE Group members. Despite RE Group has plenty software systems running, as C&L, WERPapers, WTranSPapers, currently there is not a specific SSsOIS supporting RE Group's organizational decision-making process. Thus, this case study was more a SSsOIS' requirements elicitation, therefore, we evaluated the SSsOIS' requirements and the last three activities of our process LSRV were not executed. We have applied a digital questionnaire to evaluate the quality of SSsOIS' requirements resulting from SSP application in RE Group and SSP as a method itself. This questionnaire comprised closed and open questions, closed questions to evaluate the requirements' qualities, presented in section 2.2.5, and open questions to evaluate results and SSP method. It is presented in APPENDIX D, in Portuguese, respondents' native language.

As the application of SSP in RE Group occurred in July of 2014 and the questionnaire application occurred between August and September of 2016, to support questionnaire answering we have sent the final document attached to the questionnaire, explaining the experience of SSP process in RE Group. This final document presented the storyline of SSP application and resulting artifacts, as described in previous section 5.2.1. Questionnaire was divided into three sections, being Participant profile, SSsOIS' requirements evaluation, and Method evaluation; and it is presented in . Results are presented in next section.

5.2.2. Results

In this section, we present RE Group's evaluation results according to questionnaire sections. This questionnaire had quantitative and qualitative questions, as follows:

Participants Profiles

Currently, RE Group involves eight members and the questionnaire received six responses, corresponding to 75% of the total. All respondents have a role in academy and in industry. Academic and professional profiles are described in Table 8.

Table 8: RE Group's professional and academic profiles of questionnaire respondents

Participant	Professional			Academic		
	Current profession	**Current enterprise**	**Experience (years)**	**Current position**	**Current university**	**Experience (years)**
1	RE consultant	LES-PUC-Rio	8	Professor	PUC-Rio	1
2	RE consultant	PUC-Rio	20	Professor	PUC-Rio	35
3	RE consultant	UERJ	20	Professor	UERJ	18
4	Quality analyst	Oi	24	PhD candidate	PUC-Rio	3
5	System analyst	LES-PUC-Rio	10	Professor	UFRRJ	1
6	RE consultant	LES-PUC-Rio	13	Doctor	PUC-Rio	1

Next, we have asked if respondents were present during SSP application, highlighting that being a RE Group member is sufficient to assess the quality of the elicited SSsOIS' requirements and the participation at the SSP is not required for the continuation of this questionnaire. Answers indicate 4 in 6 have participated of SSP application (67%).

Requirements Evaluation

Following, we asked respondents to asses SSsOIS' requirements regarding qualities presented in section 2.2.5, using a Likert scale to quantify *Little* (1) and *A Lot* (5). Answers are separated by qualities and cells indicate the amount of answers for that number in Linkert scale, as shown in Table 9.

SSsOIS' requirements	Possible												New						Relevant						Useful											
	Short term						Long term																		Short term						Long term					
Linkert Scale	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*
RF01	-	1	1	1	3	-	-	2	-	-	4	-	2	1	-	-	-	3	-	1	-	-	5	-	-	1	1	1	3	-	1	1	-	-	4	-
RF02	-	1	1	-	4	-	-	2	-	-	4	-	2	1	-	-	-	3	-	-	3	-	3	-	-	-	1	1	4	-	-	1	1	-	4	-
RF03	-	-	2	2	2	-	-	1	1	1	3	-	-	-	1	1	2	2	-	-	1	4	1	-	-	-	-	4	2	-	-	-	1	3	2	-
RF04	-	-	3	-	3	-	-	1	1	1	3		1	1	1	-	-	3	-	-	3	1	2	-	-	-	4	-	2	-	-	1	1	1	3	-
RF05	-	1	1	1	3	-	-	-	1	2	3	-	-	-	1	1	2	2	-	-	2	2	2	-	-	-	1	2	3	-	-	-	-	1	5	-
RF06	-	-	2	1	3	-	-	1	1	-	4	-	-	-	2	-	1	3	-	1	1	1	3	-	-	1	1	1	3	-	-	-	1	2	3	-
RF07	-	-	2	2	2	-	-	1	2	1	2	-	-	-	2	-	2	2	-	1	2	2	1	-	-	-	2	4	-	-	-	1	2	2	1	-
RF08	-	-	1	2	3	-	-	1	1	1	3	-	-	-	-	2	1	3	1	-	1	1	3	-	-	1	1	2	2	-	-	1	2	1	2	-
RF09	-	1	1	1	3	-	-		3	-	3	-	-	-	2	-	1	3	-	-	2	1	3	-	-	1	1	-	4	-	-	-	3	-	3	-
RF10	-	-	2	1	2	1	-	1	1	1	2	1	-	-	1	1	2	2	-	1	1	2	1	1	-	1	2	1	1	1	-	2	1	1	1	1
RF11	-	1	3	2	-	-	-	1	1	3	1	-	-	1	-	-	3	2	1	1	2	1	1	-	1	1	1	3	-	-	-	1	2	2	1	-
RF12	-	1	2	-	3	-	1	1	1	-	3	-	-	1	1	1	1	2	-	1	2	-	3	-	-	1	3	-	2	-	1	1	1	-	3	-
RF13	-	2	-	1	3	-	-	2	-	1	3	-	-	1	1	1	1	2	-	2	2	2	-	-	-	3	-	3	-	-	-	3	-	2	1	-
RF14	-	1	1	2	2	-	1	-	1	1	3	-	-	1	-	-	3	2	-	3	-	2	1	-	1	2	-	3	-	-	1	2	-	2	1	-
RF15	-	-	1	2	3	-	-	-	1	2	3	-	-	1	1	1	1	2	-	-	1	1	4	-	-	-	1	2	3	-	-	-	1	1	4	-
RF16	-	1	2	2	1	-	-	-	3	1	2	-	1	-	2	1	-	2	-	-	1	3	2	-	-	-	2	2	2	-	-	-	2	2	2	-
RF17	-	2	2	2	-	-	-	1	2	2	1	-	-	1	-	1	2	2	-	2	1	1	2	-	-	2	1	1	2	-	-	2	1	1	2	-
RF18	-	-	2	2	2	-	-	-	1	2	3	-	-	-	1	-	3	2	-	-	2	1	3	-	-	-	2	1	3	-	-	-	2	1	3	-
RF19	-	2	1	1	2	-	-	1	2	1	2	-	-	-	2	-	2	2	1	-	2	3	-	-	1	-	2	2	1	-	-	-	3	2	1	-
RF20	-	1	1	2	2	-	-	1	-	3	2	-	-	1	1	-	2	2	-	1	1	2	2	-	-	1	2	1	2	-	-	-	3	1	2	-
RF21	-	2	1	1	2	-	-	2	2	-	2	-	-	1	-	1	2	2	-	-	1	3	2	-	-	-	3	2	1	-	-	-	2	3	1	-
RF22	-	1	2	1	1	1	1	1	1	1	1	1	-	1	-	-	3	2	-	2	1	2	-	1	-	2	2	1	-	1	-	2	2	1	-	1
EVOL01	2	2	1	1	-	-	-	1	4	-	1	-	-	1	-	-	3	2	-	2	2	1	1	-	-	2	1	2	1	-	-	1	2	2	1	-
EVOL02	1	-	4	1	-	-	-	-	2	1	3	-	-	-	1	-	3	2	-	1	-	3	2	-	1	-	-	4	1	-	-	1	-	2	3	-
EVOL03	1	2	1	2	-	-	-	1	2	1	2	-	-	-	1	-	3	2	-	1	-	3	2	-	1	1	-	3	1	-	-	-	1	4	1	-
TOTAL	**4**	**22**	**40**	**33**	**49**	**2**	**3**	**22**	**34**	**26**	**63**	**2**	**6**	**13**	**21**	**11**	**43**	**56**	**3**	**20**	**34**	**42**	**49**	**2**	**5**	**20**	**34**	**46**	**43**	**2**	**3**	**20**	**34**	**37**	**54**	**2**

Table 9: RE Group's quantitative evaluation about requirements quality

In Table 9's last line, we can observe most answers agree elicited requirements have strong qualities. Each of 6 qualities have 150 answers (25 requirements x 6 participants). Namely:

- *Possible in short term: **55%** answers are between 4 and 5 expressing requirements are a lot possible in short term.*
- *Possible in long term: **59%** answers are between 4 and 5 expressing requirements are a lot possible in long term.*
- *New: **36%** answers are between 4 and 5 expressing requirements are a lot new and **37%** are NA.*
- *Relevant: **61%** answers are between 4 and 5 expressing requirements are a lot relevant to RE Group.*
- *Useful in short term: **59%** answers are between 4 and 5 expressing requirements are a lot useful in short term.*
- *Useful in long term: **61%** answers are between 4 and 5 expressing requirements are a lot useful in long term.*

Next questionnaire question was a qualitative question about a general evaluation of elicited requirements. Table 10 shows qualitative participants' answers confirming quantitative answers in Table 9:

Table 10: RE Group's general evaluations about elicited requirements

RE Group's answers about requirements evaluation
Everything can be developed in two years, but not necessarily this period is short. Requirements are relevant to the group; most can be implemented in short term, but when viewed unitarily.
Very useful.
My impression is the work is rich is very well detailed. However, I believe there are too many requirements. I think the most important should be selected, reducing the number at least half. To control something with quality on organizations day-to-day routine, we must have fewer controls, if less detailed specific. Much memory, a lot of data, many details, requires much more analysis time. Lose agility and focus most of the time. In large companies it is impossible to manage many indicators, for example, it is an unworkable control.
Relevant requirements to monitor group's activities.
Requirements were elicited 2 years ago, when the group was larger and more concise. Currently, any initiative is difficult due to group size and little members' availability.
Interesting but as I haven't participated in the strategic planning, it is difficult to answer some questions

Participants were also asked if they had suggestions for adding new requirements, remove, alter, combine, and decompose listed requirements. Table 11 shows the answers to this qualitative question.

Table 11: RE Group's suggestions on requirements changes

RE Group's answers about requirements change
You can combine support for publication and support for development of articles. This is more relevant because they impact the group's production.
Not now.
I do not have suggestions, but I think the way the requirements are presented, do not allow me to suggest.
It could include SimulES-W that needs reprogramming and is great to teach software engineering and requirements.
As previous answer, decrease to half, leaving only the most comprehensive and highest degree of relevance.
Programming languages classes are not the priority tasks of the group.

SSP Method Evaluation

In last section of the questionnaire, we have asked participants to evaluate SSP as a method to elicit requirements aligned to the strategic planning process. Table 12 shows the answers to this qualitative question.

Table 12: RE Group's answers about SSP evaluation

RE Group's answers about SSP evaluation
The construction of scenarios based on the matrix appears to be a strong point because it well defines the segment of the reasoning in the definition of actions. However, considering the four scenarios, which one the literature presents as the best option in case of uncertainty? Which brings the lowest risk? Be pessimistic, optimistic or more or less? The answer will enable analysis of the requirements set for the scenario, and it may be possible to draw further conclusions about the organization from that.
Method suitable for complex and long-term projects.
Very good.
If I understand correctly, my impression is that it is a richly detailed and careful method for maximum reflections to be initiated, promoted, and so the best action strategies are selected and then controlled, evaluated and monitored. The problem may be that is not very succinct (setback of the detail that enriches), may the agility be penalized, especially in a world as dynamic as which we live.

The elicitation of requirements occurs concurrently with discussions ideas, I think that this revision of requirements should also be something together, especially when it comes to strategic alignment.
Good validation, strengths: closed and open questions, weaknesses: options of responses, it could be good to give an example.

Next, participants were asked if the proposed method has contributed to SSsOIS requirements elicitation and why. Figure 28 show quantitative answers and Table 13 shows answers to qualitative question explaining their opinions.

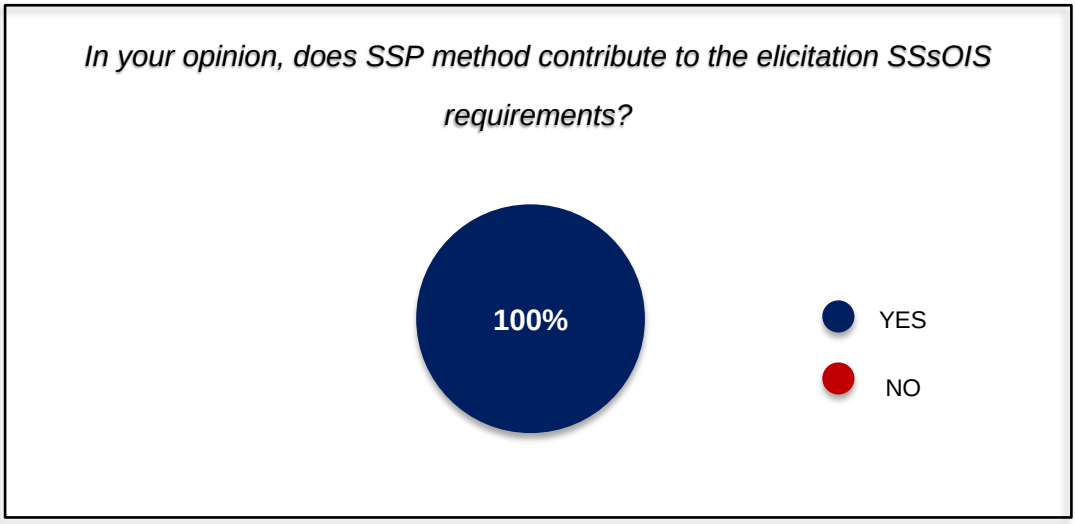


Figure 28: RE Group members' answers whether SSP contributes to requirements elicitation or not

Table 13: RE Group explanations whether SSP contributes to requirements elicitation or not

RE Group's explanations about if SSP contributes to requirements elicitation
You can think outside the box and volunteer to possible actions. Design future requirements means being able to predict IT budget and redirect actions to maintain organizational alignment.
It makes possible to explicit group's goals and their alignment to the tasks to be performed.
It provides a step by step, richly contributing to elucidation.
Because several of the elicited requirements were assessed as new and useful.
At the time, I think it helped. As the method was partitioned and has a long time that we have run it, I confess that I had a little difficulty in answering this question.
Because it questions requirements, presents inclusive questions of new requirements and evaluation of former questions.

We also have asked what participants would change in SSP method. Table 14 shows the answers to this qualitative question.

Table 14: RE Group answers about changing SSP

RE Group answers about changing SSP
Larger computer support (supporting tools).
No.
Improvement not, but evolutions, because anticipate software requirements also allows you to design several other aspects as IT and business have a lot of integration.
Try to summarize it, reduce steps and step by step, which is a major challenge, since we should not lose quality. A balance between comprehensiveness, expressiveness, agility and flexibility is difficult to conquer.
Show their applicability in small projects or median.
Again, I think we needed a presentation of the method in person again, to remember what we have done; only with the material sent is too vague to remember everything, since it was 2 years ago.

By the end of the questionnaire, we have asked RE Group members if they would apply SSP, recommend SSP and their reasons for that. Answers were again based in a Likert scale, 1 representing 'Strong no' and 5 represent 'Strong yes'. Figure 29 and Figure 30 show quantitative answers and Table 15 qualitative answers.

Would you apply SSP method to support SSsOIS' requirements elicitation in your projects?

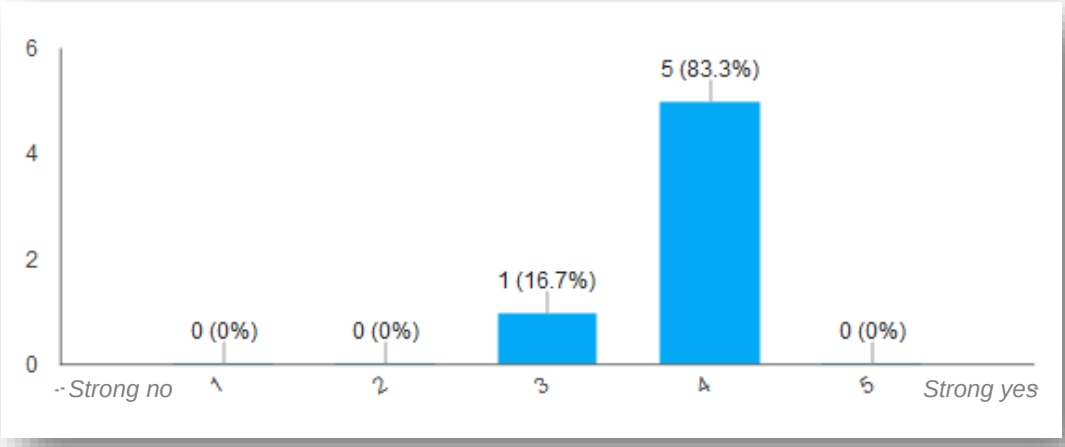


Figure 29: RE Group's answers about whether they would apply SSP or not

Would you recommend SSP method to support SSsOIS' requirements elicitation?

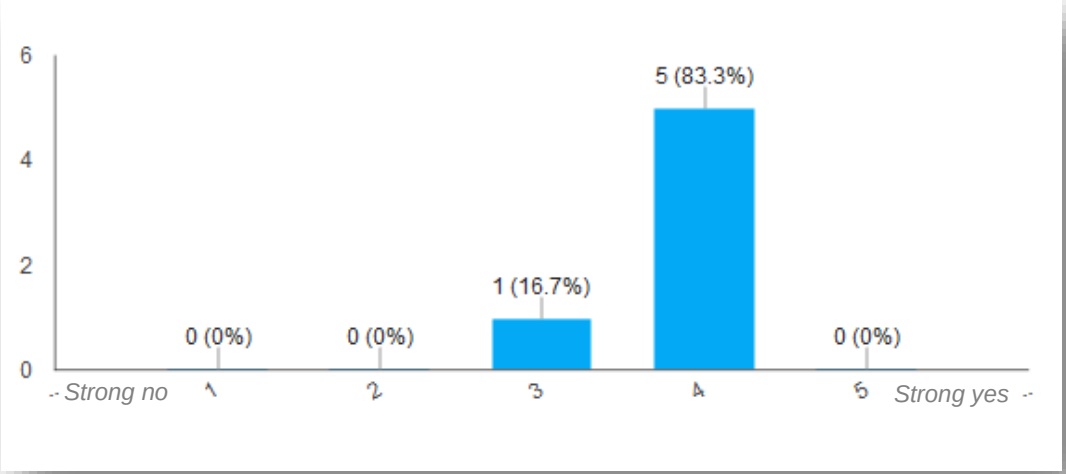


Figure 30: RE Group's answers about whether they would recommend SSP or not

Table 15: RE Group's explanations whether they would apply or recommend SSP or not

RE Group's explanations about if they would apply or recommend SSP
It's a possible strategy, but it is necessary tool support and a better distinction in terms of the timeline (maybe a scale of 5 for time). The issue is also how this scheme would be linked to requirements management and prioritization.
SSP is a rich method. It is detailed and thorough.
SSP helps to identify implicit or unknown requirements.
Same previous answer, I do not have the security to assess the method, since it was used a long time ago. I need to study and understand it better.
SSP can help in strategic planning decisions.
Validation was a little extensive and long and short-term responses may confuse. I do not think it is necessary to ask about "new" because I did not have access to the previous document or even participated in the strategic planning process.

5.2.3.
Discussion

In section 5.2, we studied the strategic planning initiative SSP case at RE Group (PUC-Rio). Participated in this initiative 9 people, been 1 Professor, 6 PhD students, 1 Master student and the first author as a facilitator. All of them are C&L users, and 2 of them are C&L developers. Strategic planning initiative was developed through emails exchange, meetings, and strategic plan collaborative writing. The initiative was planned by the 2 authors for 2 weeks, and was started by an email to RE Group comprising the approach basic description, preparing them to the strategic planning initiative. Then, during two weeks, RE Group had two meetings, each one 3 hours long, once a week, and discussed related subjects by emails. During the meetings, the RE Group collaboratively applied all approach's tools, coming to the strategic plan. This document was collaboratively refined and improved by all RE Group members, until last version. As core strategies, it presents 1 main goal for the organization and 2 for C&L; complemented by 4 strategies each; and 6 actions each. As complementing strategies, for future scenarios, RE Group has formulated 23 organizational strategies, 14 C&L strategies and 25 possible new high level SSsOIS' requirements. By the strategic planning initiative end, we conducted a questionnaire as presented in previous section.

Through application of each of the scenario-based framework seven phases, from multiple perspectives, we were able to ascertain gradual construction of a common ground for discussion, organization awareness and necessary knowledge to plan strategies for organization's future aligned with SSsOIS. In the first activity, participants defined *Scope*, i.e., the basis for strategic planning initiative, depicted in Figure 22. Second activity, *Perception Analysis* has allowed for a discussion bringing awareness of the group as an organization and identifying main factors for uncertainty, as in Figure 23, and Table 5. Third activity, the participants have identified the *Trends and Uncertainties* most likely to bring the highest impact upon the group - *Group Stability* and *Financial Opportunities* - as in Figure 23. Next activity, they elaborate on uncertainties, extending constraints to build scenarios from combinations. In Figure 24, we see the four resulting *Future Scenarios,* as in the text. Once aware of possible future scenarios, according to them, participants managed to develop multiple *Strategies*, Figure 25, overcoming possible existing perceptual biases. Following the process, they have focused on identifying

SSsOIS-related strategies to address scenarios. Finally, context is being monitored to apply strategies when necessary. Thus, from the most likely strategic changes, found in Figure 25, we can see that the *Negative Hypothesis 1 (NH1) is rejected,* since future scenarios may indeed present likely organizational changes in advance possibly bearing impacts on SSsOIS, as in Figure 26 and in Figure 27.

Regarding the *Testing Questions (TQ)* stated in section 2.2.4: as observed in Table 7 and Figure 25, our approach identified 4 possible alternative futures for RE Group, represented by the *future scenarios*. By reasoning on each one of them, RE Group was able to anticipate new strategies to manage the organization (Figure 25) and the SSsOIS (Figure 26). Hence, our approach indeed anticipated likely organizational changes (showed in Table 7, Figure 25 and Figure 26), more specifically, *strategic changes (TQ1)*. Further analysis on these likely organizational changes may bring beneficial value to SSsOIS' requirements evolution, such as more alignment with the organizational evolution, since the new SSsOIS' requirements are based on how to support the new strategies now identified *(TQ2)*. Consequently, our approach addresses SSsOIS' requirements related to the organization, or to *business rules cluster* explained in section 3.2 *(TQ3)*. Examples of high-level SSsOIS' requirements related to each organizational future scenario are presented in Figure 27.

Requirements evaluation on Table 9 shows that SSP contributed towards eliciting qualified requirements, which was confirmed by participants in Table 10 and Table 11. Regarding the method, we observed in Table 15, SSP brings a strategic thinking to requirements engineering, fostering organization awareness when eliciting SSsOIS' requirements and as a result contributing to elicit unknown requirements. Besides that, this now elicited organizational knowledge may be income for other decision-making process, for example *predicting IT budget and redirecting actions to maintain organizational alignment,* as said in Table 13. We understood that thinking following a scenario-based planning stimulates different perspectives and by the end, strategies for specific scenarios may complement each other, as in Table 12. Participants' feedback also inspired future work, discussed in section 6.4, as application and tool support in Table 14.

After performing the case study, we find the following contributions from our proposal:

- *Early organization changes identification :* an in-depth discussion about the future organization allows for identifying likely organizational changes;
- *Early identification of requirements change possibilities:* while thinking ahead about the future and about how SSsOIS could support organization strategies in each scenario, key people have identified requirements changes needs for keeping the SSsOIS consistent with new environmental requirements, as displayed in Figure 25, Figure 26 and Figure 27;
- *Identification that, the deeper each scenario analysis is, the more specific requirements evolutions are anticipated:* whilst participants would think about how future could be in each scenario, we have ascertained that the deeper they went into each, the more specific requirements evolutions were identified for keeping the SSsOIS aligned with their intents. Analysis possibility is infinite, determined by time restrictions.
- *Identification of strategies for SSsOIS management:* while formulating strategies to achieve specific goals, key people have realized that some strategies related to SSsOIS management should equally be implemented;
- *Support to align organization's strategic intents with SSsOIS:* during key uncertainties identification for the organization and for SSsOIS, we have ascertained that fostering key people towards thinking about both aspects in parallel has contributed their making decisions based on both, stimulating alignment between them;
- *Support for better strategies' creation free from managers' biases:* framework bases strategies elaboration on acknowledgement of uncertainties and on thinking about multiple possible futures.
- *Awareness of organization:* each SSP activity contributes to increasing understanding about the organization.

Finally, as this case study was executed 2 years ago, we could observe a monitoring process is as important as a structured strategic planning process. In case little effort is focused on monitoring process, results from SSP may be compromised.

5.3.
A case study on Learning Management System at Universities - modelling organizational impacts of strategic changes

In this section, we detail our second exploratory case study on investigating how to represent a general organizational dynamics model of organizational changes and consequent impacts, as in a ripple effect.

Models offer strong potential to establish a common base for discussion and reasoning, gain insights, and deepen our understanding of a phenomena being studied (HORKOFF, BARONE, JIANG, YU, AMYOT, BORGIDA and MYLOPOULOS, 2014). To understand how to model an organizational change situation, we conducted a case study about the deployment of Learning Management Systems (LMS) at Universities. The case study was carried out at the HCID's Group (Human Computer Interaction Design's Group), a Centre at Faculty of Informatics of City University London, where this PhD candidate has spent one year as a visiting PhD student. We gathered three experts in academic subjects, being a Professor with 24 years of teaching experience, an Assistant Professor with 11 years of teaching experience, a Canadian Post-doc researcher, Doctor for 6 years and this PhD candidate as a mediator. The case study plan is detailed in Table 16.

Table 16: Learning Management System Case Study Plan

Case Study Plan	
Objective	Investigate what elements in a model are important to represent a real case of organizational change and its organizational impacts in a way it can be generalizable to other organizations
The case	Personal experiences from academic experts on the organizational changes brought up by the deployment of a LMS at their own universities
Theory	Galbraith's Star Model, Figure 6, and the relation of impacts between organizational dimensions, Figure 7 (GALBRAITH, 1995)
Research question	*Q1: How to represent a situation of organizational change and its organizational impacts aiming at eliciting and understanding organizational knowledge?*
Data collection method	Workshop with experts about personal experiences on LMS deployment

Unit of Analysis	Resulting organizational change model with elements meaning in context
Selection Strategy	Academic experts

5.3.1. Description

In this workshop, we based the discussion on Galbraith's Star Model (GALBRAITH, 1995) in Figure 6, and the direct impact relations between organizational dimensions in Figure 7. Then, starting from the top of Figure 7, we considered for this case as a strategic goal: "*Improve the management of teaching practice in the university*." and as a strategic action: "*Deploy a LMS to support the teaching practice in the university*". The main organizational change is that now the process of teaching turns supported by a LMS.

Have this common sense being established, experts began to relate what they have experienced and changed in their own teaching process. Following Figure 7, experts reflected about impacts on organizational *structure* and *process*, then on *people policies* and *reward systems*.

They started discussing LMS and accessibility to the material, and consequent traceability, transparency and more accountability. It allows more control on students and professors, resulting in changing the structure of organizational power and the sense of replaceability between professors. Also, the access to the material may change the legal owner of the material (professor or university?) implying in legal issues. Besides, LMS influences communication between professor-students student-students, may have impacts on decreasing prejudice because there is less personalization. The workshop lasted about 1 hour, was recorded and later, thoroughly analysed.

As the main objective of this case study was to represent organizational changes and impacts, first, we annotate and audio recorded the workshop. Second, we modelled the discussion according to the main subjects brought up by the experts. Then, we linked each subject and the topics in them, following the reasoning by which they were raised at the meeting.

5.3.2. Results

Aiming at representing a situation of organizational change and its organizational impacts in order to extract a model generalizable to other organizations, we have modelled LMS workshop's discussion using four models as a basis, as reported below. In each modelling trial, we reviewed literature and refined the final generalizable model according to lessons learned.

Primarily, we attempted to model LMS workshop's discussion based on Gilbraith's Star Model, in Figure 6 and Figure 7. However, the discussion was too complex for this base model, presenting more classes of concepts, elements, and flows of impacts than Gilbraith's Star Model supported to fit in.

Next, considering a strategic change as an organizational intervention, we modeled LMS workshop's discussion following the Four Levels of Organizational Intervention (RUSSEL and RUSSEL, 2014). We have chosen this model because it reproduces organizational intervention according to four components present in every organization: physical (the visible aspects of the organization), infrastructure (the systems and processes for directing and managing work), behavioural (the daily actions and reactions of employees), and cultural (the underlying assumptions, values, beliefs and norms that shape daily behaviour). And, more than that, it relates organizational change's durability and complexity depending on these components. Even though this base model has contributed to a deeper understanding in what organizational levels (or dimensions) the organizational change fitted and the flow of impacts it brought, the resulting model, in APPENDIX B is complicated to build and challenging to understand.

Then, we represented LMS workshop's discussion in a concept map, portrayed in Figure 31. The main subjects and topics discussed were (set by colors): access to the material (in red), property (in blue), organizational power (in black), communication (in light green), cultural aspects (in dark green). In spite of the fact concept maps organize information and show relationships among matters, concept maps are general, not having enough elements to represent the complexity of organizational dynamics, such as organizational dimensions, flow of impacts, organizational elements, and so on.

Finally, we have modelled LMS workshop's discussion using as a basis the Configuration Model of Organizational Culture (CMOC) (DAUBER, GERHARD and YOLLES, 2012), explained in section 3.4.2. After those three trials, we realized a generalizable organizational dynamics model should represent

organizational dimensions according to their visibility, the impacts' relationships between these dimensions over time, and mostly important, internal elements of

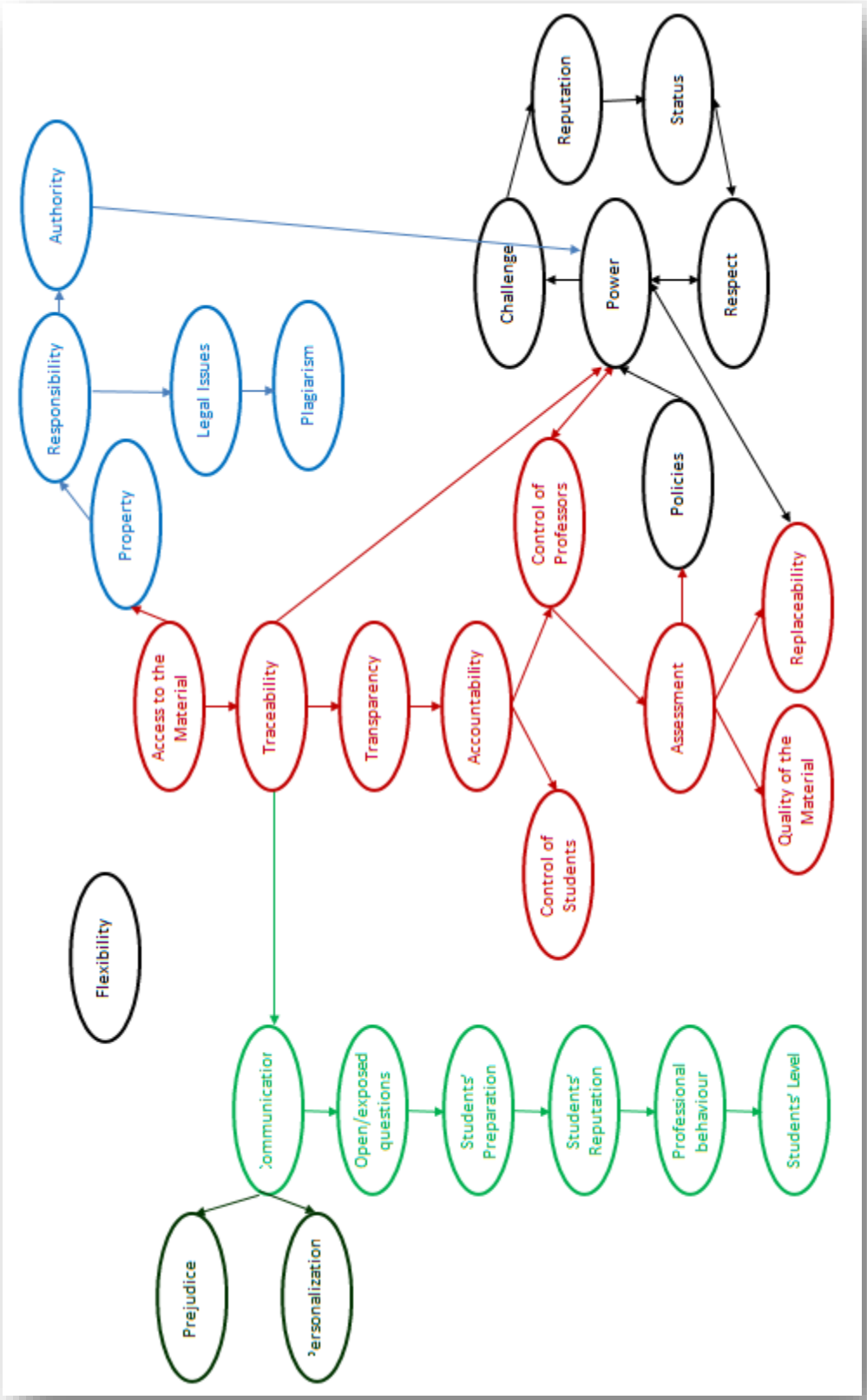


Figure 31: Workshop's discussion Concept Map

dimensions. Considering this, we have reviewed literature and CMOC satisficed this requirements. Lessons learned are discussed in detail in next section.

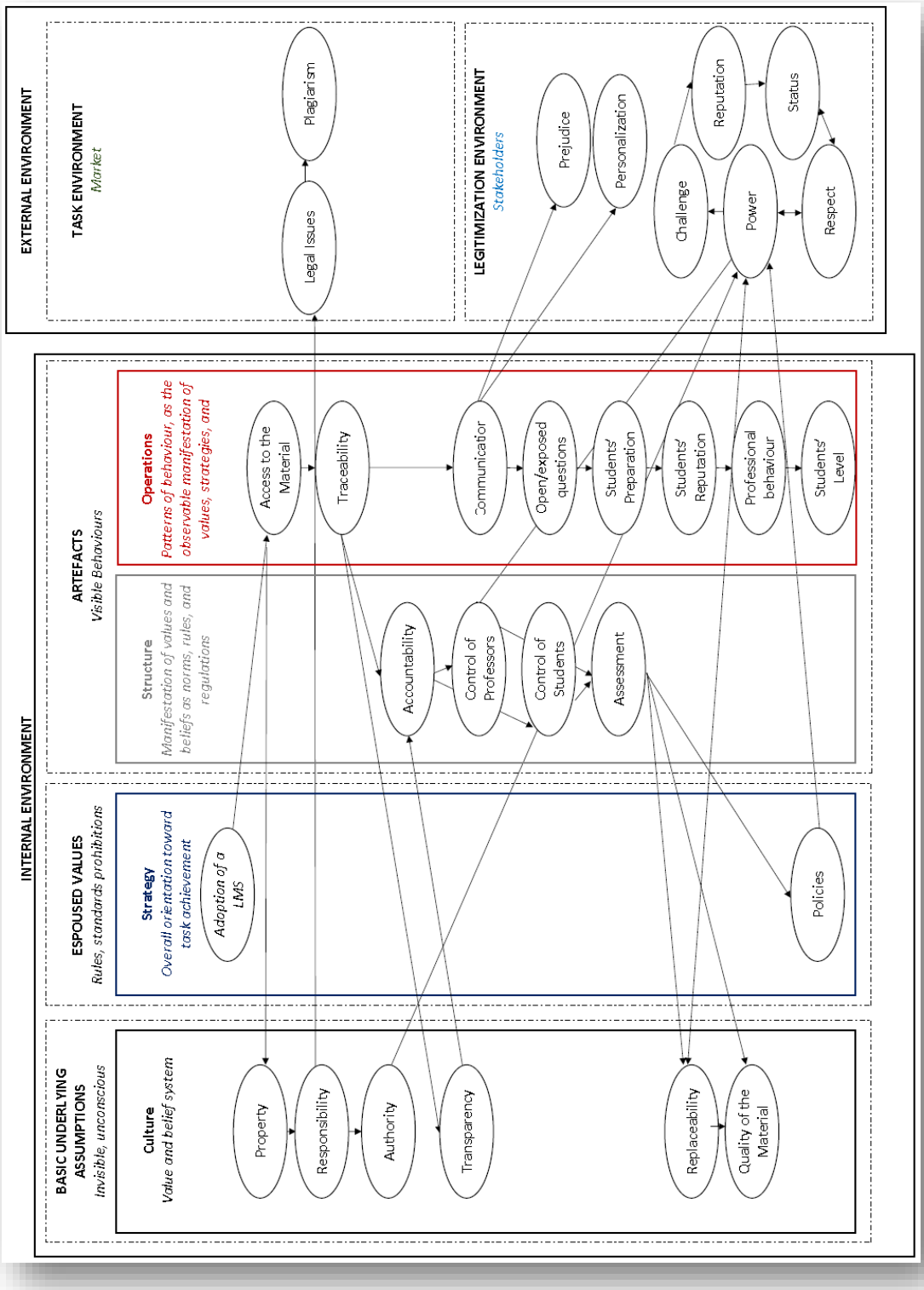


Figure 32: LMS Workshop's organizational dynamics model

5.3.3. Discussion

From LMS workshop's observations and analysis, we learned that in order to elicit and understand organizational knowledge, it would be necessary to establish supporting tools, as discussed as follows.

- **Identification of an organizational dynamics base model to establish a common ground for communication and reasoning, gain insights, and augment understanding**: Indeed Gilbraith's Star Model, in Figure 6 and Figure 7 contributed to base the conversation making explicit organizational dimension, and sparking the debate. Academic experts considered organizational dimensions to understand where organizational changes occurred and how it impacted their own organization. As for example, when the professor reported *communication has become mediated by the LMS, which prevents the identification of students by gender or social class, affecting the professor-student relationship, which is now focused on the content and oblivious to sexism or classism*. This is an example of a change on the dimensions Organizational Structure and Process impacting on the dimension of Organizational Culture. And, Four Levels of Organizational Intervention contributed to understand the depth of an organizational change over time. Thus, besides the organizational dimensions, in an organizational dynamics base model it is also important to recognize:
  - *Flow of organizational impacts (arrows)*: We observed arrows indicating the flows inspired the rationale behind the discussion, making explicit the impact direction between dimensions, bringing up information on organizational changes and impacts from academic experts;
  - *Elements*: When focusing on one dimension, it was easier to academic experts to remember of organizational changes and impacts when others said a dimension's element, as, for example, when someone talked about *activities* changing in the teaching *process*, different *resources*, changing *quality* of teaching process, and so on.
- **Identification of general organizational dynamics questions to elicit knowledge**: Academic experts repeatedly used questions based on the model to elicit information from others. As, for example, when one asked

the question: *"How the strategic action of supporting the teaching process by a LMS impacted on university's process and structure?"*. Questions like this, based on Figure 7, guided the conversation's evolution.

To sum up, we realized to elicit and understand organizational dynamics, we would have to identify an organizational dynamics model and organizational dynamics questions as supporting tools. The ODMM should present organizational dimensions, relationships between them, flow of impacts over time, and inner elements. ODQS should seek for organizational impacts between organizational dimensions. Revisiting literature, conflating and extending models, and studying real cases, we finally come up with ODMM, in Figure 18. This was the model used as a basis to model LMS workshop's discussion, in Figure 32.

Besides supporting tools, we noticed the following practices benefit the knowledge elicitation, and could benefit future performances:

- Initiate the discussion by visible artefacts (organizational dimensions Structure and Operations) and invisible artefacts will come out naturally;
- Focus one change at a time, eliciting other changes and impacts from it.

Next case study was conducted to evaluate and refine ODMM and ODQS.

5.4. A case study at UK Post Office – analysing organizational changes and impacts (OIA)

In this section, we detail our third confirmatory case study to evaluate the application of OIA, the second process of our proposal, in Figure 10, and test the negative hypothesis NH2.

To evaluate the applicability and efficiency of our OIA, second process in Figure 10, on what concerns if it would actually elicit SSsOIS' requirements, contributing to the completeness, novelty and usefulness of early requirements, we studied the case of Post Office in London. Post Office Ltd is a retail post office company in the United Kingdom that provides a wide range of services and products, including handling letters and parcels, postage stamps and banking to the public through its nationwide network of post office branches. The company is owned by the British Government's Department for Business, Innovation and Skills, through Postal Services Holding Company Limited (Post Office, 2016).

The objective of the case study was to verify if OIA's application would elicit knowledge about organizational changes and impacts which might affect SSsOIS' requirements. This case study plan is detailed in Table 17.

Table 17: Post Office's Case Study Plan

UK Post Office's Case Study Plan	
Objective	Evaluate and refine OIA through an application in a real case of SSsOIS' requirements elicitation
The case	Analysis of a strategic change in London's Post Office
Theory	• Designing organizations: An executive briefing on strategy, structure, and process (GALBRAITH, 1995) • A Configuration Model of Organizational Culture (DAUBER, GERHARD and YOLLES, 2012) • Understanding and influencing your organizational culture (RUSSEL and RUSSEL, 2014) • Guidelines for conducting and reporting case study research in software engineering (RUNESON and HÖST, 2009) • Selecting Empirical Methods for Software Engineering (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008)
Research question	*Q1: How to support organizational dynamics knowledge elicitation and understanding?* *Q2. How to elicit organizational changes and impacts?*
Data collection method	Observation Interview Document Analysis
Unit of Analysis	Resulting organizational change model SSsOIS' requirements
Selection Strategy	Strategic change real case Requirements engineers from real case (REteam) Post Office environment Post Office customer Post Office employees

The research question of this case study investigates how to support organizational dynamics knowledge elicitation and understanding, focusing on the ripple effect from organizational changes and impacts. To operationalize Q1 we have proposed ODMM, in section 4.3.1 and to operationalize Q2 we have proposed ODQS, in section 4.3.2. In this confirmatory case study, we evaluate the application of OIA, the sub process supported by ODMM and ODQS, toward the elicitation of SSsOIS' requirements.

5.4.1. Description

With the purpose of understanding Post Office in London as an organization and its current context, we performed three techniques for collecting data: *"Observation of the environment", "Interview with stakeholders"* and *"Documents analysis"*. Those techniques were supported by ODMM and ODQS tools. As sources of information, we read the next documents: pocket books and folders distributed by Post Office, explaining the company, services and products; Post Office website[3] and Post Office Wikipedia[4].

We observed Post Office environment for a day, focusing on the environment, processes, services, products, customers' behaviour, staff's behaviour, software systems, interaction between customers and employees, and customers and self-services. For this, we have chosen Trafalgar Square Post Office branch[5], because this is one of the biggest branches, providing all services provided by Post Office Ltd. and leading in number of visitors per day. To confirm collected information, finally we executed semi-structured interviews with customers and employees. We questioned how Post Office was before, and how it is now, what were main differences observed by them. In other words, we applied observations for collection of organizational elements and semi-structured interviews for collections of links between them. Annotations are shown in APPENDIX C. Information collection being made, we began the application of OIA, as described as follows.

[3] http://www.postoffice.co.uk/

[4] https://en.wikipedia.org/wiki/Post_Office_Ltd

[5] Trafalgar Square, 24/28 William Iv Street, London, Greater London, WC2N 4DL

Sub process 2 - Organizational Impacts Analysis (OIA): Analysing likely organizational changes and impacts (Figure 19)

Activity 2.1 - Point out (Figure 20)

The case study started by a discussion with UK Post Office requirements engineers tem, called from now on REteam, explaining how the UK Post Office case was carried out. In this case, some of REteam requirements engineers were hired as a consultant team to engineer the requirements of a software system having the subsequent goal: *"Improve the UK Post Office customer queuing flow and efficiency"*. For this case study, we will concentrate on the resulting *organizational strategic change*: **"Introduction of a software system into the customer attendance process"**. REteam called this software Q-matic system, a reference to "queue-matic" system.

In the former experience, the SSsOIS' requirements elicited by RETeam related to Q-matic system were:

R1. The Q-Matic system shall print the ticket with the queue number accurately.
R2. The Q-Matic system shall communicate the ticket number and counter number reliably.
R3. The customer shall recognize the ticket number and counter number successfully.
R4. The customer shall only go to the counter indicated by the counter number.

In order to understand the UK Post Office context at the moment REteam was hired ("*as it was"* context), we modelled it using i* language. SD and SR models are depicted below:

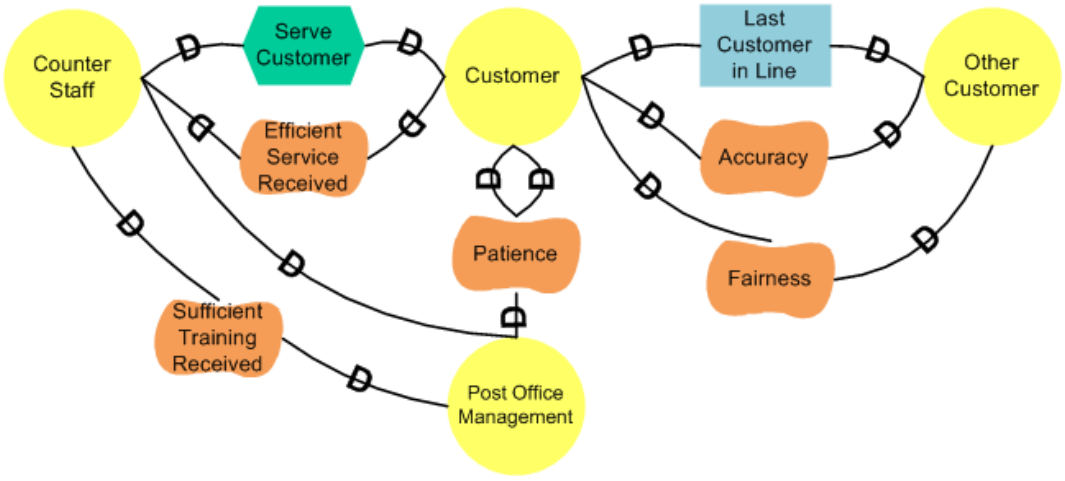


Figure 34: UK Post Office's Strategic Design - *As it WAS*

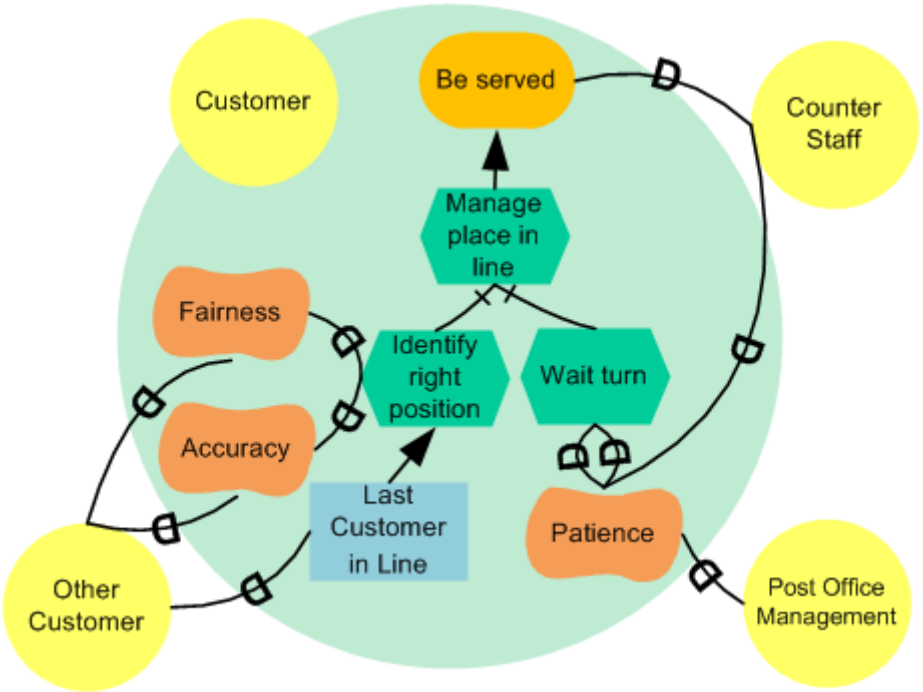


Figure 33: UK Post Office's Strategic Rationale - *As it WAS*

The process of customer attendance represented in Figure 34 and in Figure 33 was based on the physical queue formed by customers to be served, minding the rule: *first in, first served*. At that time, a customer used to arrive at the UK Post Office and ask to another customer for the last one positioned in queue. Then, the first customer in queue was called by counter staff, if they were able to serve next customer. The accuracy and fairness of the queuing process was left responsibility of customers themselves.

Current context is modelled in Figure 36 and in Figure 35. Now, UK Post Office queues are managed by the Q-matic system, a new actor in the model. Primarily, this introduction shifted responsibility for the queue from customer to Q-matic system. In order to deepen our contextual analysis, we detailed both “as it was” and “as it is” contexts using contextual scenario language, explained in section 4.3.2. Contexts are related in Table 18.

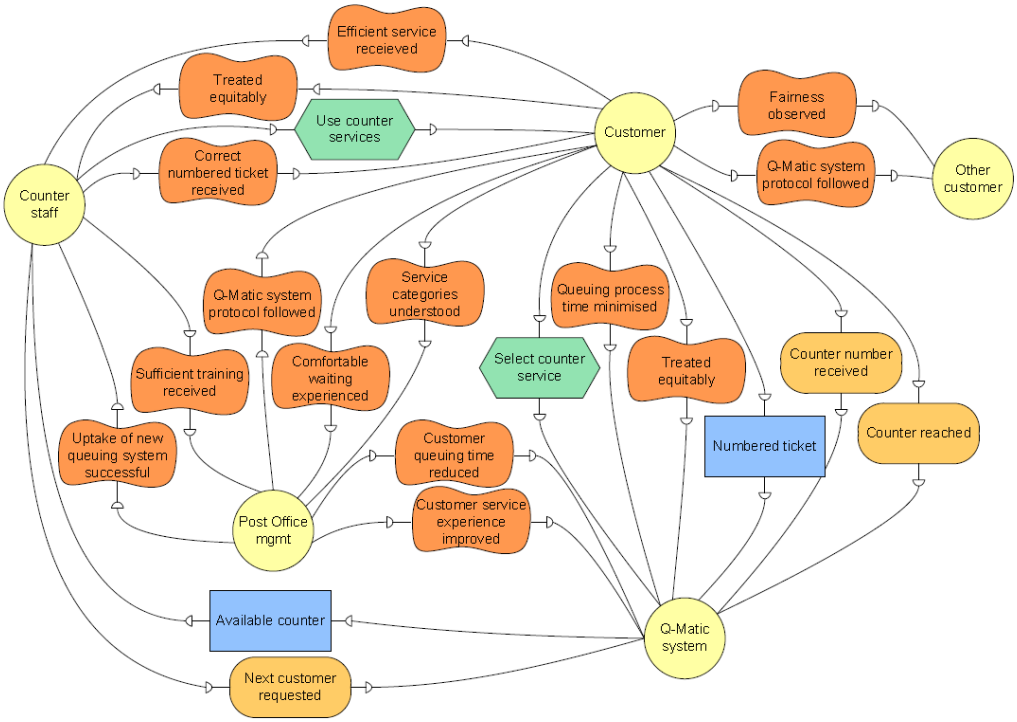


Figure 36: UK Post Office's Strategic Dependency - *As it IS*

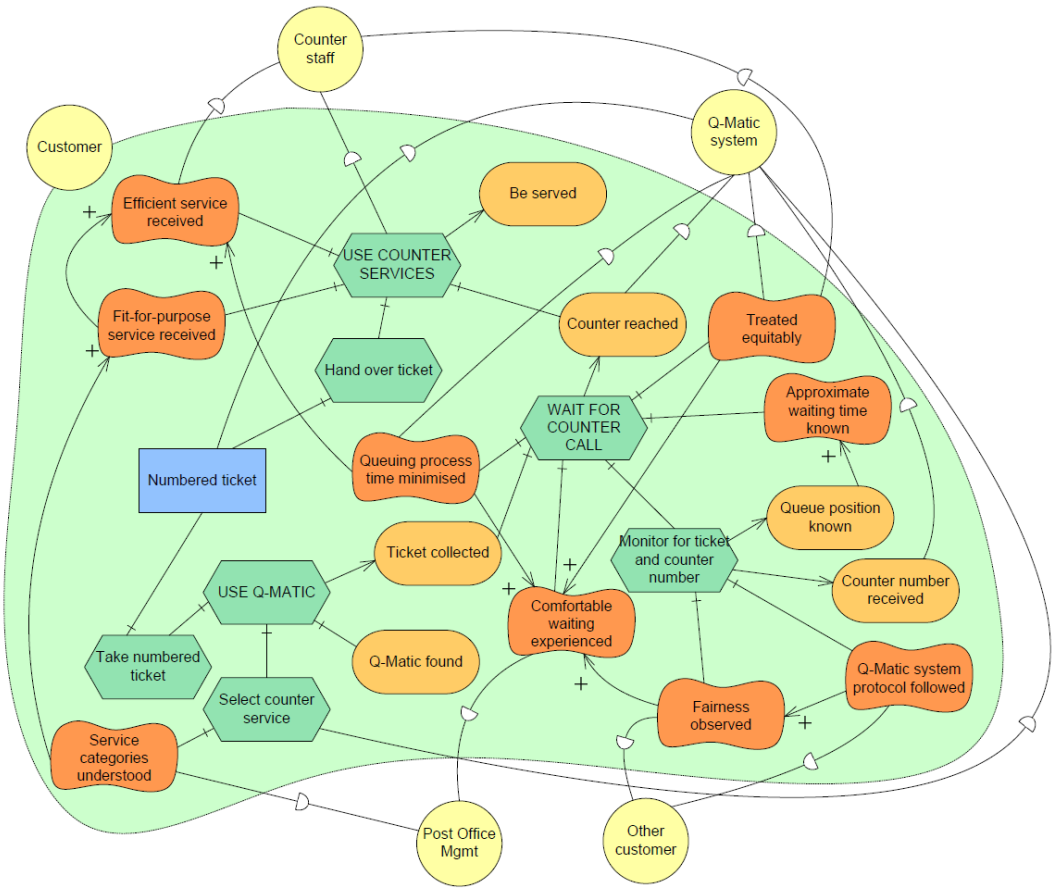


Figure 35: UK Post Office's Strategic Rationale - *As it IS*

Table 18: UK Post Office 'As it WAS' and 'As it IS' contexts

CONTEXT	
[BEFORE] Customer Perspective	**[AFTER] Customer Perspective**
1. Customer enters in the Post Office.	1. Customer enters in the Post Office.
2. Customer takes a place in the queue, after last customer.	2. Customer sees the sign: Take a ticket here.
	3. Customer heads to the Q-Matic system.
	4. Q-Matic system shows all the types of counter service offered by the Post Office.
	5. Customer selects the wanted type of counter service in the Q-Matic System.
	6. Q-Matic system computes the next queue number for the selected counter service.
	7. Q-Matic system prints the ticket with the number on it.
	8. Customer takes the numbered ticket from the Q-Matic system.
3. In queue, customer waits to be called by the counter staff.	9. Customer waits to be called, wandering.
4. When the counter becomes free, the counter staff calls next customer.	10. When the counter becomes free, the counter staff requests the next customer to the Q-Matic system.
	11. Q-Matic system calls next customer's number and shows free counter, visually, displaying in the monitor, and sonorously, announcing on the speakers.
5. First customer in queue heads to the free counter service.	12. Customer reads or hears his number and the number of the free counter from the Q-Matic system.
	13. Customer heads to the indicated counter.
	14. Customer hands over numbered ticket to the staff at the counter.
	15. The counter staff takes the numbered ticket from the customer and serves the customer.
6. Customer uses counter services.	16. Customer uses counter services.

In this organizational impact analysis, from comparison between models ‘as it was’ and ‘as it is’, we have pointed out the likely organizational changes in Table 19. In this case study, i* models have contributed to understand the major change, introduction of a new actor in the queue’s process, shifting the responsibility for the queue; while contextual scenarios have contributed to point out more specific organizational changes. We understand OIA’s outcomes are unique according to the involved analysts and to the period of time it was executed, and these outcomes are likely to be different when applied to other people or in other time instance.

Table 19: UK Post Office likely organizational changes

As it was scenario steps	**As it is** scenario steps	**UK Post Office likely organizational changes**
2	4	*Acquired transparency of information about Post Office services to customers.*
2	7,8	*Physical queue is no longer needed.*
4	10, 11	*Responsibility for calling next customer moved from staff to Q-matic system.*
5	12	*Acquired transparency of information about queue to customers and staff.*

Activity 2.2 - Identify likely organizational impacts* and *Activity 2.3 - Elicit Likely SSsOIS New Requirements

For each likely organizational change in Table 19, we applied ODQ to identify likely organizational impacts and SSsOIS’ requirements. UK Post Office case study’s resulting table has 46 columns x 23 lines. Because the resulting table is too large to be clearly presented in A4 sheets, we sectioned this resulting table according to flows of reasoning and illustrate two examples as follows. Table 20 and Table 21 illustrate a sequence of OD question, answer, consequent impact, and respective SSsOIS’ requirements.

Table 20: OIA for strategy "Improve the UK Post Office customer queuing flow and efficiency' - Flow of Adjustment [example 1]

FLOW OF ADJUSTMENT								
Performance Assessment (*impacts of new/changed* ***operations*** *on* ***structure***)			**SSsOIS' Requirements**	Performance Assessment (impacts of new/changed ***operations*** on ***structure***)			**SSsOIS' Requirements**
Structural Question	**Structural Answer**	**Structural Impact**		**Structural Question**	**Structural Answer**	**Structural Impact**	
What **new process** does this change raise?	From the information displayed, customer can estimate the time until be called and accordingly, choose the service with smaller queue; choose more than one service in an order to be served faster; choose the service that is worth on that day.	**New behaviour:** Customer is enabled to make decisions regarding their attendance by Post Office service.	**R01**. SSsOIS shall show the amount of people waiting for each service. **R02**. SSsOIS shall show estimated waiting time in each queue.	What new **process** does this change raise?	Now the client is not dependent on the counter staff anymore, so they can even choose to send their own parcels by themselves.	**New process:** Post and Go [New Service].	**R03**. SSsOIS shall support Post and Go service.

Table 21: OIA for strategy "Improve the UK Post Office customer queuing flow and efficiency' - Flow of Adjustment [example 2]

FLOW OF ADJUSTMENT			
Single-loop Learning *(impacts of new/changed **structure** on **strategies**)*			SSsOIS' Requirements
Strategic Question	Strategic Answer	Strategic Impacts	
6. Does this new structure allow new organizational **measure?**	The control over the flow of customers enables managers to extract measures in order to support the making decision process.	New Measures: 1. Total amount of customers per day. 2. Total amount of customers per month. 3. Total amount of customers per year. 4. Total amount of customers using Post and Go service. 5. Total amount of customers using counter service. 6. Total amount per counter of customers served. 7. Total amount of customers using only services. 8. Total amount of customers only buying products. 9. Total amount of each type of product sold. 10. Total amount of customers per shifts.	**R24.** SSsOIS shall calculate the total amount of customers per day. **R25.** SSsOIS shall calculate the total amount of customers per month. **R26.** SSsOIS shall calculate the total amount of customers per year. **R27.** SSsOIS shall calculate the total amount of customers using Post and Go service. **R28.** SSsOIS shall calculate the total amount of customers using counter service. **R29.** SSsOIS shall calculate the total amount per counter of customers served. **R30.** SSsOIS shall calculate the total amount of customers using only services. **R31.** SSsOIS shall calculate the total amount of customers only buying products. **R32.** SSsOIS shall calculate the total amount of each type of product sold. **R33.** SSsOIS shall calculate the number of customers per shifts.

5.4.2. Results

By the end of the study of the Post Office case, the authors identified 18 main changes, explored 6 different flows of impacts, and identified 51 possible organizational changes and consequent 40 SSsOIS' requirements changes, which if implemented correctly, will minimise undesirable effects of the impacts. The abstraction level of the requirements varied, for example, we found a need to support new services, as "Post and Go", and we pointed 10 different specific indicators to be extracted from data gathered by the SSsOIS. Information elicited by observation, interview, and document analysis is modelled following ODMM and pictured in Figure 37.

Consolidated organizational changes, consequent impacts and new SSsOIS' requirements of UK Post Office case study are listed in Table 22. Identified organizational changes and impacts as well as related SSsOIS' requirements elicited were presented to the REteam and HCID's group, as well as at iStar'15 – Eight International Workshop (co-located with the 23rd International Requirements Engineering Conference – RE15 (FERREIRA, MAIDEN and LEITE, 2015).

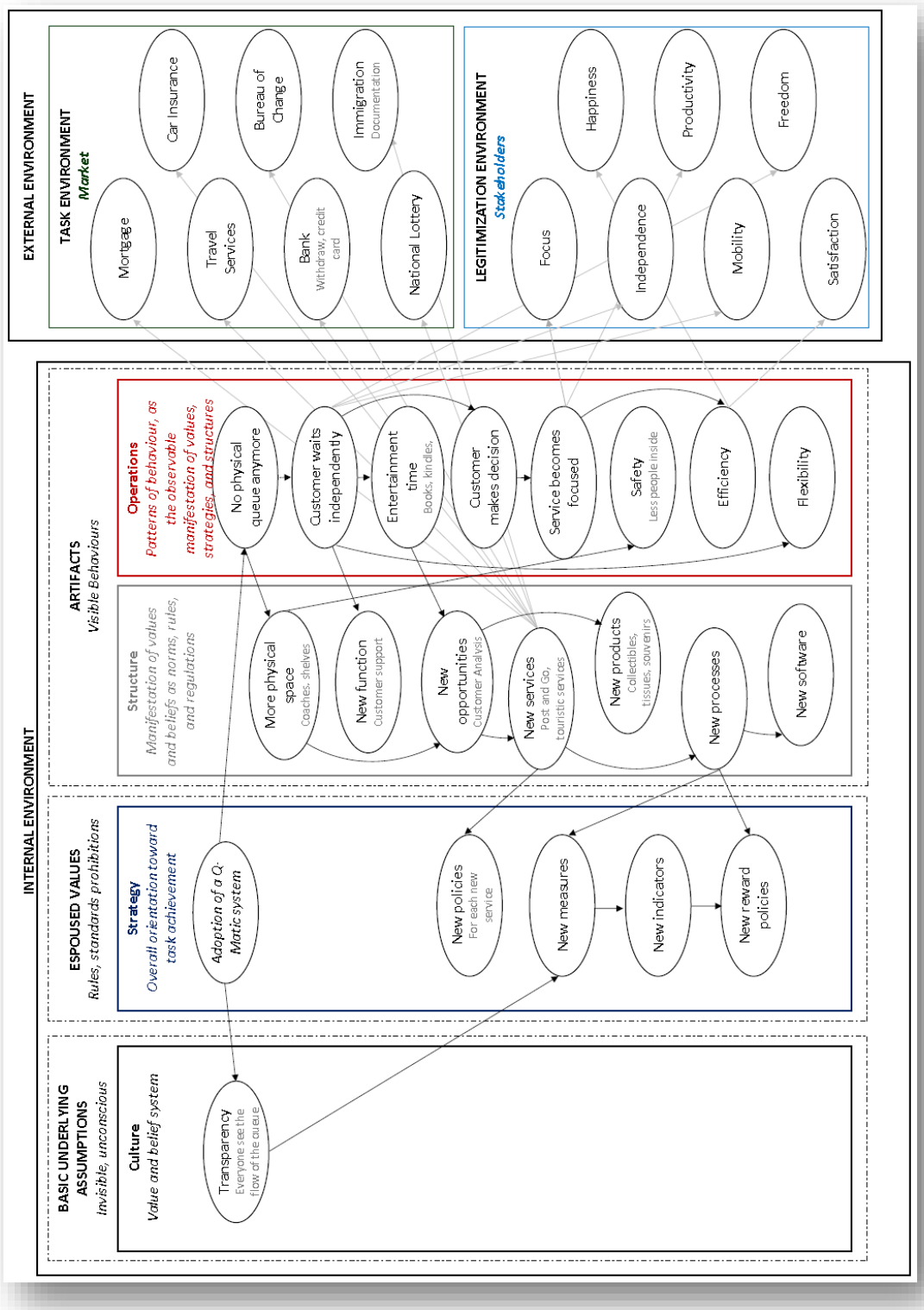


Figure 37: Post Office organizational dynamics model

Table 22: UK Post Office case study's consolidated organizational impacts and consequent new SSsOIS' requirements

Consolidated Impacts List	New SSsOIS' requirements
[New behaviour] Customer is enabled to make decisions regarding their attendance by Post Office service.	**R01**. SSsOIS shall show the amount of people waiting for each service.
	R02. SSsOIS shall show estimated waiting time in each queue.
[New process] Post and Go [New Service]	**R03**. SSsOIS shall support each element of Post and Go service.
[New function] Support customers	**R04**. SSsOIS shall support the customer to call for help anytime.
[New service to Foreigners] International Mail	**R05**. SSsOIS shall support international mail.
[New service to Foreigners] ID photos	**R06**. SSsOIS shall maintain ID photos.
[New service to Foreigners] Bureau of Change	**R07**. SSsOIS shall support bureau of change.
[New service to Foreigners] Withdraw	**R08**. SSsOIS shall support withdraw.
New service to Foreigners: Travel Insurance	**R09**. SSsOIS shall support travel Insurance.
New product to Foreigners: Travel Items	**R10**. SSsOIS shall maintain travel items.
New product to Foreigners: Souvenirs	**R11**. SSsOIS shall maintain souvenirs.
New product to Foreigners: Postcards	**R12**. SSsOIS shall maintain postcards.
New product to Foreigners: Collectibles	**R13**. SSsOIS shall maintain collectibles.
New product to Elderly: Financial service and Business Bank	**R14**. SSsOIS shall support financial service and business bank.
New product to Elderly: Tissues	**R15**. SSsOIS shall maintain tissues.
New product: Postal Packaging and Stationery	**R16**. SSsOIS shall maintain stationery.
New product: Credit card of the Post Office	**R17**. SSsOIS shall maintain credit card of the post office.
New product: Gift cards	**R18**. SSsOIS shall maintain gift cards.
New service: National Lottery	**R19**. SSsOIS shall support national lottery.
New service: Car Insurance	**R20**. SSsOIS shall support car

	insurance.
New service: Mortgage	**R21**. SSsOIS shall support mortgage.
Quality: visual accessibility	**R22**. SSsOIS shall be accessible to visually impaired people.
Quality: sound accessibility	**R23**. SSsOIS shall be accessible to hearing impaired people.
[New Measure] Total amount of customers per day	**R24**. SSsOIS shall calculate the total amount of customers per day.
[New Measure] Total amount of customers per month	**R25**. SSsOIS shall calculate the total amount of customers per month.
[New Measure] Total amount of customers per year	**R26**. SSsOIS shall calculate the total amount of customers per year.
[New Measure] Total amount of customers using Post and Go service	**R27**. SSsOIS shall calculate the total amount of customers using Post and Go service.
[New Measure] Total amount of customers using counter service	**R28**. SSsOIS shall calculate the total amount of customers using counter service.
[New Measure] Total amount per counter of customers served	**R29**. SSsOIS shall calculate the total amount per counter of customers served.
[New Measure] Total amount of customers using only services	**R30**. SSsOIS shall calculate the total amount of customers using only services.
[New Measure] Total amount of customers only buying products	**R31**. SSsOIS shall calculate the total amount of customers only buying products.
[New Measure] Total amount of each type of product sold	**R32.** SSsOIS shall calculate the total amount of each type of product sold.
[New Measure] Total amount of customers per shifts	**R33.** SSsOIS shall calculate the number of customers per shifts.
[New indicator] Employee who served more customers	**R34.** SSsOIS shall warn manager about employee who served more customers every month.
[New indicator] Amount of customers per branch	**R35.** SSsOIS shall warn manager about branch that served less customers every month.
[New indicator] Most required service	**R36.** SSsOIS shall warn manager about most required service every month.
[New indicator] Less required service	**R37.** SSsOIS shall warn manager about less required service every

	month.
[New indicator] Most sold product	**R38.** SSsOIS shall warn manager about most sold product every month.
[New indicator] Less sold product	**R39.** SSsOIS shall warn manager about less sold product every month.
[Cultural Impact] Evaluation of quantitative achievements. Possibly faster service with lower quality and higher stress	**R40.** SSsOIS shall enable customers to evaluate quality of service.

5.4.3. Discussion

From strategic goal: *"Improve the UK Post Office customer queuing flow and efficiency"* and resulting organizational strategic action: *"Introduction of a software system into the customer attendance process"*, REteam have elicited four main SSsOIS' requirements. This is an illustration of the state-of-the-practice, in which usually SSsOIS' requirements are elicited focusing on supporting strategic actions' operationalisations without thinking in advance on organizational changes and impacts caused by strategic changes. Frequently, SSsOIS" requirements come from the more accessible organizational dimensions and observable organizational elements, as organizational Structure and Operations dimensions. In this case study, we elicited forty SSsOIS' requirements coming from a deeper reasoning and understanding on how the organization might evolve considering the proposed strategic change. ODMM and ODQS were used from the beginning, to collect data in observations and interviews. OIA was also applied to organize and understand elicited knowledge. We understand OIA provides support to structure reasoning and deepen understanding of the organizational evolution to use as income to elicit SSsOIS' requirements and the *Negative Hypothesis 2 (NH2)* is rejected. Essentially, ODMM boost the ideas generation and creativity augmentation while ODQS contributed to knowledge elicitation.

It is important to highlight that, as OIA's results are the representation of the knowledge and perceptions of the person executing the process. Consequently, results, namely identified organizational changes, organizational impacts, SSsOIS' requirements, may differ according to these people' reasoning.

After this case study, we envision the opportunity to automate OIA sub process. This will be further discussed in the next chapter, Future Work.

5.5. A case study at PUC-Rio – evaluating ODA4RE in a real case

In this section, we detail our fourth confirmatory case study to evaluate the application of ODA4RE, as a whole process, in Figure 10, and test both negative hypotheses NH1 and NH2.

We have conducted our last qualitative case study to understand if SSsOIS' requirements changes originated by strategic initiatives can be anticipated by ODA4RE. This case study was led through observation, personal meetings, construction, and validation of documents, and email exchange. The case study plan is detailed in Table 23.

Table 23: PUC-Rio's Case Study Plan

PUC-Rio's Case Study Plan	
Objective	Investigate if ODA4RE brings up future/new SSsOIS' requirements
The case	Pontifical Catholic University of Rio de Janeiro (PUC-Rio), and its SSsOIS SGU (University Management System)
Theory	ODA4RE theoretical basis, presented in chapters 3 and 4
Research question	*Q1: How SSsOIS' requirements can be anticipated?*
Data collection method	Observation of ODA4RE process Questionnaire Semi structured interview Document analysis: • Institutional Development Plan (CCPA - PUC-RIO, 2012) • PUC-Rio's website (PUC-RIO, 2016) • Planning Officer's Master thesis (TORRES, 2012)
Unit of Analysis	SSsOIS' requirements
Selection Strategy	Organizational key people from PUC-Rio's Administrative Affairs Chancel, being: • Vice chancellor for administrative affairs; • Planning officer; • IT manager.

This case study was carried out to evaluate ODA4RE as a whole, hence, the research question is the same of RE Group's case study, in section 5.2. As explained in section 5.2, we proposed SSP as an operationalization to Q1. To further investigate what organizational changes and impacts strategic initiatives would raise in the organization, we proposed OIA, a sub process based on Organizational Impact Analysis. Applying OIA, we identify organizational changes and impacts and then elicit SSsOIS' requirements related to them. ODA4RE is elaborated on the assumption the organization evolves to achieve its own objectives in future. Complementing that, these objectives originate organizational changes and organizational impacts, that in turn bring about new SSsOIS' requirements. This is our theory, to be tested in this confirmatory case study. By the end, we have validated SSsOIS' requirements elicited by ODA4RE with stakeholders, the most interested people in these SSsOIS' requirements, to verify if ODA4RE do elicit valid SSsOIS' requirements, and as such be a valid operationalization to our research question.

Pontifical Catholic University of Rio de Janeiro (PUC-Rio) is a non-profit philanthropic institution, also granted the status of a public non-state institution – a Communitarian University of Higher Education. It was founded in 1940 by Cardinal D. Sebastião Leme and Father Leonel Franca S.J. In 1947, the title of Pontifical was conferred, a rare honour conceded by the Vatican establishing a special link between this university and the Pope (PUC-RIO, 2016). In 1960, Datatron Burroughs B-205, the first main frame computer, was installed at PUC-RIO exclusively for scientific purposes, first time at a university in Latin America. It was founded by the then Archbishop of Milan, Giovanni Battista Montini, later to become Pope Paul VI (STAA, 2012). PUC-Rio is the 18th between the best public and private universities in QS Latin America ranking, the world ranking by Quacquarelli Symonds, British company specializing in education and study abroad (CCPA - PUC-RIO, 2012).

As we are interested in the relationship between SSsOIS' requirements and organization's strategic goals, we have contacted PUC-Rio's Planning Counselling, part of *Vice Chancel for Administrative Affairs* (in Portuguese, Vice-Reitoria Administrativa - VRADM). More specifically, we have contacted the vice chancellor for administrative affairs and the planning officer. VRADM assists the Chancellor to perform administrative tasks, including supervision, coordination, and inspection of administrative, financial and accounting activities.

As a university, PUC-Rio is an organization with peculiarities in relation to other types of institutions, for instance the operating model requires flexible characteristics with a strong presence of the academic body. Usually, there are academics in administrative positions, due to the organization's academic focus, even in areas not directly related to the organization's ultimate goal. The flexibility of relations in management and a structure of equality within the academic body facilitate discussion and consensus on strategic decisions. University Management Information System should support this context, and the following 10 pillars (TORRES, 2012):

1. Mission and Institutional Development Plan (IDP);
2. Policies for teaching, research, graduate and extension;
3. Social responsibility;
4. Communication with society;
5. Personnel policies (considering both, the teaching and the technical-administrative body);
6. University's management;
7. Physical Infrastructure;
8. Evaluation planning;
9. Policies to assist students;
10. Financial sustainability.

In this setting, as the object of this study, we have considered the SSsOIS ***SGU*** (abbreviation of Sistema de Gestão Universitária, Portuguese expression to University Management System). SGU is a software system developed *in house* to support the administrative and financial aspects in the organization PUC-Rio. Regarding SGU, we have contacted the IT manager to support the elicitation of information elicitation from SSsOIS side.

SGU was first designed to turn administrative and financial process at PUC-Rio more agile and save resources. Essentially, it was build based on PUC-Rio's business process, or the automation of interactions between people in the university. SGU is responsible for the processes of hiring and paying staff and professors; payment of student fees; student scholarships management; academic research projects management; others.

Currently, SGU is being evolved. The SSsOIS evolution process is grounded on users demands, modeling PUC-Rio's business process and, recently, deepen the understanding on business rules related to the business processes and documents evaluation. For example, SGU's previous version

allowed document upload and download, and the document's evaluation was made by the responsible person, by downloading the document and uploading the evaluation. SGU's current version has being evolved to receive the information in a digital form instead of an uploaded document, and this digital form presents the rules related to the information, anticipating information evaluation and consequently avoiding unnecessary passage of wrong information.

In next section, we detail our last case study, according to ODA4RE's sub process, in Figure 10. IT is important to have in mind as we are contacting VRADM, this strategic planning reported in fourth case study has an *administrative bias*. In addition, due to time restriction, this is a partial strategic analysis but sufficient to present the benefits brought out by ODA4RE.

5.5.1. Description

Fourth case study was carried out mostly through face-to-face meetings with VRADM personnel. We held *three* meetings with vice-chancellor, each lasting around 1 hour, and *eight* meetings with the planning officer and the IT manager, each lasting around 2 hours. First meeting was in June 13th and last meeting was in September 27th. Results are a consolidation and posterior validation of all meetings. Questionnaire was applied to evaluate results, which answers were received until October 6th. Following, we present fourth case study according to ODA4RE's three sub process:

Sub process 1: Scenario-based Strategic Planning (SSP): Reflecting about multiple possible organizational future (Figure 11)

Activity 1.1 Plan (Figure 12)

Activity 1.1.1 – Project: Definition of Scope

We start SSP discussing about the scope of this case study. Scope is structured according to the Framing Checklist and is shown in Figure 38.

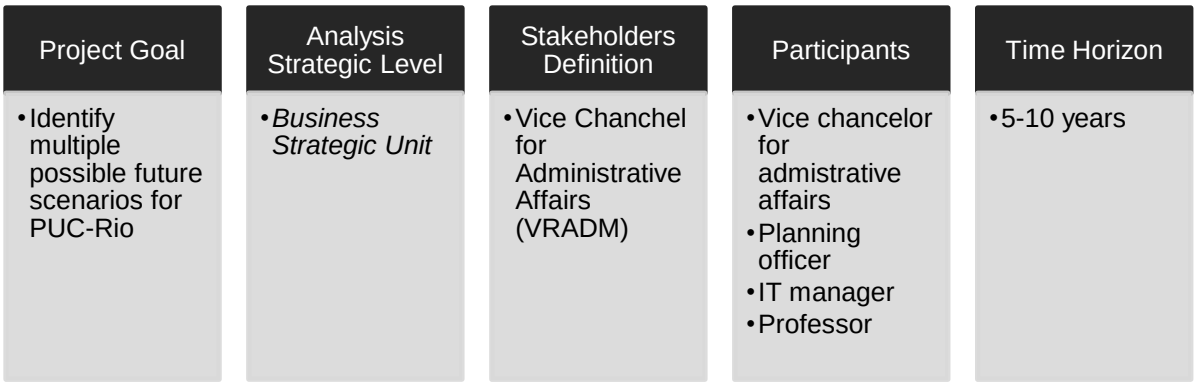


Figure 38: PUC-Rio project scope according to the Framing Checklist

Activity 1.1.2 – Understand: Perception Analysis

As in RE Group, we also have applied SWOT analysis at VRADM to foster awareness and a common sense about the organization. Participants understanding are presented in Table 24:

Table 24: PUC-Rio organizational identity

Aspect	Description
Organizational Identity	
Field	*High Education*
Target public	*It welcomes students, staff members, teachers, researchers and administrators of all religions, nationalities, ethnic groups and social classes* (PUC-RIO, 2016).
Mission	*PUC-Rio seeks excellence in research, teaching and extension, for training competent professionals inside Brazilian reality; trained to collaborate, through the knowledge acquired for the construction of a better world, according to the justice and Christian love requirements. In all its activities, PUC-Rio aims at contributing to build a society based on respect and promotion of all, especially the poor and marginalized, taking into account the challenges launched by Brazil's and World's social, political and cultural conditions. Therefore, it constitutes a space for interdisciplinary dialogue and privileged place to the question about the meaning of science and life* (CCPA - PUC-RIO, 2012).
Vision	Maintain PUC-Rio as an academic institution of reference, contributing to the growth and development of society and enhancing aspects of Research, University Management, Sustainability, Creativity and Innovation.
Values	*PUC-Rio press for the production and transmission of knowledge, bases on respect for human values and Christian ethics, aims above all at the benefit of society. The university*

	says the primacy of the person over things, of spirit over matter and of ethics over technology, so that science and technology are at the service of the human person. The university is also committed to the truth, cultural pluralism, dialogue, simplicity in action, the primacy of the common good over individual interests and development of the spirit of solidarity (PUC-RIO, 2016).
Strategic Analysis	
Strengths	• *Quality of employees in senior positions;* • *Confidence in strategic staff;* • *Credibility in the institution (internal and external);* • *Intrapersonal trust;* • *Pride of the institution and projects (eg FESP);* • *Intelligence distribution in the institution;* • *Feeling of belonging to the institution (employees);* • *Employees' long-life careers at PUC;* • *Leveraging employees' knowledge aligning to their own roles' needs;* • *Academics as mainstays of the institution;* • *Management to maintain adherence to the Law of Philanthropy;* • *Existence of a process to evaluate teachers;* • *Research resources levelheaded with tuition resources;* • *Resources for research;* • *Focus on developing research;* • *Decentralized management (PUC-Rio's treasure);* • *Development of SGU in house;* • *University management system is lean;* • *SGU is essential to the financial balance;* • *Physical space with representative identity;* • *Synergy between students, encouraged by physical space;* • *Incubator companies with high success rate.*
Weaknesses	• *Low prioritization of documentation allowing the concentration of institutional knowledge in people;* • *Acquisition process mostly decentralized (which could be better analyzed aiming at cost reduction by joint purchasing);* • *Occurrence of financial "accidents" on the tips (although rare);* • *Low effort on disseminate the institutional identity among employees and students;* • *Absence of a staff evaluation process (there is for academics);* • *Limited physical space;* • *Lack of space for creativity and innovation in the central management being reactive to internal and external demands.*

Opportunities	• *Credibility and Prestige;* • *PUC as a philanthropic university;* • *PUC-Rio as a Communitarian Institution of Higher Education (ICES) - non-state public university (bids);* • *Growth of the academic research, resulting in prestige growth and public recognition;* • *Services provision resulting of research projects;* • *Advanced process of compliance with eSocial;* • *Compliance to MEC.*
Threats	• *Budget variation from R & D resources;* • *Changes in Philanthropy Law;* • *Maintenance of cultural aspects, such as feeling of belonging in the context of employees' renovation;* • *Financial dependency from tuition fees;* • *Dependency between growth of academic research and resources to academic research;* • *Government funding the academic research project, but does not fund maintenance costs;* • *Non-compliance with eSocial;* • *Increased number of universities competing for funding.*

Next, VRADM personnel analysed Table 2 to identify most critical factors to PUC-Rio. This step was executed in a meeting having the three VRADM members. After reasoning on PUC-Rio's present and future, the main trends, uncertainties, triggers, and critical factors are listed in Table 25.

Table 25: Main trends, uncertainties, triggers and critical factors for PUC-Rio

Domain	Trigger	Uncertainty
Market	**Financial Opportunities**	•Market stability
	Changes to Market Response	•Recognition/Rankings
	Changes to Market Demands	•Research stability
Organization	**Strategic change**	•Organizational management

Activity 1.1.3 – Select: Trend and Uncertainty Analysis

This step was executed in a meeting with two participants; therefore, the analysis was made in an open discussion on trends and uncertainties concerning PUC-Rio. By the end, participants ranked the list from Table 25 according to their

agreement on potential impact and uncertainty level. The resulting analysis is pictured in Figure 39. As pictured in Figure 39, participants showed interest in reasoning on the variation of *Market Stability* and *Organizational Management*, the most critical uncertainties for VRADM, used, then, to build future scenarios.

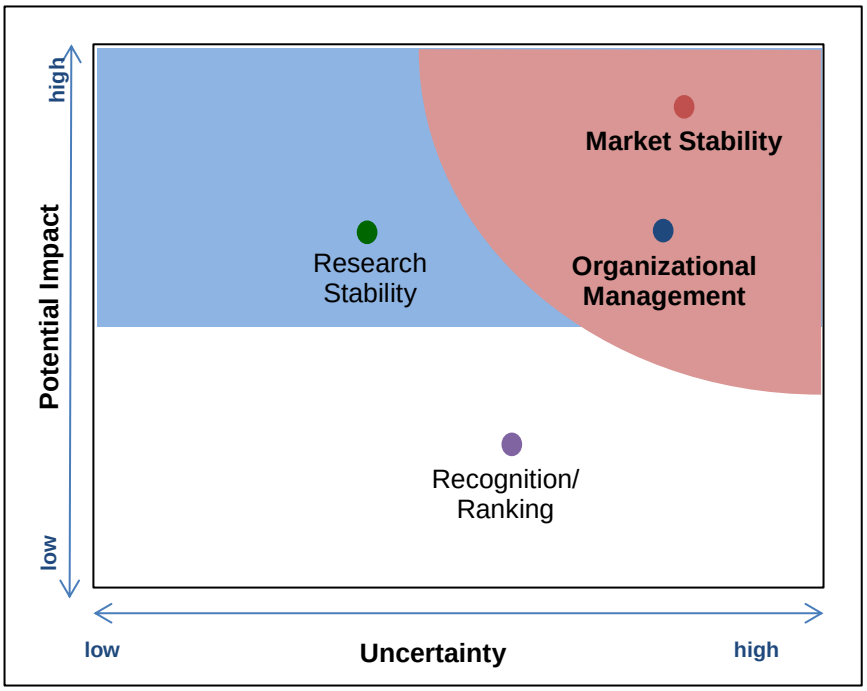


Figure 39: Impact/Uncertainty Grid for the PUC-Rio

Activity 1.1.4 – Build: Scenario Building

Resulting Scenario Matrix is the combination of aforementioned key uncertainties: *Organizational Management x Market Stability*, as presented in Figure 40.

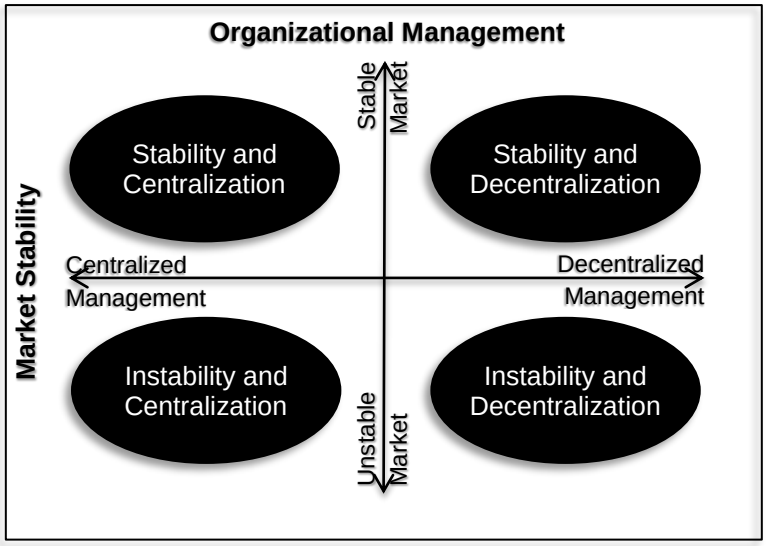


Figure 40: Scenario Matrix by PUC-Rio

Organizational Management x Market Stability

The four future scenarios for PUC-Rio result from the combination of Scenario Matrix' two axes. These scenarios are the combination between a Centralized or a Decentralized Management and a Stable or Instable Market, as described below:

- *Instability and Centralization*: This future scenario portrays an unstable market, rising prices, oscillating interest rates, recession, research funding decrease, and consequent capital retention regarding likely customers. Considering PUC-Rio's organizational management, decision-making process would be centralized, close to the top of organizational hierarchy. Decisions would be precisely and promptly made, and processes would be well controlled.
- *Instability and Decentralization*: As previous, this future scenario keeps the unstable market, rising prices, oscillating interest rates, recession, research funding decrease, and consequent capital retention regarding likely customers. However, PUC-Rio's decision-making process would be decentralized, meaning the decision-making process is spread through hierarchy lower levels. Power is distributed through organizational levels and trust is essential. Departments' coordinators have higher autonomy to make decisions.

- *Stability and Centralization*: This future scenario depicts a stable market, balanced supply and demand and a perfect competition regime. Decision-making process would be centralized, close to the top of organizational hierarchy. Decisions would be precisely and promptly made, and processes would be well controlled.
- *Stability and Decentralization*: This future scenario depicts a stable market, balanced supply and demand in a perfect competition regime. However, PUC-Rio's decision-making process would be decentralized, meaning the decision-making process is spread through hierarchy lower levels. Power is distributed through organizational levels and trust is essential. Departments' coordinators have higher autonomy.

Activity 1.1.5 – Define: Strategy Definition

This step was performed in two meetings with the vice-chancellor, plus one meeting with the planning officer and IT manager. This SSP's goal is on how to achieve the PUC-Rio's vision in all future scenarios depicted in previous step.

Before strategy definition, VRADM members identified the following themes as important strategic themes to consider during SSP:

- Academic research;
- University management,
- Sustainability;
- Creativity and Innovation.

SSP was conducted focusing on PUC-Rio as the organization and on SGU as SSsOIS and the resulting planned strategies were then consolidated as follows. In this step, we also brought ODMM to support strategic thinking and introduce participants to reason in advance.

Table 26 introduces core strategies, applicable to all future scenarios. Its first column refers to the aforementioned pillars for university management information system. Figure 41 depicts strategies regarding future scenarios in PUC-Rio's Scenario Matrix *Organizational Management* x *Market Stability*, in Figure 40.

Table 26: PUC-Rio's strategies applicable to all future scenarios

Pillar	Strategy	Action
Financial Sustainability	*Expansion of funding sources*	• Analyse market to identify companies interested in sponsoring academic research • Analyse alumni students interested in funding academic research (*endowment*) • Analyse academic research projects regarding opportunities of service provision to generate financial resources
	Support strategic decision-making process regarding financial management of Academic research x Education (tuition fees)	• Conduct comparative strategic analysis of financial data relating to academic research and education (tuition fees)
	Improve the auditing of financial management related to academic research	• Identify positive and negative employees' behaviour
University Management	*Provide business process (BP) transparency*	• Identify BP' activities generating doubts to personnel • Disclose, when possible, for instance objectives, justifications, resources allocations related to BP
	Improve PUC-Rio's acquisition process	• Analyse acquisition process by two perspectives: in each department and jointly in PUC-Rio • Identify acquisitions to be made by department and jointly at PUC-Rio
Social Responsibility	*Apply academic research to address social issues*	• Encourage academic projects coordinators to identify opportunities to contribute to society
Communication with Society	*Disseminate PUC-Rio' results to attract sponsors, students and liaisons*	• Publicize PUC-Rio's projects and results internally (personnel and students) and externally (events, companies, schools, universities, …)

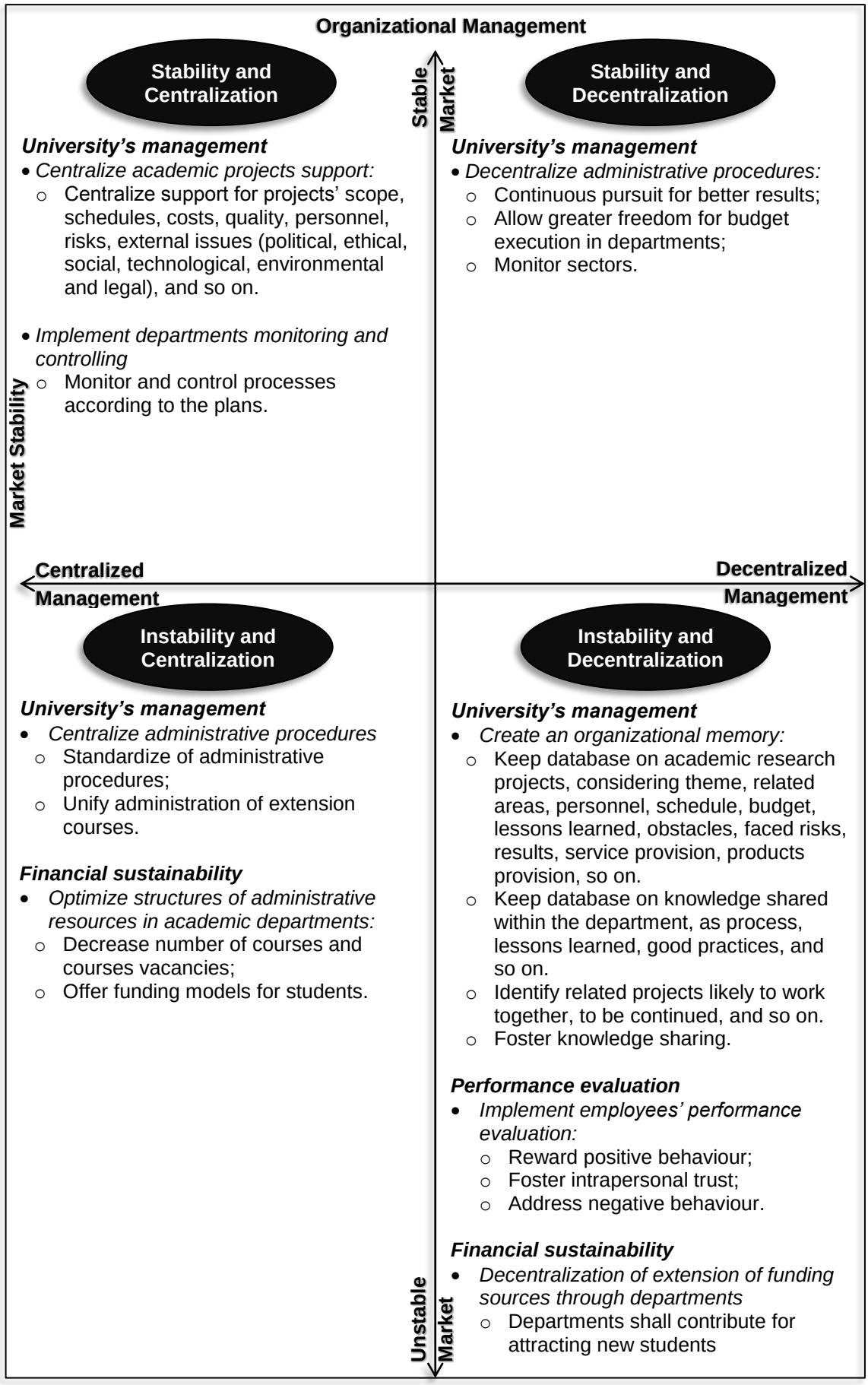


Figure 41: PUC-Rio Strategies applicable to each scenario

Activity 1.2 – Align (Figure 16)

In this step, VRADM members explained currently, SGU supports most of PUC-Rio's business process, such as academic projects control, human resources issues, students' tuition fees and scholarships, and philanthropy actions. This SSsOIS brought agility to PUC-Rio's business process and contributed to a decentralized administration of departments.

Focusing on SGU's vision, VRADM members envision SGU, besides processing PUC-Rio's transactions, also supporting managerial information and decision-making process, in other words, SGU evolving from supporting only operational level to supporting all PUC-Rio's organizational levels, tactical and strategical as well.

Following, we present SGU's new requirements elicited from Table 26, and, therefore, being applicable to all future scenarios. As in RE Group case study, these requirements are in "High Level Requirements", to be elaborated in future.

Financial Sustainability

FR01: SGU shall keep data about companies interested on sponsoring academic research, as name, areas of interest, already sponsored projects, currently sponsoring projects, and so on.

FR02: SGU shall keep data about alumni students, as name, course, current job, areas of interest, already sponsored projects, currently sponsoring projects, and so on.

FR03: SGU shall keep data about services provided by academic projects, as areas of interested, project identification, status, duration, and so on.

FR04: SGU shall issue reports comparing financial data originating from tuition fees and academic research, such as amount, destination to scholarships, university maintenance, administrative costs, and so on. Data may be group by departments, semesters, years, and so on.

NFR01: SGU shall present transparent and available data related to tuition fees and academic research for decision-making process.

FR05: SGU shall warn department coordinators about employee's variant behaviour (positive and negative) regarding financial process.

University Management

NFR02: SGU shall keep information on business process transparent and available.

FR06: SGU shall keep data about acquisitions made by departments, such as product, quantity, data, store, price, and so on.

FR07: SGU shall issue report about acquisitions to support decision-making process about which should be made by department and which should be made jointly, such as common products, store, price, most bought, and so on.

Social Responsibility

FR08: SGU shall keep data about academic project's contribution to society, such as project, area of interest, description of application to society, benefited entity, and so on.

FR09: SGU shall issue report about academic projects' contribution to society, such as project, area of interest, personnel, description of application to society, benefited entity, and so on.

Communication with Society

FR10: SGU shall issue report about academic projects' results, such as project, area of interest, personnel, department, description, scope, description of results, and so on.

Next, Figure 42 shows SGU' requirements in each future scenario. These SGU's requirements originate from Figure 41.

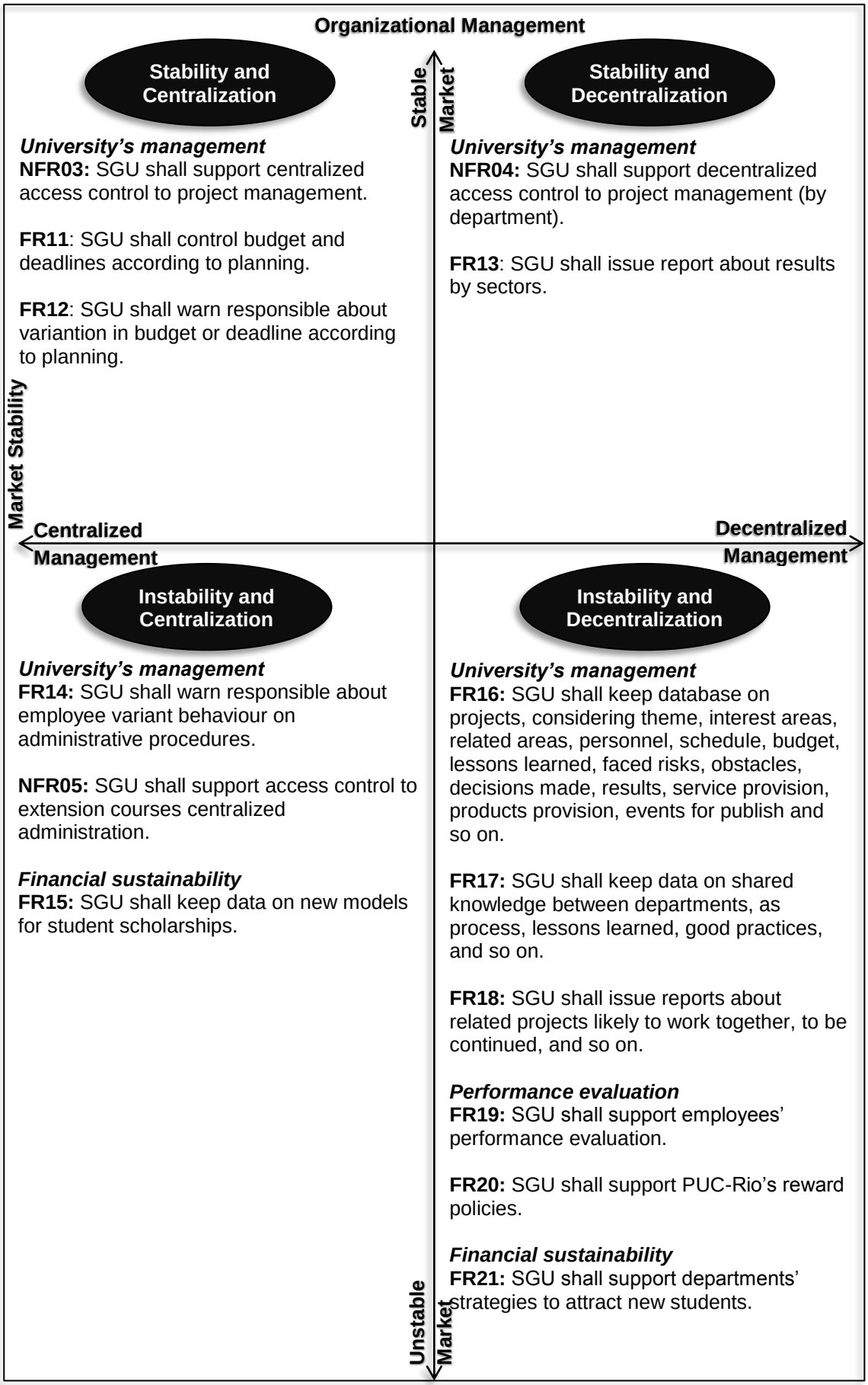


Figure 42: High level SGU' requirements to each PUC-Rio's future scenario

Activity 1.3 – Monitor

Participants have identified as indicators *Amount of New Students* x *Amount of Current Students* x *Employees Turnover* x *Research Funding* to Market Stability. The indicator to Organizational Management will is *Organizational Climate*. Monitoring those indicators will identify respective strategies to be then implemented.

Sub process 2: Organizational Impacts Analysis (OIA): Analysing likely organizational changes and impacts (Figure 19)

Activity 2.1 - Point out (Figure 20)

To understand the current context of PUC-Rio [As Is], according to VRADM perspective we modelled the strategic dependency model and strategic rationale model using i* language, as shown in Figure 43 and Figure 44. Next, based on the strategic plan presented above, and in Table 26, Figure 41, in the general SSsOIS' requirements for PUC-Rio frame, and in Figure 42 we modelled the context of PUC-Rio with strategies implemented [To Be], shown in Figure 45 and Figure 46. Because they were used during the whole ODA4RE, these are final models, presenting information elicited during the entire process.

To reason on one specific scenario in PUC-Rio, we have chosen the *project development context*, because it represents one of the most important SGU's elements, according to the responsible for SGU. In this specific case study, as we are contacting directly organizational strategists, we understand i* is the language that best represents our discussions, because of the strategic nature and high level of abstraction of strategic goals and action. Then, we modelled the academic project development context using i* instead of contextual scenarios, which would demand a more detailed level of informational regarding operational aspects. Current project development context [As Is] is pictured in Figure 47 and Figure 48 and future project development context in Figure 49 and Figure 50.

By comparing models 'as is' and respective 'to be', we have pointed out main differences between them. These differences subsequently were discussed in meetings with VRADM members and, in Table 27, we have listed the differences most discussed about. In this case study, PUC-Rio's strategies mostly represented adding elements in i* models.

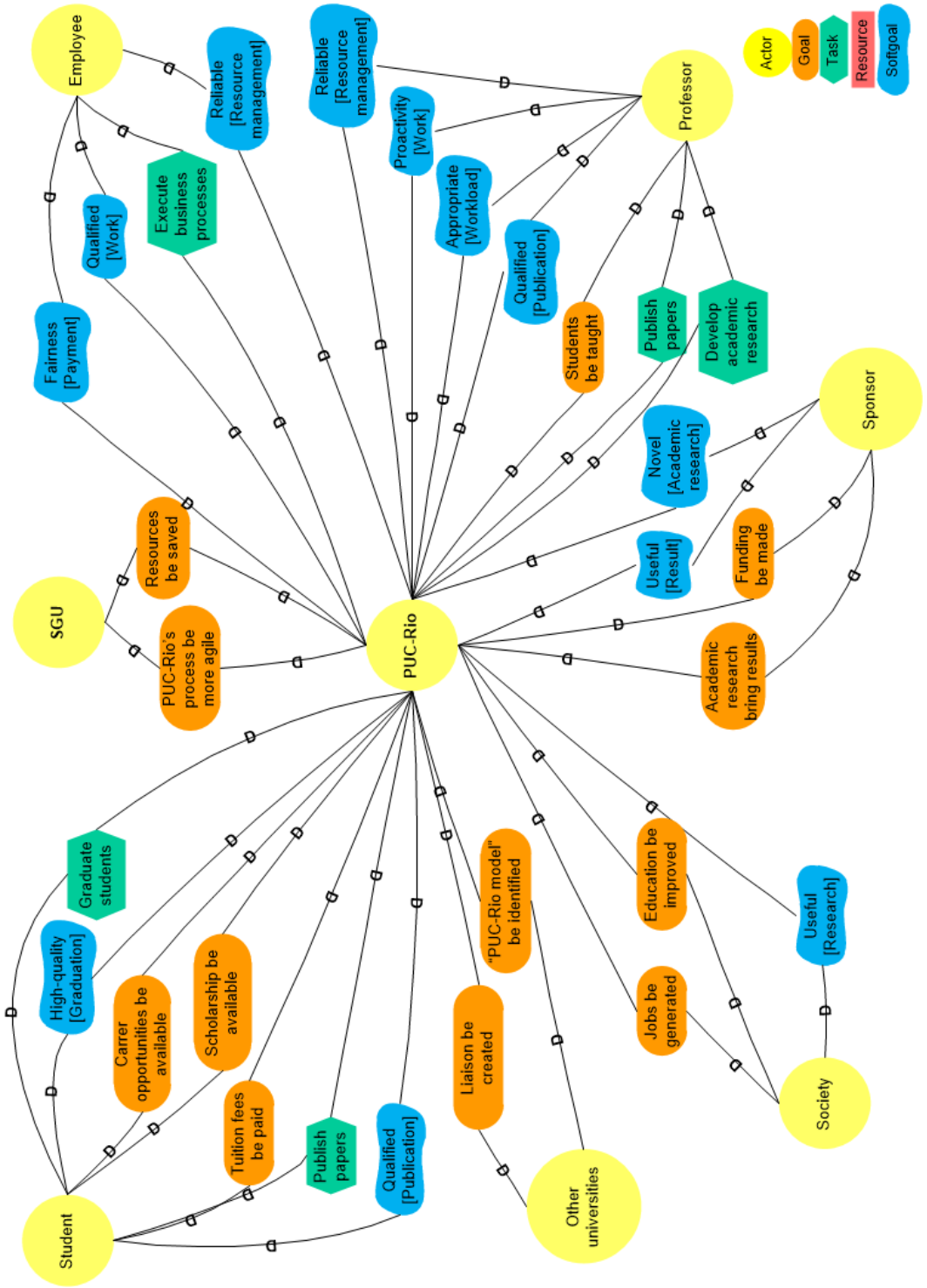


Figure 43: PUC-Rio Strategic Design - As Is

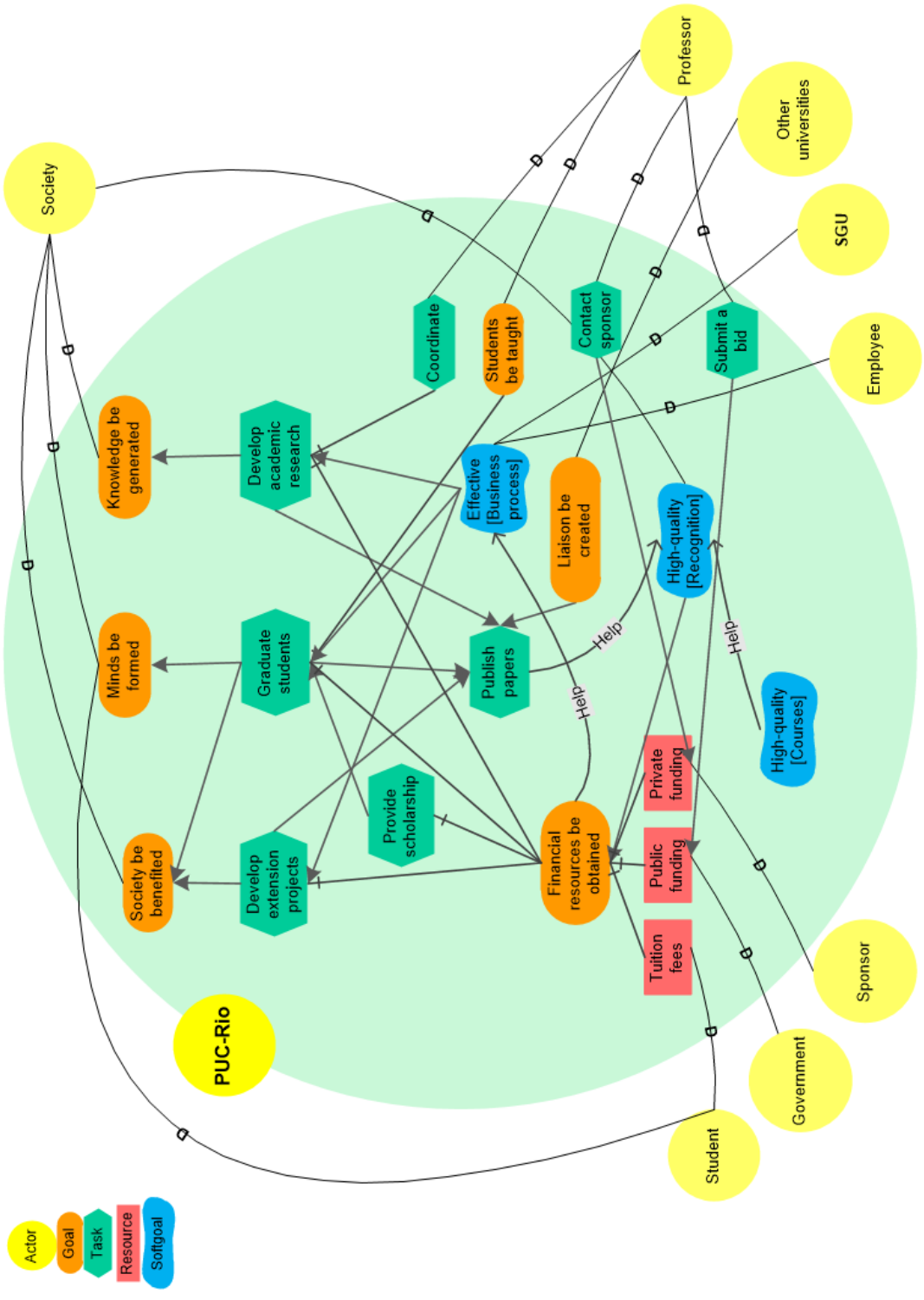


Figure 44: PUC-Rio Strategic Rationale - As Is

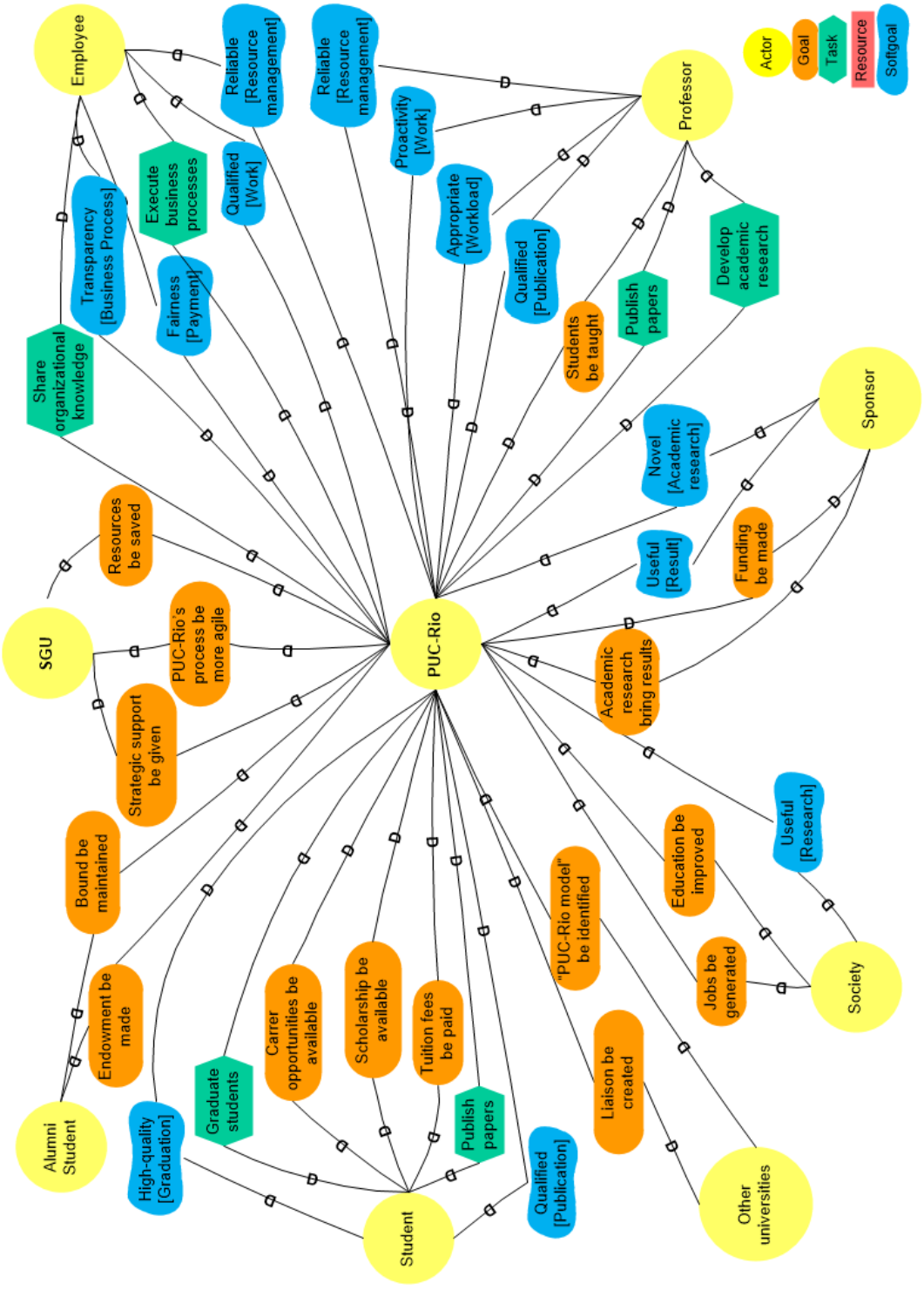


Figure 45: PUC-Rio Strategic Design - To Be

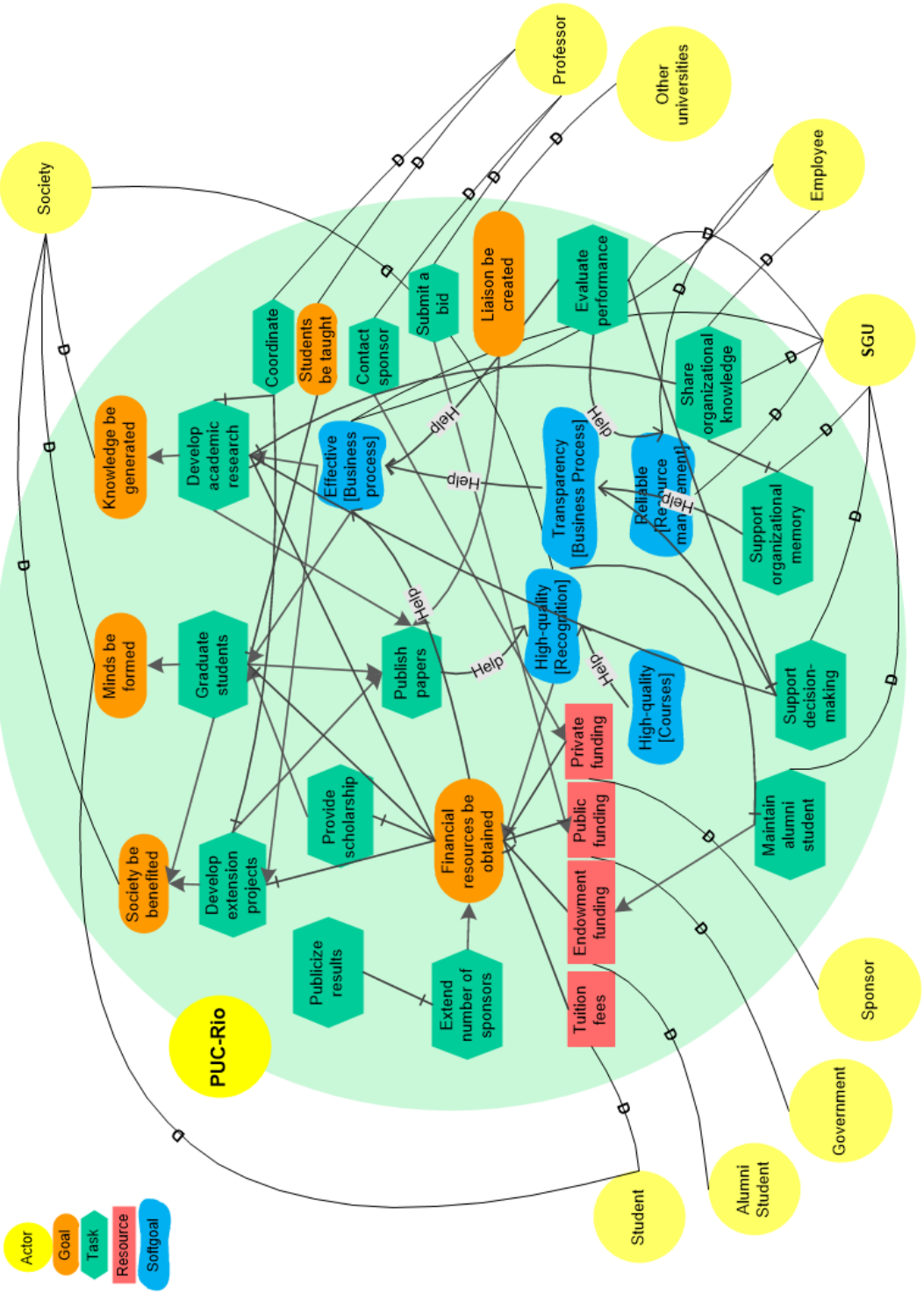


Figure 46: PUC-Rio Strategic Rationale - To Be

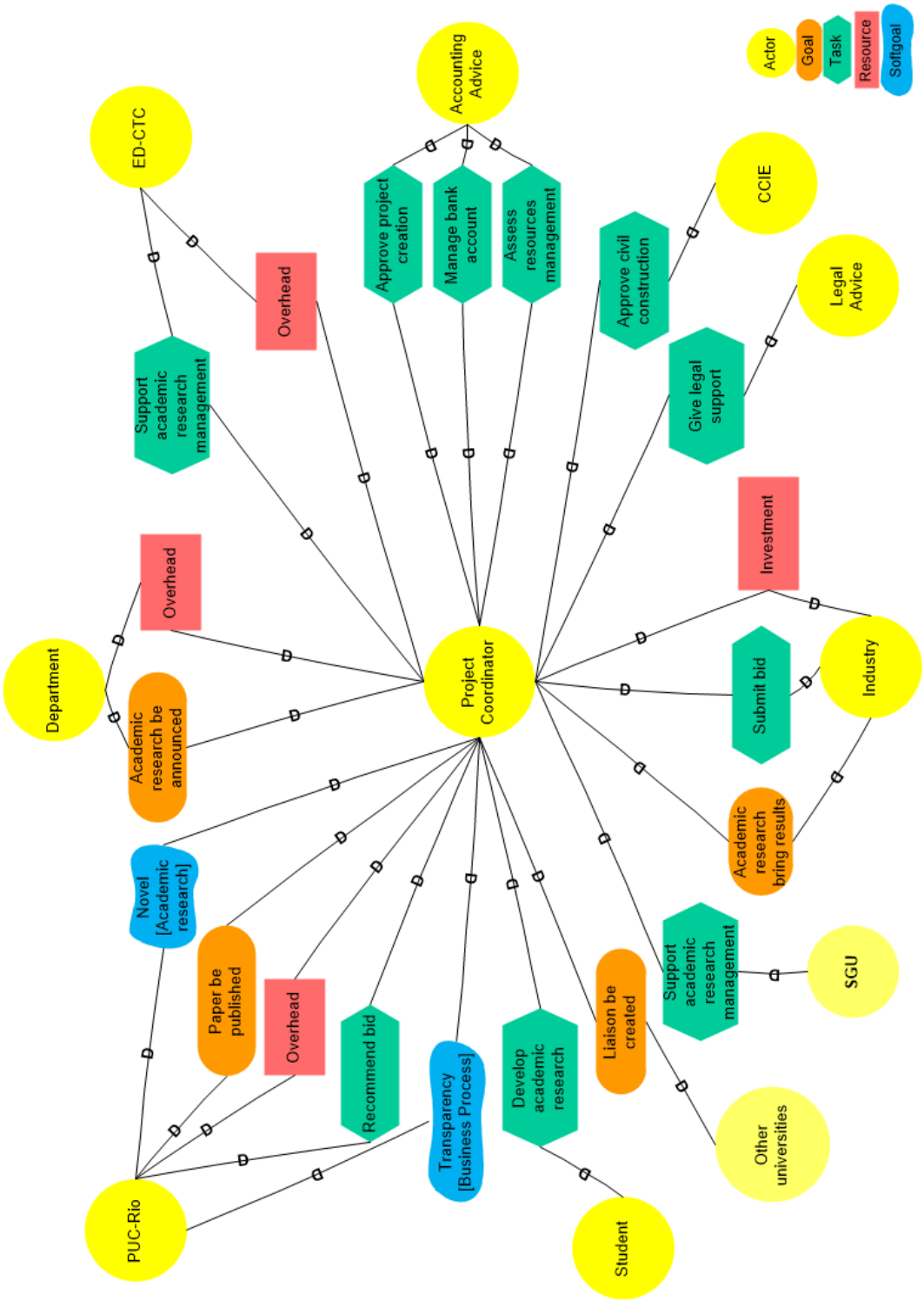


Figure 47: PUC-Rio Project Development Strategic Design - As Is

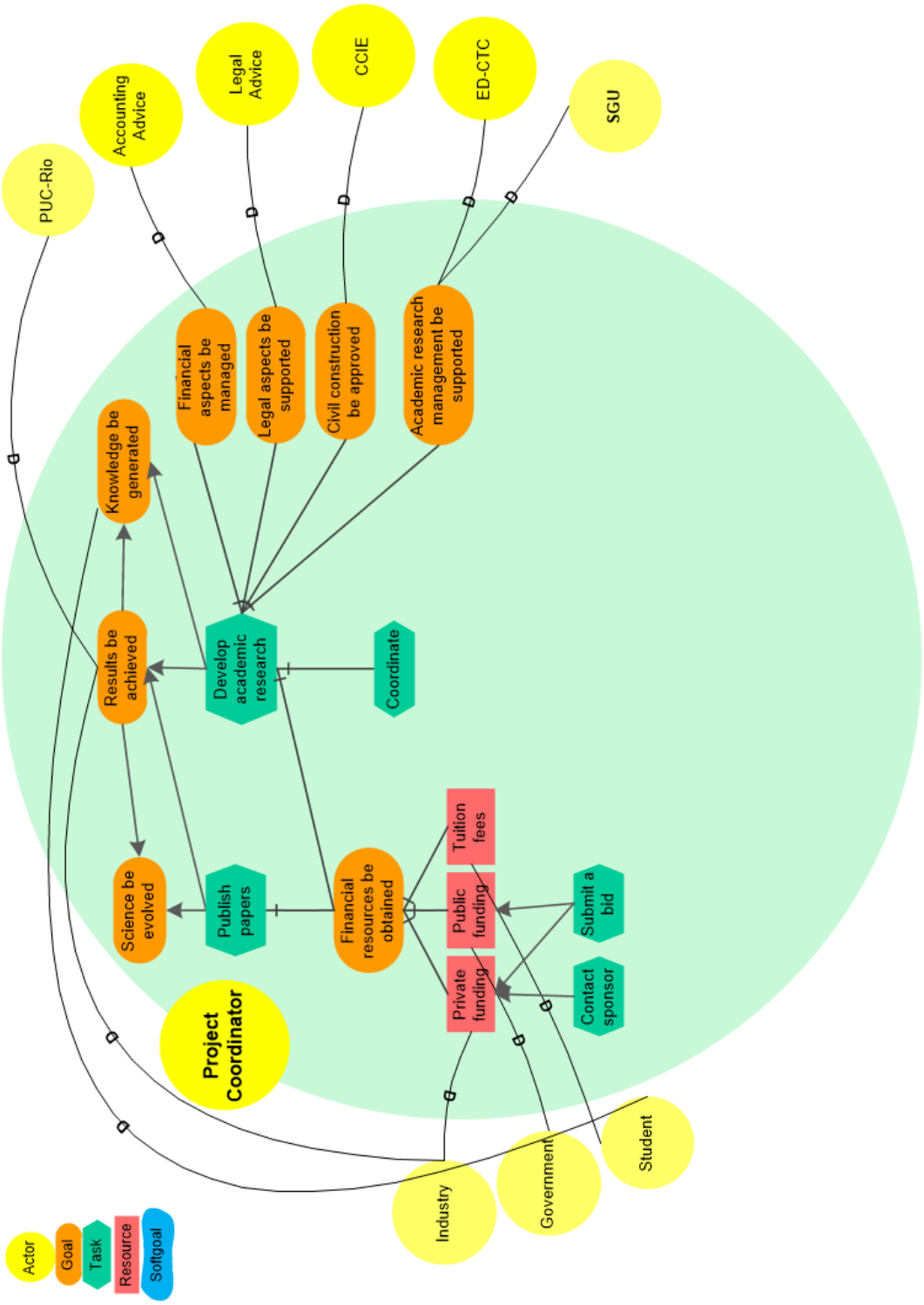


Figure 48: PUC-Rio Project Development Strategic Rationale - As Is

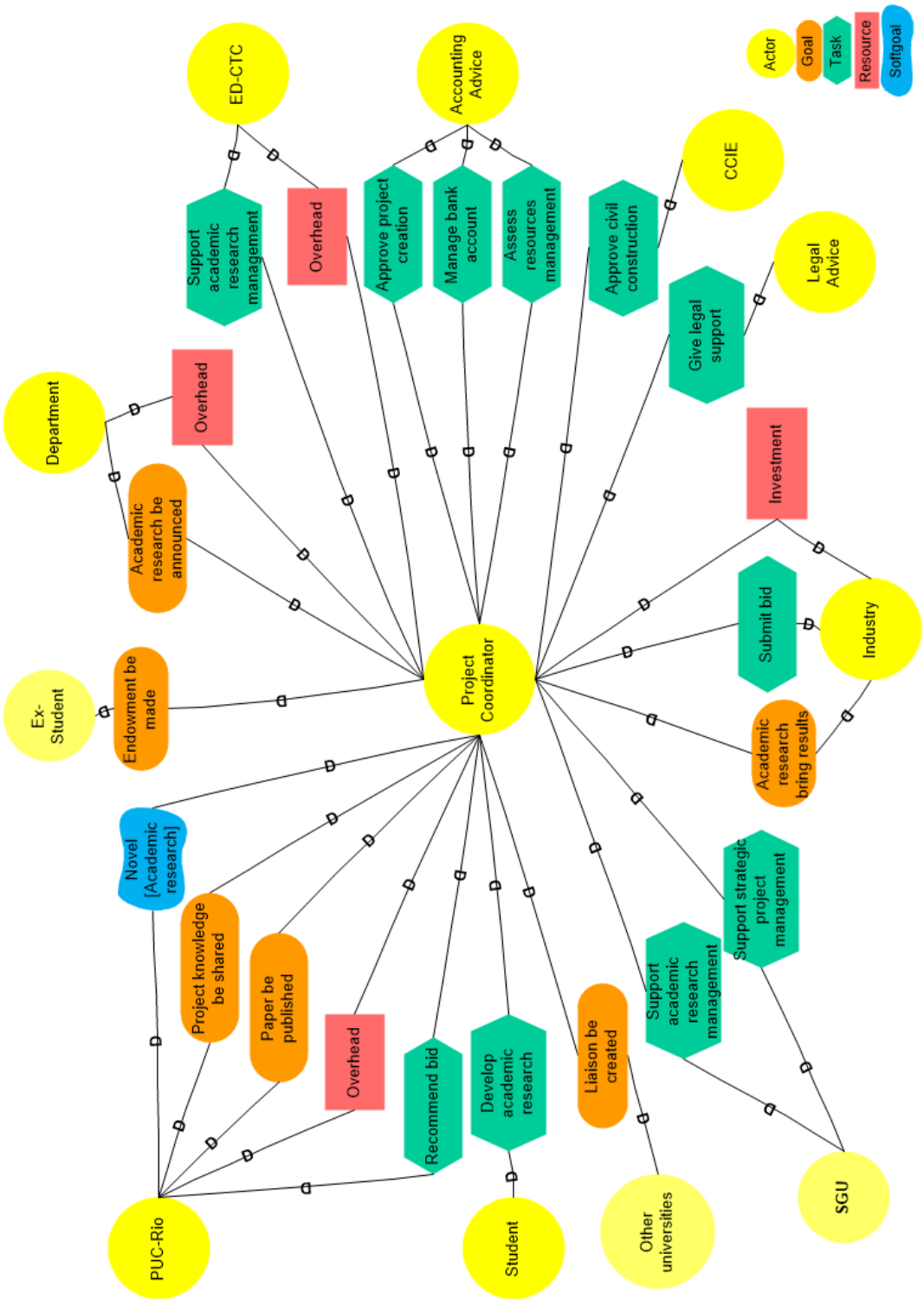


Figure 49: PUC-Rio Project Development Strategic Design - To Be

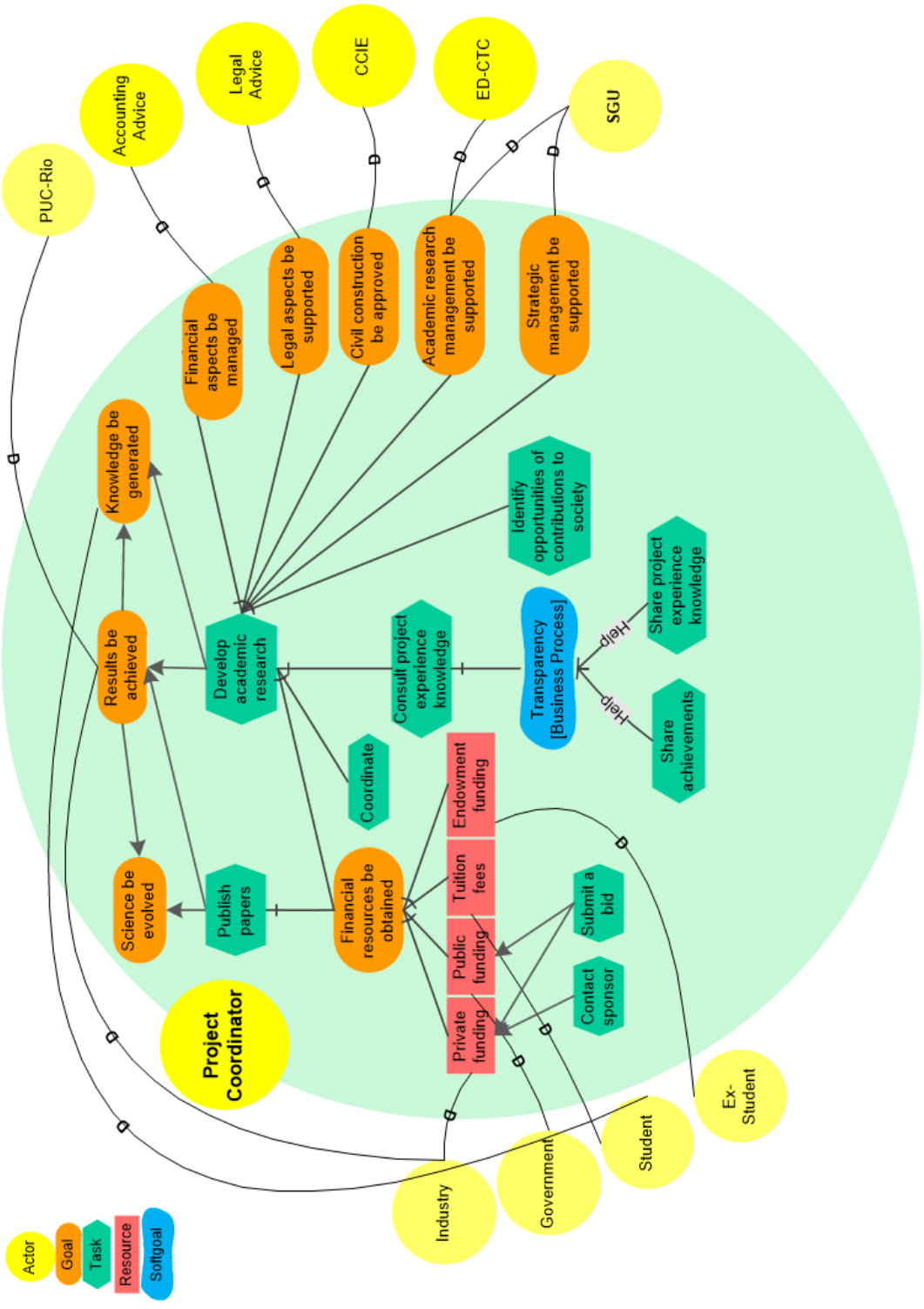


Figure 50: PUC-Rio Project Development Strategic Rationale - To Be

Table 27: PUC-Rio likely organizational changes

ID	i* models Comparing As Is and To Be	Actor	i* element	PUC-Rio likely organizational changes
01	SD PUC-Rio	Employee	Task	Share organizational knowledge
02	SD PUC-Rio	Employee	Softgoal	Transparency [Business Process]
03	SD PUC-Rio	Alumni student	Goal	Endowment be made
04	SD PUC-Rio	SGU	Goal	Strategic support be given
05	SR PUC-Rio	PUC-Rio	Task	Publicize results
06	SR PUC-Rio	PUC-Rio	Task	Extend number of sponsors
07	SR PUC-Rio	SGU	Task	Support organizational memory
08	SR PUC-Rio	SGU	Task	Support decision-making
09	SR PUC-Rio	SGU	Task	Evaluate performance
10	SR PUC-Rio	Alumni student	Resource	Endowment funding
11	SD Project	Alumni student	Goal	Endowment be made
12	SD Project	SGU	Task	Support strategic project management
13	SR Project	Project Coordinator	Task	Consult project experience knowledge
14	SR Project	Project Coordinator	Softgoal	Transparency [Business Process]
15	SR Project	Project Coordinator	Task	Share achievements
16	SR Project	Project Coordinator	Task	Share project experience knowledge
17	SR Project	Project Coordinator	Task	Identify opportunities of contributions to society
18	SR Project	SGU	Goal	Strategic management be supported

Activity 2.2 - Identify

This meeting lasted 1 hour and 30 minutes and because of unforeseen professional issues, only one VRADM was available to participate during the whole meeting.

We understand regarding the high complexity of PUC-Rio's strategic objectives, they may be grouped by closer areas and each area be deeply explored in different OIA executions. Therefore, due to time restriction, for this case study, VRADM members have chosen two specific areas to analyse likely organizational impacts, being "*Creating an Organizational Memory*" and "*Promoting Endowments*". To foster dynamicity to organizational information elicitation, the sequence of ODQ was based on ODMM and did not follow a specific flow. ODQ were selected according to subjects being discussed.

Table 28: OIA for strategy 'Creating an Organizational Memory'

OD Question	OD Answer	SGU' Requirements
What are the **objectives** of this new operation?	Creation, transfer and application of knowledge in PUC-Rio. Improve documents management. Foster knowledge management. Promoting and structuring sharing on projects information. Foster knowledge communication	**FR18 [improvement]:** SGU shall issue reports about related projects likely to work together, to be continued, crossing different departments and so on. **FR22**: SGU shall support documents management, for instance, keeping all projects proposals, projects results reports, publications, thesis, academic production, administrative, and so on. **FR23**: SGU shall issue report on project production, as project proposal, publications, academic production, interest areas, and so on. **FR24**: SGU shall support communication between stakeholders, primarily by email, futurely by messenger. **FR25**: SGU shall warn project coordinators about "Events for Publish" as conferences, workshops, companies, schools, so on, and personnel being present. **FR26:** SGU shall issue report on projects' results and alumni students according to interest areas. **FR27:** SGU shall communicate to software systems of main sponsors (import or export data). **NFR06**: SGU shall guarantee secrecy to confidential information.
What are **inputs** for this new structure?	Academic production Projects results (academic and professional) Administrative information	
What are **outcomes** from this new structure?	Interconnection between different departments Shared lines of research Liaisons Reuse of knowledge Personal interaction Explore consultancy projects. Generation of a common knowledge database enhancing opportunities for projects and enriching projects subjects. Identify consequences from information exposition to stimulate publicizing. Publicize PUC-Rio's results to approach industry and alumni students	
How does **security** apply to this new input?	Identification of secrecy demands in projects to prevent publication	

OD Question	OD Answer	SGU' Requirements
Does the organization have a **current process** related to the new operations?	Yes, tracking alumni students	**FR28**: SGU shall support tracking alumni student process. **FR29**: SGU shall support promoting endowment from alumni students process. **FR31**: SGU shall keep database on alumni students, as name, course, publications, projects, interest areas, current occupation, and so on. **FR32**: SGU shall issue report on alumni students and interest areas. **NFR07**: SGU shall keep data related to endowments transparent.
Does the organization need a **new process** related to the new operations?	Yes, promoting endowment, but the core model is not identified yet. May be used an investments fund or contract a service to assist it.	
What are the **objectives** of this new operation?	Keep alumni students bounded to the institution.	
How do the changes affect the **relationship** between **stakeholders**?	Approximate alumni students with same interests. Being part of an alumni students associating brings prestige.	
Is there current **function** to support the new strategy change?	Alumni students association (existent).	
What are **outcomes** from this new structure?	Tracking alumni students contributes to publicizing PUC-Rio and to promote endowments	
How does this new structure need to be executed regarding **quality** aspects?	Process supporting endowments demand to be transparent. The more transparent, more able to receive endowments.	
Does the organization have a **legal** influence in the market?	Legislation is not precursor but successor to the habit. Maybe we need to start this habit to have laws supporting it… or maybe not. Let us see. However, if government could encourage endowment to universities, as encourages to hospitals, it would benefit alumni students and other interested people.	
What are **outcomes** from this new structure?	Promoting endowments contributes to PUC-Rio's prestige, being recognized as a big university as abroad universities for example.	

Table 29: OIA for strategy 'Promoting Endowment'

Sub process 3: Validating SSsOIS' requirements changes (LSRV) (Figure 21)

Considering the Strategic Plan was elaborated during this case study, the implementation of SGU's requirements identified in previous sections depends on when the strategy is going to be implemented. Recapping, the identification of strategies to be implemented is outcome of Monitoring step from SSP. Therefore, validation of SGU's requirements with VRADM was carried out using a questionnaire similar to the one applied to RE Group. It is presented in APPENDIX D, in Portuguese, respondents' native language. Results are presented in next section.

5.5.2. Results

In this section, we present VRADM members' evaluation results according to questionnaire sections, as follows. This questionnaire had quantitative and qualitative questions, similar to the one applied to RE Group:

Participants Profiles

The VRADM members who actively participated in this case study were the vice-chancellor, the planning officer, and IT manager. However, in the validation of SGU's requirements only the planning officer and the IT manager have taken part because their positions are closely related to SGU. Table 30 shows their academic and professional profile.

Table 30: PUC-Rio's professional and academic profiles of questionnaire respondents

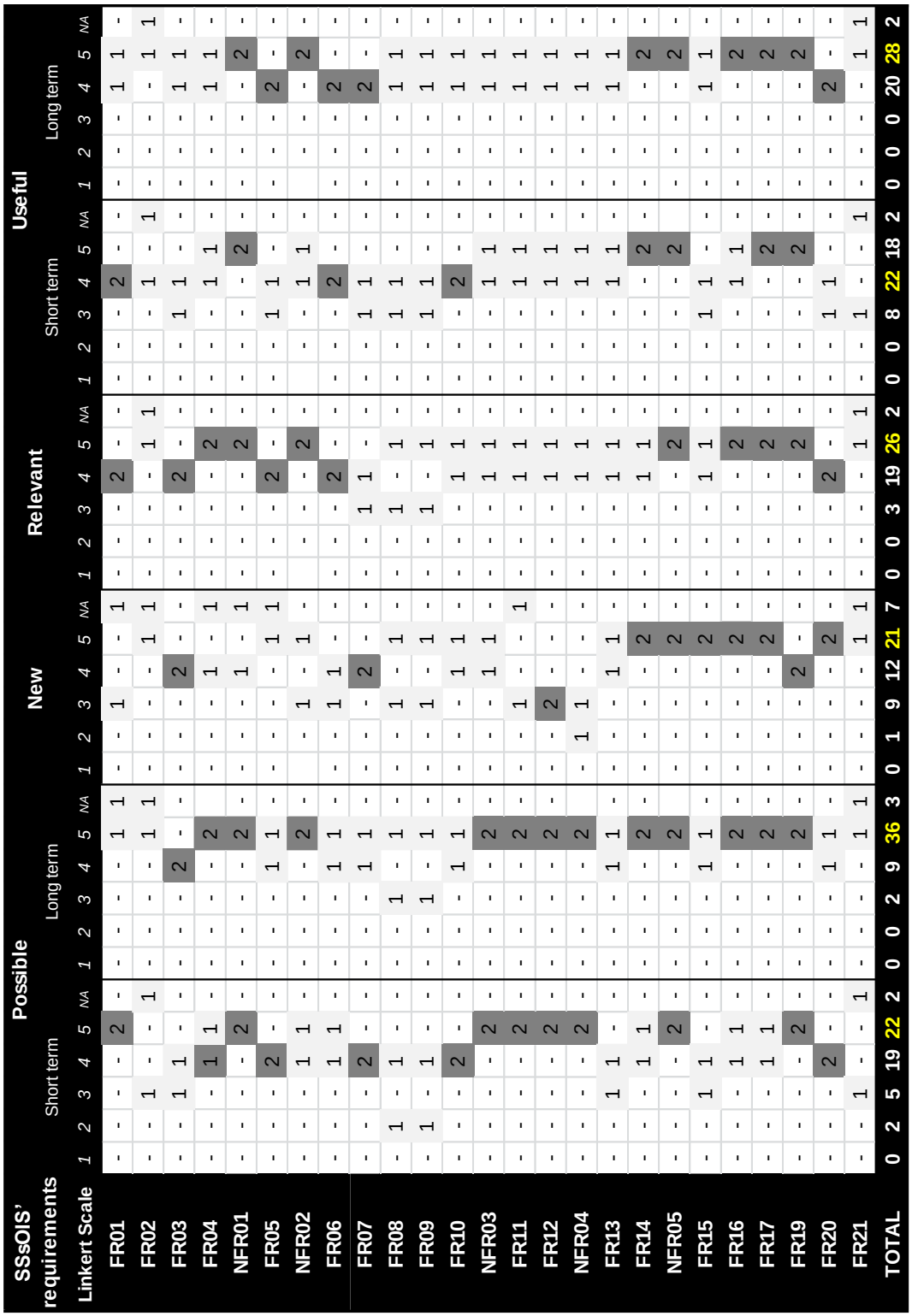
Participant	Professional			Academic		
	Current profession	**Current enterprise**	**Experience (years)**	**Current position**	**Current university**	**Experience (years)**
1	Planning officer	PUC-Rio	6	Professor	PUC-Rio	6
2	IT manager	PUC-Rio	15	Professor	PUC-Rio	10

Requirements Evaluation

Elicited requirements for SGU were evaluated according to qualities presented in section 2.2.5, using a Likert scale to quantify *Little* (1) and *A Lot* (5). In this case study, we also asked participants to identify the *priority to implement* of SGU's requirements, showed Table 33 in and Table 34. Answers are

separated by qualities and cells indicate the amount of answers for that number in Linkert scale. Table 31 presents SGU's requirements elicited by SSP and Table 32, SGU's requirements elicited by OIA. 'Final total' sums up evaluations from SGU's requirements elicited by SSP and by OIA, for qualities and priority.

Table 31: PUC-Rio's quantitative evaluation about SGU's requirements quality elicited by SSP



SSsOIS' requirements	Possible										New											Relevant										Useful									
Linkert Scale	Short term					Long term					Short term					Long term					Short term					Long term					Short term					Long term				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
FR01	-	-	-	-	2	-	-	-	1	1	-	-	1	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	1
FR02	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	-	1
FR03	-	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	1
FR04	-	-	-	1	1	-	-	-	1	1	-	-	-	1	2	-	-	-	1	2	-	-	-	-	2	-	-	-	1	1	-	-	-	1	1	-	-	-	-	2
NFR01	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2
FR05	-	-	-	2	-	-	-	-	1	1	-	-	1	1	-	-	-	-	1	1	-	-	-	2	-	-	-	-	1	1	-	-	-	2	-	-	-	-	2	-
NFR02	-	-	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	1	2	-	-	-	-	1	-	-	-	1	1	-	-	-	-	1
FR06	-	-	-	1	1	-	-	-	1	1	-	-	1	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-
FR07	-	-	-	2	-	-	-	-	1	1	-	-	-	2	-	-	-	-	1	1	-	-	1	1	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	1
FR08	-	1	-	1	-	-	1	-	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
FR09	-	1	-	1	-	-	1	-	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
FR10	-	-	-	2	-	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
NFR03	-	-	-	-	2	-	-	-	-	2	-	-	-	-	1	-	-	-	-	1	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
FR11	-	-	-	-	2	-	-	-	-	2	-	-	1	-	-	-	-	1	-	-	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
FR12	-	-	-	-	2	-	-	-	-	2	-	-	2	-	-	-	-	2	-	-	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
NFR04	-	-	-	-	2	-	-	-	-	2	-	1	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	1	-	-	-	1	1	-	-	-	-	1
FR13	-	-	1	1	-	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	1	1	1	-	-	1	1	1	-	-	-	1	1	-	-	-	-	1
FR14	-	-	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	1	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2
NFR05	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2
FR15	-	-	1	1	-	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	1	1	1	-	-	1	1	1	-	-	-	1	1	-	-	-	-	1
FR16	-	-	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	1	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2
FR17	-	-	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2
FR19	-	-	-	-	2	-	-	-	-	2	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-	-	-	-	2	-
FR20	-	-	-	2	-	-	-	-	1	1	-	-	-	-	2	-	-	-	1	1	-	-	-	2	-	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1
FR21	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1
TOTAL	0	2	5	19	22	0	2	9	36	3	0	1	9	12	21	0	7	3	19	26	0	0	3	22	18	0	2	8	22	18	0	0	0	20	28	0	2	2	2	2

Table 32: PUC-Rio's quantitative evaluation about SGU's requirements quality elicited by OIA

SSsOIS' requirements	Possible												New						Relevant						Useful											
	Short term						Long term																		Short term						Long term					
Linkert Scale	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*	*1*	*2*	*3*	*4*	*5*	*NA*
FR18	-	-	2	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	-	-	1	-	1	-	-	-	1	1	-	-	-	-	-	1	1	-
FR22	-	-	-	2	-	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-	2	-
FR23	-	-	-	2	-	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	1	1	-
FR24	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	1	-	1
FR25	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	1	-	1
FR26	-	-	1	-	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	1	-	-	1	-	-	-	-	1	1
NFR06	-	-	-	1	1	-	-	-	-	-	2	-	1	-	-	-	1	-	-	-	-	-	2	-		-	-	1	1	-		-	-	-	2	-
FR27	-	-	1	-	1	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-
FR28	-	-	1	-	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	1	-	-	1	-	-	-	-	1	1
FR29	-	-	2	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	1	1	-
FR30	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	1	-	-	1	-	-	-	-	1	1
FR31	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	1	-	1
NFR07	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	-	2	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	-	1	1	-
TOTAL	**0**	**0**	**8**	**9**	**3**	**6**	**0**	**0**	**0**	**5**	**15**	**6**	**1**	**0**	**2**	**1**	**16**	**6**	**0**	**0**	**2**	**6**	**12**	**6**	**0**	**0**	**7**	**10**	**3**	**6**	**0**	**0**	**0**	**8**	**12**	**6**
FINAL TOTAL	**0**	**2**	**13**	**28**	**25**	**8**	**0**	**0**	**2**	**14**	**51**	**9**	**1**	**1**	**11**	**13**	**37**	**13**	**0**	**0**	**5**	**25**	**38**	**8**	**0**	**0**	**15**	**32**	**21**	**8**	**0**	**0**	**0**	**28**	**40**	**8**

Table 34: PUC-Rio's prioritization of SGU's requirements elicited by SSP

SSsOIS' requirements	Priority					
Linkert Scale	*1*	*2*	*3*	*4*	*5*	*NA*
FR01	-	-	-	2	-	-
FR02	-	-	-	1	-	1
FR03	-	-	2	-	-	-
FR04	-	-	-	2	-	-
NFR01	-	-	-	1	1	-
FR05	-	1	1	-	-	-
NFR02	-	-	-	2	-	-
FR06	-	-	1	1	-	-
FR07	-	-	2	-	-	-
FR08	-	-	2	-	-	-
FR09	-	-	2	-	-	-
FR10	-	-	1	1	-	-
NFR03	-	-	1	-	1	-
FR11	-	-	1	-	1	-
FR12	-	-	1	-	1	-
NFR04	-	1	-	-	1	-
FR13	-	-	-	2	-	-
FR14	-	-	-	1	1	-
NFR05		-	-	-	2	-
FR15	-	-	-	2	-	-
FR16	-	-	1	-	1	-
FR17	-	-	-	1	1	-
FR19	-	-	-	1	1	-
FR20	-	-	2	-	-	-
FR21	-	-	1	-	-	1
TOTAL	0	2	18	17	11	2

Table 33: PUC-Rio's prioritization of SGU's requirements elicited by OIA

SSsOIS' requirements	Priority					
Linkert Scale	*1*	*2*	*3*	*4*	*5*	*NA*
FR18	-	-	1	1	-	-
FR22	-	-	-	2	-	-
FR23	-	-	1	1	-	-
FR24	-	-	-	1	-	1
FR25	-	-	1	-	-	1
FR26	-	-	1	-	-	1
NFR06	-	-	-	1	1	-
FR27	-	-	1	1	-	-
FR28	-	-	-	1	-	1
FR29	-	-	1	-	1	-
FR30	-	-	-	1	-	1
FR31	-	-	1	-	-	1
NFR07	-	-	1	-	1	-
TOTAL	0	0	8	9	3	6
FINAL TOTAL	0	2	26	26	14	8

Looking at Table 32's Final Total line, we can observe the majority of answers evaluated elicited SGU's requirements with 5 in Linkert scale, representing 'A Lot' for explored qualities. Each of 6 qualities have 76 answers (38 requirements x 2 participants). Having this in mind, qualities were evaluated as below:

- *Possible in short term:* ***59%*** *answers are between 4 and 5 expressing requirements are a lot possible in short term.*

- *Possible in long term:* ***86%*** *answers are between 4 and 5 expressing requirements are a lot possible in long term.*
- *New:* ***66%*** *answers are between 4 and 5 expressing requirements are a lot new.*
- *Relevant:* ***83%*** *answers are between 4 and 5 expressing requirements are a lot relevant to RE Group.*
- *Useful in short term:* ***70%*** *answers are between 4 and 5 expressing requirements are a lot useful in short term.*
- *Useful in long term:* ***89%*** *answers are between 4 and 5 expressing requirements are a lot useful in long term.*

As seen in Table 33 and Table 34, we asked participants to prioritize SGU's requirements. Last line of Table 33 presents 26 SGU's requirements are prioritized as *3*, 26 as *4* and 14 as *5*, i. e. **53%** of elicited SGU's requirements have high priority (4 or 5) to be implemented according to participants.

Next questionnaire question was a qualitative question about a general evaluation of elicited SGU's requirements. Table 35 shows qualitative participants' answers confirming quantitative answers in Table 31 and Table 32:

Table 35: PUC-Rio members' general evaluations about elicited SGU's requirements

PUC-Rio members' general evaluation of elicited SGU's requirements
Very important requirements, which give to SGU development planning a decisive alignment with the corporate strategy, which are presented in important issues such as 'Tracking of Alumni Students' and 'Promoting Endowment'.
I found a great opportunity to identify requirements linked to strategic objectives. With this approach you can prioritize requirements and even implement them knowing that their impact may be related to the needs of present, of tomorrow and of a future already planned.

Following, we asked VRADM members if they had suggestions for adding new requirements, remove, alter, combine, and decompose listed requirements. Table 36 shows the answers to this qualitative question.

Table 36: PUC-Rio members' suggestions on requirements changes

PUC-Rio members' answers about requirements change
I consider they meet discussed objectives.
Yes, in my assessment, a requirement should not treat at the same time academic, administrative and research issues.

ODA4RE Method Evaluation

In last section of the questionnaire, we have asked participants to evaluate ODA4RE as an approach to elicit requirements aligned to the strategic planning process. Table 37 shows the answers to this qualitative question.

Table 37: PUC-Rio members' answers about ODA4RE evaluation

PUC-Rio members' evaluation of ODA4RE
I believe the method, because it integrates strategic management to the direction of software development, generates benefits, anticipates changes (including high impact) and facilitates the preparation and necessary adaptation.
Very good.

Next, participants were asked if the proposed method have contributed to SGU's requirements elicitation and why. Figure 51 shows quantitative answers and Figure 51 shows explanations about their opinions.

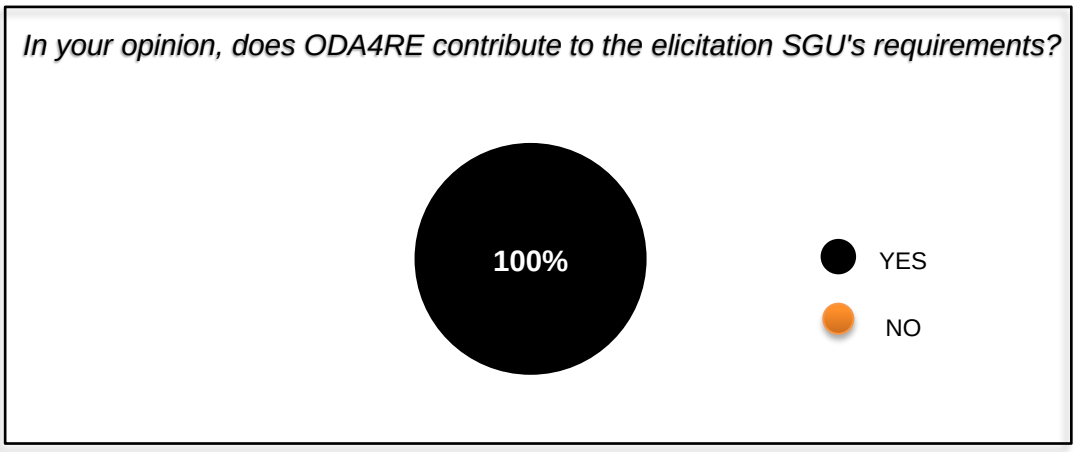


Figure 51: PUC-Rio's answers whether ODA4RE contributes to requirements elicitation or not

Table 38: PUC-Rio members' explanations whether ODA4RE contributes to requirements elicitation or not

PUC-Rio members' explanations if ODA4RE contributes to requirements elicitation
Not being specifically my area, I see that the results corroborate my statement.
It allows you to classify and prioritize the requirements more directly linking their impact on the organization's strategy.

We also have asked what participants would change in ODA4RE method. Figure 41 shows the answers to this qualitative question.

Table 39: PUC-Rio members' answers about changing ODA4RE

PUC-Rio members' answers about changing ODA4RE
My knowledge is limited to provide an improvement to the method.
For a better guarantee of the requisite understanding, I find it interesting that they can be put to system requirement level and not only on the user requirement level. Thus, for each requirement it should be possible to establish the capabilities that the system should provide for the attainment of its purpose.

By the end of the questionnaire, we have asked PUC-Rio members if they would apply ODA4RE, recommend ODA4RE and their reasons for that. Answers were again based in a Likert scale, 1 representing 'Strong no' and 5 represent 'Strong yes'. Figure 52 and Figure 53 show quantitative answers, and Table 40 and Table 41 qualitative answers.

Would you apply ODA4RE to support SGU's requirements elicitation in your projects?

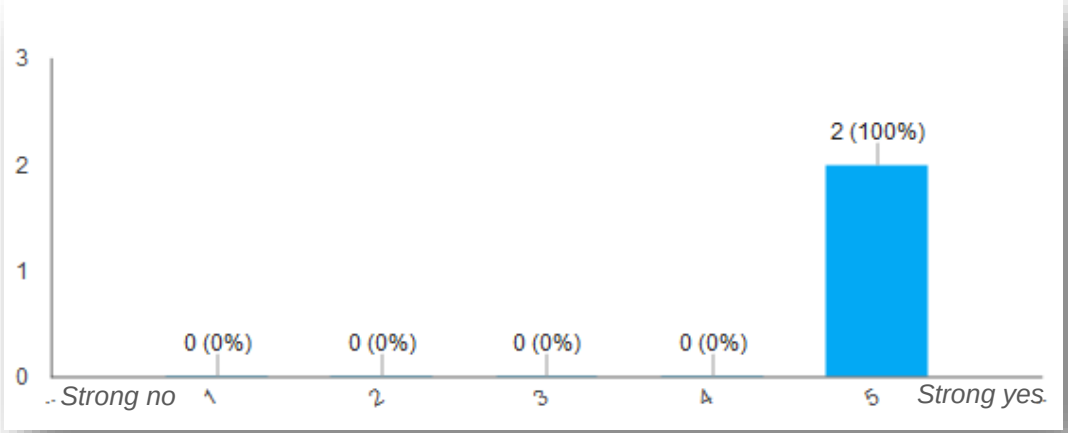


Figure 52: PUC-Rio members' answers about whether they would apply ODA4RE or not

Table 40: PUC-Rio members' answers if they would apply ODA4RE

PUC-Rio members' answers if they would recommend ODA4RE
Having shown good results specifically to SGU itself, ODA4RE's application shows being of interest for the institution.
Yes

Would you recommend ODA4RE to support SSsOIS' requirements elicitation?

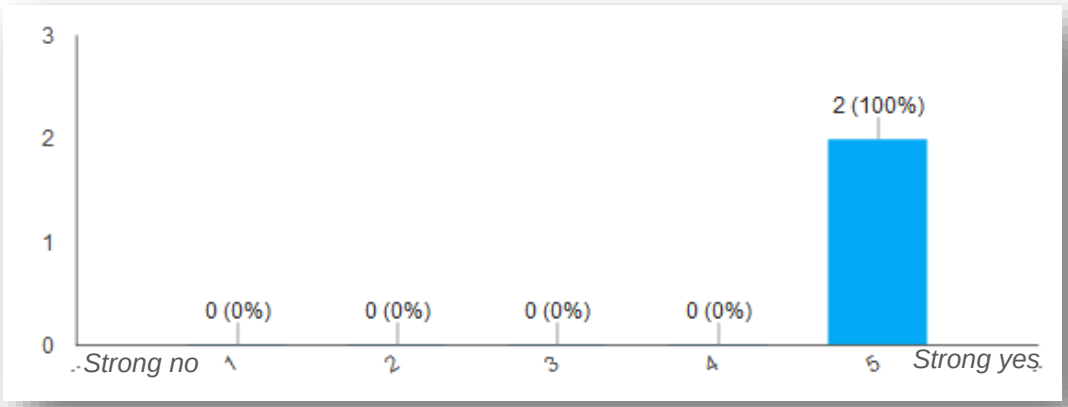


Figure 53: PUC-Rio members' answers about whether they would recommend ODA4RE or not

Table 41: PUC-Rio members' answers if they would recommend ODA4RE

PUC-Rio members' answers if they would apply ODA4RE
Having shown good results, ODA4RE's application is of interest for the institution.
To identify requirements for managerial and strategic interest of the organization, which are not related to business processes.

5.5.3. Discussion

In section 5.3, we studied the ODA4RE case at PUC-Rio University. This initiative started in June 13th and ended by October 6th. During this period, we carried out eight face-to-face meetings and documents exchange by emails. Took part of this case study, the Vice-chancellor for Administrative Affairs, the planning officer, and the IT manager, all members of the Vice Chancel for Administrative Affairs (VRADM in Portuguese).

We have started this case study by applying SSP. We defined we would contact VRADM because we were interested in the relationship between SGU and PUC-Rio, as Figure 38. This brought an administrative perspective to this case study. Some meetings were conducted separately with the vice chancellor, due to professional commitments, and then findings in one meeting were shared in the next and so on. Perception analysis constructed a common basis of knowledge on PUC-Rio's organizational identity in Table 24. By analysing trends and uncertainties, VRADM members have chosen Market Stability and Organizational Management as most critical for PUC-Rio, resulting in four scenarios in Figure 40. Following, we identified 7 core strategies and 11 actions to achieve them; and 8 scenarios strategies and 17 scenario actions. From analysing SGU role in PUC-Rio, it was identified an interest to evolve this SSsOIS to support strategic decisions. From identified strategies, we have elicited 10 functional requirements (FR) and 2 non-functional requirements (NFR). From scenario strategies, we elicited more 11 FR and 3 NFR, summing up 21 FR and 5 NFR. By applying OIA, we elicited more 11 FR and 2 NFR. Finally, VRADM members validated elicited SGU' requirements, being 38 FR and 7 NFR. We understand identified strategies from future scenarios may indeed present likely organizational changes in advance possibly bearing impacts on SSsOIS, as in Figure 42, therefore *rejecting Negative Hypothesis 1 (NH1)*. Additionally, Table 28 and Table 29 show organizational changes and consequent impacts influencing SSsOIS*, rejecting Negative Hypothesis 2 (NH2)*. Hence, *the General Negative Hypothesis (GNH1) is rejected, as SSsOIS' requirements changes originated by strategic initiatives were anticipated.*

SGU's requirements evaluation, presented on Table 31 and Table 32, shows ODA4RE contributed towards eliciting qualified requirements, which was qualitatively confirmed in Table 35. PUC-Rio members highlighted they recognize

ODA4RE anticipates SSsOIS' requirements, as comments in Table 35 and in Table 37, rejecting again *GNH1*.

SGU current evolution process illustrates a common market practice in SSsOIS evolution: SSsOIS evolution oriented to the organizational *operational level*, implemented according to business process modelling and prioritization of user requirements made on demand, without aligning SSsOIS' requirements with strategic planning. We can observe ODA4RE contributed to elicit requirements more aligned to strategic objectives, as comment in Table 40, and anticipating possible organizational impacts, going beyond SSsOIS evolution techniques applied before at PUC-Rio.

As identified in the first case study with the RE Group, VRADM members also agree that strategic objectives and actions identified for each future scenario have the potential to be implemented in other scenarios as well. Picturing possible multiple futures stimulated them to reason on possible critical uncertainties and plan on how to deal with them by identifying related strategies and actions. However, by analysing them, some are likely to be also relevant to the company in others future scenarios.

In addition, we observed overtime participants have started proactively to foresee consequent organizational impacts from likely organizational changes. They started to think what could be the likely impacts on the institution resulting from specific strategic objectives, and, by themselves, to use ODQS based on the ODMM. ODQ contributed to systematize knowledge elicitation, guiding requirements engineer and organizational key people.

Finally, according to VRADM members, important strategic objectives were identified during this case study, as for instance "Provide process transparency", "Create an organizational memory", "Expansion of funding sources", "Promote contribution to society". Strategic objectives identified in this case study are going to be addressed from now on and further effective actions are going to be established, implemented, monitored, and improved to achieve these strategic objectives. This thesis authors are part of this project.

5.6. General Discussion

In this section, we discuss confirmatory case studies under the perspective of five aspects. We combine case study 1 (SSP at RE Group) with SSP part of our case study 4 (ODA4RE at PUC-Rio) and case study 3 (OIA at UK Post

Office) with OIA part of our case study 4 (ODA4RE at PUC-Rio). We do not include case study 2 (LMS at universities) because, differently from others, it is exploratory, with the objective of understanding how to represent organizational changes and consequent impacts.

SSsOIS' requirements completeness: In this aspect, we combine case study 1 and 4 because participants validated respective elicited SSsOIS' requirements. As depicted by Table 10, Table 31 and Table 32, qualities of most of elicited SSsOIS' requirements were graded by 4 or 5 Likert scale, indicating the consistency of elicited SSsOIS' requirements and organizational members understanding. Additionally, in case study 4, the fact these SSsOIS' requirements were not yet in the original SGU' specification represents a step towards SGU' requirements completeness.

Domain knowledge: We observed SSP have contributed to participants from case studies 1 and first part of 4 to share their organizational knowledge contributing to organizational awareness. In conjunction, participants built up important concepts as organizational identity, analysis, and strategies, sharing a common ground for discussion, as seen in previous frames with general strategies in each case and scenario strategies in Table 7 and Table 26. In case study 3 and second part of 4, domain knowledge was elicited by the application of observation, documents reading, and interview techniques, all supported by ODMM and ODQS. Then, elicited organizational knowledge was modelled in i* models and contextual scenarios, and clarified to participants to elaborate their ideas.

Decision rationale: OIA comprises ODMM and ODQS to support eliciting and reasoning on organizational knowledge. Table 20 and Table 21 in case study 3, and Table 28 and Table 29 in second part of case study 4, show the decision rationale of participants on these cases.

Stakeholders involvement: Stakeholders were involved in all studied sub process in these cases. We consider them the main source of organizational knowledge and our thesis' objective is to elicit and understand their organizational knowledge.

Traceability: As showed by all case studies, elicited SSsOIS' requirement are directly related to the strategy and to stakeholders that generated them.

Besides that, a characteristic that have stood out between case studies 1 and 4 was the *complexity* of strategic objectives. In case study 1, strategic objectives were punctual, favouring the elicitation of more specific SSsOIS' requirements. However, in case study 4, some strategic objectives are not well defined yet, what results in higher level SSsOIS' requirements. Elaboration of these higher level SSsOIS' requirements depends on the original strategy maturing.

Moreover, analysing case study 3 and case study 4, *time* made the difference. The more time to explore organizational knowledge, the more organizational changes and impacts elicited.

Impressions, comments and opinions and expressed during the case study

In addition, organizational key people (OKP) have demonstrated by observations made at meetings, ODA4RE had a positive impact on the strategic thinking and decision-making processes. Some observations are listed below:

OKP1. Thank you for make me think about the future of this organization (Strategist from RE Group).

OKP2. Our meetings make me think! (Strategist from PUC-Rio).

OKP3. I am not used to think strategically and now I have an opportunity to exercise it. (IT manager from PUC-Rio).

OKP4. Looking at ODMM I can realize we should also identify some characteristics from the sponsors. For instance, if their strategic objectives related to academic research investment are for short or long term and if their financial conditions are strong enough to support this objective over time. (Strategist from PUC-Rio).

OKP5. OD questions are not easy to respond. They demand internalization and analysis to construct the answer. (Planning officer from PUC-Rio).

OKP6. The representation of the information discussed in our meetings in the i models is worth the experience.* (Planning officer from PUC-Rio).

OKP7. Looking at your i models, I can see a lot of new SGU' requirements to implement.* (IT manager from PUC-Rio).

5.7. Threats to the validity

In this section, we discuss threats to the validity of this study. We have identified three possible threats, which are listed below.

Construct validity. In order to evaluate if the elicited SSsOIS' requirement was novel, i.e. if it was brought forth because of a sub process of ODA4RE, participants had to grade according to Likert scale the quality "New" for case studies 1 and 4. However, we identified a high score for "New" as Not Applicable in case study 1. We believe participants may refer to the fact that there was no previous SSsOIS specification (as answer in Table 15) to compare. Therefore, the quality "New" may have not been analysed as it was intended to. Yet, we understand the qualities "Relevant" and "Useful" may have a similar interpretation, even though participants of our case studies have not commented about it. Nevertheless, all SSsOIS' requirements qualities explored in the questionnaires for case studies 1 and 4 were described before the questions. In addition, as some PUC-Rio's strategic objectives are not well delimitated yet, some SGU' requirements are at the information systems level. Because of this, they may have not being understood as they were meant to.

Internal validity. Most participants of case studies have a strategic profile, with a certain experience in strategically thinking. As a consequence, when they answered ODQ, they may have explicit a knowledge that was already clear for them, even though in these cases it was not explicit to the organization. Therefore, the process of eliciting organizational knowledge from them may have been less complex than in the situation in which participants do not have any experience with strategic processes.

External validity. To tackle this issue, we have evaluated our proposal in real cases of different domains, i.e. a research group, a post office, and a university; and, in different countries, Brazil and United Kingdom. However, the fact that each organization is unique is a threat to the generalisation of the results of our study.

Repeatability. ODA4RE is a process supported by tools and these tools are based on well-known requirements engineering techniques to elicit knowledge, as questionnaires and forms. For example, ODMM is a model and ODQS is an instantiation of a questionnaire both to the organizational dynamics area. For that reason, we believe requirements engineers may be able to repeat our studies, however some training on strategic management theory may be needed. We plan to develop future work toward this direction, as mentioned in section 6.4. Moreover, ODA4RE's procedures are documented in detail to be followed for other researchers, and all documents generated in our case studies are registered and available[1] online for consultation.

Yet, it is important to highlight usually strategic planning initiatives are long-term process, occasionally taking years to be concluded (BRANDS, WULF and MEISSNER, 2013) (PUC-RIO, 2016). For our case studies, due to time restriction, we have reduced the strategic planning projects duration but outcomes are still real, relevant, and useful to present contributions brought by ODA4RE, as shown by results.

For improving validity of our case studies, we have applied following strategies (EASTERBROOK, SINGER, STOREY and DAMIAN, 2008):

- **Triangulation:** We have used different sources of data, being three case studies in different domains and countries, to confirm results and build a coherent picture;
- **Member checking:** All results we validated with our case studies participants to ensure that the interpretations of the data make sense from their perspective;
- **Prolonged contact with participants:** Authors are part of RE Group and of PUC-Rio University as well. In addition, post office was a part of their daily life during exchange year. This to ensure there was a reasonable understanding of the issues and phenomenon under study.

5.8. Final Remarks

In this chapter, we presented four case studies. In first case study, we evaluated SSP at an academic research group, namely RE Group. Second case study, we investigated how to represent organizational changes and consequent

impacts exploring experiences from academic experts, in London. Third case study, we evaluated OIA in the context of UK Post Office. Finally, we evaluated ODA4RE as a whole process at a Brazilian academic university. Overall, resulting SSsOIS' requirements were positively evaluated by stakeholders indicating contributions towards SSsOIS' requirements completeness.

From case studies, we observed applying ODA4RE contributes to anticipate SSsOIS' requirements related to the organizational domain, *rejecting General Negative Hypothesis (GNH1)*. Also, we noticed, depending on the objectives, each sub process, SSP, OIA or LSRV, can also be applied separately, considering each of their main goal.

6
Conclusions, Contributions and Future Work

In this chapter, we close our research, presenting our conclusions, contributions, limitations and future work.

6.1.
Conclusions

In a rapidly changing world, facts mutate every day. More than specific directions, we need a support to analyse the current reality and then make decisions. In this work, we proposed ODA4RE, an approach grounded on eliciting and understanding organizational knowledge, focusing not only on what drives the changes, but also on the consequences of the changes, to prepare SSsOIS for evolution.

ODA4RE comprises three sub processes, being SSP, OIA and LSRV. SSP is a scenario-based strategic planning approach aiming at identifying organizational strategies aligned to SSsOIS and eliciting SSsOIS' requirements from these strategies. OIA is an organizational impacts analysis intending at eliciting and understanding organizational knowledge in advance, i.e. supporting stakeholders to elicit and understanding organizational changes and impacts influencing SSsOIS' requirements. Finally, LSRV is the validation of elicited likely SSsOIS' requirements with stakeholders, based on identifying conflicts and making decisions to achieve a final SSsOIS' Requirements Specification document.

Regarding challenges we raised in section 1.2:

C1.How to support stakeholders to think about the future of the organization to anticipate SSsOIS' requirements changes?

For that, we proposed SSP. SSP introduces strategic planning intertwined to requirements engineering. It promotes awareness about the organization identity (mission, vision, values, SWOT analysis) and applies a 'scenario planning' strategy to identify multiple possible futures for the organization.

Intertwined to that, we propose to stakeholders to think on the current role of SSsOIS to the organization and what is expected from it in future, also identifying strategies to manage SSsOIS in the multiple possible future previously identified. By the end, we elicit SSsOIS' requirements from resulting Strategic Plan.

C2.How to identify and understand likely impacts on the organization from changes influencing SSsOIS requirements?

For that, we proposed OIA. OIA uses i* models to understand the strategic context and contextual scenario walkthroughs to deepen the contextual analysis. To support organizational knowledge elicitation, we proposed ODQS, a set of questions based on organizational dynamics and to understand the flow of organizational changes and impacts we proposed ODMM, a model to represent organizational dynamics.

C3.How to understand the flow of impacts in the organization caused by one organizational change, in order to apply this knowledge to SSsOIS' requirements elicitation?

ODMM is based on business literature and is a conflation of recognized organizational models (GALBRAITH, 1995) (SCHEIN, 1985) (HATCH and CUNLIFFE, 2006) (DAUBER, GERHARD and YOLLES, 2012). It represents organizations based on their dimensions and on how they relate to each other, considering changes and impacts over time. For each dimension, we elicited inner elements, based on literature review, personal experience, and case studies.

6.2. Contributions

We believe our thesis is a step towards the following aspects, as discussed in section 5.6:

ODA4RE - Approach to anticipate SSsOIS' requirements changes based on Organizational Dynamics: ODA4RE contributes to requirements engineering by basing the anticipation of SSsOIS' requirements changes on organizational dynamics through the application of strategic management theory and organizational impacts analysis. Yet, ODMM and ODQS contribute to trigger reasoning and stablish a common ground for discussion.

SSsOIS' requirements completeness: Case studies results shows contributions towards future SSsOIS' requirements completeness by making tacit knowledge explicit. Our study results show important strategic objectives were revealed by SSP and elaborated by OIA, building up organizational knowledge for anticipation of SSsOIS' requirements. By the end, SSsOIS' requirements were elicited from this now uncovered organizational knowledge.

Domain knowledge: ODA4RE stimulates organizational awareness, building up organizational knowledge between stakeholders. It starts from the organizational identity, flowing to organization's status, SWOT analysis, organization's future objectives, and strategies to achieve them in multiple possible futures. Then, it supports the identification of the role of SSsOIS in the organization and associated strategies and requirements to keep SSsOIS aligned to the organization in the multiple possible futures. This information is then represented in i* models and contextual scenarios to stakeholders to elaborate on them.

Decision rationale: Besides identifying strategies, ODA4RE supports organizational key people to elicit likely changes and impacts brought forth from those strategies, and to make decisions on this information. The rationale is based on the sequence of questions, answers, and analysis supported by OIA.

Stakeholders involvement: Organizational key people are the main source of knowledge in this work. ODA4RE encourages the involvement of stakeholders for elicitation and validation of SSsOIS' requirements. Procedures are interactive and models enhance communication and collaboration with the analysis process. Yet, we believe the fact stakeholders are united to discuss organizational knowledge, establishing a common ground of knowledge is beneficial to organizational learning.

Traceability: As SSsOIS' requirements are elicited in parallel with strategic planning, there is contribution to its 'reason to exist' (why) and to its origin. For example, if one strategic intention is not accomplishing what it was meant to and needs to be adapted, SSsOIS' requirements related to it could be directly changed as well.

6.3. Limitations

One limitation of our work is the *effort* to apply ODA4RE, meaning extra work comparing to traditional requirements engineering techniques (SOMMERVILLE, 2011), since we bring the strategic management context to SSsOIS' requirements engineering. Although we have performed studies to evaluate ODA4RE's effectiveness, we have not evaluated ODA4RE's efficiency yet. As detailed in section 5.5, we performed PUC-Rio's case study, in which we applied ODA4RE as a whole, in 19 hours. Therefore, we believe proactively eliciting and understanding organizational knowledge to elicit SSsOIS' requirements would compensate reactive software evolution.

Other limitation of our work is the *complexity* to apply ODA4RE. At a first glance it may appear as a cumbersome process. However, we understand it comprises three sub processes, which can be operationalized separately, according to the organization's objectives. In other words, to deal with the magnitude of the resulting organizational changes, OIA may be led in a modularized way, allocating different teams to different modules, for instance, each set of changes may be discussed in different meetings for different teams.

Other limitation of our work is *usability*. The more information elicited, the more effort demanded to analyse and understand this new information. We believe prioritizing information according to their criticality level would help to focus on important issues needing a deeper understanding to work on.

As a limitation also is the need of participants to *think in advance*. Our work is based on the human capacity of understanding their knowledge and experiences, and using it as input to think in advance. Nevertheless, during case studies, we observed over time participants started to learn to think ahead and collaborate more and more.

Finally, other limitation of our work is *time*. Due to time restriction, after ODA4RE application, we were not able to analyse how elicited SSsOIS' requirements were addressed by organizations over time. This is one of our objectives in future works.

6.4. Future Work

As follows, we describe some future works we envision from this work:

Carry out further validation: in the future, we intend to evaluate ODA4RE considering different approaches, as different *Perspectives*, for instance from other requirements engineers perspective, ones not being involved in ODA4RE elaboration, investigating their impressions on carrying out our approach. From the *perspective of stakeholders from other organizational levels,* considering first, it is needed to understand the direction high managers want the organization to head and then, understand how lower organizational levels will receive it. Yet, we believe operational levels may have more detailed organizational knowledge on likely organizational impacts because of their daily work experience. *Investigation in long-term:* applying ODA4RE and monitor how Strategic Plan is addressed in a long term and how useful SSsOIS' elicited requirements are for the organization. *Revisiting organizations where case studies were carried out:* coming back to the organizations and analyse SSsOIS' elicited requirements qualities over time.

Identify patterns of changes and patterns of impacts from strategies. According to identified strategies, generate a database of likely organizational changes and of respective impacts. Then, presenting them to stakeholders to analyse which are relevant to the new system and, when relevant, generate new requirements for them.

Identify relationship between organizational profiles and ODA4RE effectiveness. Investigate which organizational characteristics and which organizational profiles would be better benefited by ODA4RE and why, and the less benefited as well.

Identify relationship between organizational maturity and ODA4RE. Investigate how ODA4RE should be streamlined to proper address different levels of organizational maturity and different organizational profiles.

Develop a software tool to support ODA4RE. During case studies, we observed that if some parts of ODA4RE were supported by a software tool, it would benefit ODA4RE's agility. For instance support to keep traceability from Strategic Plan to SSsOIS' requirements; analyse models 'as is' and 'to be', automatically identifying changes between them; support ODQS use, presenting questions related to chosen dimension, recording answers and keeping SSsOIS' requirements traceability from them; construct a set of questions and answers, to manage organizational knowledge on changes and impacts; support LSRV sub process, keeping traceability between SSsOIS' requirements conflicts and decisions made.

Application in other research areas. We also envision application of ODA4RE for other areas, as *Organizational Adaptive Information Systems (OAIS):* Investigate how ODA4RE may contribute to OAIS requirements engineering. *Creativity:* investigate whether OIA may contribute to Creativity Workshops, used as a basis for exploring creative organizational ideas. *Human-Computer Interaction:* Investigate how to *culturally represent* an organization through interface and interaction using ODA4RE.

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APPENDIX A

In this appendix, we present generic questions to organizational impact analysis. They should be instantiated to each organization having a process of organizational change and impact analysis. ODQS is meant to spark insights in organizational key people and to be complemented according to their own knowledge.

INTERNAL ENVIRONMENT

Patterns of Behaviours

Impacts of new/changed structure on operations

1. What are the **objectives** of this new operation?
2. Does this new structure need **inputs**?
3. What are the **inputs** for this new structure?
4. How does *security* apply to this new **input**?
5. What are the **activities** needed?
6. Is this **activity** needed?
7. Is any **activity** missing?
8. How does the concept of security apply to this **activity**?
9. What are the **rules** needed?
10. Are all **business rules** respected?
11. What are the **resources** needed?
12. How does *security* apply to this new **resource**?
13. How does this new structure need to be executed regarding **quality** aspects?
14. Is it possible to make it **faster**?
15. Is it possible to make it **cheaper**?
16. Does this new structure need **outputs**?
17. How does *security* apply to this new **output**?
18. Who is the **agent** responsible for this new structure?

Performance Assessment

Impacts of new/changed operations on structure

1. How do these new operations affect organizational **structure (power decision)**?

2. Does the organization need other organizational **functions** to execute the new operations?
3. How does the **new** function relate to **existing** functions?
4. Does the organization need new **processes** to execute the new operations?
5. How do the new **processes** relate to the others?
6. Does the organization need new **software** to support the new operations?
7. Do new operations affect the **work shifts** structure?
8. Is the organization going to produce new **products**?
9. Is the organization going to provide new **services**?
10. Is there any **target market** change?
11. Does this structural change bring a new class of customers?
12. How is this new operation going to affect other branches?
13. Where does this new operations fit in organizational structure?
14. How do these new operations affect the space in where they are going to be executed?

Operationalization

Impacts of new/changed strategies on structure

1. What are the **consequences** of this new strategy on organizational structure?
2. How does this new strategy change current **functions**?
3. What new **functions** are needed to implement these new strategies?
4. How does this new strategy change current **process**?
5. What **new processes** are needed to implement these new strategies?
6. What **new process** does this change raise?
7. Is the new **software** going to communicate with other software?
8. Is the new **software** going to need inputs from other software?
9. Is the new **software** going to provide outputs to other software?
10. How are the organizational **shifts** affected by the new strategies?
11. How do these new strategies affect the **products**?
12. Does the organization need **new products**?
13. How do these new strategies affect the **services**?
14. Does the organization need **new services**?
15. Do these changes affect the types of **market** of this organization (health care, government education, etc.)?
16. How do these new strategies affect the **target public**?
17. How do these new strategies affect the **branches** of this organization **spread throughout the world**?
18. How do these new strategies affect the **space** in where they are going to be operationalized?

Single-loop Learning

Impacts of new/changed structure on strategies

1. How does this new structure affect the organizational **strategies**?

2. Are the organizational **goals** respected?
3. Are the organizational **norms** respected?
4. Are the organizational **regulations** respected?
5. Are the organizational **policies** respected?
6. Does this new structure need a new **organizational measure**?
7. Does this new structure bring new **indicators**?
8. What new **measures** can be used to people assessment?
9. Are **people measures** adequate to people evaluation?
10. What are the new **reward policies**?
11. Are the **reward policies** in compliance with employees' structure?
12. How does this new structure affect **organizational capabilities**?

EXTERNAL ENVIRONMENT

Legitimacy Management

Impacts of new/changed operations on stakeholders

1. How do the changes affect **customers**?
2. Are the operations satisfying **customers'** *expectations*?
3. How is ***communication*** with **customers** now?
4. Are the operations *safe* for the **customers**?
5. How do the changes affect the ***relationship*** between **employee** and **customers**?
6. Are the operations in compliance with **shareholders** *intentions*?
7. How do the changes affect the ***relationship*** with **shareholders**?
8. Does the organizational need all previous **suppliers**?
9. Does the organization need other **suppliers**?
10. How does the alteration of **suppliers** affect the organization?
11. How the changes affect the ***relationship*** with **suppliers**?
12. Are **employees** closer to the change executing the right *roles*?
13. What *skills* are needed from the **employees** closer to the change?
14. Are the expectations of employees being satisfied?
15. Is there opportunity to gather **sponsors**?

Cultural Pressure

Impacts of new/changed stakeholders' management on operations

1. What operational adjustments are needed to satisfy **customers'** expectations?
2. What operational adjustments are needed to satisfy **employees'** goals?
3. What operational adjustments are needed to satisfy **shareholders'** intentions?
4. What operational adjustments are needed to support new **suppliers**?
5. What operational adjustments are needed to satisfy the **sponsors**?
6. Are employees' **competencies** being considered in the organizational processes?

Action

Impacts of new/changed operations on market

1. Are the needs of the **target market** being satisfied by the organization?
2. Does the organization have an external **political** influence?
3. Does the organization have an **ethical** influence in the market?
4. Does the organization have a **sociocultural** influence in the market?
5. Does the organization have a **technological** influence in the market?
6. Does the organization have an **environmental** influence in the market?
7. Does the organization have an **legal** influence in the market?

Market Feedback

*Impacts of new/changed market on operations /*PESTEL Analysis*/*

1. What is the **political situation** of the country and how can it affect this organization?
    a. Trading policies
    b. Government changes
    c. Shareholder and their demands
    d. Funding
    e. Governmental leadership
    f. Lobbying
    g. Foreign pressures
    h. Conflicts in the political arena

2. What are the prevalent **economic factors** for this organization?
    a. Disposable income
    b. Unemployment level
    c. Foreign exchange rates
    d. Interest rates
    e. Trade tariffs
    f. Inflation rate
    g. Foreign economic trends
    h. General taxation issues
    i. Taxation changes specific to product/services
    j. Local economic situation and trends

3. How much importance does **culture** has in the market and what are its determinants?
    a. Ethnic/religious factors
    b. Advertising scenarios

c. Ethical issues
d. Consumer buying patterns
e. Major world events
f. Buying access
g. Shifts in population
h. Demographics
i. Health
j. Consumer opinions and attitudes
k. Views of the media
l. Law changes affecting social factors
m. Change in Lifestyle
n. Brand preferences
o. Working attitude of people
p. Education
q. Trends
r. History

4. What **technological innovations** are likely to pop up and affect the market structure?
    a. Technological development
    b. Research and development
    c. Trends in global technological advancements
    d. Associated technologies
    e. Legislations in technological fields
    f. Patents
    g. Licensing
    h. Access into the technological field
    i. Consumer preferences
    j. Consumer buying trends
    k. Intellectual property and its laws
    l. How mature a certain technology is
    m. Information technology
    n. Communication

5. What **environmental concerns** are important for this organization?
    a. Employment law
    b. Consumer protection
    c. Industry-specific regulations
    d. Competitive regulations
    e. Current legislation home market
    f. Future legislation
    g. Regulatory bodies and their processes
    h. Environmental regulations

6. What **current legislations** regulate this organization? Can there be any change in the legislations that can affect this organization?
    a. Ecological
    b. Environmental issues

i. International
ii. National

c. Stakeholder/ investor values
d. Staff attitudes
e. Management style
f. Environmental regulations
g. Customer values
h. Market value

Guidance

Impacts of new/changed culture on strategies

1. Are the strategies aligned to organizational **values**?
2. Are the strategies aligned to organizational **beliefs**?
3. Are the strategies aligned to existing **feelings**?
4. Are the strategies aligned to organizational **assumptions**?
5. Are the strategies aligned to organizational **symbols**?
6. Are the strategies aligned to organizational **myths**?
7. Are the strategies aligned to organizational **ideologies**?

Double-loop Learning

Impacts of new/changed strategies on culture

1. How are the new strategies going to affect organizational **values**?
2. How are the new strategies going to affect organizational **beliefs**?
3. How are the new strategies going to affect existing **feelings**?
4. How are the new strategies going to affect organizational **assumptions**?
5. How are the new strategies going to affect organizational **symbols**?
6. How are the new strategies going to affect organizational **myths**?
7. How are the new strategies going to affect organizational **ideologies**?

APPENDIX B

APPENDIX B shows LMS workshop's discussion modelled according to the Four Levels of Organizational Intervention (RUSSEL and RUSSEL, 2014).

Goal: ***Improve the management of teaching practice.***

Strategy: *Adoption of a Learning Management System to support the teaching practice.*

Main organizational change: Process of teaching turns supported by LMS.

Impacts		**Access to the Material independent of time or place**				**Communication**			**Preparation of the material**
Physical *Process, tools and structure* (visible aspects of the organization)	**Before**	**Classroom**	Students living at the same place of the university	Physical Material	Students obtain material from classes	Mostly native students	Mostly native speaker students	Questions are made face-to-face (mostly private questions)	Preparation of lectures during the semester (dynamic)
	After	**Anywhere**	Students living all over the world	Digital Material	Student access material online	More international students	More non-native speaker students	Questions are posted on the LMS (mostly public questions)	Preparation of most lectures before the semester starts
Infrastructure *Strategy systems, measurement and reward* (systems and process for directing and managing work)		*Strategy*: Internationalization of the university		*Measure*: Interaction of students with LMS				*Measure*: Professor has to answer students' questions within 48 hours	*Measure*: Process of teaching aligned with the recommended by the university
									Measure: Material uploaded
Behavioural *What groups and individuals do* (daily actions and reactions of employees)		1. Students teach themselves		1. Students can read in advance				1. Students' questions are open and can be answered by other students or the professor	1. Digital remote teaching requires more discipline from both professor and students
		2. Students can jump to wrong conclusions and disseminate it		2. Students can come more prepared				2. Decreases professor' work in the sense s/he does not have to deal with each one directly anymore	2. More upfront work
		3. Students miss professor's stories and comments		3. Professor may save time because there is no need to explain the basic anymore				3. Professor is able to direct students' discussions	3. Need to set everything else up, the Professor can't wing it
				4. The easier access to the answers of problems brings the need to the				4. Professor must keep students' questions and answers	4. More preparation

		professor assistant to renew exercises each turn			on track	
		5. Record of recurrent doubts of students increases quality (since the material can be prepared based on previous doubts). problems and questions raised by students)			5. Mismatch between the message send (the deliveries) and the received (students' perceptions about the type of course – remote or not)	5. More planning
		6. Material must be prepared to be understandable by a student by himself (constructed based on recurrent			6. [EXPOSURE] Students must adjust their behaviour to be more professional	6. More time managemen t
		7. Technology allows students to record lectures by themselves			7. [EXPRESSIVE BEHAVIOUR] As students only expose themselves in case they are sure about their points, the consequenc e is it pulls the level up	7. Less downstream work
		8. Digital systems demand more reflection since the students answers will be exposed for the entire class				8. Increases flexibility to students
						9. Decreases flexibility to the Professor, since s/he had worked upfront (if s/he has to change the material, there is more work to do since the material usually is done before the

						beginning of the class)
						10. Less coordination loses asynchronous working
						11. Professor has more time during the semester
						12. Teaching process changes. Turns more flexible
Cultural *Deeply held assumptions, values, beliefs, and norms* (the underlying assumptions, values, beliefs, and norms that shape daily behaviour)	1. The easier the access to information, the less importance to physical attendance				1. Increases transparency	
	2. The easier access to information, the lower engagement to physical attendance (In the old days it was more difficult to catch up when a student missed a class due to more difficult access to the material)				2. Decreases flexibility	
	3. The easier access to information the smaller power the professor has (the access to information decreases the power of the individual – good for the students) (losing classes before would make the student rely on the professor to catch up).				3. [ACCESS-POWER] The previous access to the material allows students to prepare their answers to elaborate on their reputation	
	4. False assumptions about the really catching up in case an absence.				4. [POWER] LMS avoid the establishment of supremacy of some extroverted students at the expense of the shy ones	
	5. Digital decreases the personalisation. As the interaction between professor and students is intermediated by the LMS, it undermines the connection between					

	them				
	6. [RECOGNITION]: People want other people know their names and it is undermined by the LMS				
	7. [RECOGNITION]: LMS brings impartiality; students can be identified as numbers (Girls will not be recognized by their gender anymore)				
	8. Identification of students by clusters				
	9. [QUALITY] The easy access contributes to the compromise with the quality of the material as well as with continuous improvement				
	10. [CONTROL]: the easier access to the material of the professor makes it more controllable by the university				
	11. [SOCIAL INTERACTION] Professor moderates his behaviour according to the feedback of students (if he observes the students respond to the lecture).				
	12. [TRANSPARENCY]: Accessibility raises transparency.				
	13. [POLICIES]: Polices can be created according to the information raised from the analyses of the information (transparency stimulates the creation of policies).				
	14. [TRACEABILITY]: Transparency raises traceability.				
	15. [ACCOUNTABILITY]: Traceability raises accountability.				
	16. [CONTROL]: Accountability raises control.				
	17. [ASSESSMENT]: Control raises assessment.				
	18. [QUALITY]: Assessment raises quality.				
	19. [OWNERSHIP]: As the material is now on the internet, it raises the need to make decisions about its ownership (who is the owner of the material now? Professor or university?).				
	20. [RESPONSIBILITY]: Depending on the ownership, it raises the need to make decisions about its responsibility (who is responsible for the material now? Professor or university?).				
	21. [AUTHORITY]: Depending on the responsibility, it changes the authority structure in the organization (whoever is responsible for the material (information) is the authority now, either professor or university).				
	22. [AUTHORIZATION]: Whoever is the authority, has the power of authorization now, either professor or university.				
	23. [REFERENCES]: Whoever is the author, should be referenced as it when quoting the material.				
	24. [PLAGIARISM]: The availability of				

	the material raises issues related to plagiarism.				
	25. [LEGAL ISSUES]: Who has legal rights over the material?				
	26. [REPLACEABILITY] Would the control make professors replaceable?				

The flow of the changes is not limited by the columns. Usually, cultural impacts are consequence of more than one physical impact, and organizational changes impact horizontal and vertically.

APPENDIX C

This appendix presents annotations made from observations of a day at a Post Office on London and informal semi-structured interviews with customers and Post Office staff.

London, May 2015.

CLIENT

1. Client arrives (winging)
2. Sees the sing: Take a ticket here
3. Goes to the totem
4. Chooses the service they want
5. Takes a ticket with a number
6. Looks at the monitors
7. There are three types of attendance showed in the monitors:
   a. Counter services
   b. Travel services
   c. Identity services
8. Waits on the couches
9. As it is possible to hear when one is called, clients can wonder around, checking products, services.
   a. The possibility to walk around raises opportunity to new services and products.

ENVIRONMENT

1. There are couches.
2. Clients on their smartphones
   a. Using internet
   b. Calling
3. Clients having a conversation.

4. Clients talking.
5. Staff helping clients that are waiting (frequently in the self-service counter (post and go)).
6. Quick response to the clients (less than 10 minutes to be served).
7. Clients don't have to wait behind of other clients anymore.
8. Clients can estimate the time they will be served.
9. The space could have been rearranged, since there is no line anymore.
10. The work process could also have been improved according to changes in the space.

Q-MATIC SYSTEM

1. Shows the three types of services.
2. Last 3 numbers called in orange, below each service.
3. Ticket Number X Please go to counter N (also in **voice**).
4. Orientations to the clients
    a. Orange tickets numbers will be served next…
    b. Please be ready to be called forward.

POST OFFICE SERVICES

1. Post and Go: self-service (buy stamps and send your items to the UK or abroad; pay by cash or card)
2. Bureau de change
3. Financial service and business banking
4. Business Point fast drop (a fast track mail desk for business and online customers)
5. Postal Packaging and stationery
6. Sale
    a. travel items
    b. postcards
    c. gift cards
7. Talk to us
8. Mortgage
9. Withdraw
10. Tissues
11. National Lottery

12. Franked Mail – actually, after I learned the real meaning of franked I observed this is not a new service.
13. Collectibles
14. Every service presents visual and sound response

STAFF

1. Even it is the end of the workday, the staff present good mood.
2. Staff can focus only on the service.
3. Staff doesn't have to worry about queues anymore.
4. Staff has the opportunity to analyse clients from the moment they got in the office (I was asked if everything was okay a couple of times).

IMPACTS

1. This brought flexibility to the clients. Once they know when they are going to be served, they can direct their attention to other issues, like other services offered in the post office itself.
2. As the client chooses the type of service they need previously, the post office can organize their service according to the possible choices/amount of clients.
3. Happy clients, smiles to the staff that smiles back.
4. Independence to clients: (self-service, ticket machine, buying other products, services);
5. Opportunity to offer new services ;
6. Opportunity to analyse the clients and what they need:
    a. Clients in general
        i. ID photos (for documentation)
        ii. Advertisement
            1. Own services
                a. Monitors
                b. signs
            2. Sponsors
        iii. Credit card of the post office
        iv. Car insurance
    b. Tourists
        i. Postcards of London;
        ii. Bureau of change;

iii. Abroad services;
iv. Travel insurance.

c. Elderly
   i. Voice accessibility
   ii. Visual accessibility

7. Opportunity to analyse the new process
   a. Opportunity to analyse what is going to be need to the new process to work
   b. Example: Post and Go: the client will do the service by themselves. They need to know how to classify the letters and parcels in order to post them. Then, the post office has to provide a schema of sizes, in a way the client can easily make it by themselves
   c. Opportunity to analyse the disposition of the new space:
      i. Example: dispose the couches in a way the clients face the products
      ii. Example: improve the work process

APPENDIX D

APPENDIX D presents the questionnaires used to evaluate SSP results in RE Group and ODA4RE at PUC-Rio.

Avaliação dos Requisitos elicitados a partir do Plano Estratégico do Grupo de Engenharia de Requisitos da PUC-Rio

O objetivo desse questionário é avaliar a qualidade dos requisitos de software elicitados a partir do Plano Estratégico do Grupo de Engenharia de Requisitos da PUC-Rio, bem como o método aplicado. Os resultados obtidos e o método são apresentados em detalhe no documento StrategicPlanREGroup.docx enviado em anexo ao convite para responder esse questionário.

É importante ter em mente que os requisitos elicitados são para um Sistema de Software que apoie o Sistema da Informação da Organização (Sistema de Software que apoia o Sistema da Informação da Organização - SSaSIO). E que o que está sendo avaliado são os requisitos do SSaSIO e não as estratégias formuladas.

Este questionário é subdividido em 3 seções, sendo elas Perfil do Participante, Avaliação dos Requisitos, Avaliação do Método, com maioria de questões de múltipla escolha.

Bom trabalho e muito obrigada por sua colaboração!

* Required

Perfil do Participante

O objetivo dessa seção é elicitar informações sobre os participantes nos aspectos acadêmico e profissional.

1. **Profissão atual** *

2. **Empresa atual** *

Formação Acadêmica

Por favor, liste sua maior formação acadêmica e ano de conclusão.

3. **Curso e ano de conclusão** *

Experiência Profissional

Por favor, liste sua experiência profissional conforme função exercida e anos totais de experiência nessa função.

4. **Função e anos de experiência** *

Participação no Planejamento Estratégico do Grupo de ER da PUC-Rio

A pertinência ao Grupo de ER da PUC-Rio é suficiente para avaliação das qualidades dos requisitos de software produzidos. A participação no momento do Planejamento Estratégico não é obrigatória para a continuação desse questionário.

5. **Você estava presente no projeto de Planejamento Estratégico do Grupo de ER da PUC-Rio** *

Mark only one oval.

- Sim
- Não

6. **Que horas são agora? Em hh:mm:ss, por favor.** *
   Gostaríamos de ter consciência do tempo que a avaliação dos requisitos tomará dos participantes. Por isso, solicitamos o tempo de início da resposta nesse momento e, ao final, o tempo de fim.

Avaliação da qualidade dos Requisitos de Software elicitados pelo método

Nesse questionário, por favor, considere:

* Possível a curto prazo: o requisito é possível de existir no contexto do grupo em um período de até 2 anos;
* Possível a longo prazo: o requisito é possível de existir no contexto do grupo depois de 2 anos;

* Novo: o requisito é novo para o grupo, elicitado pela aplicação do método;

* Relevante: o requisito é importante para o sucesso do grupo;

* Útil a curto prazo: o requisito é útil para o grupo em um período de até 2 anos e
* Útil a longo prazo: o requisito só será útil para o grupo depois de 2 anos.

Considere o número 1 para quantificar Pouco [característica] e 5 para Bastante [característica].

Requisitos Gerais

Esses requisitos foram elicitados a partir das Estratégias Gerais elaboradas pelo Grupo de ER da PUC-Rio, apresentadas na Tabela 3 do documento StrategicPlanREGroup.docx .

7. **RF01: SSaSIO deve manter reuniões do grupo, considerando data, horário, local, participantes, tópicos a serem discutidos, questões a serem resolvidas, log e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

8. **RF02: SSaSIO deve gerar relatórios sobre as reuniões do grupo, como por exemplo, tópicos discutidos, frequência de tópicos em discussão, questões resolvidas, questões pendentes, membros presentes, frequência dos membros, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

9. **RF03: SsaSIO deve gerenciar tarefas a serem realizadas pelos membros do Grupo de ER.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

Cenário de Escassez de Recursos e Instabilidade de Membros

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de escassez de recursos e instabilidade de membros no grupo, apresentadas nas Figuras 5 e 6 no quadrante Shortage and Instability.

10. **RF04: SSaSIO deve manter tópicos de pesquisa sendo desenvolvidos pelo Grupo de ER, como por exemplo, área principal, subtópicos, membros pesquisando esse tópico, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

11. **RF05: SSaSIO deve manter informações sobre Journals sobre os assuntos sendo desenvolvidos no Grupo de ER, como título, Qualis CAPES, descrição, assuntos, tamanho do artigo, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

12. **RF06: SSaSIO deve manter informações sobre financiadores e investidores em pesquisa, como por exemplo, nome, critério de seleção, áreas contempladas, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

13. **RF07: SSaSIO deve manter lista de tarefas relacionadas ao C&L, membro do Grupo de ER responsável e status.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

Cenário de Escassez de Recursos e Estabilidade de Membros

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de escassez de recursos e estabilidade de membros no grupo, apresentadas nas Figuras 5 e 6 no quadrante Stability and Shortage.

14. **RF08: SSaSIO deve gerenciar produção de artigos em grupo, como por exemplo, autor, área, track de pesquisa, eventos a submeter, Qualis CAPES, deadlines, tamanho do artigo, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

15. **RF09: SSaSIO deve gerar relatórios cruzando tópicos sendo desenvolvidos pelo Grupo de ER e respectivos Journals a serem submetidos, apresentando dados relevantes sobre o Journal, como título, Qualis CAPES, descrição, assuntos, tamanho do artigo, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

16. **RF10: SSaSIO deve gerar relatórios cruzando membros do Grupo de ER interessados em tópicos relacionados, apresentando, por exemplo, nome, curso, tema de pesquisa, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

17. **RF11: SSaSIO deve dar suporte a curso sobre a linguagem LUA para membros do Grupo de ER, com mentor, estudantes, progresso, tarefas, status e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

Cenário de Fartura de Recursos e Instabilidade de Membros

Esses requisitos foram elicitados a partir das estratégias elaboradas para um possível cenário de escassez de recursos e instabilidade de membros no grupo, apresentadas nas Figuras 5 e 6 no quadrante Wealth and Instability.

18. **RF12: SSaSIO deve manter informações sobre pesquisadores e grupos externos desenvolvendo tópicos de pesquisa próximos aos desenvolvidos pelo Grupo de ER, como nome, local, área de pesquisa principal, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

19. **RF13: SSaSIO deve dar suporte à organização de atividades sociais internas, como, por exemplo, data, horário, local, tarefas de organização, responsáveis, status, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

20. **RF14: SSaSIO deve manter informações sobre programadores de linguagem LUA, como, por exemplo, nome, contato, nível de conhecimento, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

Cenário de Fartura de Recursos e Estabilidade de Membros

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de escassez de recursos e instabilidade de membros no grupo, apresentadas nas Figuras 5 e 6 no quadrante Wealth and Stability.

21. **RF15: SSaSIO deve manter informações sobre eventos e conferências de interesse do Grupo de ER, como nome, data, local, custo de inscrição, Qualis CAPES, tracks de pesquisa, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

22. **RF16: SSaSIO deve gerenciar organização de eventos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

23. **RF17: SSaSIO deve gerenciar equipe de apoio.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

24. **RF18: SSaSIO deve gerenciar recursos físicos (infra-estrutura) do Grupo de ER.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

25. **RF19: SSaSIO deve manter informações sobre pesquisadores do Grupo de ER, como nome, curso, tópico de pesquisa, interesses de pesquisa, progresso nas disciplinas, pendências no curso, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

26. **RF20: SSaSIO deve gerenciar evolução do C&L, como requisitos, tarefas associadas, responsáveis, status, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

27. **RF21: SSaSIO deve gerenciar curso de C&L, como data, horário, público alvo, interessados, carga horária, assunto, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

28. **RF22: SSaSIO deve gerenciar curso de linguagem LUA, como data, horário, público alvo, interessados, carga horária, assunto, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

29. **EVOL01: C&L deve ser desenvolvido para outras linguagens (Java, Ruby).** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

30. **EVOL02: C&L deve apresentar interface para dispositivos móveis.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

31. **EVOL03: C&L deve ser integrado a outras plataformas, as Facebook, Google+.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para o grupo						
Útil a curto prazo						
Útil a longo prazo						

Geral

Por favor, utilize esse espaço para comentar sobre todos os requisitos listados acima.

32. **Qual sua avaliação sobre os requisitos elicitados? Quais são suas impressões, sugestões e críticas?** *

O objetivo dessa questão é validar os requisitos elicitados com os membros do grupo de ER da PUC-Rio.

33. **Você tem sugestões de adição de novos requisitos, remoção, alteração, combinação ou decomposição dos requisitos listados?** *

O objetivo dessa questão é evoluir os requisitos elicitados com os membros do grupo de ER da PUC-Rio.

Avaliação do Método

O método em questão é o apresentado na Figura 1 do documento StrategicPlan.REGroup, enviado em anexo ao email convite a esse questionário. Os resultados obtidos em cada passo também são

listados nesse documento.

34. **Qual sua avaliação sobre o método aplicado? Quais são suas impressões sobre esse método? Pontos fortes? Problemas?** *

    O objetivo dessa questão é validar o método aplicado com os membros do grupo de ER da PUC-Rio.

35. **Na sua opinião, o método proposto contribui para a elicitação de requisitos de SSsOIS?** *

    O objetivo dessa questão é verificar se os membros do Grupo de ER acreditam que o método tenha trazido contribuições para a elicitação de requisitos de SSsOIS.
    Mark only one oval.

    - ◯ Sim
    - ◯ Não

36. **Por quê?** *

    O objetivo dessa questão é elicitar a razão dos membros do grupo para reconhecer ou não contribuições do método para elicitação de requisitos.

37. **Você tem sugestões de melhoria para o método aplicado?** *

    O objetivo dessa questão é evoluir o método aplicado com os membros do grupo de ER da PUC-Rio.

38. **Você aplicaria esse método para elicitação de requisitos de SSsOIS em seus projetos?** *

O objetivo dessa questão é verificar se os membros do grupo de ER da PUC-Rio aplicariam o método apresentado.
Mark only one oval.

	1	2	3	4	5	
Fortemente Não	◯	◯	◯	◯	◯	Fortemente Sim

39. **Por quê?** *

O objetivo dessa questão é elicitar a razão de cada membro do grupo de ER da PUC-Rio para aplicar ou não o método apresentado.

_____

_____

_____

_____

_____

40. **Você recomendaria esse método para elicitação de requisitos de SSsOIS?** *

O objetivo dessa questão é verificar se os membros do grupo de ER da PUC-Rio recomendariam o método apresentado.
Mark only one oval.

	1	2	3	4	5	
Fortemente Não	◯	◯	◯	◯	◯	Fortemente Sim

41. **Por quê?** *

O objetivo dessa questão é elicitar a razão de cada membro do grupo de ER da PUC-Rio para recomendar ou não o método apresentado.

_____

_____

_____

_____

_____

42. **Que horas são agora? Em hh:mm:ss, por favor.** *

Gostaríamos de ter consciência do tempo que a avaliação dos requisitos tomou dos participantes. Por isso, solicitamos o tempo de início da resposta, no início, e nesse momento o tempo de fim.

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Google Forms

Avaliação dos Requisitos elicitados a partir do Plano Estratégico da PUC-Rio sob a ótica da VRADM

O objetivo desse questionário é avaliar a qualidade dos requisitos de software elicitados a partir do Plano Estratégico da PUC-Rio sob a ótica da VRADM, bem como o método aplicado. Os resultados obtidos e o método são apresentados em detalhe no documento PUC-RioStrategicPlan.docx enviado em anexo ao convite para responder esse questionário.

É importante ter em mente que os requisitos elicitados são para um Sistema de Software que apoie o Sistema da Informação da Organização (Sistema de Software que apoia o Sistema da Informação da Organização - SSaSIO). E que o que está sendo avaliado são os requisitos do SSaSIO e não as estratégias formuladas.

Este questionário é subdividido em 3 seções, sendo elas Perfil do Participante, Avaliação dos Requisitos, Avaliação do Método, com maioria de questões de múltipla escolha.

Bom trabalho e muito obrigada por sua colaboração!

* Required

Perfil do Participante

O objetivo dessa seção é elicitar informações sobre os participantes nos aspectos acadêmico e profissional.

1. **Profissão atual** *

2. **Empresa atual** *

Formação Acadêmica

Por favor, liste sua maior formação acadêmica e ano de conclusão.

3. **Curso e ano de conclusão** *

Experiência Profissional

Por favor, liste sua experiência profissional conforme função exercida e anos totais de experiência nessa função.

4. **Função e anos de experiência** *

5. **Que horas são agora? Em hh:mm:ss, por favor.** *
   Gostaríamos de ter consciência do tempo que a avaliação dos requisitos tomará dos participantes. Por isso, solicitamos o tempo de início da resposta, no início, e nesse momento o tempo de fim.

Avaliação da qualidade dos Requisitos de Software elicitados pelo método ODA4RE

Nesse questionário, por favor, considere:

* Possível a curto prazo: o requisito é possível de existir no contexto da PUC-Rio em um período de até 5 anos;
* Possível a longo prazo: o requisito é possível de existir no contexto da PUC-Rio depois de 5 anos;

* Novo: o requisito é novo para a PUC-Rio, elicitado pela aplicação do método;

* Relevante: o requisito é importante para o sucesso da PUC-Rio ;

* Útil a curto prazo: o requisito é útil para a PUC-Rio em um

período de até 5 anos e

* Útil a longo prazo: o requisito só será útil para a PUC-Rio depois de 5 anos.

* Prioridade: corresponde à prioridade de implementação do requisito para a VRADM PUC-Rio.

Considere o número 1 para quantificar Pouco [característica] e 5 para Bastante [característica].

Requisitos Gerais

Esses requisitos foram elicitados a partir das Estratégias Gerais elaboradas pela VRADM da PUC-Rio, apresentadas no quadro da página 14 e 15 do documento PUC-RioStrategicPlan.docx .

Sustentabilidade Financeira

6. **RF01: SGU deve manter os dados sobre empresas interessadas em patrocinar a pesquisa acadêmica, como o nome, áreas de interesse, projetos já patrocinados, projetos patrocinados patrocinados, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

7. **RF02: SGU deve manter dados sobre alunos egressos, como o nome, curso, trabalho atual, áreas de interesse, projetos que participou, projetos já patrocinados, projetos que patrocina, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

8. **RF03: SGU deve manter dados sobre serviços prestados por projetos acadêmicos, como áreas de interesse, identificação do projeto, status, duração, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

9. **RF04: SGU deve emitir relatórios comparando dados financeiros provenientes de mensalidades e de pesquisa acadêmica, tais como valor, destino a bolsas de estudo, a manutenção da universidade, a custos administrativos, e assim por diante. Os dados podem ser agrupados por departamentos, semestres, anos, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

10. **RNF01: SGU deve manter dados relacionados a mensalidades e pesquisa acadêmica transparentes e acessíveis para o processo de tomada de decisão.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

11. **RF05: SGU deve avisar coordenadores de departamento sobre o comportamento variante do empregado processo financeiro, para positivo e negativo.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Gestão Universitária

12. **RNF02: SGU deve manter informações sobre os processos de negócios transparentes e disponíveis.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

13. **RF06: SGU deve manter dados sobre aquisições realizadas por departamentos, como produto, quantidade, dados, armazenamento, preço, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

14. **RF07: SGU deve emitir relatório sobre aquisições para apoiar o processo de tomada de decisão sobre quais devem ser feitas por departamento e quais devem ser feitas em conjunto, tais como produtos comuns, loja, preço, mais comprados, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Responsabilidade Social

15. **RF08: SGU deve manter dados sobre a contribuição do projeto acadêmico para a sociedade, tais como projeto, área de interesse, descrição da aplicação para a sociedade, entidade beneficiada, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

16. **RF09: SGU deve emitir relatório sobre a contribuição dos projetos acadêmicos para a sociedade, tais como projeto, área de interesse, pessoal, descrição do aplicativo para a sociedade, entidade beneficiada, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Comunicação com a Sociedade

17. **RF10: SGU deve emitir relatório sobre os resultados dos projetos acadêmicos, como o projeto, área de interesse, pessoal, departamento, descrição, escopo, descrição dos resultados, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Cenário de Estabilidade de Mercado e Gestão Centralizada

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de Estabilidade de Mercado e de Gestão Centralizada, apresentadas na Figura 40 no quadrante Stability and Centralization.

Gestão Universitária

18. **RNF03: SGU deve dar suporte ao controle de acesso do gerenciamento centralizado de projeto.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

19. **RF11: SGU deve controlar o orçamento e os prazos conforme planejamento.** *
Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

20. **RF12: SGU deve avisar responsável sobre variante no orçamento ou prazos conforme planejamento.** *
Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Cenário Estabilidade de Mercado e de Gestão Descentralizada

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de Estabilidade de Mercado e de Gestão Descentralizada na PUC-Rio, apresentadas na Figuras 40 no quadrante Stability and Decentralization.

Gestão Universitária

21. **RNF04: SGU deve dar suporte ao controle de acesso do gerenciamento de projeto descentralizado (por departamento) .** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

22. **RF13: SGU deve emitir relatório sobre os resultados por setores.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Cenário de Instabilidade de Mercado e Gestão Centralizada

Esses requisitos foram elicitados a partir das estratégias elaboradas para um possível cenário de Instabilidade de Mercado e Gestão Centralizada na PUC-Rio, apresentadas na Figura 40 no quadrante Instability and Centralization.

Gestão Universitária

23. **RF14: SGU deve avisar responsável sobre o comportamento variante de empregado em procedimentos administrativos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

24. **RNF05: SGU deve dar suporte ao controle de acesso à administração centralizada de cursos de extensão.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Sustentabilidade Financeira

25. **RF15: SGU deve manter novos modelos de financiamento para os alunos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Cenário de Instabilidade de Mercado e de Gestão Decentralizada

Esses requisitos foram elicitados a partir de estratégias elaboradas para um possível cenário de Instabilidade de Mercado e de Gestão Decentralizada na PUC-Rio, apresentadas na Figura 40 no quadrante Instability and Decentralization.

Gestão Universitária

26. **RF16: SGU deve manter base de dados sobre projetos, considerando tema, áreas de interesse, áreas relacionadas, pessoal, cronograma, orçamento, lições aprendidas, riscos enfrentados, obstáculos, decisões tomadas, resultados, prestação de serviços, fornecimento de produtos, eventos para publicar.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

27. **RF17: SGU deve manter os dados sobre conhecimento compartilhado entre departamentos, como processos, lições aprendidas, boas práticas, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Avaliação de Desempenho

28. **RF19: SGU deve apoiar a avaliação de desempenho dos funcionários.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

29. **RF20: SGU deve dar suporte às políticas de recompensa da PUC-Rio.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Sustentabilidade Financeira

30. **RF21: SGU deve apoiar as estratégias dos departamentos para atrair novos alunos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Requisitos elicitados a partir da Análise de Impactos (Brainstorm Criativo)

Esses requisitos foram elicitados a partir de estratégias elaboradas para as respostas listadas na Tabela 28 e Tabela 29.

Gestão Universitária - Memória Organizacional

31. **RF18 [melhorado]: SGU deverá emitir relatórios sobre projetos relacionados que possam trabalhar em conjunto, a serem continuados, cruzando diferentes departamentos e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

32. **RF22: SGU deve apoiar a gestão de documentos, por exemplo, mantendo todas as propostas de projetos, relatórios de projetos, resultados e publicações, teses, produção acadêmica, documentos administrativos, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

33. **RF23: SGU deve emitir relatório sobre a produção do projeto, como proposta de projeto, publicações, produção acadêmica, áreas de interesse, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

34. **RF24: SGU deve suportar a comunicação entre partes interessadas, inicialmente por e-mail, futuramente por messenger.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						

35. **RF25: SGU deve avisar coordenadores do projeto sobre "Eventos para Publicar", como conferências, workshops, empresas, escolas, etc., e pessoal que estará presente.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

36. **RF26: SGU deve emitir relatório sobre resultados de projetos e alunos egressos de acordo com áreas de interesse.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

37. **RNF06: SGU deverá garantir o sigilo de informações confidenciais.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

38. **RF27: SGU deverá se comunicar com sistemas de software dos principais patrocinadores de projetos (importação ou exportação de dados).** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Gestão Universitária - Fomento de Endowment

39. **RF28: SGU deve dar suporte ao processo de acompanhamento de alunos egressos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

40. **RF29: SGU deve dar suporte ao processo de fomento de endowment por alunos egressos.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

41. **RF30: SGU deve manter base de dados sobre alunos egressos, como nome, curso, publicações, projetos, áreas de interesse, ocupação atual, e assim por diante.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

42. **RF31: SGU deve emitir relatório sobre alunos egressos e áreas de interesse.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

43. **RNF06: SGU deve manter informações relacionadas a endowment transparente.** *

Mark only one oval per row.

	1	2	3	4	5	Não se aplica
Possível a curto prazo						
Possível a longo prazo						
Novo						
Relevante para a PUC-Rio						
Útil a curto prazo						
Útil a longo prazo						
Prioridade						

Geral

Por favor, utilize esse espaço para comentar sobre todos os requisitos listados acima.

44. **Qual sua avaliação sobre os requisitos elicitados? Quais são suas impressões, sugestões e críticas?** *

    O objetivo dessa questão é validar os requisitos elicitados com os membros da VRADM da PUC-Rio.

45. **Você tem sugestões de adição de novos requisitos, remoção, alteração, combinação ou decomposição dos requisitos listados?** *

    O objetivo dessa questão é evoluir os requisitos elicitados com os membros da VRADM da PUC-Rio.

Avaliação do Método ODA4RE

O método em questão é o apresentado nas 4 Figuras que abrem o documento PUC-RioStrategicPlan.docx, enviado em anexo ao email convite a esse questionário. Os resultados obtidos em cada passo também são listados nesse documento.

46. **Qual sua avaliação sobre o método aplicado? Quais são suas impressões sobre esse método? Pontos fortes? Problemas?** *

    O objetivo dessa questão é validar o método aplicado com os membros da VRADM da PUC-Rio.

47. **Na sua opinião, o método proposto contribui para a elicitação de requisitos de SSaSIO?** *

O objetivo dessa questão é verificar se os membros da VRADM acreditam que o método tenha trazido contribuições para a elicitação de requisitos de SSaSIO.
Mark only one oval.

- ◯ Sim
- ◯ Não

48. **Por quê?** *

O objetivo dessa questão é elicitar a razão dos membros da VRADM para reconhecer ou não contribuições do método para elicitação de requisitos.

_____

_____

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_____

49. **Você tem sugestões de melhoria para o método aplicado?** *

O objetivo dessa questão é evoluir o método aplicado com os membros da VRADM da PUC-Rio.

_____

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_____

50. **Você aplicaria esse método para elicitação de requisitos do SGU em seus projetos?** *

O objetivo dessa questão é verificar se os membros do da VRADM da PUC-Rio aplicariam o método apresentado.
Mark only one oval.

	1	2	3	4	5	
Fortemente Não	◯	◯	◯	◯	◯	Fortemente Sim

51. **Por quê?** *

O objetivo dessa questão é elicitar a razão de cada membro da VRADM da PUC-Rio para aplicar ou não o método apresentado.

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52. **Você recomendaria esse método para elicitação de requisitos de SGU?** *

O objetivo dessa questão é verificar se os membros da VRADM da PUC-Rio recomendariam o método apresentado.
Mark only one oval.

	1	2	3	4	5	
Fortemente Não	◯	◯	◯	◯	◯	Fortemente Sim

53. **Por quê?** *

O objetivo dessa questão é elicitar a razão de cada membro da VRADM da PUC-Rio para recomendar ou não o método apresentado.

_____

_____

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_____

54. **Que horas são agora? Em hh:mm:ss, por favor.** *

Gostaríamos de ter consciência do tempo que a avaliação dos requisitos tomou dos participantes. Por isso, solicitamos o tempo de início da resposta, no início, e nesse momento o tempo de fim.

_____