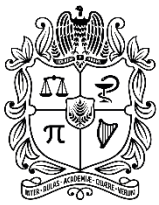

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GOAL MODELING FOR THE STRATEGIC ALIGNMENT OF BUSINESS AND IT

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Bogotá D.C. , Colombia

2022

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Tesis presentada como requisito parcial para optar al título de:

Doctor en Ingeniería de Sistemas y Computación

Director

Jairo Hernán Aponte Melo Ph.D.

Línea de Investigación:

Requirements Engineering

Grupo de Investigación

Colectivo de investigación en Ingeniería de Software - ColSWE

Universidad Nacional de Colombia

Facultad de Ingeniería, Departamento de Ingeniería de Sistemas e Industrial

Bogotá D.C., Colombia

2022

"I must not fear. Fear is the mind-killer. Fear is the little-death that brings total obliteration. I will face my fear. I will permit it to pass over me and through me. And when it has gone past, I will turn the inner eye to see its path. Where the fear has gone there will be nothing. Only I will remain."

Dune - Frank Herbert

“So long, and thanks for all the fish”

Hithchhiker’s Guide to the Galaxy -
Douglas Adams

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Miguel Eduardo Torres Moreno

Fecha 01/07/2022

Acknowledgments

I want to thank my advisor, Dr. Jairo Aponte, for his endless patience and attentiveness. My colleagues and the community within Pontificia Universidad Javeriana, Dr. Efraín Ortíz and Dr. Rafael González, for their insight and methodological guidance.

To my mom for her help while collecting, tabulating, and transcribing data from the interviews.

To my wife, for her endless love, patience, and caring for my physical and mental health, this work is for her. Mary, you are the only truth I know in the world; finally, you can say you are married to a doctor (not the kind that matters, but…).

To my geek geriatric friends who made this time more enjoyable.

I want to dedicate this thesis to my two cats Azrael and Lucifer, without whom I am sure I would have finished sooner.

In loving memory of those we have lost along the way: Néstor, Carmen, and Ana María.

Resumen

Modelado de Metas para la Alineación Estratégica de Negocios y TI

La brecha entre el desarrollo y el análisis de las estrategias de negocio y de TI, en la práctica y la literatura, afecta la forma en que TI usa las estrategias para definir y priorizar los recursos para proyectos, iniciativas y operaciones de TI. Cerrar esta brecha ayuda a respaldar mejor los desarrollos futuros, los cambios en la operación y los nuevos proyectos e iniciativas dentro de las unidades de negocio y de TI, asegurando una base analítica para la toma de decisiones. Presentamos un modelo de gestión de objetivos de negocio/TI/requisitos tempranos que admite i) la priorización y definición de requisitos relacionados con las estrategias de negocio y de TI, ii) analizar cómo estos requisitos se pueden asociar con sistemas nuevos y antiguos, y iii) la operación de TI/SI. El modelo y el proceso propuestos permiten construir un modelo de metas estratégicas de negocio y TI/SI que se puede analizar y aplicar en el gobierno de TI para respaldar la alineación funcional de negocio/TI.

El modelo se construyó mientras se realizaba un estudio de caso en una universidad colombiana aplicando *Design Science Research*. Posteriormente, el modelo se evaluó utilizando métodos cualitativos y cuantitativos, con expertos dentro de la organización del estudio de caso y profesionales externos de la academia y la industria. Los resultados de la evaluación indican que el modelo es útil dentro del contexto deseado. Los entrevistados también destacan que el modelo facilita un mejor proceso de toma de decisiones basado en parámetros e indicadores que son difíciles de negociar con las partes interesadas. Tal característica es de suma importancia para los estrategas. Finalmente, señalan que el modelo mejora la gestión de la estrategia y podría impactar positivamente en las estrategias tácticas y operativas.

Palabras clave: lenguaje de requisitos orientado a metas, ingeniería de requisitos orientada a metas, modelado de metas, alineación estratégica, alineación negocio/TI

Abstract

Goal Modeling for the Strategic Alignment of Business and IT

The gap between Business and IT strategy development and analysis, in practice and literature, affects how IT uses strategies to define and prioritize resources for IT projects, initiatives, and operations. Closing this gap helps to support future developments better, changes in operation, and new projects and initiatives within the business and IT units, ensuring an analytical base for decision-making. We present a Business/IT goal/early requirements management model that supports i) the prioritization and definition of requirements related to both Business and IT strategies, ii) analyze how these requirements can be associated with new and old systems, and iii) the internal operations of IT/IS. The proposed model and process allow to build a Business and IT/IS Strategic Goals Model that can be analyzed and applied in IT Governance to support Business/IT Functional Alignment.

The model was built while performing a case study in a Colombian university applying Design Science Research. The model was later evaluated using qualitative and quantitative methods, with experts within the case study organization and external practitioners from the academy and industry. The evaluation results indicate that the model is helpful within the desired context. Interviewees also highlight that the model facilitates a better decision-making process based on parameters and indicators that are hard to negotiate with stakeholders. Such a feature is of utmost importance for strategists. Finally, they point out that the model improves strategy management and could positively impact tactical and operational strategies.

Keywords: Goal-oriented Requirement Language, Goal-oriented requirements engineering, Goal modeling, Strategic Alignment, Business/IT Alignment

Esta tesis de doctorado se sustentó el 27 de mayo de 2022 a las 7:00 a.m., y fue evaluada por los siguientes jurados:

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Chapter 1. Introduction

Requirements Engineering (RE) is the discipline responsible for the collection, analysis, specification, verification, validation, and management of information systems and software requirements [1], [2]. Since its inception, RE's primary concern has been to appropriately use and manage requirements and specifications in software/system development projects. These specifications are typically written in natural language, making it difficult to understand when designing, implementing, and testing the software/system [3].

RE as an area of knowledge has evolved in the last decades, originally from Software Engineering and then moving away from it to cover other knowledge areas, due to the diverse RE applications and influences on several types of development projects or products. Over time, it has been identified as a critical discipline for success in systems and software projects because it supports several processes such as [1], [3]–[5]:

- Showing results and value to the Stakeholders (i.e., Customers, users, participants) and Stockholders (i.e., investors and senior management who will not necessarily be users of the final product),
- Allowing stakeholders to discuss different points of view,
- Verifying product design,
- Allowing the customer to accept the products with precise and measurable criteria,
- Enabling the development team to be sure they are solving essential problems,
- Letting testers know what to test on the product in the context of the customer's real needs,
- Ensuring that project managers can have adequate information on the status and progress of the project.

In the 1990's it was recognized the importance of extending the scope of this discipline from the Software Development realm to the concept of Information System (IS) (hardware, software, organization, and people) and to the business itself [2], [6], [7]. Researchers such as Wiegers [3], [8], and Alexander [5] insist that although knowledge on the subject has deepened over the years, it has been thought from the engineering point of view and not from the people's standpoint, who will ultimately be the users and evaluators of the built products and systems. That is why identifying business goals and objectives of both individuals and groups, at the management and strategic level, and negotiating these objectives until they are transformed into useful requirements for system and software development team, has become an essential subject. These advancements also relate to another expected impact on the organization: achieving *Strategic Business and Information Technology Alignment* (BITA). BITA harmonizes business and IT decisions within the organization, allowing for the traceability, prioritization, management, control, verification, validation, acceptance of the product, and ensuring that the resulting information systems (IS) and technology (IT) environment meet the real needs of the business and its evolution over time.

BITA has been a recurring research topic for the past thirty years, mainly due to the strong impact of information technology (IT) investment in hardware/software and its long-term effects on the organizations' performance[9]. Therefore, alignment should focus on how IT and business achieve mutual harmony. Over time, alignment should evolve into a state where both strategies, i.e., Business and IT, evolve together. To be achieved, alignment requires

management activities to achieve cohesive goals across all the organization units: IT, finance, marketing, human resources, etc. [10].

Strategic goals represent high-level requirements that an organization seeks to fulfill within a specified period. Building a model or method to structure and analyze Business/IT strategic goals (i.e., organizational structure, business/support processes, software systems, and technical infrastructure) is of prime importance for the organization to plan, prioritize, and in general, find a more efficient way to achieve such goals.

1.1. The Problem

This section delves into the literature review performed for identifying the main problems that arise from strategic alignment and how it is being studied and treated from various knowledge areas, leading to the identification and discussion of the problem that we aim to study and address in this research.

The first interest of the author of this proposal has evolved from the relationship between Business and System Requirements to a perspective where Business Analysis (BA), Enterprise Architecture (EA), and Business and IT Governance turn into intertwining enablers that allow organizations to achieve Business/IT Alignment, leading into better business and system requirements management.

According to Khan [13], [14], the rate of evolution (i.e., the rate of requirements change over the system's life cycle) of Business Requirements compared to IT Requirements is very different. Although Enterprise Architecture (EA) seeks to coordinate such evolution processes, the lack of specific models and strategies is another promising open field of study. In this regard, Khan proposes a co-evolution model for Business and IT requirements to ensure business efficiency.

Several recent works use Requirements Engineering concepts to support alignment among business models, strategy and goals, EA, and IS/IT. B-SCP is the most cited Requirements Framework that aims to support alignment [15]–[17]. The foundations of this framework are rooted in three themes: business strategy, context, and process. Its primary goal is to allow verification/validation of requirements to support the business strategy by tracing it to the business processes that support that strategy [16]. For each subject, different models are used: i) i* for strategy, ii) Jackson context diagrams for context, and iii) role activity diagrams (RADs) for processes [16]. However, the Framework does not consider existing business analysis-related models or plans and builds its goal models by a redefinition of the iStar model. Furthermore, since the original work was published around 2006, BPMN was not as widely used, and instead, RAD was adopted.

Singh and Woo [18], use a multidisciplinary research strategy to identify different aspects that can be used to develop a strong BITA. Their work is based on the theory of 'line of sight', which is the ability of a stakeholder to relate the organization's strategic goals and the stakeholder's actions that contribute to fulfilling those goals [19]. The rationale behind this is that stakeholders are the ones that state the system's requirements. The developed system will inherently be misaligned if they lack a precise understanding of its activities or duties concerning the strategic goals. Based on this assertion, Singh and Woo propose the 3g Framework, which traces strategic goals to systems by identifying operational goals, which in turn support the system's requirements.

Several other methods and frameworks have been proposed that use GORE methods (especially i*) to support the development of BPM models. The main reason behind this is precisely the direct relationship between strategic and business goals and their operationalization using business processes. Decreus et.al.[20] discuss several challenges and perspectives when using goal models that, in turn, are transformed into business process models. More recently, Serrano and Amaya developed a model that aims to trace and relate motivational elements (i.e., the organization's mission, vision, strategy, and tactics) to BPMN models [21], [22]. Through the definition of a conceptual framework that seeks to assess the effectiveness of an organization's strategy, using matrixes that trace and relate the strategic model with the BPMN representation, this is achieved using iStar along with two motivational tools such as the BMM (Business Motivation Model)[23], and VMOST [24]. Horkoff et al. developed languages and tools that support enterprise engineering and modeling efforts [25]–[28] based on iStar. The main idea behind this is to perform automatic model validation to enable enterprise planning and the development of aligned business plans.

1.1.1. Identifying the Problem's Relevance in a Real-World Context

We performed a case study where we applied a proven instrument to assess and measure the BITA maturity degree of an organization [29]. Furthermore, another goal was to identify possible projection issues for future work concerning BITA and identify specific problematic elements concerning the relationship between business and IT of the evaluated organization. We used interviews of open-ended questions that were inquired to the same group of people alongside the survey to achieve this.

The studied university is classified among the top five (5) universities in Colombia, and according to the QS Ranking, as of 2019 is classified 521-530 in the world and ranked seventeen (17) in Latin America [30]. It currently has more than fourteen hundred (1400) full-time professors, two thousand (2000) part-time professors, and more than fifteen hundred (1500) administrative officials and serves little more than twenty-five thousand (25,000) students between undergraduate, graduate, and continuing education. It has two branches, one principal located in Bogotá and another one in the city of Cali.

Sixty-two (62) people from the Bogota headquarters were summoned by email; these people had to have managerial roles and be involved in the organization's decision-making processes. Forty-seven (47) people responded and were interviewed personally in sessions of about an hour and a half (on average); the interviews were conducted between March to August 2018.

All the surveys were tabulated, and thirty-eight (38) interviews were transcribed for further analysis, emphasizing the personnel belonging to the Administrative Vice-chancellorship and the DTI (Direction of Information Technology), also to be able to contrast the perceptions of the groups and enrich the analysis. Groups of interviewees were defined, separating the people who belong to IT units (12) against those belonging to business (35) units of the organization.

We reported the most relevant quantitative findings and some qualitative judgments that have been identified by performing the analysis of the interviews. However, due to the large volume of information collected, it has been reported in two documents: first, a research paper presented at a conference, and a longer and more detailed document showing the results and analysis of the data and interviews. The second one was presented to the top management of the organization being studied.

After performing the alignment analysis, we were able to contrast the state of the art with a case of alignment in the aforementioned institution. Thus, we were able to:

- Compare and analyze the results obtained from the literature review and the collected perceptions to real-life facts gathered through the analysis of the surveys/interviews.
- Give sustenance for the first noticed problem when identifying the gap in the literature review in the context of Design Science Research.
- Identity when and how such a gap occurs in real-life situations. Thus, the purpose is to determine the relevance of the stated problem for the practitioner community in general and the possible contributions to the knowledge base that this research could ensure.
- From this case study, we learned that the role of IT should be questioned concerning the definition of strategic business planning. IT role as a service provider must change to that of an enabler or even the driver of the organization's strategy. Also, IT position and function in the organizational hierarchy must be examined. This study allowed us to understand the different dimensions of alignment and its importance when the organization is growing, and IT's role must be more than operational.

The results suggest that in the aim of achieving strategic alignment between business and IT, in both literature and practice, there is still a gap in terms of models, methods, and concrete actions that allow for creating and maintaining a closer relationship between Business and IT strategies and their impact on the daily operations of IT.

1.1.2. Putting it all Together

In Requirements Management of both Information Systems and IT, several essential elements such as negotiation and evolution are still missing when relating literature and actual practice. Enterprise architecture frameworks provide recommendations for each represented abstraction, such as requirements, systems, architectures, and roles. However, they do not provide methods and procedures to support the maintenance and evolution of the architecture. On the other hand, in aspects of management strategy and its relationships with business and systems requirements, in most cases, these relations are only explicitly made regarding the Business strategy, leaving aside IT strategy.

Most efforts in the requirements management knowledge area have been made for developing functional integration between business strategy and operation and IT/IS infrastructure (e.g., Henderson and Venkatraman's *Strategy Execution* pattern [32]). However, there are no requirements management models or methods that relate Business and IT Strategy to IT/IS infrastructure to the best of our knowledge. Developing such *methods and models* is necessary to support Henderson and Venkatraman's *Technology Potential* pattern (see Chapter 2[32].

Based on the review performed by Daneva et al. [11], regarding state of the art and research opportunities in RE, the following stand out: i) requirements scaling, how requirements are managed to evolve along with the systems, and how to also handle different levels of detail for requirements (e.g., business vs. system vs. software); ii) impact of RE research on industrial practice, iii) negotiation of requirements, iv) conflict resolution, and v) bringing RE/GORE (Goal-Oriented Requirements Engineering) to actual practice in real-life environments; this means how to apply academic research into real-world scenarios and ensure that the theory, models, and methods are correctly used in such situations. These opportunities are related to RE/GORE by themselves. They involve other areas of knowledge such as social sciences, Business Analysis (BA), Enterprise Architecture (EA), IT Governance, and Business/IT alignment.

According to Luftman [31], understanding alignment as a process is required to achieve BITA. Thus, it is crucial to identify best practices, guidelines, artifacts, and tools to guide and support the process and help the organization maintain and improve its alignment. Our initial findings lead us to identify a gap between the Business and IT strategies [32]. Such gap can be filled using tools from BA, RE, or GORE methods suitable to analyze and support decision-making to achieve alignment among IT projects and operation of IT/IS through analysis techniques. These opportunities suggest bringing together the characteristics of an alignment process proposed by Luftman and delineating best practices, methods, and tools to analyze and support the management and improvement of BITA.

Our findings show that the gap between Business and IT strategy development and analysis, in practice and literature, affects how IT uses strategies to define and prioritize resources for IT projects, initiatives, and operations [33]–[36]. Closing this gap helps to better support future developments, changes in operation, and new projects and initiatives within the business and IT units, ensuring an analytical base for decision-making. Thus, we aim to propose the construction of a Business/IT goal/early requirements management model that supports i) the prioritization and definition of requirements related to both Business and IT strategies, ii) analyze how these requirements can be associated with new and old systems, and iii) the internal operations of IT/IS.

Therefore, this thesis seeks to address the following main research question:

How could strategic business/IT functional alignment be supported through analyzing, connecting, and tracing strategic goals?

Furthermore, we aim to answer the secondary questions that follow:

- How can we develop a strategic alignment goal model that supports management and analysis of business and IT strategies in the context of IT governance?
    - Which are the abstractions needed for expressing strategic goal alignment?
    - Which types of analysis/reasoning should be performed on strategic alignment goal models to support the decision-making processes?
- How can we evaluate whether the proposed model satisfies the research objectives?

1.2. General and Specific Objectives

Based on the proposed questions, we discuss the objectives we seek to achieve with the development of this thesis.

1.2.1. Main Objective

Build a Business and IT/IS Strategic Goals Analysis Model that can be used and applied in the context of IT Governance to support Business/IT Functional Alignment.

1.2.2. Specific Objectives

As outlined above and based on the specific questions, the following are the goals that we aim to achieve with this thesis:

1. **Identify and classify GORE's current state of practice regarding the specification, management, negotiation, and validation of Business and IT/IS goals derived from both Business and IT strategies.**

This goal aims to gain a deeper understanding of how GORE models such as iStar (i*)[37] and, in particular, GRL [38], [39] have been used to analyze individual and organizational goals and how the results of such analyses have been used in the decision-making process for achieving such goals. Specifically, this goal aims to identify how strategies, in the form of strategic plans, can be mapped into GORE models using the concepts of the Business Motivation Model [40] and other related frameworks to help in the forming of BITA.

2. **In the context of GORE models, identify and classify the elements that characterize IT operation and management.**

This goal seeks to identify and characterize in a general way the tasks and operations that IT performs, as well as find out how these elements can be represented or mapped to elements in GORE models to be used as input for the proposed model and provide support for BITA.

3. **Build a strategic goals model based on both Business and IT strategies using GORE methods and Goal Modeling.**

This goal aims at building the proposed model based on the outputs and achievements of the previous goals. The model will be based on GRL (an iStar derived language) and will provide a method for using it to map and construct the model by relating motivational, strategic and operational elements within the context and scope of the problem.

4. **Demonstrate and evaluate the use of the proposed model through experimental techniques.**

Finally, this last objective seeks to assess the usability of the proposed model in a limited and restricted setting using a controlled experiment.

1.3. Scope

The model's primary focus is to analyze the functional alignment between Business and IT at the strategic level. This analysis is performed using a GORE language, GRL [38], [39], that has been deemed suitable for goal analysis and early requirements engineering [41]–[49]. On the other hand, we rely on previous research and existing models such as the Business Motivation Model (BMM) [40] to classify and organize strategic goals.

The proposed model only considers strategic goals and early requirements to support alignment and leaves the users to further perform classic systems and software requirements techniques, since this process falls outside the scope of our problem. Furthermore, the model provides methods to analyze such elements that can be later used to negotiate and derive other requirements (e.g., system, business, and software).

Our model is directly influenced by the selected company’s context and the findings when executing the controlled experiment because of the relevance cycle of the methodology, which allows for the defined model and method to be contextualized in a real-world setting (this is explained further in the following section). However, the use and evaluation of the model gave rise to recommendations, identification of best practices, and ways to extend and generalize it, bringing a contribution to the knowledge base, strategic alignment and business/IT strategic management, requirements engineering and in particular goal-oriented requirements engineering.

1.4. Methodology

Design Science (DS) is a paradigm for solving problems associated with Information Systems [50], [51]. Generally speaking, DS proposes two activities: construction and evaluation of artifacts (e.g., models, methods, or systems) accompanied by contextual knowledge that helps people in developing, using, and maintaining IT solutions[52]. Figure 1 describes the DS model of basic recommendations proposed in Hevner et al. [50]. In the model, the **Environment** restricts the scope of the problem by identifying existing or planned **individuals**, **organizations**, and **technologies**; from this knowledge, the **Business Needs** are identified; framing the issues in such Business Needs provides **Relevance** to the research in progress. With the identified Business Needs, two complementary activities are carried out in parallel: i) Research of Information Systems (**IS Research**), through the Design/Justification of theories that seek to solve the initial Business Need, and ii) the building of the **Knowledge Base**, which provides the inputs for the IS Research to work for a solution framed in such knowledge; giving **Rigor** and sustenance to the developed solution employing formal methods of **Evaluation** of the resulting artifact.

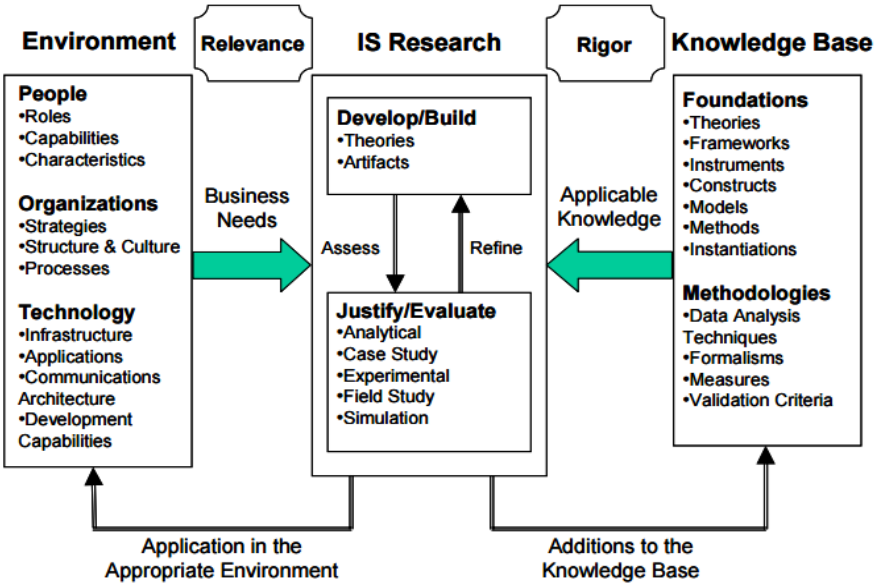


Figure 1 Design Science. Taken from Hevner et al.

Hevner et al. [50] argue that DS can be confused with traditional Systems Design, in which existing knowledge is applied to the solution of organizational problems; in contrast, DS seeks to solve problems yet to be solved and whose solution contribute to an organization, but also the knowledge-base in the form of a designed artifact, providing rigor, parameters for future new designs, and contributions in design theory.

The following are the types of possible DS contributions [52], [53]:

1. **Invention**: when new solutions solve new problems; these are the rarest examples, primarily because of the difficulty in identifying and conceptualizing the problem, which is the most significant contribution of an invention.
2. **Improvement**: when a new solution for known problems is developed that improves previous ones by genuinely advancing the knowledge about the issue.
3. **Exaptation**: when known solutions within a knowledge field are applied for solving problems in a different knowledge area.

4. **Routine design**: this happens when existing knowledge is applied to a current problem routinely. In this case, no original research contribution is expected and, in essence, is traditional IS design.

According to Gregor et al. [53] classification of DS types, this research can be classified as **Improvement**, which is defined as the development of new or better solutions for known problems in the "… form of more efficient and effective products, processes, services, technologies, or ideas…".

1.4.1. Framework – Activities and Methods

To make Hevner's practices operative, Peffers et al. [54] propose a detailed set of activities to perform a DS endeavor. They specifically present a sequence of formal steps around the principles proposed by Hevner, namely the Design Science Research Methodology (DSRM), which incorporates the practices and procedures necessary to carry out this research and seeks to support three goals: i) being consistent with previous literature, ii) proving a nominal process model for researching DS, and iii) providing a mental model for the presentation and evaluation of research in Information Systems using DS. For authors in the field of Information Systems (IS), it is a discipline of applied research, meaning that the theory of other disciplines, such as economics, information technology, and social sciences, is often applied to solve problems at the intersection of information technology (IT) and organizations.

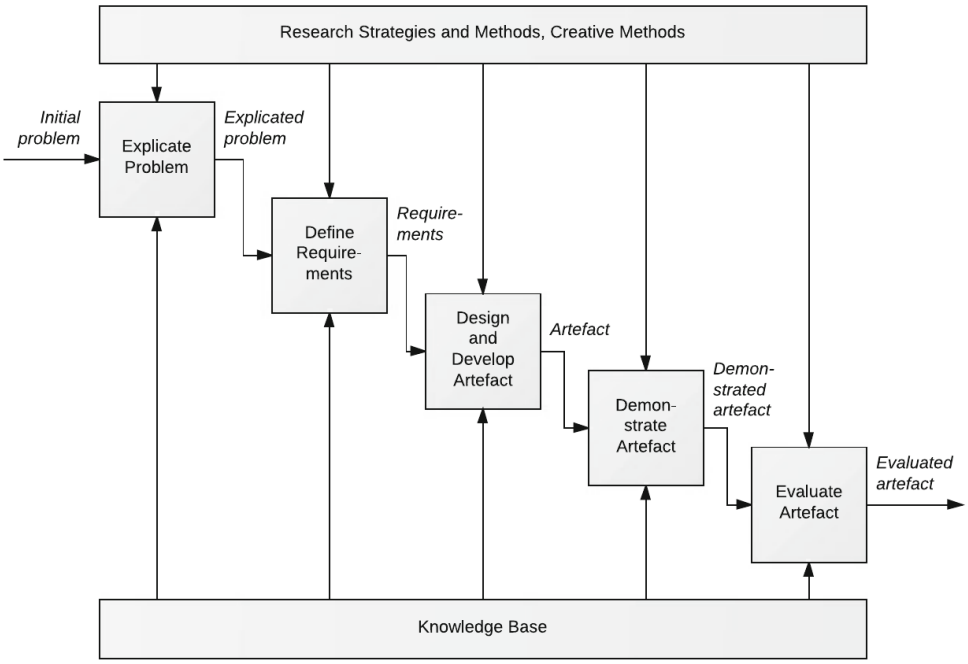


Figure 2 DSRM Process Model. Taken from Johannesson et al. [52]

The proposed DSRM process has six steps (See Figure 2), as detailed by Johannesson et al. [52], where the squares depict the core activities in the center of the figure. All activities apply different research strategies and methods and use the **knowledge base** to build the expected outputs. The activities are not necessarily performed in the depicted order; they can be carried out sequentially or iteratively while performing the relevance and rigor cycles (see Figure 1).

The following are the descriptions of the activities [52], [54]:

- **Explicate Problem.** The principal goal is to identify the problem and the motivation to solve it, implying that the problem must be formulated and justified by showing its significance and relevance by the parameters described by Hevner. To be able to understand the problem, the causes must be identified and analyzed.
- **Define Requirements.** It seeks to define the goals to be achieved by implementing the artifact through eliciting its requirements based upon the given problem definition. The requirements must determine the functionality of the resulting artifact, its structure, qualitative attributes such as the expected new knowledge generated, and how the artifact should be used in the context of the given problem.
- **Design and Develop Artifact.** It aims to create an artifact that seeks to solve the defined problem and meet the specified requirements. Designing the artifact implies that its functionality and structure are described in ways that can be easily tested and demonstrated.
- **Demonstrate Artifact.** It seeks to use the developed artifact in a real-life scenario as a proof of concept to prove its usability. The goal is to show that it effectively solves one or more instances of the problem.
- **Evaluate Artifact.** It seeks to determine how well the defined goals and requirements are fulfilled and how the designed artifact improves the knowledge and problem.
- **Communicate (**not depicted in Figure 2**).** Its principal goal is to report the research results (intermediate or final) to a selected community of interest, i.e., researchers, academic, and industry practitioners. The DS results that are often published include the problem description, artifact, design, structure, utility, and detailed rationale supporting the decisions made while designing the artifact and performing the DS process, i.e., the strategies and methods used.

It is worth noting that DS aims to create artifacts and answer questions about them (e.g., their functionality, structure, and rationale) and the usage environments. Since most artifacts in DS are IS/IT related and have some social factor inherent to the users of the artifact, qualitative and quantitative research strategies and methods are required throughout the whole DS process.

1.4.2. Specific Methods and Resources

This section describes the specific methods and resources required for performing each activity included in the depicted DS framework as applied in the research.

Explicate Problem and Define Requirements

A thesis proposal was the outcome of performing the first two activities of the DSRM Process Model, even though the requirements were refined and detailed as part of the initial stages of the design and development of the artifact (See Chapter 4). The methods used were **literature reviews, surveys, and interviews** (for example, Luftman's SAM [29]). We understood the context of the problem (Strategic Alignment) and the different frameworks, tools, and methods used to achieve it. On the other hand, Luftman's SAM, allowed us to get a deeper understanding of the organization and the dimensions used to assess alignment. This approach also allowed us to collect data and knowledge about who, and how strategic planning is performed within the organization.

The resources used to perform these activities were mainly bibliographic databases, library resources, and reference management software to manage references data and related research materials.

Design and Development of the Artifact

Since the primary purpose of this activity is to produce *descriptive knowledge* in the form of specifications, designs, and rationale behind them [52], research methods are less used, and more attention is put into the identification and refinement of requirements and the selection of ideas that can answer such requirements. These ideas are then turned into sketches and refined representations into elements representing the artifact's structure and functionality.

In this activity, the leading resource was knowledge from the research literature, databases, and other library resources that support the theory about the problem and the solution and design theory about the structure and function of the artifact. This was achieved by applying iterative literature reviews [55], which supported identifying current concepts, methods, and trends while documenting the decisions made when building and refining the theory about the problem and solution.

The two primary sources of knowledge were centered around iStar and GRL, particularly research groups from the University of Ottawa and the University of Toronto. The lead researchers Dr. Daniel Amyot, Dr. Eric Yu, and Dr. Jennifer Horkoff. They had led the discussion on standardization and use of iStar and its variants and are co-authors and contributors to the GRL standard [38], [39].

The artifact was designed by building the conceptual framework upon wide known and used frameworks, allowing us to identify trends, definitions, and methods used to perform organization alignment and operations. The result of this exercise was a metamodel of concepts and relationships that was later used to relate such concepts to specific GRL concepts.

Demonstration and Evaluation of the Artifact

For the context of this project, this pair of activities were developed concurrently. The demonstration seeks to use the artifact in a specific case to show its usability; Specifically, this was achieved by executing an experiment using a real-life organization but restricting the artifact's size and scope of use.

For the specific case of the evaluation and demonstration of results, González et al. [56] argue that due to the problem-oriented nature of DS, the artifact must be analyzed from different research perspectives and contexts: people (organization), processes, theoretical and application results. They propose criteria to test artifacts (See Table 1). Moreover, they insist that depending on the artifact (e.g., result, process, model, or method), it is imperative to identify the specific type of analysis to be applied. For this project, the artifact produced is a model and the methods related to its usage. On the other hand, the documentation related to the decision-making process to build and use the artifact was used to test its consistency, completeness, and traceability to the concepts of the original problem. Finally, the model's usability was evaluated by surveying the case study organization's practitioners and external academics and industry practitioners by applying an *ex-post evaluation,* i.e., the artifact's evaluation after it has been used in the proposed organization and its development process shared to the evaluators [52]).

Type of Artifact	**Evaluation Criteria**
Constructs: concepts that form the vocabulary of a domain	Completeness, simplicity, understandability, ease of use

Models: sets of propositions or statements expressing relationships among constructs	Fidelity, completeness, level of detail, robustness, ease of use
Methods: sets of steps used to perform a task	Operationality, efficiency, generality, ease of use
Instantiations: realizations of an artifact in its environment	Efficiency, effectiveness, impact

Table 1 Types of artifacts used in DSRIS.[56]

To characterize, explain and define the evaluation of the resulting model, the evaluation design criteria proposed by Cleven et al. [57] were used. Most of the results from applying the model are quantitative. However, the analysis of such data would be qualitative in how it would or could be used in IT Governance decision-making processes. This characteristic makes the model usable in both organizational and strategic levels; the artifact type, as explained before, is a model; the epistemology of the artifact is based on interpretivism, i.e., the evaluation of the artifact depends significantly on the characteristics of the subject that is performing the assessment. The evaluation function covers two aspects: i) knowledge, i.e., performing the evaluation would also generate new knowledge on how to evaluate or contribute to changes in the artifact in the context of DS. This is equivalent to performing a **Rigor cycle;** ii) control, i.e., knowledge on the artifact, and its use must be assessed to determine if the evaluation criteria have been fulfilled and the artifact is in effect usable, this is equivalent to perform a DS **Relevance cycle**. The method to perform the evaluation must be an Illustrative Scenario, i.e., the application of an artifact to a synthetic or real-world situation to illustrate the artifact's suitability or utility [58]. The artifact to be evaluated is the DS artifact (model and method) since the construction of the artifact is documented and demonstrated by the thesis document. For this project, the philosophy that guided the evaluation was realism, where the objects and structures in the assessment were objectively given. In particular, this model was evaluated from the deployment perspective, i.e., considering the comprehensibility and acceptance of using and implementing the artifact in the context of IT governance. The point of view for the valuation is *"artifact against the real world."*,i.e., The artifact's suitability is evaluated in a real-world scenario in an organization that imposes restrictions and constraints on the artifact based on its reality. On the other hand, after demonstrating the model, it was evaluated from a summative and formative point of view. In this regard, the Unified Theory of Acceptance and Use of Technology (UTAUT) [59] was used to determine the potential usage effects of artifacts generated from a DS perspective.

Communicating Results

The identified audiences for this work are the academic communities of the two research areas studied: Strategic Alignment (Management Science) and GORE (RE and Computer Science); additionally, the organizations interested in the knowledge generated by this research.

The results were published in conference papers, journals, or book chapters. Moreover, one technical report based on Luftman's Strategic Alignment Maturity Model was delivered to the case study organization. Table 2 shows the delivered documents and their status.

Title	Description	Status	Reference
GOAL MODELING FOR THE STRATEGIC ALIGNMENT OF BUSINESS AND IT (Thesis Proposal)	The thesis proposal was built during the first two (2) years of doctoral studies.	Delivered and approved	N/A

Estado de la Alineación Estratégica Negocio / TI en la Pontifica Universidad Javeriana	Case study based upon Luftman's SAM for the analyzed organization.	Delivered to the case study organization in September 2018	N/A
IDENTIFICANDO BRECHAS ENTRE LAS TECNOLOGÍAS DE LA INFORMACIÓN Y EL NEGOCIO: UNA APROXIMACIÓN DESDE LA LITERATURA Y LA PRÁCTICA	Conference paper from Luftman's SAM evaluation.	Published - Conference Paper	M. E. Torres Moreno and J. H. Aponte Melo, "IDENTIFICANDO BRECHAS ENTRE LAS TECNOLOGÍAS DE LA INFORMACIÓN Y EL NEGOCIO: UNA APROXIMACIÓN DESDE LA LITERATURA Y LA PRÁCTICA," presented at the 19 Convención Científica de Ingeniería y Arquitectura, Palacio de convenciones de la Habana - Cuba, Nov. 2018.
Assessing Business-IT Alignment Maturity at a Colombian University	Journal paper from refined and detailed Luftman's SAM evaluation.	Published - Journal	M. E. Torres-Moreno and J. H. Aponte-Melo, "Assessing Business-IT Alignment Maturity at a Colombian University," *JCIT*, vol. 23, no. 4, pp. 1–22, Oct. 2021, doi: 10.4018/JCIT.20211001.oa8.
Business/IT Alignment Maturity Diagnosis of a Health Organization using Luftman's Strategic Alignment Maturity Model	Conference paper from Luftman's SAM evaluation in a health care institution in Villavicencio.	Under review – Revista Ingeniería e Investigación Facultad de Ingeniería Universidad Nacional de Colombia	
GOAL MODELING FOR THE STRATEGIC ALIGNMENT OF BUSINESS AND IT	This Thesis Document.		
Business and IT/IS Strategic Goals Analysis Model	Journal paper reporting the model and its evaluation.	Journal paper - Submission pending	

Table 2 List of products derived from this thesis.

1.5. Structure of the Thesis

This section describes the thesis structure and reports the research objectives covered by each chapter.

- Chapter 2, Conceptual Framework (Specific Objectives 1 and 2). This chapter introduces the baseline of our work, i.e., the concepts related to strategic planning within a corporation and an IT unit. They include the Business Motivation Model [40], Business Model Canvas [60], Balanced Scorecard [61], Corporate and IT governance principles and standards [62], [63], Value Chain, Business Process Management and Notation [64], and Enterprise Architecture [65].

- Chapter 3, Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL) (Specific Objectives 1 and 2). For the creation of the proposed model and method, the Goal-Oriented Requirements Language (GRL) [38], [39] was selected as the language to express the model and its results. This chapter describes the general use of the language, its elements, and how they are used. Moreover, the strategy evaluation algorithms are described.
- Chapter 4, Features and Requirements of the Proposed Model (Specific Objective 3). Based on the specific objectives of this research, this chapter refines and describes the desirable requirements for the **Business and IT/IS Strategic Goals Analysis Model.** Such features and requirements were derived by reviewing the representational and analysis needs reported in the conceptual framework and GRL uses.
- Chapter 5, The Business and IT/IS Strategic Goals Analysis Model (Specific Objectives 3 and 4). This chapter presents the **Business and IT/IS Strategic Goals Analysis Model,** its modeling guidelines, and its different uses in IT and corporate Governance to support Business/IT Functional Alignment.
- Chapter 6, Case Study (Specific Objective 4). This chapter describes the organization selected for the case study, its structure, and how it performs its strategic planning process. Moreover, it demonstrates how the proposed model was used based on its context and current strategic planning.
- Chapter 7, Evaluation of the Proposed Model (Specific Objective 4). This chapter describes the evaluations performed to assess the model's usability based on qualitative and quantitative information.
- Chapter 8, Contributions, Limitations, and Future Work. This chapter concludes the thesis by discussing its main contributions and the drawbacks of the model. This chapter also proposes topics for further investigation as part of future work.

Chapter 2. Conceptual Framework

This chapter presents the concepts and frameworks generally cited in the literature, ranging from strategic alignment, planning, management, and corporate and IT governance frameworks. It concludes with operational issues such as project management and enterprise architecture. These conceptual frameworks are pertinent for the building of the model since their definitions and concepts allow us to define a metamodel (See Annex 1) of such concepts and then later map them into the language we will use to describe the model (GRL described in Chapter 3)

2.1. Business and IT Strategy Constructs and Abstractions

2.1.1. Strategic Business and Information Technology Alignment (BITA)

Strategic Alignment has been a research topic of interest for the last thirty years, mainly due to the substantial impact of IT investment in hardware and software and its long-term effects on the organization's performance [66]. The definition of Strategic Alignment has evolved along with understanding and ongoing research on the topic. In that sense, the most recent description of alignment, according to Luftman, "*…Strategic alignment focuses on the activities that management performs to achieve **cohesive goals** across the IT (Information Technology) and other functional organizations (e.g., finance, marketing, H/R, manufacturing). Therefore, alignment addresses both how IT is in **harmony** with the business, and how the business should, or could be in harmony with IT. Alignment evolves into a relationship where the function of IT and other business functions adapt their strategies together…"* [29].

In their seminal work, Chan and Reich [66] identified several dimensions of alignment, such as:

- The **strategic/ intellectual dimension** refers to how the business and IT strategic plans are related and guarantee collective evolution [9].
- The **structural dimension** refers to the level of fit between the business and IT units' organizational structure and how they both function and articulate and make clear decisions.
- The **social and cultural dimensions** are defined by how much the people are committed to and understand the business' goals, plans [9], and the degree of formalism when planning, communicating, and enacting business and IT joint initiatives.

It is also essential to notice that most research efforts are focused on the strategic/intellectual and structural dimensions [67].

On the social and cultural dimension, the work by Reich and Benbasat is the most cited in recent research on Business/IT alignment (BITA) [9], [67]. In their study, Reich and Benbasat identify four social/cultural factors that influence alignment: *"… (1) shared domain knowledge between business and IT executives, (2) IT implementation success, (3) communication between business and IT executives, and (4) connections between business and IT planning processes…"* [9]. For them, alignment is achieved by first measuring the degree of understanding of business goals (short term alignment) and vision (long term alignment), and then acting accordingly to the findings.

In perspective, alignment should be present at all levels of an organization, i.e., strategic, operational, system, project, and even at the individual (person) level. In that sense, the work of Henderson and Venkatraman (1993) [32] is regarded as seminal in the area. It is the basis of

many proposals for conceptualizing a Strategic Alignment Model (SAM). This model, however, considers only the structural and strategic/intellectual dimensions [9]. The model defines four domains: i) business strategy, ii) IT strategy, iii) Organizational infrastructure and processes, and iv) IT infrastructure and processes; these four domains have each different components that together support alignment at different levels and various forms within and outside the organization (see Figure 3).

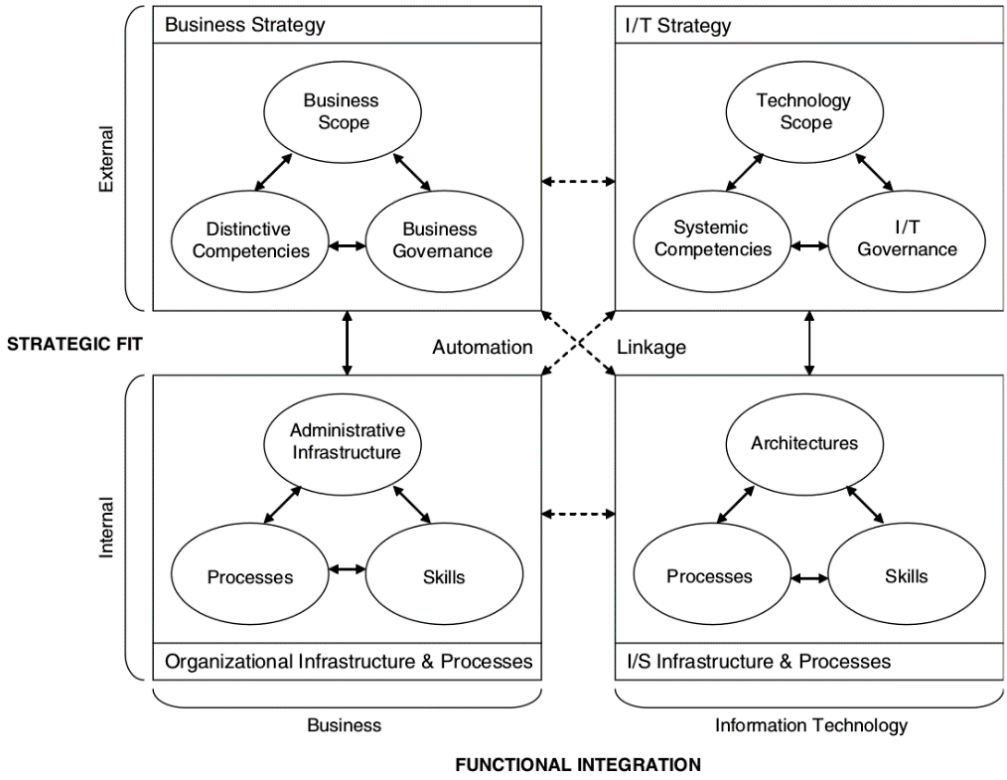


Figure 3 Strategic Alignment Model (Henderson and Venkatraman) [32]

The SAM is described by a separation between internal and external domains, which gives rise to the concept of *Strategic Fit*. The **external domain** (top row of the illustration) refers to the organization's environment. Its primary concerns are how it competes and creates alliances with other organizations and attracts and maintains customers by creating differential products to stand apart from its competitors.

On the other hand, the **internal domain** (bottom row of the illustration) refers to the organization's internal structure through its people, business processes, and supporting information systems. However, Henderson and Venkatraman argue that IT strategy should articulate itself in both domains (internal and external). Also, the **functional integration** represents the integration between Business and IT/IS (Information technology/information systems) domains, for example, utilizing the collective evolution of the organization's business processes and its IT infrastructure.

The model is then used to identify the organization's strategic perspective, which the model presents as a mesh of three elements of the model (i.e., business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes), and each component of the triad is defined as [68]:

- **Domain anchor:** Which "drives, catalyzes, or enables" strategic forces applied to the *domain pivot*.
- **Domain pivot**: Represents the element that defines the "problem or opportunity" that requires attention.
- **Impacted domain:** This is the functional area affected by the given problem.

In this sense, Henderson and Venkatraman identified four specific strategic perspectives or "patterns of linkage," which gives the strategist essential tools to plan and define strategy. The views are defined as [32], [68] (see Figure 4):

- **Strategy execution** (Business Strategy - *anchor*, Organizational infrastructure – *pivot*, IT infrastructure - *Impacted domain*): In this pattern, the assumption is that a business strategy enables the organizational choices supported by the IS infrastructure. This is the typical way people understand the relationship between business and IT/IS.
- **Technology potential** (business strategy, IT strategy, IT infrastructure): This pattern seeks to implement the business strategy through an intense interplay with IT strategy and IS infrastructure.
- **Competitive potential** (IT strategy, business strategy, Organizational infrastructure): in this pattern, IT strategy plays the lead role with its potential for researching and using emerging IT capabilities, which in turn pushes for the creation of new products and services, giving rise to a dynamic and changing business strategy (which in the previous patterns is seen as almost static).
- **Service level** (IT strategy, IT infrastructure, Organizational infrastructure): This pattern indicates that the organization's core business goal is oriented toward IT/IS services. Moreover, the business strategy is built to allow the exploration of markets and to bring new customers.

Technological Architect	**Strategic Execution**	**Technology Potential**	**Competitive Potential**	**Service Level**
Nature of Domain Relationships				
Role of Top Management	Leader	Technological Visionary	Business Visionary	Prioritizor
Role of IT Management	Functional Manager	Technology Architect	Business Architect	Service Manager
IT Focus	Reactive/ Responsive	Enable Value – Add to Business	Drive Value – Add to Business	Business within a Business
IT Performance Criteria	Financial	IT Value to Product / Service	Product /Service Value from IT	Customer Satisfaction
Strategic Planning Method	Business Process Re-engineering or IT Planning	IT Strategy	Business Strategy	IT Planning, IT Re-engineering, or Execution

Figure 4 Henderson's and Venkatraman's Patterns of Linkage [68]

Recent research by Zhang et al.[34], propose extending the model separating IT from IS (thus creating a new column in the model, leaving IS as the middle column), and separating the functional row into “enterprise planning” and “solution delivery” (leaving “enterprise planning” as the middle row), this proposal identifies new relationships for alignment. On the other hand, Majstorovic [69] argues that BITA is too complex to specify and understand using Venkatraman’s patterns. It could only be analyzed by every single relationship and not as a set of relationships.

2.1.2. Business Motivation Model – BMM

The Business Motivation Model (BMM) [23] is an Object Management Group (OMG) [70] specification created and designed as a Business Model specification tool that seeks to abstract the motivational aspects of an organization. Moreover, assist in defining a business plan, providing standard vocabulary and an easy way to understand relationships between such concepts—relating business rules, processes, and organizational units and the resulting courses of action to achieve goals and objectives.

The core concept of the BMM is motivation, i.e., why an organization decides to perform its business activity; usually, the foundation for such a decision is based upon the construct of the organization’s aspirations or its *Vision* and the action plans defined to achieve its *Mission*.

The BMM has two significant areas: first, the *Ends* and *Means* of business plans. Ends are results the organization wishes to achieve (Goals/Objectives); Means are elements that the organization employs to attain those Ends (Strategies, Tactics, Business Policies, and Business Rules). Secondly, Influencers help characterize elements of the business plans and the assessments made about the impacts of such Influencers on Ends and Means (i.e., **SWOT** Analysis - Strengths, Weaknesses, Opportunities, and Threats). **SWOT** analysis can focus on different levels: product, project, division, organization, or even the mission itself. It avoids unrealistic goals and ensures profitability and achievability [71].

The model applies to any organization of any type or size; this concludes that any unit inside an organization can have its business plan, including refined elements from the larger organization.

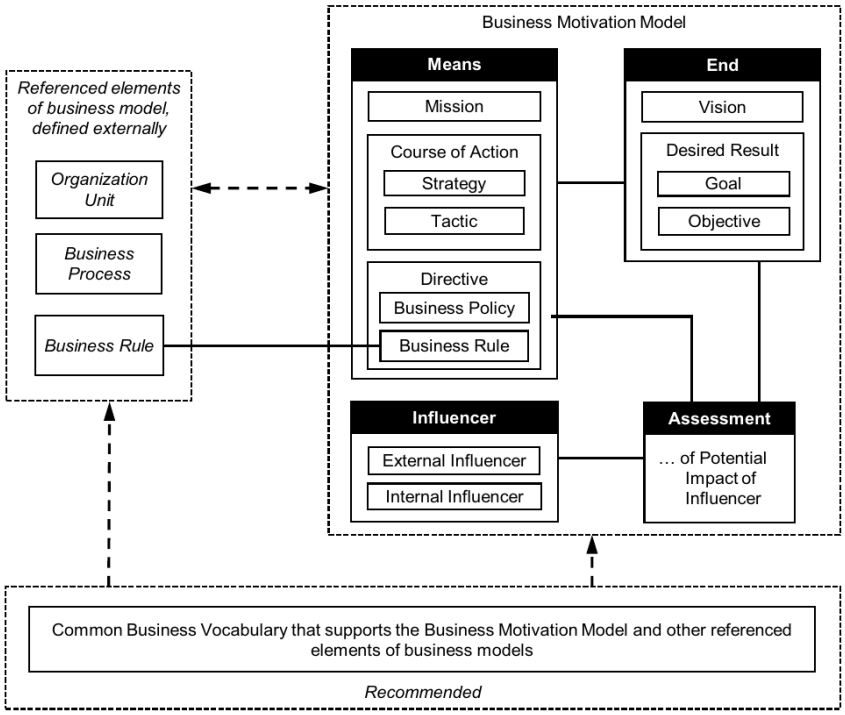


Figure 5 Overview of the BMM [23]

Figure 5 presents an overview of concepts and their relationships with other elements external to the BMM. External to the model is the Business Vocabulary, particular to the specific business for the business plan. Table 3 introduces the definitions of BMM concepts and an example of each concept for a car rental company (EU-Rent) [23].

Concept	**Description**
Vision (End)	An overall image of what the organization wishes to be or become. Vision:" Be the car rental brand of choice for business users in the countries in which we operate."
Goal (End)	An attainable and qualifiable state of the organization to be achieved or maintained to reach the Vision. Goal: "To provide industry-leading customer service."
Objective (End)	It is a measurable, attainable, and time-bound step towards achieving a Goal. Objective: "By the end of the current year, to score 85% on EU-Rent's quarterly customer satisfaction survey."
Mission (Mean)	Indicates the ongoing operational activity of the organization, describing the perspective of what the business should be. The Mission focuses on achieving the Vision. Mission: "Provide car rental service across Europe and North America for both business and personal customers."
Strategy (Mean)	Defines what needs to be done regarding resources, skills, or competencies to achieve a goal. Strategy: "Operate nation-wide in each country of operation, focusing on major airports, competing head-to-head, on-airport, with other premium car rental companies."
Tactic (Mean)	Represents a measurable part of one or more strategies and aids in achieving objectives. Tactic: "Outsource maintenance for small branches."
Directive	In general, they are rules/policies that govern, control, and guide how strategies and tactics are to be performed, giving them restrictions, limits, or just saying how things should be done. Directive: "A EU-Rent agent who is found, after a managerial review, to have rented a vehicle to a customer without a valid driver's license is to be fired." Business Policy: "Rental payments must be guaranteed in advance.", Business Rule: "A customer must present a valid driver's license in order to rent a EU-Rent vehicle."
Influencer	It is something/factor that can affect the means or ends. The organization may be internal or external (customers, technology, environment, partners, regulators,

	suppliers). Influencer – Competitor: "Two smaller competitors have merged, and the joint enterprise is now bigger than EU-Rent in several European countries.", Influencer – Customer: "EU-Rent's primary target is business customers, but it recognizes the need to appeal also to personal renters.", Influencer – Environment: "Car parking and storage in city centers is limited and expensive."
Assessment	It is a judgment on how the influencers affect the enterprise. BMM recommends using SWOT (Strength, Weakness, Opportunity, Threat) to identify which influencers are related to which end and means. Assessment – Strength: "Infrastructure: geographical distribution of branches," Assessment – Weakness: "High turnover of branch counter staff frequently causes a shortage of experienced staff in branches. This can cause delays in dealing with exceptions and problems."
Organizational Unit	In charge of identifying the "Who" in the model, units within the organization define ends, perform means, manage assets, and manage/execute/monitor the business plan. Organizational Unit: Branch, Human resources.
Business Process	Implement the courses of action (Means) by providing the How: steps, sequences, branches, cycles, synchronization, structure, and events. The Directives restrict them. The BMM specification cites the BPMN specification as the place where it is defined and refined. Business Process: Rent a car, Repair a car

Table 3 Description of BMM Concepts [23]

2.2. Strategic Planning / Management

Strategic management or planning is an organization's actions to gain and sustain a differentiated competitive advantage over its competitors [72]. It covers and integrates the different general areas of an organization such as management, marketing, finance, intellectual property, infrastructure, research and development, and finally, information technologies. It is the responsibility of the board of directors and the executive board to search for a plan that allows the organization to compete and improve profit with special care for ethical and social responsibility along with environmental sustainability, which represents the organization's impact on society and the individuals who are customers or employees of the organization [73].

2.2.1. The Process of Strategic Planning

The general strategic planning process consists of three stages [72]:

1. **Strategy formulation**: It is in charge of developing a Vision and Mission by analyzing external opportunities and threats from competitors or other influences in the organization's environment and internal strengths and weaknesses that can be controlled and improved. Allowing for the definition of long-term objectives by defining scenarios and strategies that will shape the operations and ways the organization does business (i.e., creating new services or products, diversifying, expanding operations, merging).
2. **Strategy implementation**: Defines policies, intermediate objectives, allocate resources, and supports creating strategic management culture within the organization. The strategist must make these decisions based on current performance information with the support of managers and employees that contribute to the strategic planning by identifying specific objectives to manage and achieve.
3. **Strategy evaluation**: Is the constant activity that strategists perform to comprehend and assess the level of achievement of the strategic goals; allowing for refinement of strategies through rechecking the external and internal factors and their evolution, measuring performance at the operative level, and the impact of current strategies, and finally taking corrective actions that update current strategies.

2.2.2. Business Model Canvas - Osterwalder et al.

Along with Porter's Value Chain Model, Osterwalder and Pigneur's Business Model Canvas [60] is recognized as the principal instrument to visualize, assess, and manage business models. An organization's business model describes how it creates, delivers, and captures value for its customers.

The Canvas model depicts graphically different elements while building, maintaining, and characterizing an organization's business model, showing how value can be delivered to customers. Usually, it is built for each business product or service.

Using a grid (as depicted in Figure 6), the identified elements can be placed using sticky notes (Post-it[1]) using brainstorming sessions to present, discuss, manage, and update the business model. The Canvas model's different purposes can be to satisfy new market requirements, bring new technologies to customers, disrupt, or create a market.

Figure 6 Canvas Model. From Osterwalder and Pigneur [74].

The principal elements of the model are [60] (as seen in Figure 6):

1. **Customer segments**: it forms groups of customers into segments that allow the characterization of customers' needs and behaviors. The organization can focus on the different value offers made to different segments, using different communication channels and relationships based on the segment's willingness to invest in the product.
2. **Value propositions**: The organization identifies the products and services that can bring value based on the customer segments. Includes the possible reasons why a customer would choose a product, service, or provider over another; The product or service solves a customer's problem and fulfills their needs.
3. **Channels:** identify how a company raises awareness of its products or services by defining its customer segments' communication, distribution, and sales channels. The characterization of a channel must also identify how the organization aids the customer to evaluate the value proposition, how a customer can purchase the product/service, how value is delivered to the customer, and how support is provided after the purchase. When answering these questions, the organization can also identify the budgetary impact of maintaining each defined channel or if a business partner could manage it.

[1] https://en.wikipedia.org/wiki/Post-it_Note

4. **Customer relationships** describe the various kinds of relationships the organization will provide to each segment to acquire more customers, retain the ones already in business, and increase sales. Several categories can be established and analyzed regarding cost, benefits, and impacts: generic/dedicated personal assistance, self-service, automated services, communities, and co-creation.
5. **Revenue streams** identify how cash is produced from every segment employing one-time or continuous payments/transactions. It must answer the questions: how much are the customers paying? How much are they willing to pay? How are they paying? How are they willing to pay? Finally, how much is each revenue stream contributing to the total revenue of the organization?
6. **Key resources**: it describes the assets the organization needs to make the business model work. It Clarifies how such resources (physical, financial, intellectual, or human) can be obtained.
7. **Key activities**: it identifies the most important activities the organization must perform to make the business model operational in contrast with the segments, value proposition, distribution channels, and customer relationships.
8. **Key partnerships** describe the suppliers and partners that can support the business model, thus creating and maintaining alliances beneficial to the organization and the value given to customers to create or maintain the business market.
9. **Cost structure**: finally, using all the previous analyses, it identifies the essential cost that impacts the business model: creating /delivering value, supporting the customer's relationship, and revenue stream.

2.2.3. Balanced Scorecard (BSC)

Kaplan and Norton first proposed the Balanced Scorecard (BSC) in the 1990s due to a perceived need for additional measures (other than financial) that affect the survival of a company over time [61]. The BSC is used to formulate, manage, communicate, control the achievement of the

company's strategy, and in general, seek alignment of the different units within it by making the strategy actionable at all levels [75].

The BSC is a methodology that organizes the strategy in four dimensions: financial, customer, internal business process, and learning and growth. The strategy of the organization is mapped within the four dimensions into **Objectives.**

The following items further refine each objective:

- A **measure** is defined to verify it, i.e., a quantifiable formula and variable(s) that, once measured, can indicate if the objective was or was not achieved.
- A **target** of the measure, i.e., a numeric value that indicates the achievement of the objective.
- One or more **Initiatives** that support the achievement of the goal is an activity, project, or program that, together with other initiatives, will meet the objective [75] (see Figure 7).

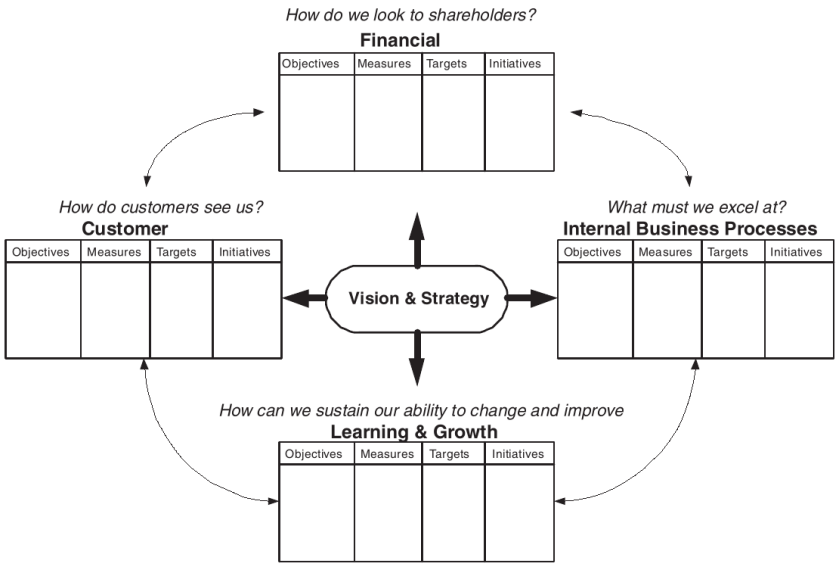


Figure 7 The Balanced Scorecard [76]

The authors recommend using these four dimensions; it has been proven that other dimensions can be added depending on the organization's context, e.g., non-profit vs. for-profit organization. Each dimension must respond to specific questions relevant to the fulfillment of the strategy [77]. The following are the recommended perspectives [61], [75], [76] (see Figure 7):

Financial perspective: Answers the questions raised around the financial goals based on revenues, profit, return of investment, etc.

Customer perspective: Seeks to identify the customer-related goals that the company seeks to achieve, in terms of the market, customer segments (new or current), customer perceived value of the product /service the company provides.

Internal perspective: Describes the goals needed to achieve the financial and customer's perspectives, identifying opportunities, innovation, sales and marketing, delivery, and product quality from the activities and processes in the operation that have a high cost per transaction, very high frequency, and significant impact on customer's satisfaction.

Learning and Growth perspective: It identifies the goals at the human-resource level. For the organization to achieve the strategy, it will almost certainly be necessary to capacitate/educate employees and integrate the initiatives into the organization's operations, i.e., role definitions, organizational culture, compensation based on performance, and IT integration.

For the BSC's goals to be achieved, each dimension's defined objectives must be analyzed and relationships to other goals defined. This step, called Strategy Mapping, ensures the alignment of all the objectives defined in the BSC towards the top-most goals [61], [76] (see Figure 8).

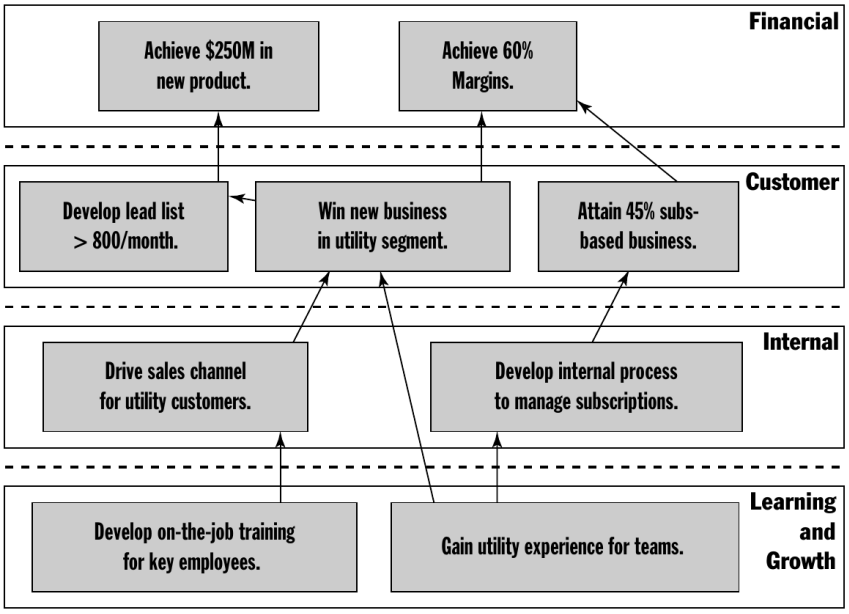


Figure 8 Example of a Strategy Map [75].

The Strategy Map must contain no more than 25 objectives to be manageable. The BSC is then followed by monthly meetings to follow up on the initiatives and the current measurements. The BSC is updated accordingly to the new findings [76]. It is also recommended that each organizational unit (e.g., human resources, operations, accounting, IT) perform its self-tailored BSC using the initial BSC. This process is called Cascading, which will give rise to identifying each unit's initiatives, ensuring the alignment of strategic goals to operative goals in each unit [77]. The IT Governance Institute [78] recommends redefining the four perspectives for the IT function by bearing in mind the following questions [78], [79]:

• Enterprise contribution—How do business executives view the business value delivered by the IT department?

• User orientation—How do internal or external users view the IT department?

• Operational excellence—How effective and efficient are the IT processes that develop or deploy IT?

• Future orientation—How well is IT positioned to meet future needs?

2.3. Corporate and IT Governance

Governance of enterprises, especially in the USA and Europe, has become a relevant topic; as significant failures associated with accounting and financial mismanagement occurred at the beginning of the XXI century (e.g., Enron, WorldCom) [80]; leading to the definition of laws such

as the Sarbanes-Oxley Act in the USA that seeks to improve governance processes, responsibilities, financial reporting, and auditing [80], [81].

Corporate governance relates to different knowledge areas such as economics, finance, accounting, law, management, and organizational behavior. Its primary goal is to maintain trust and ensure a well-defined ethical and legal conduct of the people representing others' interests (stockholders typically) [81].

Corporate governance includes *strategic* and *operational governance*, which impact corporate behavior and performance [82]. When one defines good governance, the ethical behavior expected from the leadership and a sound decision-making process are the key pillars to achieving continuous improvement and reaching compliance and accountability supported by a well-defined strategy and performance [82].

In general, governance transforms, directs, and controls an organization by integrating a mission, vision, and strategic goals by establishing policies, processes, controls, decisions, issues, and risks [81], [82]. Corporate governance includes **GRC** (Governance, Risk, and Compliance), including significant responsibilities such as governance, risk management, and compliance with the laws and regulations that restrict its operation in its geographical/financial area involvement [82]. Other essential characteristics of a corporation with good governance are: **adaptability** of the business model to changes in the environment, **alignment** of the different units with corporate strategy and with each other, **action** on strategic planning and **achievement** of such strategic goals, and **awareness** of the reality and environment in which the organization performs [82].

As the rule of law defines, governance is exerted by the **board,** acting as a representative of the company's **shareholders** (which renounce to be involved in the company's management). The board's primary responsibility is to direct the company the best they can for the profit of the shareholders and the prosperity of the company by directing its **management (leaders and senior executives)**, thus creating a tripartite relationship of trust between the board, shareholders, and management [62], [81].

A crucial ethical discussion surge while the board exerts its responsibilities: does the board always have in mind shareholders' benefits, or must it also consider all related stakeholders (clients, employees, society, etc.)? This concept is called the Agency Theory. Even though the board represents the shareholders, it must consider these other stakeholders to define/control the company as part of their ethical and social responsibilities [82].

2.3.1. Levels of Governance

Vagadia [82] presents a three-layer hierarchy of responsibilities in the whole of governance: i) Corporate and ii) Strategic governance, and iii) Operative (see Figure 9).

The top-most level corresponds to the actual **Corporate Governance**, in charge of ensuring accountability through the **BSC** use. It is in charge of defining the governance framework that will manage the organization and its risk; its concern is to ensure conformance (to laws, codes, and organizational structures and responsibilities) and performance.

In general, **Corporate Governance** must deliver utilizing principles such as [82]:

1. “The corporate governance framework should promote transparent and efficient markets, be consistent with the rule of law, and articulate the division of responsibilities among different supervisory, regulatory, and enforcement bodies.
2. The corporate governance framework should protect and facilitate the exercise of shareholders’ rights.
3. The framework should ensure the equitable treatment of all shareholders, and all shareholders should have the opportunity to obtain redress for any violation of their rights.
4. The framework should recognize other stakeholders’ rights granted by law or mutual agreement and encourage active cooperation between the corporation and other stakeholders in creating wealth, jobs, and the sustainability of a financially sound business.
5. The framework should ensure that timely and accurate disclosure is made on all material matters regarding the corporation, including its financial situation, performance, ownership, and governance.
6. Corporate governance should ensure the company’s strategic guidance, the effective monitoring of management by the board, and the board’s accountability to the organization and the shareholders.”

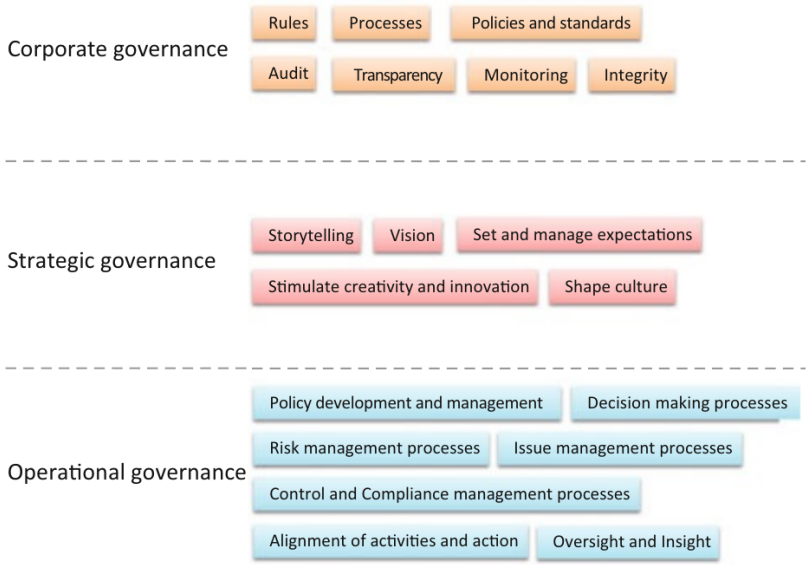


Figure 9 The three layers of governance. Edited from [82].

The **Strategic Governance** layer’s primary responsibility is to support the CEO and executive directors in developing the vision and strategic objectives and, in general, monitoring the strategic performance of the plans and strategies built to achieve them (see section Business Motivation Model – BMM).

The Operational Governance layer oversees defining the decision-making process, roles and responsibilities of the organization’s units and individuals in the sense of policy development, risk management, control, and compliance processes, and finally, the definition of portfolios, programs, and project governance (see section .

Project, Program, and Portfolio).

2.3.2. IT Governance

As in corporate governance, good IT governance defines policies, processes, issues, and risks that seek to achieve the strategic goals defined by the corporation's and IT's strategic planning—aligning the enterprise by the evolution of an IT architecture that delivers business value. IT governance gives the board and management the tools to measure and achieve its growth and the corporation's financial health [79], [80]. The most cited standards supporting IT Governance activities are COBIT [83] (see section COBIT) and ITIL (see section Information Technology Infrastructure Library – ITILv4).

IT governance's primary goals are: to ensure strategic alignment, value delivery, and manage risk and performance of IT-related operations/initiatives; through the implementation of policies and compliance practices, strategic deployment of technology, a well-developed information/infrastructure security strategy, and education for stakeholders on the potential of IT for the organization [80].

IT governance involves some of the following [78]–[80]:

- Ensure IT Units are recognized as the exclusive providers and decision-making entities on IT-related issues within the organization,
- Control and measurement of IT-related operations and its products,
- Define and monitor the quality-of-service levels of IT-related products/initiatives,
- Harmonization of IT-related implementations and the units that will operate them,
- Being engaged in the continual evolution of the corporation's business processes,
- Definition of IT policies/regulations to ensure compliance,
- Being accountable and justifying IT-related investments and resource usage,
- Ensure alignment between corporate strategy and IT's.

For the organization to measure value and show IT compliance, two tools are cited as the most relevant: the Balanced Scorecard (see Section Balanced Scorecard) and the Business Case [79]. A **business case** is a formal document that analyzes a potential investment in a structured manner. It includes essential information, rationale, and financial data to justify the investment. Its primary goal is to support the decision-making process for starting or renouncing an initiative and, in the end, secure investment success [79].

2.4. Governance Standards

In the following section, we present some of the most cited standards supporting, defining, and proposing frameworks for effective Corporate and IT governance.

2.4.1. The Committee of Sponsoring Organizations (COSO) Internal Controls Framework and Enterprise Risk Management (ERM)

The Committee of Sponsoring Organizations of the Treadway Commission' (COSO) internal control framework [84], is a de facto standard for auditing and internal control in enterprises, used by the board, management, and others to support and control the achievement of strategic and corporate goals, reliability on financial reporting and finally compliance of laws and regulations [80], [85]. It focuses on five components: risk assessment, control environment, control activities, information and communication, and monitoring [81]. COSO also developed the COSO enterprise risk management (ERM) framework, applicable to corporate governance enforcers [84].

Other related standards that were reviewed:

i) ISO 26000 [86] is a non-mandatory standard whose primary focus is on assessing and addressing the corporate social responsibility of organizations and on developing and implementing economic, social, and environmental sustainability activities;

ii) ISO 27000 [87] is a standard for Information Security management systems. It is closely related to COSO's Internal control framework. It defines a family of standards for the organization's development and implementation of a framework to manage its information assets' security; it covers financial information, intellectual property, employees, customers, or providers' entrusted information. It must allow the application of external assessments and auditing.

2.4.2. ISO/IEC 38500 2015 International Standard for the Corporate Governance of Information and Communication Technology

ISO 38500 is a standard based on principles and recommendations, with broad guidance for the ruling governing bodies to reinforce IT governance. However, it does not include guidelines for auditing responsibilities and does not replace the application of other standards such as COBIT or ITIL [88], [89].

It describes a set of principles for good corporate governance of IT. These principles must guide and be put upfront when making decisions following governance responsibilities (i.e., GRC). The principles are [88]:

- **Responsibility** identifies the groups or individuals with the authority and responsibility to perform the actions related to IT's supply and demand.
- **Strategy** invites the organization and IT to build their strategies together by sharing knowledge and understanding of IT capabilities and needs.
- **Acquisition** of IT assets is a transparent, rigorous process for risk management, for both long and short term, that seeks to balance benefits, opportunities, and costs.
- **Performance** indicates that IT has the capabilities, services, and quality required to fulfill its present and future requirements.
- **Conformance** identifies how IT meets legislation and regulation and has defined policies enforced through the organization.
- **Human behavior** indicates that IT has practices supporting and respecting the people involved in all service instances it provides.

The board of directors must ensure effective governance by performing the following tasks [89]:

- **Evaluate**: the bodies responsible for IT Governance must evaluate the current and future use of IT within the organization based on strategic principles (e.g., external businesses, financial issues, current and future IT developments, and impact).
- **Direct**: the directing body must oversee implementing the strategic plans, assigning, and making accountable the management roles for delivering on such plans. This also implies the correct use of information on progress from daily operations and the enacted plans.
- **Monitor**: define monitor systems that include auditing capabilities to ensure compliance and accountability.

2.4.3. COBIT

Internal control is defined as a process [80] established by the board of directors, management, and other personnel. As previously discussed, its primary goal is to provide reasonable assurance in achieving goals, effectiveness, the efficiency of operations, reliability of financial reporting, and IT systems and processes, showing demonstrable compliance [80]. At the same time, managers are responsible for implementing and managing internal control processes using known frameworks and standards. Auditors review and test such internal controls to report to those interested [80].

The Information Systems Audit and Control Association (ISACA) (since 1996) has developed an IT-oriented internal control assessment and guidance framework: COBIT (Control Objectives for Information and related Technology) [83], [90]–[92].

COBIT was first developed to support the work of auditors who had to investigate information systems and technology. Later it covered other aspects, like the ones proposed by COSO [85], concerning IT governance practices, internal controls, risk management, and every linkage on how IT delivers value [80].

Like other related frameworks and standards, COBIT defines a set of five principles [80]:

- **An integrated IT framework**. To support IT joint operations with other business units to create, maintain, and continuously measure the relationships' quality and value.
- **Stakeholder value drivers.** Processes should exist to ensure that IT and other enterprise operating units deliver the promised benefits following a delivery cycle. A strategy that optimizes costs must be defined and followed while emphasizing intrinsic enterprise values of IT and related activities.
- **Resources focus on a business context.** Seek the optimization of resources for optimal investments, thus ensuring IT resources, information systems, infrastructure, and people.
- **Risk management.** A clear understanding of risk, compliance, and joint risk management responsibilities may impact the entire enterprise.
- **Performance measurement.** Deploy processes to control and monitor strategy implementation through portfolio management strategies and service delivery (see section Project, Program, and Portfolio).

The framework defines a high-level group of processes that define IT governance and management [80]. In this sense, COBIT serves the board for guidance on IT governance and the CEO and executives' IT management [83].

COBIT groups its governance and management objectives into five domains. Each domain represents a process group. A domain is detailed using the following information items: an identification, a high-level description of the processes, a purpose statement, information about the cascading IT-related goals that are to be achieved by the process, description and use of inputs, and destination of the outputs of the process, a set of goals and related examples of valuable metrics, a RACI (Responsible, Accountable, Consulted, Informed) chart depicting proposed the different levels of involvement of the different enterprise and IT roles, a set of process practices, and finally some guidance and reference material [90].

Each domain is named using verbs that indicate the purpose and areas of activity of the objectives they seek to achieve [83]:

The Governance objectives are managed by the **Evaluate, Direct, and Monitor (EDM)** domain group; Its primary goal is to define, implement, and control the strategy's implementation along with the senior management.

The process groups for the management objectives are [80], [90]:

- **Align, Plan and Organize (APO):** in charge of keeping the direction set by IT's mission and vision and, in general, managing IT's portfolio, EA, budget, human resources, etc.
- **Build, Acquire, and Implement (BAI):** it describes the definition, acquisition, implementation, and set in motion of IT initiatives and their correct integration into the business.
- **Deliver, Service, and Support (DSS):** These are the processes in charge of ensuring operation services are delivered to the business and its support.
- **Monitor, Evaluate, and Assess (MEA):** it describes the performance monitoring, conformance, and compliance of TI management processes, services, systems, and operations.

2.5. Business and IT Operations / Processes

2.5.1. Business Processes and Value Chain

The core element at the heart of an organization is the business process. A Business process presents a collection of related events, activities, and decisions involving some actors and resources, which collectively lead to an outcome of value to an organization or its customers. By studying such processes, an organization can identify which activities it performs that differentiate its competition and disaggregate its core business processes and supporting processes.

Business Process Model and Notation (BPMN) is a body of principles, methods, and tools to design, analyze, execute and monitor business processes to support its automation, looking for improvements in efficiency and cost reduction and better control of assets in an organization [64]. The BPMN specification provides a set of graphical elements and an interchange format for organizations to communicate and use such processes consistently.

Processes modeling uses the following elements [64], [93] (see Figure 10):

1. **Flow elements** are elements that define the behavior of the process in the form of *events (*things that can happen that affect the flow), *activities* (the work that the organization is performing), and *gateways* (decision points in the process).
2. **Objects (data)** represent the information produced or consumed by activities (inputs/outputs and stores).
3. **Connection elements** allow the connection of flow elements to each other and objects, thus defining the order and sequence of actions.
4. **Grouping elements** allow grouping elements of modeling to represent the concept of role or responsibility for executing the actions (i.e., actors).

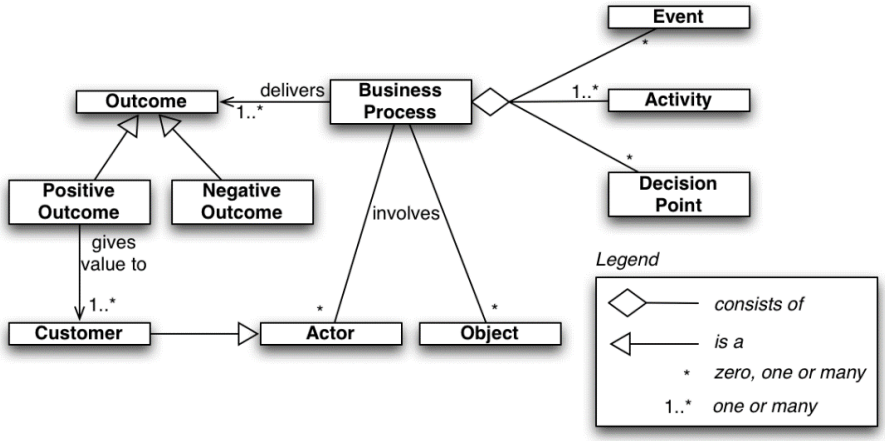


Figure 10 What is a Business Process? Taken from Dumas et al. [93]

A useful model to identify and classify business processes is Porter's Value Chain [94]. This model presents the organization as a set/chain of ordered activities that give value to the organization allowing it to identify leverage elements to improve by using, for instance, technology for supporting such processes. On the other hand, it gives the organization tools to identify and classify its business processes as primary or supporting (see Figure 11). *Primary Activities* are the activities most closely involved in producing and distributing the product or service at the core of its business. It includes the operation, input, and output logistics of assets, marketing, sales, service, and support.

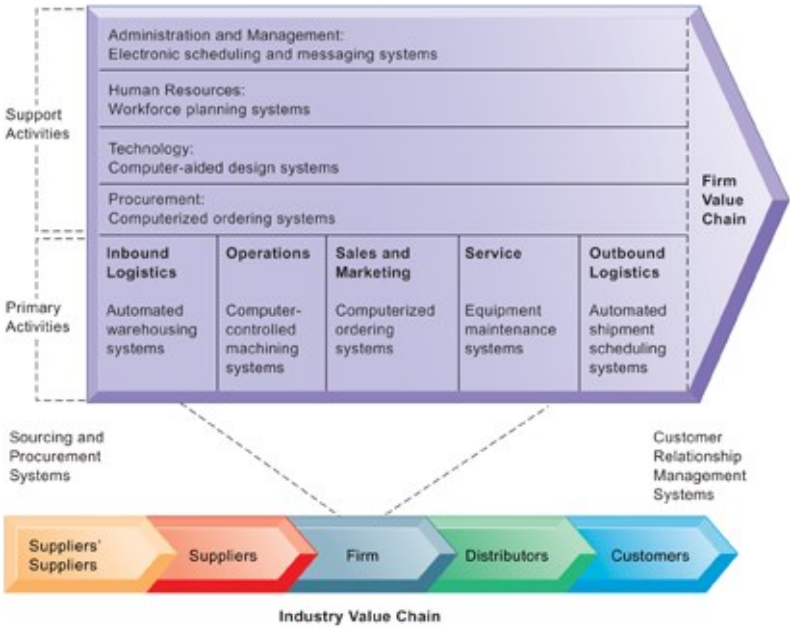


Figure 11 Value Chain. Taken from Laudon et al. [94].

On the other hand, *Support Activities* allow the primary activities to achieve their goals. They cover the administration and management of the infrastructure, human resources, and purchasing (other than assets for the product). Porter's model allows the organization to benchmark itself against competitors, recognize the industry's best practices, and even identify disruptive ways to perform and give new value to its customers.

2.5.2. Information Technology Infrastructure Library – ITILv4

ITIL represents a business process framework to support IT Service Management (ITSM) [31], and its current version is ITILv4, published in 2019 [95]. It describes processes, concepts, and principles for an organization that wishes to improve the business through IT services.

ITIL is maintained by AXELOS, a company founded by the United Kingdom government. AXELOS also supports PRINCE2 [96], a method for project management in competition with the one provided by the Project Management Institute (PMI) PMBok (Project Management body of knowledge) [97] (see section Projects and Initiatives - PMBok – Project Management Body of Knowledge).

From this point on, this section describes ITILv4's main components from the current specification from AXELOS [95].

The basis of ITIL is the concept of *Service Management*, which represents a set of an organization's capabilities that enables and manages value generation for customers (internal or external) in the form of services. *Services* are how an organization creates value (i.e., the perceived benefit or utility) for its customers. Services achieve value through delivering Products, configuring the organization's resources that offer value to the customer. In this context, ITIL considers that to achieve value, it is essential to co-create it through constant collaboration between the organization and its customers, allowing them to participate in the definition of requirements and improvements of the processes.

Products are then described and formalized by a *Service Offering,* a formal definition of a Service, and offered to a target customer group. It can include:

- Goods provided to a customer,
- Access to resources to a customer under certain conditions,
- Service actions to fulfill a customer's need.

Each organizational unit provides and supports its Services, which are pipelined and organized into a *Service Value System* (SVS). The SVS represents the various components (people, business units, business processes, IT, partners, and suppliers) that facilitate value creation.

To analyze and characterize the SVS, ITIL proposes four dimensions. These dimensions must also be analyzed and crossed to enrich the SVS. These dimensions are:

- **Organizations and people:** this dimension seek to comprehend the responsibilities, structure, ways of staffing, and the required competencies of individuals and organizational units; it also includes leadership, management, and cultural styles.
- **Information and technology** describe the knowledge and information created, required, and managed within a service. It specifies the technology that supports the service's information architecture. It includes information exchanges with other services and their quality attributes in the form of information architecture.
- **Partners and suppliers**: this dimension aim at characterizing the relationships with external organizations responsible for any activity that helps produce value for the service (i.e., design, deployment, support, development, or improvement). It also implies the definition of contracts and the separation of responsibilities.
- **Value streams and processes**: its primary purpose is to identify the organization's main activities, sequence, and relationships and how each allows value creation for the customer.

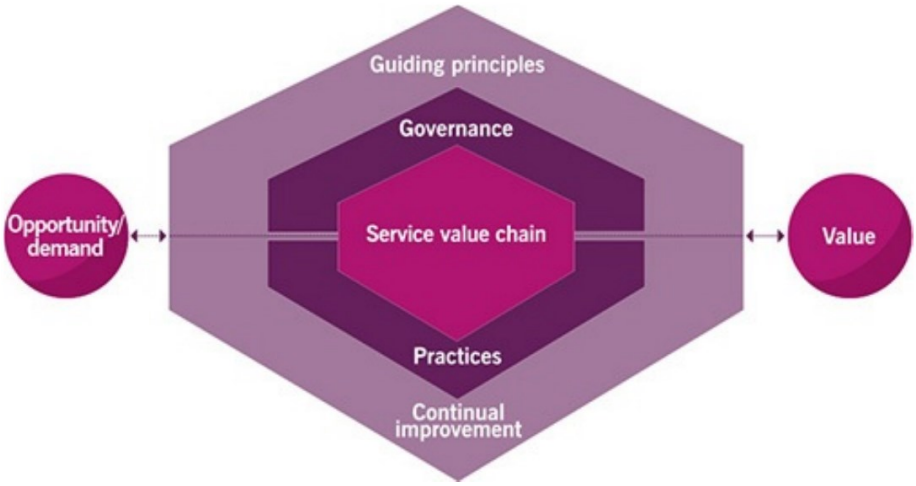


Figure 12 The ITIL service value system [95].

The ITIL Service Value System (SVS) describes a system through its inputs (opportunities/demand), its outputs (value for the customer), and the elements that transform such inputs into outputs.

The components of the SVS are as follows (as seen in Figure 12):

- **Guiding principles**: Recommendations that guide the organization in all circumstances can change over time, along with the organization's motivational elements.
- **Governance**: It depicts how the organization is directed and controlled by its governing body, seeking to achieve the organization's goals through the enforcement of its policies and external regulations. It regularly evaluates and monitors the performance of the organization.
- **Service value chain**: The SVS's central element identifies the core activities required to manage value creation by administering the products and services. It includes the planning and improvement of products and services, the engagement with customers to learn about their value requirements, and the development, implementation, and continual improvement of the services and products.
- **Practices**: it depicts a series of organizational resources used to perform a task or accomplish some goal; some proposed practices are management, architecture service, and technical management.
- **Continual improvement** is the continual organizational activity performed at all levels to ensure that its performance achieves its customers' expected value.

2.6. Projects and Initiatives - PMBok – Project Management Body of Knowledge

The Project Management Institute (PMI) develops the Project Management body of knowledge (PMBok) as a set of generally recognized practices applied in the context of the Project Management profession; it also includes the standard ANSI/PMI 99-001-2017 [97].

From this point on, this section describes PMBok's main elements from the current specification published in 2017 [97].

The central definition in the PMBok is the concept of "***project,***" which is specified as: "…a temporary endeavor was undertaken to create a unique product, service, or result..."; a

project's result can be measured or verified, and aims at achieving a goal for an organization. A project is different from daily operations because it has a beginning and an end. It delivers its result, fulfilling a need for new products or services at the business level in the project's beneficiary organization.

Projects allow the organization to evolve while focusing on the specific elements of the project and then delivering business value (i.e., quantifiable benefit), which can be tangible (e.g., monetary assets, equity, utility) or intangible (e.g., goodwill, brand recognition, strategic alignment). At the end of the process, value is transferred to the organization's operations level (i.e., using the delivered product or service).

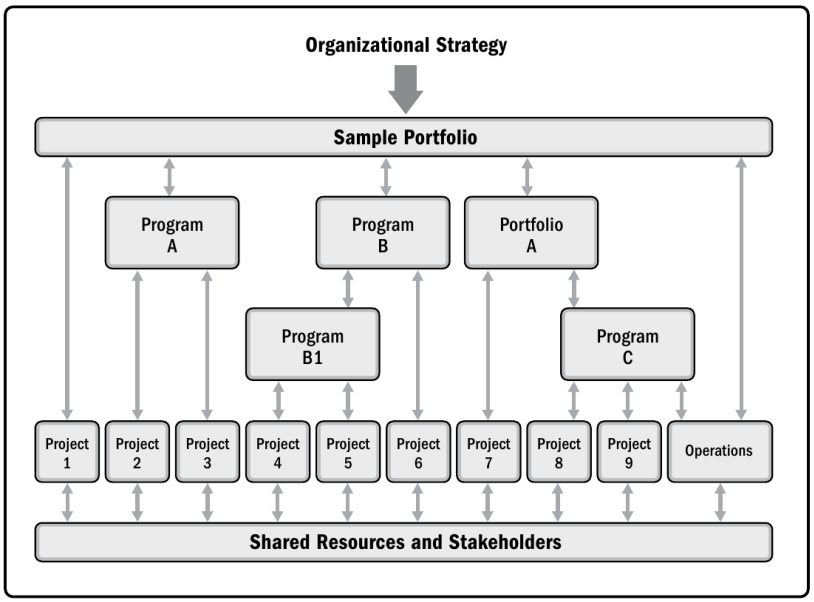


Figure 13 Portfolio, Programs, Projects, and Operations [97].

2.6.1. Project, Program, and Portfolio

Depending on the organization's size, projects are managed through tools and techniques to achieve strategic goals and objectives. As seen in the example in Figure 13, projects can be managed through portfolios or programs; each has its manager, who manages and coordinates the projects under its responsibility. A ***Program*** is defined as managed projects that separately achieve individual goals. However, their sum approaches a more important goal; the program manages and controls related aspects of the projects for optimal use of resources (i.e., do the projects the right way). In that sense, a ***Portfolio*** manages projects and programs and coordinates resources for strategic goal achievement (i.e., doing the right projects and programs for the organization).

2.6.2. Project Life Cycle and Process Groups

A project has a beginning and end; there is a series of *phases* that a project passes to fulfill its goals. Each ***phase*** is a set of activities that achieve an intermediate result or deliverable. A phase is delimited by ***gates*** that allow evaluating the exit criteria of a phase and the entrance criteria of the next (see Figure 14).

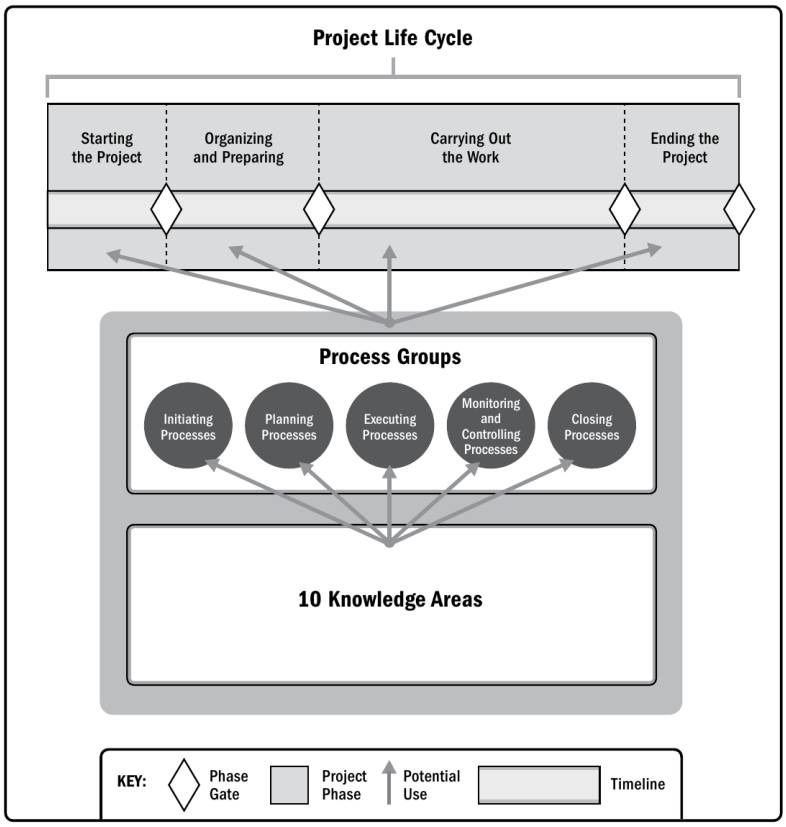


Figure 14 Interrelationship of PMBOK® Guide Key Components in Projects[97]

These phases are managed using a systematic set of activities and acceptable practices, transforming inputs into desired outputs in each phase. To achieve this, PMBok proposes the integrated execution of sets of grouped activities: ***Process Groups***.

Process Groups define inputs, outputs, tools, and techniques applied in any given phase. It includes Initiating, Planning, Executing, Monitoring and Controlling, and Closing, based upon Project Management Knowledge Areas, aiming to attend different perspectives when managing a project.

The PMBok defines the following knowledge areas:

- **Project Integration Management**. Describes the necessary activities to coordinate all the other activities in the project management groups. Support the interrelationships, communication, and consolidation of efforts through the projects' life cycle.
- **Project Scope Management**. Manages the project (i.e., what must be done and only what must be done) by identifying what must not be included.
- **Project Schedule Management**. Manages the calendar and sequence of activities to effectively fulfill the project's completion in the stipulated timeframe.
- **Project Cost Management**. Describes the activities in charge of budget management to ensure that the project's executed budget fits the original estimated budget by the end.
- **Project Quality Management**. The activities are performed to ensure that the quality expectations of the sponsor and beneficiary organization of the project are included within the projects' life cycle. It also embraces managing stakeholders' expectations and ensuring the continuous process improvement of project management activities.

- **Project Resource Management**. Describes the activities required to manage the acquisition of resources required to complete the project. Resources include people, materials, machines, tools to execute the project.
- **Project Communications Management**. Depicts the activities necessary to manage information within the project and its stakeholders' direction to ensure effective communication and the correct diffusion and storage of information.
- **Project Risk Management**. Describes the activities needed to perform risk management (identification, prioritization, analysis, planning, response, and monitoring of risks) to increase the project's success.
- **Project Procurement Management**. Defines the activities required to purchase or acquire products, results, or services outside the project, including managing agreements with external providers.
- **Project Stakeholder Management**. Identifies the activities needed to identify and manage the relationships of people, groups, or organizations that the project could impact or affect.

Other knowledge areas can be applied to the project, the product or service being delivered (e.g., software, telecommunications, food, etc.)

It is recommended that a project management office (PMO) be instituted to standardize project-related processes across the organization, institute governance activities, and encourage improvement activities around the project management processes. The PMO also supports strategic alignment, ensuring value is delivered through the different enacted projects.

2.6.3. Requirements Management

In a recent effort to be consistent with the Project Management and Business Analysis knowledge areas, the PMI published The Requirements Management Guide [98] to give the Project Management Process Group sustenance. The guide seeks to reconcile and give recommendations on the general requirements management processes needed to support any project initiative at any level (portfolio, program, project).

The guide presents a set of standardized and structured activities for developing and managing requirements on a project; activities may occur independently or iteratively as program and project needs dictate. The general description of the activities are (see Figure 15) [98]:

- **Needs assessment** activities are performed in Business Management to identify and specify a current business problem or opportunity at the portfolio level; It can be performed in a program or project to review, update, and confirm decisions.
- **Requirements management planning** is a critical portion of the overall project planning activities in conjunction with the program or project management plan. Planning the requirements activities ensures the program or project's optimal definition of scope, quality attributes, and product management.
- **Requirements elicitation** is the activity performed by the team to draw out information from stakeholders and other sources further to understand the business's needs, restrictions, and product characteristics to address a problem or opportunity and identify the stakeholders' preferences and conditions for the solution address those needs.

- **Requirements analysis** examines, decomposes, and synthesizes the elicited information into an actionable set of items (i.e., requirements) that allows measuring, controlling, and achieving the stated goals and objectives.
- **Requirements monitoring and controlling** is the continuous process that uses the requirements to ensure they are tracked, monitored, and controlled in the product's scope.
- **Solution evaluation** is the process that validates the project's products to be implemented or finished based on the specified requirements.
- **Project or phase closure** ensures that the product, service, or result has been transitioned from development to production/maintenance. Solution evaluation activities are performed on an as-needed basis to ensure the solution continues to meet the needs of the business and continues to deliver the expected value.

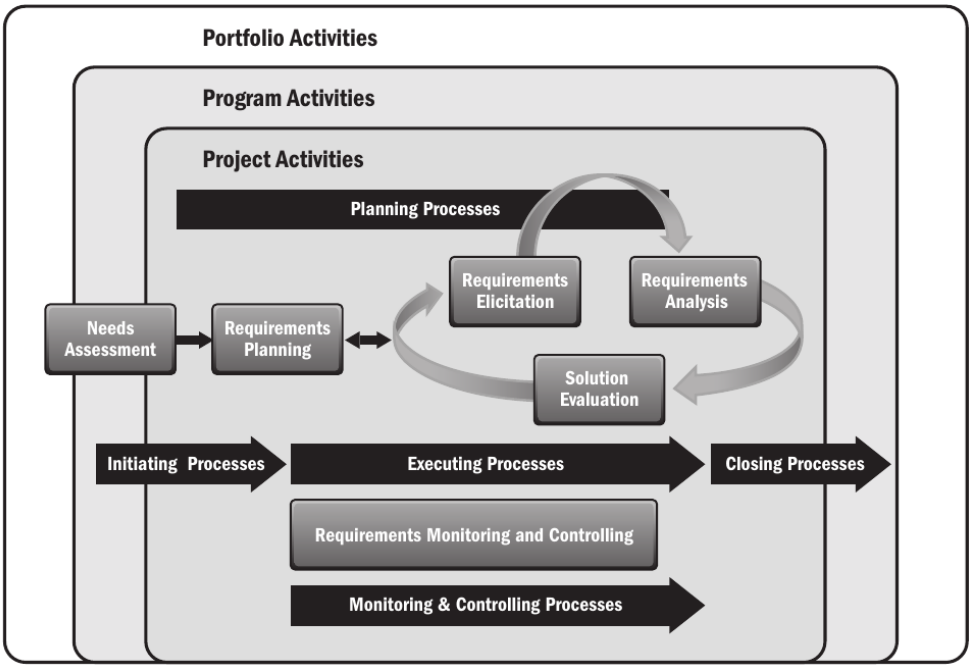


Figure 15 Mapping of the Requirements Process to the Project Management [98]

2.7. Enterprise Architecture

Enterprise Architecture (EA) 's central concept is **architecture**, meaning a system and its parts, relationships, and evolution and design [99]. EA is a set of principles, methods, and models to represent the enterprise with these concepts in mind: Identifying its parts, organizational structure, business processes, information systems, and supporting infrastructure [99] defines the enterprise architecture's concept, function, shape, interfaces, context, and constituent parts [100]. EA aims at modeling all the parts of a business to identify its problem's root causes and support decision-making processes for assigning resources, viability analysis, expense regulation, and alignment of the strategic goals to information systems and IT infrastructures [65]. Implementing and managing EA goes hand in hand with other governance instruments that support it, such as BSC, Business Modeling, ITIL, COBIT, and BPM.

Different EA frameworks depict and provide descriptions of the aspects and detail within an EA; these frameworks present different viewpoints and modeling techniques to create and maintain them. However, they do not contain the actual modeling concepts; to avoid this, they

rely on specific modeling languages (e.g., UML, BPMN, Archimate, SysML). Examples of these frameworks are:

IEEE 1471 – ISO /IEC 42010 2011 Standard [101]: This standard aims to define an architecture, especially for software-intensive systems, information systems, and embedded systems and their relationship with the mission, environment, stakeholders, and their high-level concerns, based on the concept of views and viewpoints.

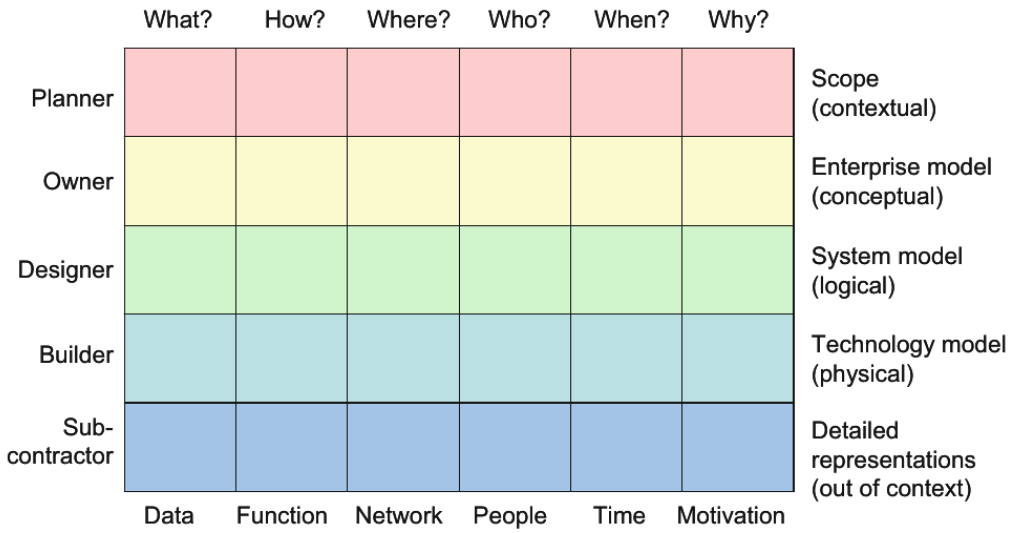


Figure 16 The Zachman framework [99].

The Zachman Framework [99], [102], published in 1987, defines two dimensions. The first is the perspectives of different roles of people involved in the development, use, and maintenance of the architecture (i.e., planner, owner, designer, builder, sub-contractor); the second dimension deals with the 5W+H (what, where, who, when, why and how). Each crossing in the table can be answered by viewpoints that describe the relation. The framework does not present a detailed process or a sequence that explains how to implement it (see Figure 16).

This section presents and details **TOGAF** (The Open Group Architecture Framework) version 9.2 [65] to understand EA's elements, processes, and governance elements.

The concept that supports TOGAF is **Capability**, meaning the organization, processes, skills, roles, responsibilities, and systems that enable the organization to function, give the expected business outputs, and fulfill its business goals.

The main components of the framework are the following [65], [99]:

- **Architecture capability framework:** which treats the governance of the architecture and repository management,
- **Architecture development method (ADM):** describes the phases and sequence of proposed activities to develop an EA (See Figure 17),
- **Architecture content method:** describes the different deliverables and artifacts that compose the architecture through four closely related architectures: business, data, application, and technology infrastructure.
- **Enterprise continuum:** comprises different reference models to illustrate different levels of documentation for the different architectures.

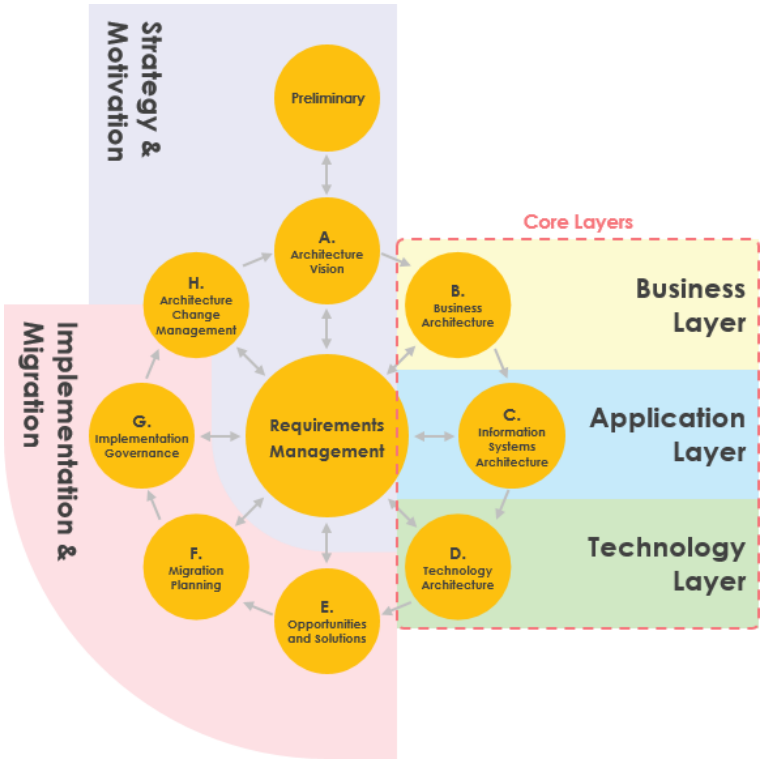


Figure 17 The ADM [103].

The phases of the ADM are the following [65], [104] (see Figure 17):

- **Preliminary**: prepares the organization to develop successful EA projects by defining the governance and support, methods, tools, repository, stakeholders, strategic goals, and ruling principles of the EA.
- **A. Architecture vision**: defines the scope, restrictions, and expectations of the EA and a roadmap for the ADM with resources and budget.
- **B. Business Architecture, C. IS Architecture, D. Technology Architecture**: defines the different architectures to understand the business structure, IS, applications, and technological components. By selecting reference models, viewpoints, and tools. Each architecture defines the baseline (what exists today) and its target (the aspirational architecture) that the ADM wishes to achieve.
- **E. Opportunities and Solutions, F. Migration Planning**: refines a portfolio of projects, schedules, and resources, performing viability analysis of the different projects and implementing a migration strategy to achieve the target.
- **G. Implementation Governance, H. Architecture Change Management**: prioritizes the changes' deployment and updates the baseline architecture accordingly.
- **Requirements Management**: This is a continuous process for managing the requirements and stakeholders' concerns through the ADM cycle. This general process can be performed using recommendations from the requirements engineering knowledge area and the PMI's requirements management practice [98].

The ADM is a continuous process that, in the final stages, delivers initiatives and projects that must be developed. Its results are later integrated into the organization's daily operation, usually under IT management and governance, with direct coordination with the central government.

Chapter 3. Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL)

3.1. Goal-Oriented Requirements Engineering

As Information Systems become more complicated in coverage, amount of data, processing transactions, and a high level of intertwining with the social/human environment; the techniques used to analyze and design such systems also became more complex—giving rise to models that reflect the system's social characteristics and the influences of people, organizations, and other systems.

Goal-Oriented Requirements Engineering (GORE) has risen to help model and understand socio-technical systems and model the complex relationships between stakeholders and significantly help them understand the "why" of such needs and not only the "what "or "how" of traditional software and systems modeling [105].

Goals in requirements engineering improve the requirements analysis phase by using languages to define the system requirements. GORE modeling centers its efforts on graphically identifying agents (people, organizations, systems) and their goals, dependencies, and relationships between agents and goals, allowing to analyze different solutions or possibilities to achieve goals, permitting verification, and decide upon goal satisfaction [106].

3.1.1. iStar (i*)

The iStar modeling framework [49], first proposed by Yu and Mylopoulos, introduces social modeling and reasoning (why, how, who) into information system engineering methods, especially at the requirements level. iStar origins can be traced to the non-functional requirements (NFR) framework [107], [108]; this framework represents and analyzes non-functional requirements; an NFR is represented as a *softgoal*, which in turn represents a goal with no precise definition or criteria as to whether is satisfied or not. Softgoals relate to each other. Such relationships are depicted as influences on the other softgoals (i.e., affecting positively or negatively the achievement of a given goal); NFR is decomposed into finer grain softgoals representing possible operationalizations (design alternatives) of NFRs. The framework introduces a qualitative method of analysis for deciding the status of softgoals, breaking them down into softgoals, and including possible implementation alternatives that hurt or help achieve them [108], this allows the user of the model to rationalize the alternatives for the development of the system having the NFR as a starting point.

iStar has been proved helpful for requirements engineering, agent-oriented modeling, business process reengineering, organizational impact analysis, and model-driven development. Since its initial development, iStar has been improved and widely adopted. It has given rise to new extensions for new uses, such as Tropos [109], to model multiagent systems, and many others, as reported recently by Gonçalves et al. [110]. On the other hand, the academic community in the year 2016 published the official iStar 2.0 guide [37] to standardize and upgrade the language's uses and grammar.

3.2. Goal-Oriented Requirements Language (GRL)

In early 2000 the International Telecommunication Union (ITU-T), led by Dr. Daniel Amyot, developed the User Requirements Notation (URN) standard z.150 and z.151 [38], [111]. URN is intended for elicitation, analysis, specification, and validation of requirements. It combines two separate views: the goal view using a language called GRL (Goal requirements language) and the scenarios view using a language called UCM (Use case map) notation [112].

For our case, and because of this project's scope, we focus our work on GRL; In particular, GRL is a variant of iStar and the NFR framework with some differences, which we will explain further in the section.

As explained previously, the central element in these languages is the concept of **goal** (i.e., a high-level objective of the business, organization, or system); in that sense, **requirements** (software, system) specifies how a goal can/should be accomplished by a proposed system [38]. GRL aims to do through decomposition (i.e., subdividing) of goals into fine-grain elements to better understand and define requirements by storing and managing the **rationale** behind the decisions. Rationale elements include addressed issues, alternatives considered, decisions made to resolve the issues, and criteria used to guide decisions.

3.2.1. GRL Overview

From this point on, this section's literature sources are the standard z.150 [38], z.151 [111], slides from the *software requirements* class provided by Dr. Daniel Amyot from the University of Ottawa [113], and the iStar guide [37], which provides some recommendations on the use of the GRL language. GRL provides a graphical and textual notation; it allows connecting requirements to business objectives for reasoning about (non-functional) requirements. GRL is based on iStar (concepts/syntax) and the NFR framework (evaluation mechanism); it additionally provides the use of indicators, strategies, and extension mechanisms [111].

GRL models the "why" aspect of the model's goals and other intentional concepts with little or no operational details and supports goal and trade-off analysis and evaluations through a set of algorithms (qualitative, quantitative, and mixed).

The central element of social modeling are **actors**; they are the active entities that aim to achieve or satisfy goals by applying their knowledge to tasks, using resources, and collaborating with other actors. An actor defines stakeholders or systems and is represented as a circle with containable elements (knowledge and intentions) (See Figure 18). Knowledge and **intentions** of actors are represented by **goals**, **softgoals**, **tasks**, **resources,** and **beliefs**. Additionally, GRL provides a mechanism to assess, compare, and reason using **indicators**, which are real-world measurements for a more accurate assessment of goal satisfaction. Finally, **links** connect elements in the model. There are different links for structural and intentional relationships (**decompositions**, **contributions**, and **dependencies**) [111].

GRL uses these intentional elements to define strategies to analyze options and trade-offs among stakeholders and their often-conflicting goals. Strategies are defined as a set of intentional elements, and indicators are given an initial real-world satisfaction value. Those values are then propagated to other elements in the graph through their connecting links, allowing them to assess the proposed strategy and the stakeholder's goals' satisfiability (i.e., one possible solution to be compared with others) [111].

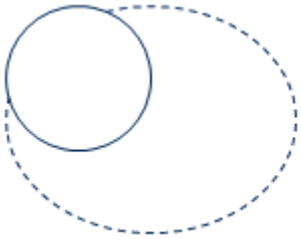


Figure 18 Actor with boundary [111].

An actor is evaluated based on its intentional elements, associated indicators, and importance within the model. The importance value is an integer assigned (from 0 to 100). A value of 0 means that the actor is not essential to the overall GRL model. In contrast, a value of 100 means that the actor is highly important; on the other hand, it can also be assigned using qualitative values: **none**, **high**, **medium**, and **low**. Only the relevant importance attribute is considered, depending on the type of evaluation used (i.e., qualitative, quantitative) (See Figure 19, which presents two actors, one with an importance qualitative value of (H) **high** and another with a quantitative one of **80**) [111].

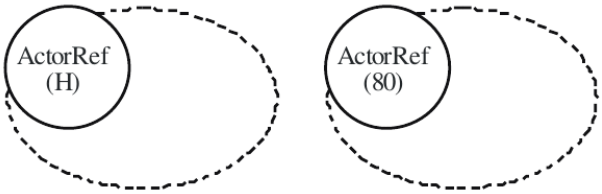


Figure 19 GRL actor with importance values (qualitative left and quantitative right) [111].

3.2.2. Intentional elements

In GRL, intentional elements are containable elements used to answer why such elements were chosen, characterize alternatives, and define the criteria used to discuss the alternatives and the reasons for choosing one strategy over another.

Intentional elements may be included within actors' definitions, and they can be linked to each other. There are different types of intentional elements specified, and intentional elements can be decomposed and given (as actors) a quantitative or qualitative importance level. An Intentional element describes an intention or capability and describes part of an actor's intentions or capabilities when it is contained within an actor.

An intentional element can be (See Figure 20 and Figure 21) [111]:

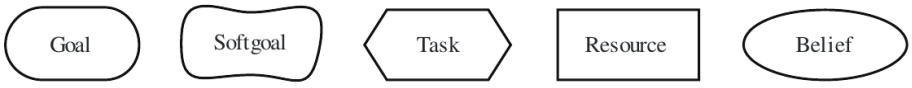


Figure 20 GRL Intentional element types [111].

- A **(hard) Goal** is a condition or state of matters that the stakeholders would like to achieve (within the scope of the modeled system or problem). It can express a business, system, or individual wishes to achieve and describe a target information system's functional requirements. It is expected to be **achievable** and **measurable**.
- A **Softgoal** is a condition or state of matters within the modeled system's scope or problem that the actor would like to achieve. However, in contrast with a (hard) goal, there are no clear-cut (objective) criteria for whether it is achieved or not. In

information systems design, softgoals are used to describe qualities and non-functional requirements.

- A **Task** specifies a particular way of doing something. Tasks are, in essence, actions that solve or operationalize the goals and softgoals. Tasks can be decomposed into fine-grain tasks to represent actions and restrictions on achieving the high-level task. In developing an information system, tasks may include operations, processes, data, constraints, and agents in the target system to achieve the goals and softgoals.
- A **Resource** is a physical or informational entity consumed and used to perform a task. The main concern is whether the resource is or is not available.
- A **Belief** is used to represent a restriction or design rationale. These elements allow for domain characteristics to be considered and be reflected appropriately in the decision-making process; Allowing for the reviewing, justification, and change of the system and enhancing traceability of the decisions (this element is not present in the iStar 2.0 language guide [37]).
- An **indicator** includes current observable data values into the GRL model against a target, threshold, and worst value parameters. It outputs a satisfaction level that can be propagated to goals, softgoals, tasks, and resources in the rest of the model but **cannot be decomposed or receive contributions**. They can be used (1) at design time via GRL evaluation strategies or external data sources and (2) at runtime using monitoring sensors and real-time data [114]. In sections Arithmetic Semantics of GRL Models and Algorithms for GRL Evaluation of Strategies, Indicators will be discussed deeply.

Figure 21 GRL Examples of intentional elements [111].

Figure 21 presents examples of the various intentional elements described previously [111]:

- "Voice Connection Be Setup" is defined as a (hard) goal because it can be achieved and measured entirely.
- "High Reliability" is defined as a softgoal because this can never be entirely achieved or, in some cases, measured (but can be perceived as sufficiently achieved).
- "Make Voice Connection Over Wireless" is defined as a task because this is a particular way of setting up a connection; a similar task could be "Make voice connection over the Internet," representing a different way of achieving the goal. With an importance value of 0 – is not shown in the figure.
- "Internet Connection" is a resource because it is a physical entity that can be available or not to perform a task.
- "Wireless is less reliable than the Internet" is defined as a belief because it provides a rationale for some design decisions.

Figure 22 shows an example of an actor (Telecom provider) with two intentional elements: one goal (Voice connection be setup) with an importance value of 50 and a task (Make voice connection over wireless).

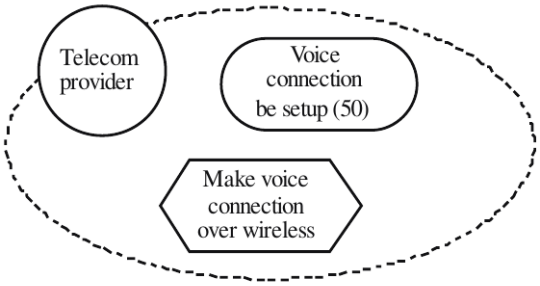


Figure 22 GRL actor contains a goal and a task [111].

3.2.3. Links

A link realizes an intentional relationship that connects an actor, intentional element, or indicator to another actor, intentional element, or indicator. GRL characterizes and enriches such links using various notational elements that will later evaluate the GRL model.

Contribution and Correlation Links

Contribution links represent how an intentional element affects/contributes to a destination's satisfaction (as a restriction, the destination of a contribution link shall not be of the type *resource*, *belief*, or *indicator*). The **destination must be a soft goal** since there is no clear-cut concern to achieve it, unlike goals, tasks, and resources. A **correlation link** is the same as a contribution link, except that the correlation is a side-effect (represented as a dashed line).

A source element's contribution has various degrees or levels of impact on the destination element's satisfaction. The contribution is used to evaluate the goal model depending on the selected evaluation type (qualitative or quantitative).

Valid qualitative contribution levels are: **Make**, **Help**, **SomePositive**, **Unknown**, **SomeNegative**, **Hurt**, **Break**. Figure 23 shows the icons used when annotating GRL contribution/correlation links depending on their qualitative contribution.

Figure 23 GRL contribution type [111].

The contribution of a source can be either positive or negative and with intermediate degrees (The contribution can be sufficient to the satisfaction of the destination) [111]:

- "**Make**: The contribution is positive and sufficient.
- **Help**: The contribution is positive but not sufficient.
- **SomePositive**: The contribution is positive, but the extent of the contribution is unknown.
- **Unknown**: There is some contribution, but the extent and the degree (positive or negative) of the contribution are unknown.
- **SomeNegative**: The contribution is negative, but the extent of the contribution is unknown.
- **Break**: The contribution of the contributing element is negative and sufficient.
- **Hurt**: The contribution is negative but not sufficient."

A contribution without a contribution type indicates an Unknown contribution.

A quantitative contribution can be a value in [-100..100], where (100) corresponds to *Make* and (-100) to *Hurt*.

Contributions are represented as labels/icons beside the arrowhead (destiny of the link) depending on the type of analysis to be performed (quantitative/qualitative analysis) (See Figure 24).

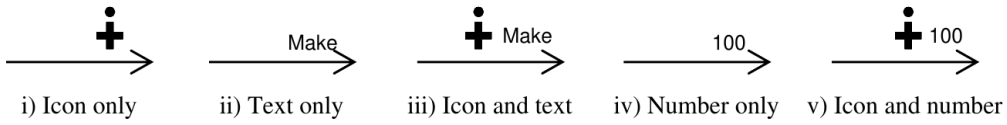


Figure 24 GRL contribution links with contribution values [111].

Figure 25 presents a GRL diagram, including three contributions and two correlations [111]:

- "… **Make Voice Connection Over Wireless** has a **positive and sufficient** *contribution* on **High Reliability**.
- **Make Voice Connection Over the Internet** has **some positive** *contribution* on **High Reliability**.
- **Wireless is less reliable than the Internet** has **some negative** *contribution* on **High Reliability**.
- **Make Voice Connection Over Wireless** has **some negative** *correlation* (side-effect) on **Minimize Spectrum Usage**.
- **Make Voice Connection Over the Internet** has **some positive** *correlation* (side-effect) on **Minimize Spectrum Usage**…."

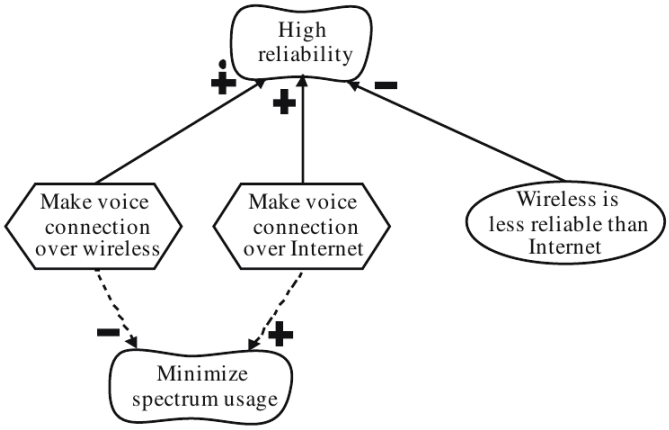


Figure 25 GRL contributions and correlations [111].

Decomposition Link

Decomposition links define different **source intentional elements** that need to be satisfied/available so that an **intentional target element (goal or task)** can be satisfied. i.e., a target is decomposed into **tasks** that **must be performed**, **goals to be achieved**, **softgoals** that **must be satisfied**, and **resources** that **must be available** to achieve the target. **A target can be decomposed by only one decomposition type (AND, XOR, IOR**) [111].

An **AND** decomposition type indicates that all the source intentional elements are necessary for a target intentional element to be satisfied.

An **XOR** decomposition type indicates that one and only one of the source elements must be satisfied for a target to be satisfied. This type of decomposition allows for the definition of

alternative means to achieve the target. Figure 26 shows two valid representations of XOR decompositions (both mean the same).

An **IOR** decomposition type indicates that for a target to be satisfied, it is sufficient that one of the source elements is satisfied.

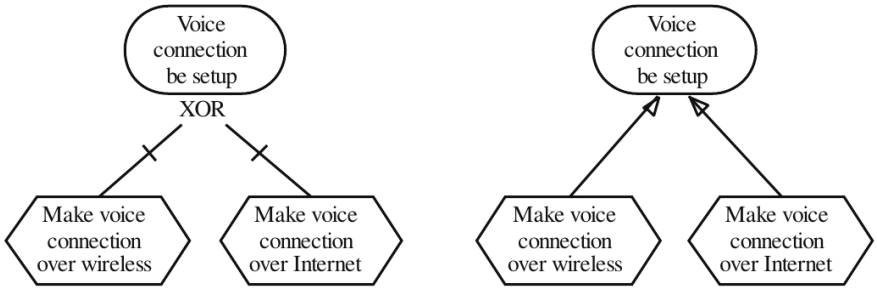


Figure 26 XOR decomposition: normal (left) and means-end (right) presentations [111].

Figure 27 presents four examples of decomposition links: "…The first refinement (leftmost) shows a goal decomposed into two necessary sub-goals (AND-refinement) to achieve the parent. The second refinement shows alternatives (OR-refinement): to book a trip, either the parts are booked, a bundle is booked, **or both** alternatives are chosen; while the former sub-element is a sub-state of affairs to achieve (a goal), the latter sub-element is a concrete set of actions to execute (a task). The third refinement exemplifies the existence of a single alternative. The fourth refinement shows the uncovering of goals while analyzing tasks: the goal "Details validated" is in the model because it is a goal achieved after performing the task "Process form "…" [37].

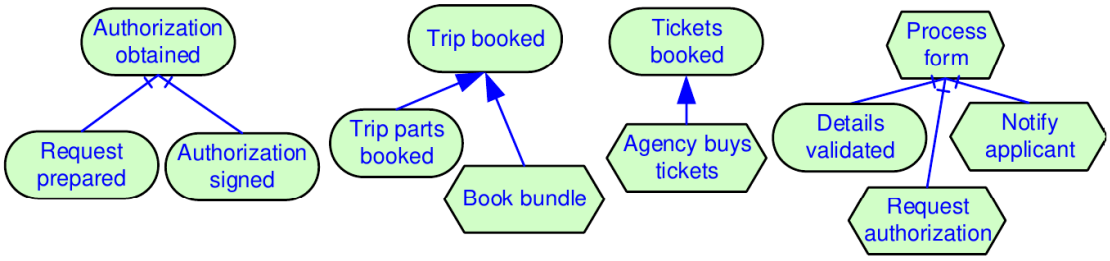


Figure 27 Examples of contribution links [37].

Finally, Table 4 presents the types of links between intentional elements.

		Link ends – Arrowhead pointing to (target)			
		Goal	***Softgoal***	***Task***	***Resource***
Link starts from (source)	***Goal***	Decomposition	Contribution	Decomposition	N/A
	Softgoal	Contribution	Contribution	Contribution	Contribution
	Task	Decomposition	Contribution	Decomposition	N/A
	Resource	N/A	Contribution	Decomposition	N/A

Table 4 Links between intentional elements: an overview. Adapted from [37].

Dependency Link

Dependency links are designed to show intentional dependencies between actors, i.e., how an actor depends on another to achieve its goals. A dependency link has three elements [37]:

1. A **Dependee**: the actor who provides and achieves the definition of the intentional element or indicator (i.e., specifies how to satisfy the dependum),

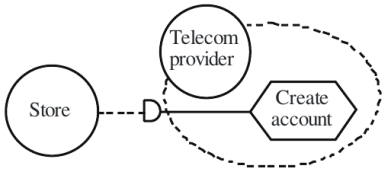
2. A **Depender**: the actor who depends on another actor to achieve something (intentional aspect),
3. A **Dependum**: the intentional element which is the center of the dependency relationship.

Dependency links can also be understood by identifying three elements: the **WHY**, which is inside the **depender**, the **HOW,** which is the responsibility of the **dependee,** and the **WHAT**, which is outside both actors, i.e., the **dependum**.

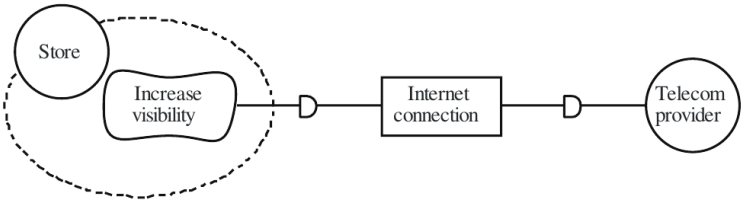
In both iStar and GRL, dependencies can be expressed in more generic ways, but they are not recommended if the final intent is to evaluate the model [111]. According to the GRL Standard, there can be different configurations. See Figure 28 for an example of each (D1 and D2 represent different instances of dependency, i.e., D1 depender to dependum and D2 dependum to dependee):

1. **Configuration 1** (Depender – D1→ What – D2→ Dependee): **Depender** depends on **Dependee** for **WHAT** (the dependum). The **HOW** and **WHY** are inside the actors and are unknown at the moment. Example: "…The **Store** depends on the **Telecom Provider** to provide an **Internet Connection…**" [111].
2. **Configuration 2** (Depender – D1→ How): **Depender** depends on **Dependee** for **HOW** (e.g., a task or a subgoal). The **Dependum** and **WHY** are unknown at the moment. Example: "…The **Store** depends on the **Telecom Provider** to **create an account**, and the dependum and why it is required are both unknown…" [111].
3. **Configuration 3** (Why – D1→ What – D2→Dependee): **WHY** in the **Depender** depends on **Dependee,** for **WHAT** (dependum); **HOW** is unknown at the moment. Example: "…To **increase its visibility**, the **Store** depends on the **Telecom Provider** to provide an **Internet Connection** …" [111].
4. **Configuration 4** (Why – D1→ How): **WHY** in **Depender** depends on **Dependee** for **HOW;** The **dependum** is unknown. Example: "…To **increase its visibility**, the **Store** depends on the **Telecom Provider** to **create an account** …" [111], **WHAT** is unknown.
5. **Configuration 5** (Depender – D1→Dependee): **Depender** depends on **Dependee**. **WHAT** (dependum), **HOW,** and **WHY** are unknown at the moment. Example: "…The **Store** depends on the **Telecom Provider…"** [111].
6. **Configuration 6** (Why – D1→What – D2→How): **WHY** in **Depender** depends on **HOW** in **Dependee** for **WHAT** (the dependum). Example: "…To **increase its visibility**, the **Store** depends on the **Telecom Provider** to provide an **Internet Connection** by **creating an account**…" [111]. This representation is the most complete and recommended to evaluate the model.

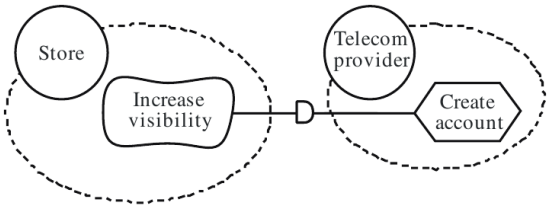
GRL dependencies (configuration 1)



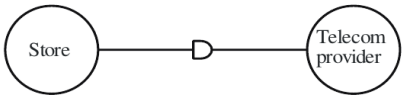
GRL dependencies (configuration 2)



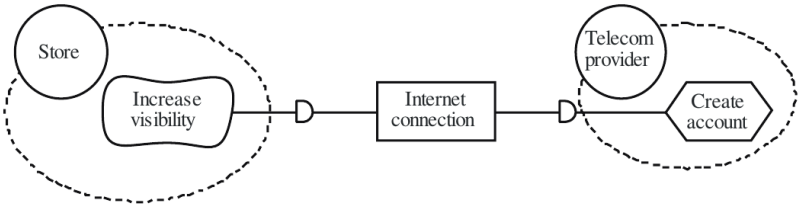
GRL dependencies (configuration 3)



GRL dependencies (configuration 4)



GRL dependencies (configuration 5)



GRL dependencies (configuration 6)

Figure 28 GRL Dependencies. Different possible configurations [111].

GRL and iStar discriminate four types of dependencies accordingly to the **WHAT** (the type of dependum). The dependum specializes in the semantics (meaning) of the dependency relationship [37]:

- Goal dependency: the **dependee** is free to choose how to achieve the goal.

- Softgoal dependency: the **dependee** is free to choose how to satisfy the softgoal sufficiently.
- Resource dependency: the **dependee** is expected to make the **resource** available to the **depender.**
- Task dependency: the **dependee** is expected to **execute the task** in a particular way.

In other words, different dependum types indicate a different degree of freedom for the dependee: i.e., goals and softgoals are less restrictive than tasks and resources.

3.2.4. Strategies

The initial way of characterizing actors and their needs can be represented in a recurring GRL pattern: *As an **[Actor],** I want to **[task]** in order to **[contribution]** achieve **[goal].*** For example, Figure 29 represents the following: *As a **professor**, I want to **use Moodle** to **help minimize the number of lost assignments**.*

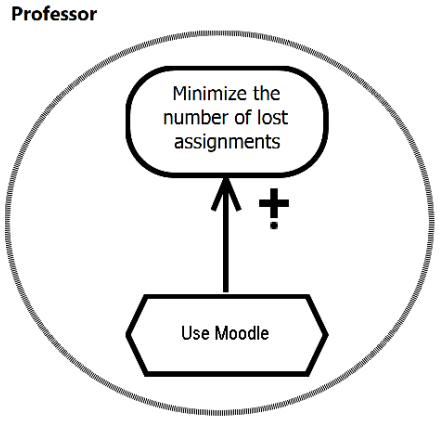


Figure 29 Example of a user story, adapted from Amyot's material.

In general, GRL models present a recurring pattern: the **System** (actor) being developed has several functional **goals**, with various alternative ways of achieving them by executing specific **tasks**. There are several **stakeholders** (actors) involved, with their **concerns** often non-functional (captured with **softgoals**) and goals to be achieved with the **help** or **influence** of the system (See Figure 30).

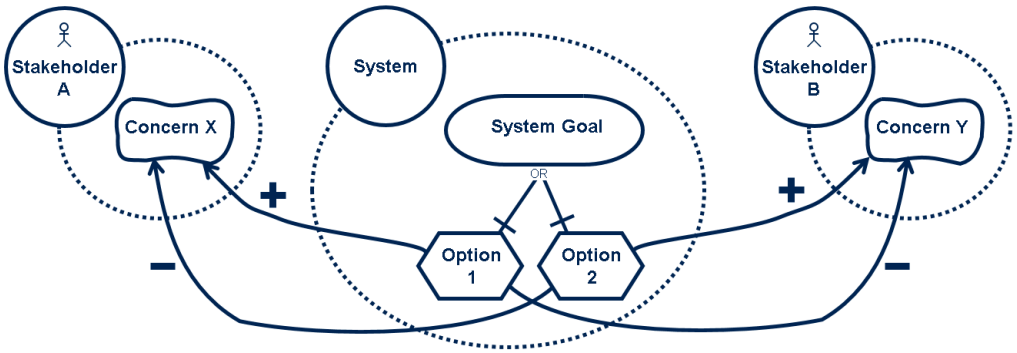


Figure 30 A typical GRL model. From Amyot's material.

GRL allows for initial satisfaction values to be set for some intentional elements or indicators defined in (what GRL calls) a **Strategy** (which corresponds to one possible solution). These strategies can be compared, allowing trade-off analysis of the alternatives by propagating satisfaction levels to the other intentional elements and the actors, showing the impact of the

proposed solution (strategy) on high-level goals (and softgoals) for each actor. Usually, the propagation starts at the bottom (leaf) elements of the model and propagates to the top-most ones (usually goals) [111].

Indicators use real-world measures; they can be quantitative or qualitative. As with the other intentional elements, their satisfaction levels can be propagated to other intentional elements through the different decomposition, contribution, and dependency links connecting them. The evaluation takes into consideration:

- Initial satisfaction levels of leaves in the graph (intentional elements),
- links, types of links, and contribution/decomposition types,
- Importance value is defined for intentional elements.

Finally, Figure 31 presents a typical GRL model with most of the elements we discussed in previous sections. The model presents two actors (*Administration leaders* and *System*); the System's goal is to *provide patient info*. It has two alternatives: the *Voice Recording System (VRS)* or the *On paper task*, which is decomposed into three subtasks. The *Administration Leaders* (actor) seeks to fulfill one goal (*Shift to paperless documentation*) and three softgoals (*Minimize cost*, *maximize privacy and security,* and *better use of resources*). The System actor operationalizes the *Administration leaders*' goals.

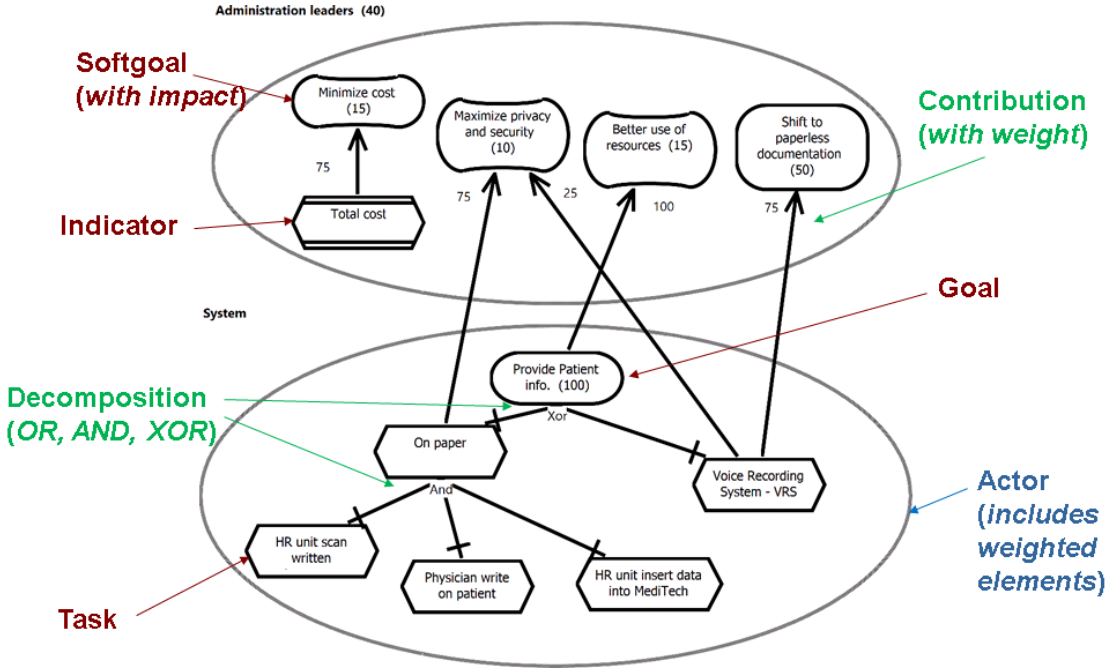


Figure 31 Example of a GRL model. From Amyot's material.

3.2.5. Arithmetic Semantics of GRL Models

As explained before, GRL models include three elements [114]:

- **Actors** are composed of intentional elements, which aggregate to the evaluation of the satisfaction value (v) of the actor; It also contains an importance value (depicted as an integer value within brackets below the actor's name), which is also used when computing the whole model's satisfaction value,
- **Intentional elements** (goals, softgoals, tasks, resources, and indicators) have a satisfaction value (v) calculated at runtime based on a selected GRL strategy. They also

have an importance value, which represents the element's weight when performing the computation of the satisfaction value of their containing actor (depicted as an integer value within brackets below the intentional element's name),

- **Intentional links** relate intentional elements and actors and propagate the satisfaction values within the model.

Indicators

As explained previously, **indicators** capture real-world values (i.e., key process indicators - KPIs). When the model is evaluated, it can be converted to qualitative or quantitative values that can be propagated during the model's evaluation. An indicator within an actor means that the indicator's definition belongs to the actor and consequently describes an actor-specific measurement [111]. An indicator can be characterized as follows:

- An **evaluation value:** observed or simulated in a what-if strategy,
- a **target value:** the KPI is fully satisfied if the evaluation value reaches it,
- a **worst-case value:** the KPI is fully denied if the evaluation value reaches it,
- a **threshold value:** the KPI is neutral if the evaluation value equals it,
- a **unit** of measure (e.g., $, kg).

Within the GRL model, an indicator is represented by an integer value (i.e., if decimal points are required to represent the indicator, the measurement unit must be adjusted). For example, if a real-world value is $1.15, the indicator must be set to 115, and the unit of measure will be cents and not dollars [111]. Figure 32 shows a task (with an importance value of 100) and an indicator (with an importance value of 40) contained within a "Telecom Provider" actor. The indicator is connected to the task with a Contribution link (with a contribution of 100). The indicator also has a Dependency link with a task within the "Technician" actor [111].

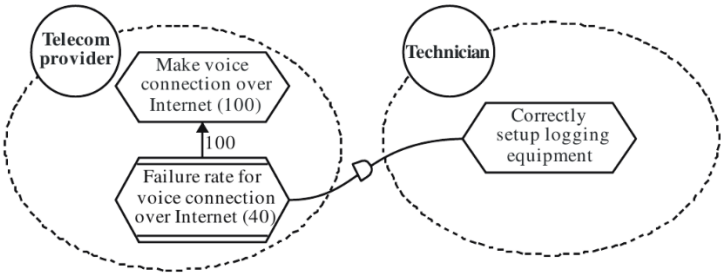


Figure 32 Example of a GRL model with an indicator [111].

An indicator can also be measured in quantitative terms. Depending on the type of measure used, it will be used for the evaluation. Real-world values are converted to quantitative real-world values into quantitative and qualitative GRL evaluation values based on linear intrapolation. The linear conversion requires three values to be set: a **target**, a **threshold**, and the **worst value**. Those values are mapped to the evaluation values with ranges [-100,100] like this: target value to 100, worst value to -100, and threshold value to 0. Thus, when a real-world value R is captured and falls within the **target** and the **threshold**, it gets intrapolated to the range [0..100] using the following formula [111]:

$$\frac{\text{R} - \text{Threshold Value}}{\text{Target Value} - \text{Threshold Value}} \times 100 \qquad (1)$$

If the real-world value R falls between the **threshold** and the **worst** value is intrapolated to the range [–100, 0] using the formula [111]:

$$\frac{\text{R – Threshold Value}}{\text{Worst Value – Threshold Value}} \times (-100) \quad (2)$$

If the **target** is the same as the **threshold** or the **worst** is the same as the **threshold**, then the conversion result is the evaluation value of 0. Suppose R is outside the range [targetValue, worstValue]. In that case, it is evaluated like this: If R is beyond the **target**, the evaluation value will be 100. If R is beyond the **worst** value, the conversion result is the evaluation value of –100 [111] (see Figure 33).

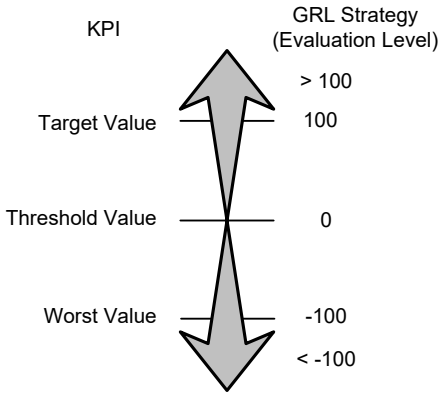


Figure 33 Linear intrapolation. From Amyot's material.

For the purpose of evaluation when the **target** value is higher than its **worst** value, to assess the satisfaction of the indicator, the equation will be (C represents the **current** value, T the **target**, TH the **threshold**, and W the **worst** value):

$$v(I) = \begin{cases} 100 & if\ C \geq T \\ 0 & if\ C \leq W \\ abs\left(\frac{C-TH}{T-TH}\right) \times 50 + 50 & if\ TH \leq C < T \\ -abs\left(\frac{C-TH}{W-TH}\right) \times 50 + 50 & if\ W < C < TH \end{cases} \quad (3)$$

On the other hand, when the **target** value is less than the **worst** value, to assess the satisfaction of the indicator, the equation will be:

$$v(I) = \begin{cases} 100 & if\ C \leq T \\ 0 & if\ C \geq W \\ abs\left(\frac{C-TH}{TH-T}\right) \times 50 + 50 & if\ T < C \leq TH \\ -abs\left(\frac{C-TH}{TH-W}\right) \times 50 + 50 & if\ TH < C < W \end{cases} \quad (4)$$

Figure 34 shows an example where the **worst** real-world value is 80, the **threshold** is 40, and the **target** is 20. The assignments are like this: the **worst** value intrapolates to -100, the **target** to 100, and the **threshold** to 0. In the example, the R-value captured was 60; it gets intrapolated to 40.

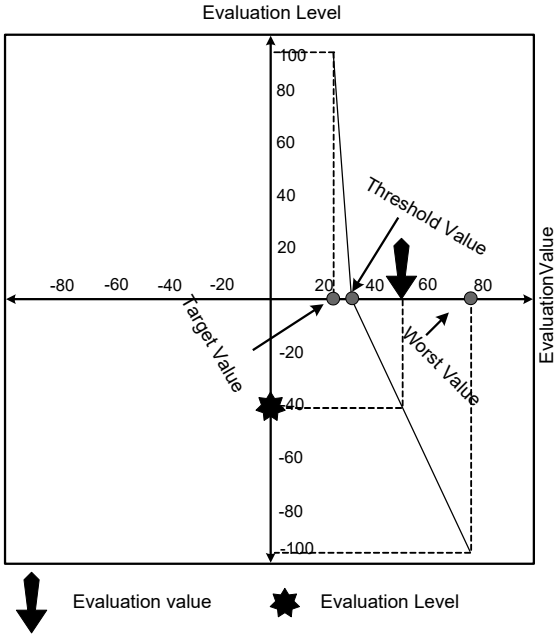


Figure 34 Example of GRL intrapolation. From Amyot's material.

As explained before, the quantitative evaluation value is represented by values in the rank [-100..100]; this value can also be transformed into a qualitative value (see Table 5) to propagate through the GRL model upwards.

Quantitative value	***Qualitative Value***
-100	Denied
(-100,0)	Weakly denied
0	None
(0,100)	Weakly satisfied
100	satisfied

Table 5 GRL mapping between qualitative to quantitative evaluation values [111].

Satisfaction Values

When a strategy is being evaluated and depending on the type of evaluation performed (qualitative or quantitative), GRL uses icons or an integer value [-100..100] to annotate the actor/intentional element's satisfaction.

The qualitative labels based on the degree of satisfaction can be [111]:

- "**Denied**: The intentional element or indicator is sufficiently dissatisfied,
- **Weakly Denied**: The intentional element or indicator is partially dissatisfied,
- **Weakly Satisfied**: The intentional element or indicator is partially satisfied,
- **Satisfied**: The intentional element or indicator is sufficiently satisfied,
- **Conflict**: There are arguments strongly in favor and strongly against the satisfaction of the intentional element or indicator,
- **Unknown**: The satisfaction level of the intentional element or indicator is unknown,
- **None**: The intentional element or indicator is neither satisfied nor dissatisfied."

Figure 36 shows the associated icon with its corresponding label. Figure 37 shows actors with different satisfaction values (qualitative/quantitative).

Figure 35 GRL qualitative labels [111].

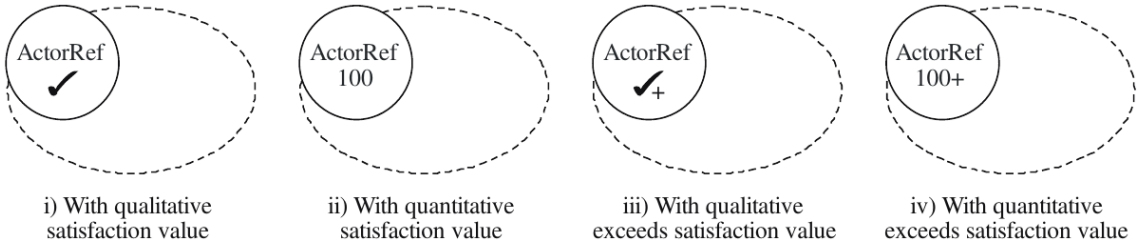


Figure 36 GRL actors with satisfaction value [111].

When a GRL model is evaluated, it can show both the reference symbol and the current evaluation value of the referenced intentional element or indicator definition (see Figure 37).

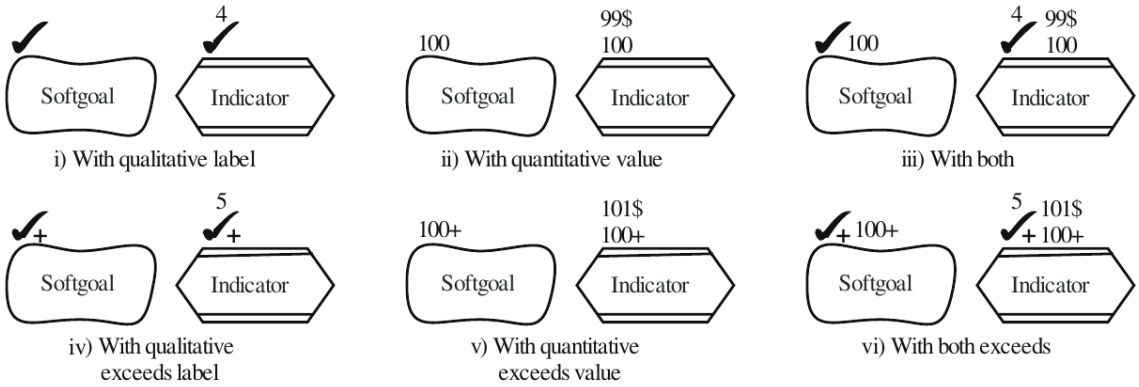


Figure 37 Intentional elements and indicators with satisfaction values [111].

As seen in Figure 37, depending on the type of analysis performed, GRL can use a qualitative label icon (i) and (iv), a quantitative integer value (ii) and (v), or both (iii) and (vi) to annotate the intentional element. An additional (+) symbol (iv), (v), and (vi) indicates that the satisfaction value exceeds the target. Also, for indicators, the real-world value and measuring unit can be included in the model above the other symbols [111]. In the example, (i) and (iv) represent a Likert scale value (4 - Satisfies and 5 -Exceeds, respectively); (ii) and (iii) represent a quantitative value with money ($) as a measuring unit [111].

Quantitative Arithmetic of Links

The different types of links that connect intentional elements (contribution, decomposition, and dependency) allow for the computation of the satisfaction value (qualitative or quantitative) of other intentional elements, actors, and the model.

Every strategy starts by defining an initial quantitative satisfaction value for intentional leaf elements (Satisfaction is evaluated over [0...100]). Those values are then propagated upwards to the other intentional elements; the satisfaction value of the source $(v(S))$ is a function of the destination $(v(D_x))$. Figure 38 show the different types of links: (i) AND and OR, (ii) decomposition, (iii) contribution, and (iv) dependency; where (S) are source intentional elements and (D_x) are destination intentional elements.

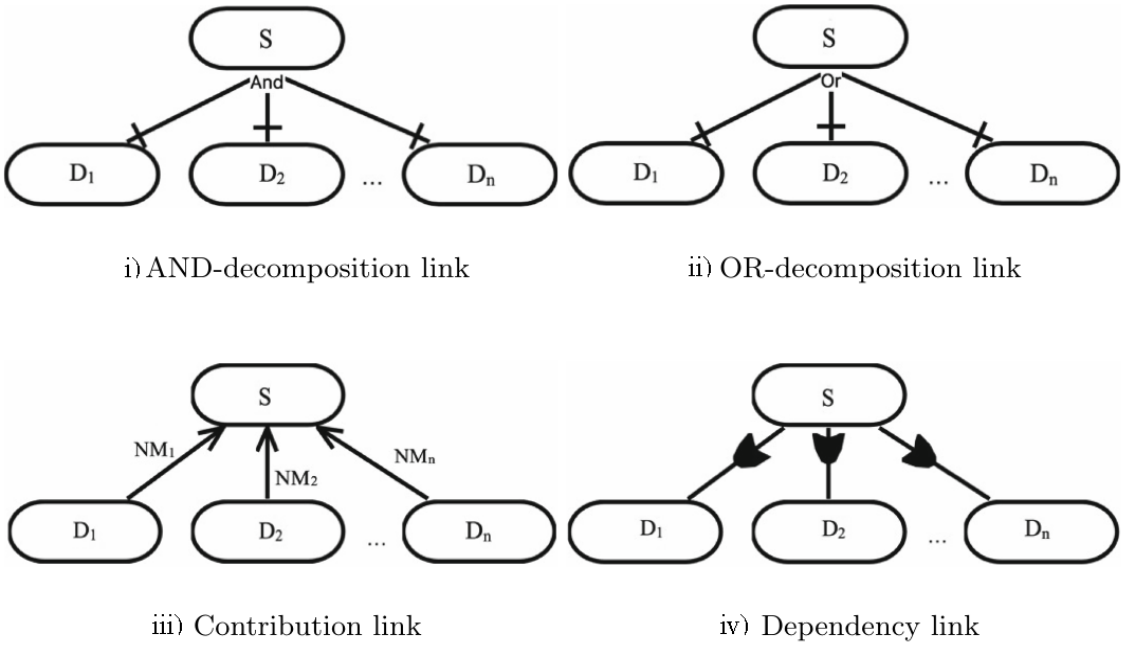


Figure 38 GRL Links [114].

Each type of link is evaluated as follows [114]:

1. **AND-decomposition** (Figure 38 (i)): the minimum is propagated.

$$v(S) = Min(v(D_1), v(D_2), \ldots, v(D_n)) \qquad (5)$$

2. **XOR and OR-decomposition** (Figure 38 (ii)): the maximum is propagated. However, for the XOR type, the maximum is also used. However, a warning is generated if more than one intentional element has a value different from 0 [111].

$$v(S) = Max(v(D_1), v(D_2), \ldots, v(D_n)) \qquad (6)$$

Figure 39 shows an example of a qualitative evaluation of decomposition links. The values of the intentional elements that were initialized are marked with an (*). A warning will be generated in case (c) after the evaluation because two sources have values different from 0 [111].

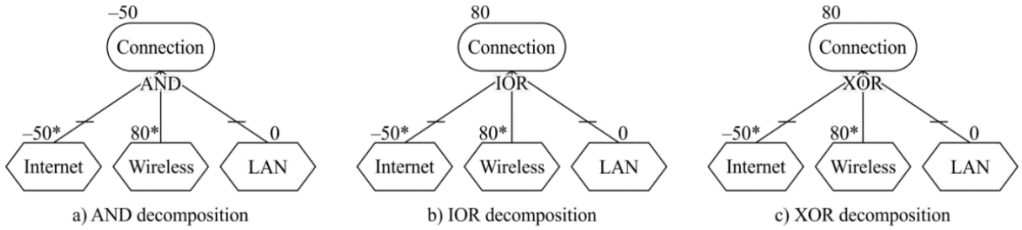


Figure 39 Quantitative evaluation of decomposition links [111].

3. **Contribution links** (Figure 38 (iii)): were NM_x represents the quantitative contribution/weight of the destination intentional element D_x. A truncated weighted sum is propagated. It is essential to clarify that contributions are additive to the target element's satisfaction and do not represent probabilities or confidence levels.

$$v(S) = Max(0, Min(100, \frac{\sum_{x=1}^{n}(v(D_x) \times NM_x}{100})) \qquad (7)$$

4. **Dependency links** (Figure 38 (iv)): the source's satisfaction (defaulted to 0) is truncated to the minimum satisfaction of its dependees.

$$v(S) = Min(v(S), v(D_1), v(D_2), \ldots, v(D_n)) \quad (8)$$

An intentional element can be linked simultaneously to others in any GRL model through different links (decomposition -only one of this type-, contribution and dependency). In those cases, the recommended order of evaluation is: first, evaluate decomposition links; secondly, contribution links are evaluated. Finally, dependency links are used to truncate the result [114].

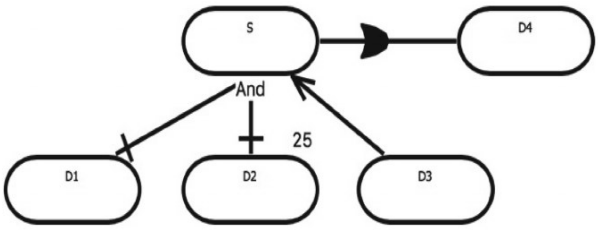


Figure 40 Multiple GRL types of links [114].

For example, the arithmetic interpretation of Figure 40 is:

$$v(S_{decomp}) = Min(v(D_1), v(D_2)) \quad (9)$$

$$v(S_{contrib}) = Max(0, Min(100, \frac{25 \times v(D_3) + 100 \times v(S_{decomp})}{100})) \quad (10)$$

$$v(S) = Min(v(S_{contrib}), v(D_4)) \quad (11)$$

Quantitative Arithmetic of Actors and the Model

An actor's quantitative satisfaction value can be assessed; it is necessary to evaluate its intentional elements (those with non-null importance values). If the sum of the weights (importance) is greater than 100, a weighted average is used; if not, a simple weighted sum is used.

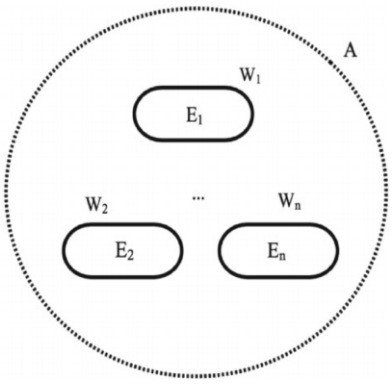


Figure 41 Actor containing intentional elements with importance weights [114].

Figure 41 shows an actor A comprising *n* root intentional elements noted by E_x, each with importance with the importance W_x. The arithmetic semantics of an actor is calculated as [114]:

$$v(A) = Max(0, Min\left(100, \frac{\sum_{x=1}^{n}(v(E_x) \times W_x)}{Max(100, \sum_{x=1}^{n}(W_x))}\right)) \quad (12)$$

If all root intentional elements have a greater than zero value, they are weighted equally (i.e., with a weight equal to $100/n$).

In the same sense, actors themselves can be weighted to assess the entire GRL model's satisfaction. The model's satisfaction has similar semantics to what was explained before for an actor (i.e., a weighted sum or average) [114].

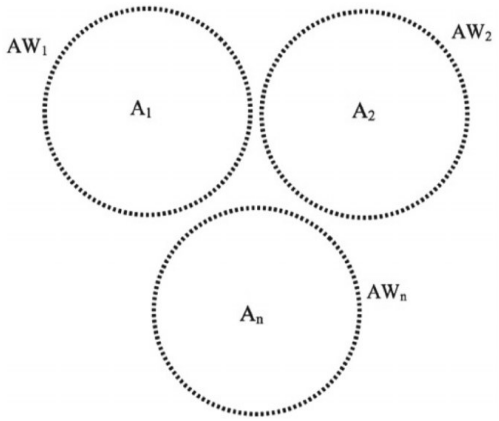


Figure 42 Actors with importance weights in a model [114].

Figure 42 shows *n* actors notated as A_x, each with a weight (importance) AW_x. The general quantitative evaluation value of a GRL Model is [114]:

$$v(Model) = Max(0,\ Min\left(100, \frac{\sum_{x=1}^{n}(v(A_x) \times AW_x)}{Max(100, \sum_{x=1}^{n}(AW_x))}\right)) \qquad (13)$$

Additional semantic rules for GRL models include [114]:

1. If the model has no actors to assess the models' satisfaction, a default actor with an importance value of 100 is created to contain all the model's intentional elements.
2. Similarly, as an actor with intentional elements with no importance assigned, a model with no weight value assigned to its actors is assessed by considering an actors' weight equal to $100/n$.

Qualitative Arithmetic of Links

Qualitative labels evaluate the intentional elements, actors, and the model. It uses qualitative contributions as described in the section Contribution and Correlation Links: **Make**, **SomePositive**, **Help**, **Unknown**, **Hurt**, **SomeNegative**, and **Break** (see Figure 23 for their visual representation). Once an element is evaluated, it is marked with a qualitative evaluation label, which can be: **Satisfied**, **Weakly Satisfied**, **None**, **Weakly Denied**, **Denied**, **Conflict**, **Exceeds,** and **Unknown** (see Figure 43 for their visual representation) [111], [115].

Figure 43 GRL qualitative evaluation labels [111].

Qualitative importance values of intentional elements and actors are **(H)High**, **(M)Medium**, **(L)Low**, and **None**. Because these values are discrete, when propagating the values, they are considered individually. Lookup tables and partial orderings are often used to define the necessary functions to assess the intentional element, actor, or model [111], [115].

Each type of link is evaluated as follows [111], [115]:

1. **AND-decomposition**: the minimum is propagated as in the quantitative evaluation. The minimum can be found when the qualitative values are ordered from minimum to maximum as follows:

$$Denied < (Conflict = Undecided) < WeaklyDenied < None < WeaklySatisfied < Satisfied \quad (14)$$

When the result is **Conflict**, it is substituted with **Undecided** to avoid propagation of conflicts. This facilitates the discovery of conflicts (root causes) when analyzing complex models. Figure 44 presents four examples of qualitative AND-type decomposition.

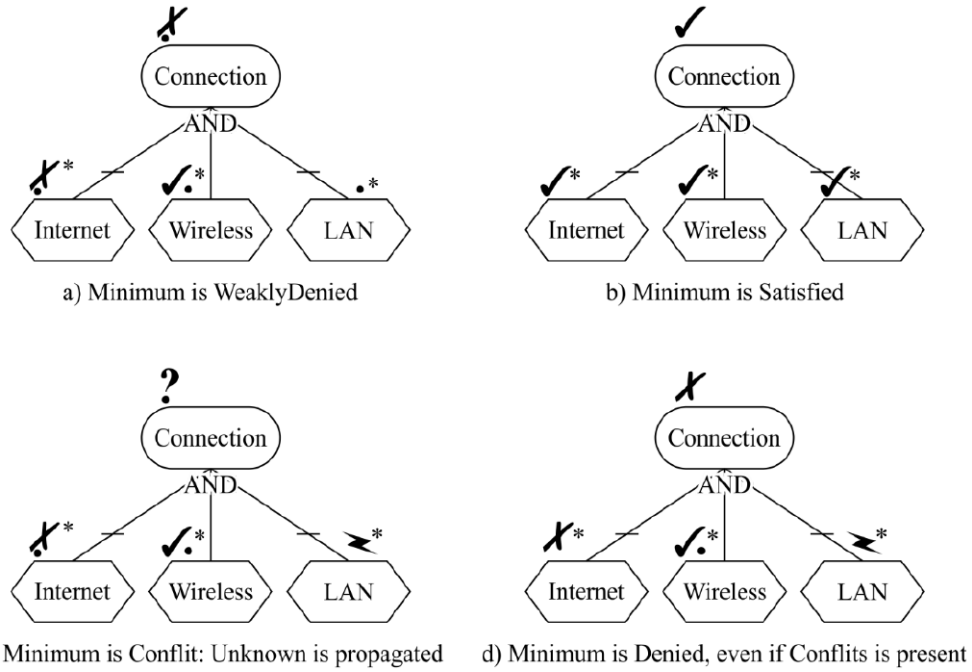


Figure 44 Example: Qualitative evaluation of AND-type decomposition links [111], [115].

2. **XOR and OR-decomposition**: also, as with quantitative evaluation, the maximum is propagated. Qualitative values are ordered as follows:

$$Denied < WeaklyDenied < None < WeaklySatisfied < (Conflict = Undecided) < Satisfied \quad (15)$$

Also, **Conflict** results are substituted with **Undecided** (conflicts are not propagated). Figure 45 provides four examples of qualitative OR-type decomposition.

For an XOR-type decomposition link, the maximum is propagated. However, a warning is generated if more than one source element has a quantitative evaluation value different than **None**.

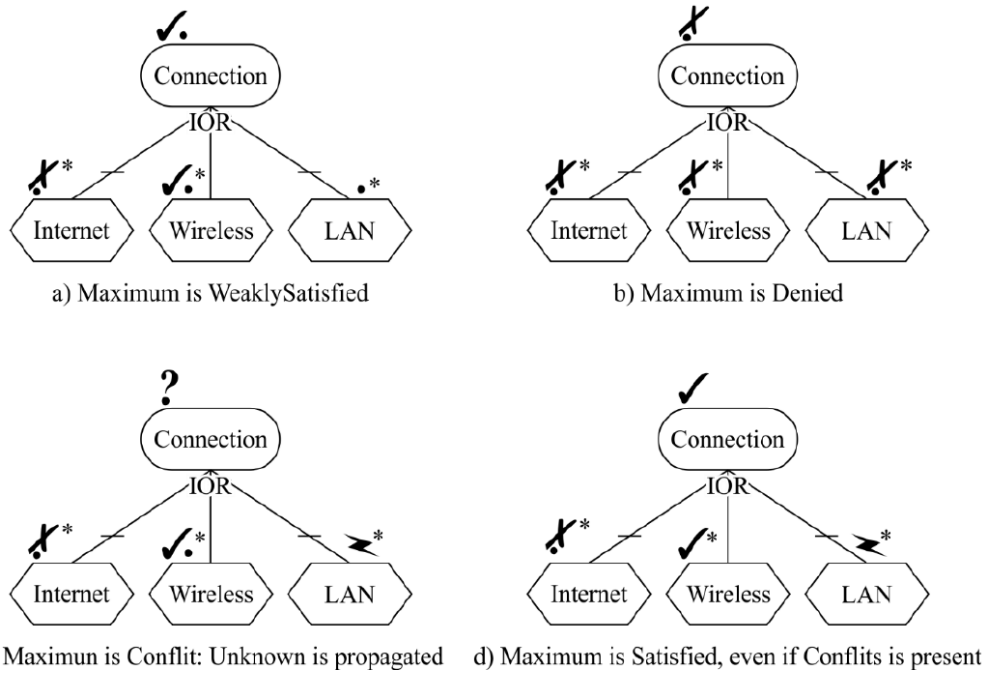


Figure 45 Example: Qualitative evaluation of IOR-type decomposition links [111], [115].

3. **Contribution links**: To evaluate contributions, a more complex algorithm is required. The first step counts the different types of evaluations of the leaf intentional elements, modified by the links that connect them to the evaluated element. Table 6 shows the propagated contribution depending on the source contribution (rows) and the link's contribution label (columns).

	Make	***Help***	***SomePositive***	***Unknown***	***SomeNegative***	***Hurt***	***Break***
Denied	Denied	Weakly Denied	Weakly Denied	None	Weakly Satisfied	Weakly Satisfied	Satisfied
Weakly Denied	Weakly Denied	Weakly Denied	Weakly Denied	None	Weakly Satisfied	Weakly Satisfied	Weakly Satisfied
Weakly Satisfied	Weakly Satisfied	Weakly Satisfied	Weakly Satisfied	None	Weakly Denied	Weakly Denied	Weakly Denied
Satisfied	Satisfied	Weakly Satisfied	Weakly Satisfied	None	Weakly Denied	Weakly Denied	Denied
Conflict	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
None	None	None	None	None	None	None	None

Table 6 Weighted Contribution function [111], [115].

The total counts are compared. First, it compares the satisfied (ns) and the denied (nd) contributions.

$$CompareSatisfiedAndDenied(ns, nd) =$$

$$Conflict, if\ (ns > 0\ and\ nd > 0)$$

$$Satisfied, if\ (ns > 0\ and\ nd = 0)$$

$$Denied, if\ (nd > 0\ and\ ns = 0)$$

$$None, if\ (ns = 0\ and\ nd = 0) \qquad (16)$$

Then, in the same way, it compares the count of WeaklySatisfied (ws) and the WeaklyDenied (wd) values. If they are equal, then these contributions cancel each other out, and **None** is returned.

$$CompareWSandWD\ (ws, wd) =$$

$$WeaklySatisfied, if\ (nws > nwd)$$

$$WeaklyDenied, if\ (nwd > nws)$$

$$None, if\ (nwd = nws) \qquad (17)$$

Finally, the two previous results are compared using Table 7. The row specifies the contribution of the weak contributions and the columns' possible values of the satisfied/denied contributions.

	Denied	***Satisfied***	***Conflict***	***None***
Weakly Denied	Denied	Weakly Satisfied	Conflict	Weakly Denied
Weakly Satisfied	Weakly Denied	Satisfied	Conflict	Weakly Satisfied
None	Denied	Satisfied	Conflict	None

Table 7 CombineContributions function [111], [115].

Figure 46 shows two examples with three contributions. Both strategies initialize two elements in each example:

For case (a), by using Table 6 [111], [115]:

- $(WeaklyDenied \times SomePositive) = WeaklyDenied$
- $(WeaklySatisfied \times Make) = WeaklySatisfied$, and
- $(None \times SomeNegative) = None$.
- The count is: $ns = 0, nd = 0, ws = 1, wd = 1$
- Comparing satisfied (ns) and denied (nd), there is a tie; therefore, the function return $None$.
- Comparing WeaklySatisfied (ws) and WeaklyDenied (wd) also results in a tie, therefore returns $None$.
- Finally, by crossing the previous results $(None, None)$ to Table 7, the result is $None$.

For case (b), by using Table 6 [111], [115]:

- $(WeaklySatisfied \times SomePositive) = WeaklySatified$
- $(WeaklySatisfied \times Make) = WeaklySatisfied$, and
- $(None \times SomeNegative) = None$.
- The count is: $ns = 0, nd = 0, ws = 2, wd = 0$
- Comparing satisfied (ns) and denied (nd), there is a tie. Therefore, the function returns $None$.
- Comparing WeaklySatisfied (ws) and WeaklyDenied (wd) results in a ws win, therefore returns $WeaklySatisfied$.
- Finally, by crossing the previous results $(None, WeaklySatisfied)$ to Table 7, the result is $WeaklySatisfied$.

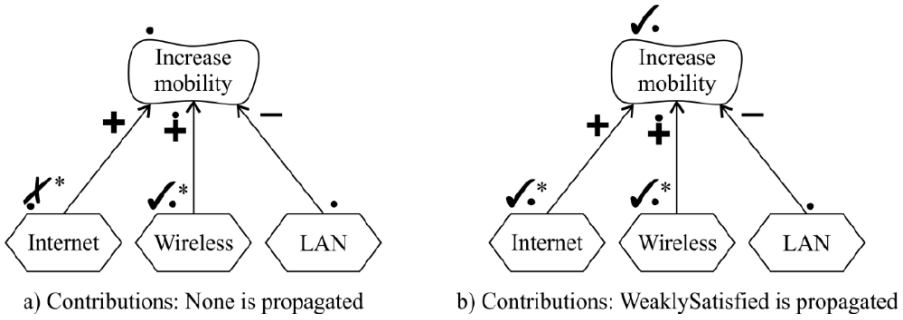


Figure 46 Example: Qualitative evaluation of contribution links [111], [115].

4. **Dependency links**: This algorithm returns the minimum value between all the contribution values of the target elements. As the AND-type decomposition, the values are ordered from minimum to maximum:

$$Denied < (Conflict = Unknown) < WeaklyDenied < None < WeaklySatisfied < Satisfied \quad (18)$$

Again, **Conflict** results are substituted with **Unknown** as conflicts are not propagated.

Figure 47 shows two examples: "…(a) *Internet Connection* becomes $WeaklyDenied$ since this value is less than $None$. *Low Costs*, on the other hand, will keep its value of $None$ because it is less than $WeaklySatisfied$. The *Increase Visibility* softgoal gets the value $WeaklyDenied$ because this is the minimum between $None$ and $WeaklyDenied$. Example (b) illustrates that a $Conflict$ value in a target element propagates to an $Unknown$ value in the source element (e.g., *Low Cost*), unless there is a $Denied$ value in another target element (in which case the propagated value is $Denied$, e.g., for *Increase Visibility*)…" [111]

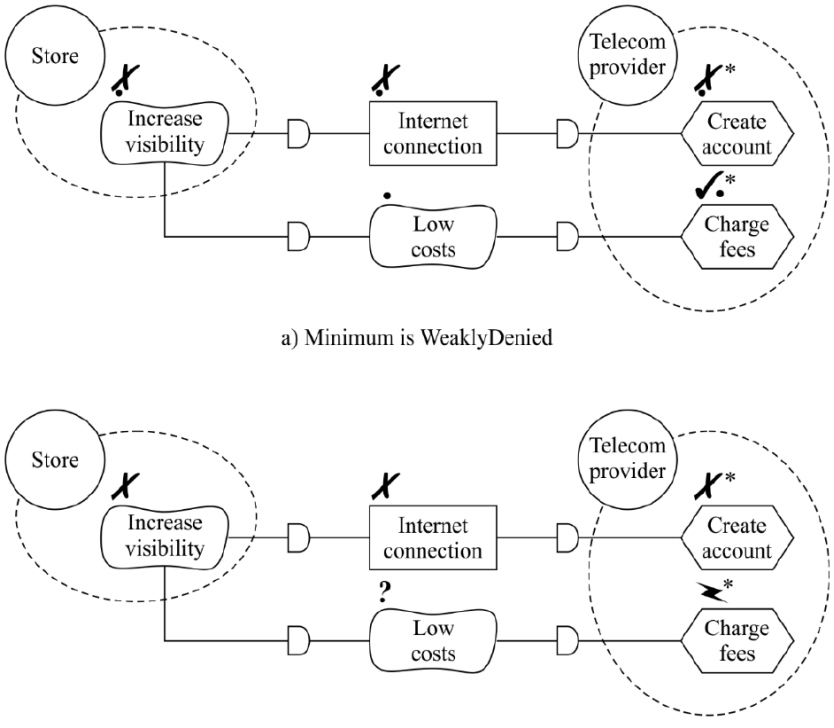


Figure 47 Example: Qualitative evaluation of dependency links [111], [115].

Qualitative Arithmetic for Actors and the Model

Actors are assessed using the qualitative satisfaction value and qualitative importance value (High, Medium, Low, None) of each containable element bound to the actor [111], [115].

The algorithm to assess the actor's evaluation is similar to the algorithm for contribution links. First, the quantitative contribution value is weighted according to the element's importance; Table 8 shows the importance value in the rows; The columns show the qualitative contribution of the element being evaluated. Their crossing represents the result of the evaluation.

	Denied	***WeaklyDenied***	***WeaklySatisfied***	***Satisfied***	***Conflict***	***Unknown***	***None***
High	Denied	WeaklyDenied	WeaklySatisfied	Satisfied	Conflict	Unknown	None
Medium	WeaklyDenied	WeaklyDenied	WeaklySatisfied	WeaklySatisfied	Conflict	Unknown	None
Low	WeaklyDenied	None	None	WeaklySatisfied	Conflict	Unknown	None
None	None	None	None	None	None	None	None

Table 8 WeightedImportance function [111], [115].

Finally, in the same way, as the contribution links are evaluated, the different types of contributions are counted (also including the number of conflicts).

Figure 48 shows an actor with four softgoals, three of which with importance other than None, by using Table 8 [111], [115]:

- Reliability: $(High \times Satisfied) = Satified$
- Low cost: $(Low \times Satisfied) = WeaklySatisfied$
- High Perf: $(Medium \times WeaklyDenied) = WeaklyDenied$
- Low Weigh: $(None \times WeaklySatisfied) = None$
- The count is: $ns = 1, nd = 0, ws = 1, wd = 1$
- Comparing satisfied (ns) and denied (nd) results in a win for ns. Therefore, the function returns $Satisfied$.
- Comparing weakly satisfied (ws) and weakly denied (wd) results in a tie. Therefore returns $None$.
- Lastly, by crossing the previous results $(Satisfied, None)$ to Table 7, the actor is evaluated as $Satisfied$.

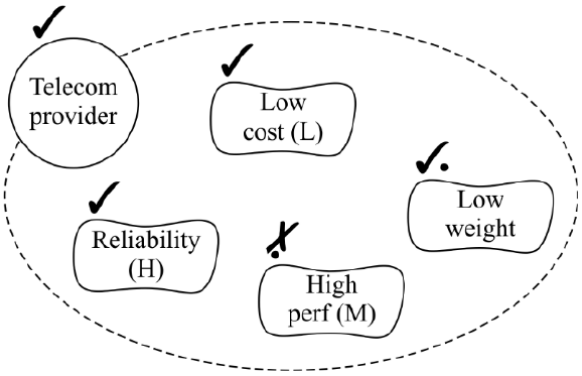


Figure 48 Example: Qualitative evaluation of actors[111], [115].

The qualitative evaluation value for the GRL model is calculated in the same way as the actors, except that the qualitative evaluation values and qualitative importance values of actors are used instead [111], [115].

3.2.6. Putting it all Together - Examples

The first example is presented in Figure 31 (From Amyot's presentations): The model presents two actors (*Administration leaders* and *System*); the System's goal is to *provide patient info*. It has two alternatives: The *Voice Recording System (VRS)* or the *On paper task*, which is decomposed into three subtasks. The *Administration Leaders* (actor) seeks to fulfill one goal (*Shift to paperless documentation*) and three softgoals (*Minimize cost*, *maximize privacy and security,* and *better use of resources*). The System actor operationalizes the *Administration leaders*' goals.

For the context of this example, we only use simple tasks and links and will not use indicators (e.g., Total cost) or dependency links.

For this first example, we analyze three strategies:

1. The first strategy to be analyzed is the "Voice Recording System (VRS)." As explained before, we will assume the indicator "Total Cost "will start evaluated as satisfied along with the VRS, as mentioned earlier (see Figure 49).

   Figure 50 shows the performed analysis and propagation; the elements marked with (*) represent the elements with a starting value at the beginning of the strategy. The colors (red - denied, green - satisfied, and different shades of red and green) represent the degree of satisfaction of every goal and softgoal. The values on top of each intentional element and below each actor's name represent the evaluation's quantitative value.

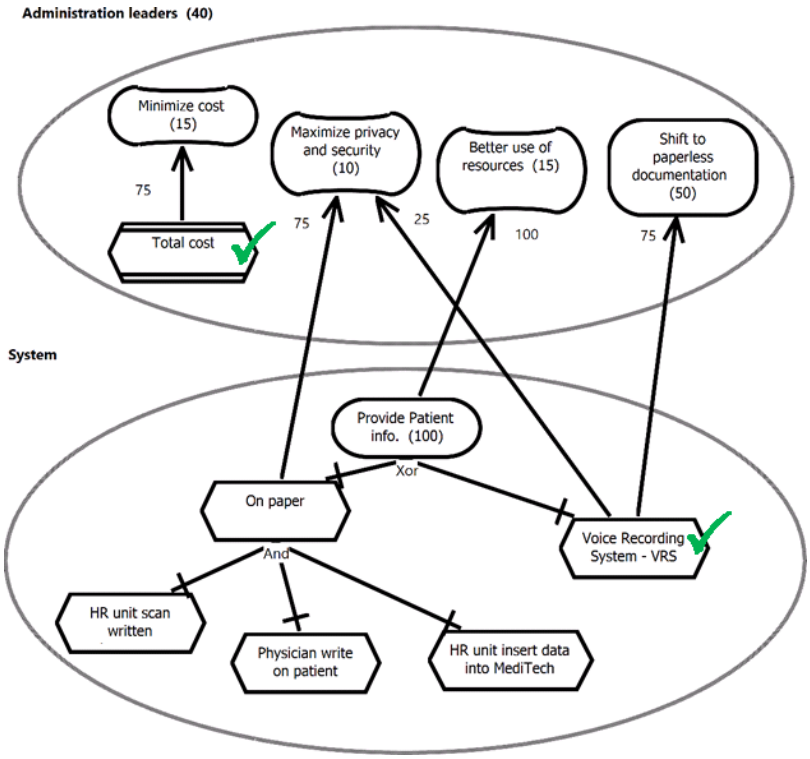


Figure 49 Strategy 1: Voice Recording System – VRS. From Amyot's material.

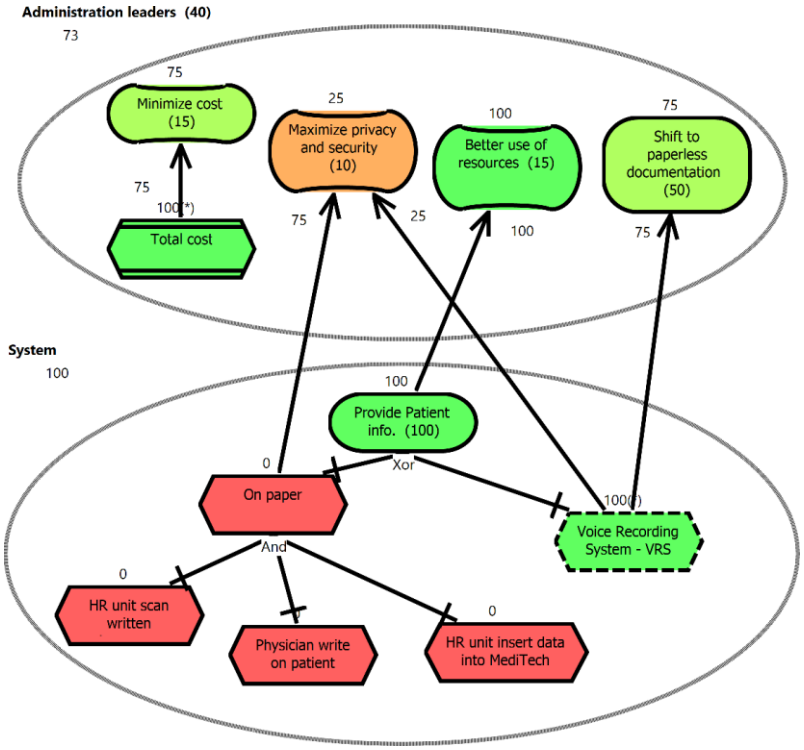


Figure 50 Strategy 1: Voice Recording system VRS - Propagation. From Amyot's material.

2. The second strategy to be analyzed will be "On paper," as before, we will assume the indicator "Total Cost" will start evaluated as satisfied (see Figure 51). Figure 52 shows the performed analysis and propagation; the elements marked with (*) represent the elements with a starting value at the beginning of the strategy.

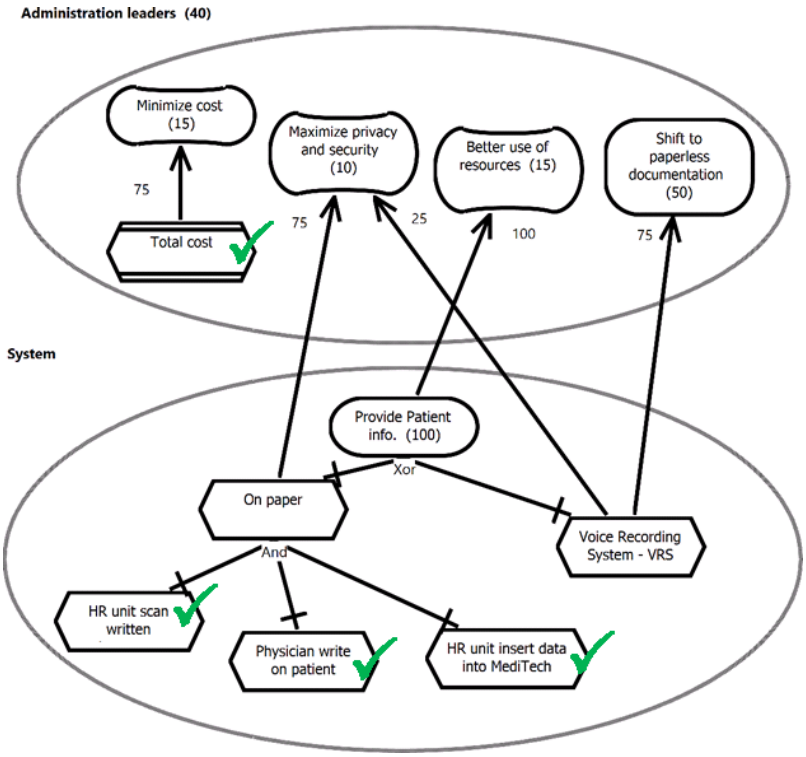


Figure 51 Strategy 2: On Paper. From Amyot's material.

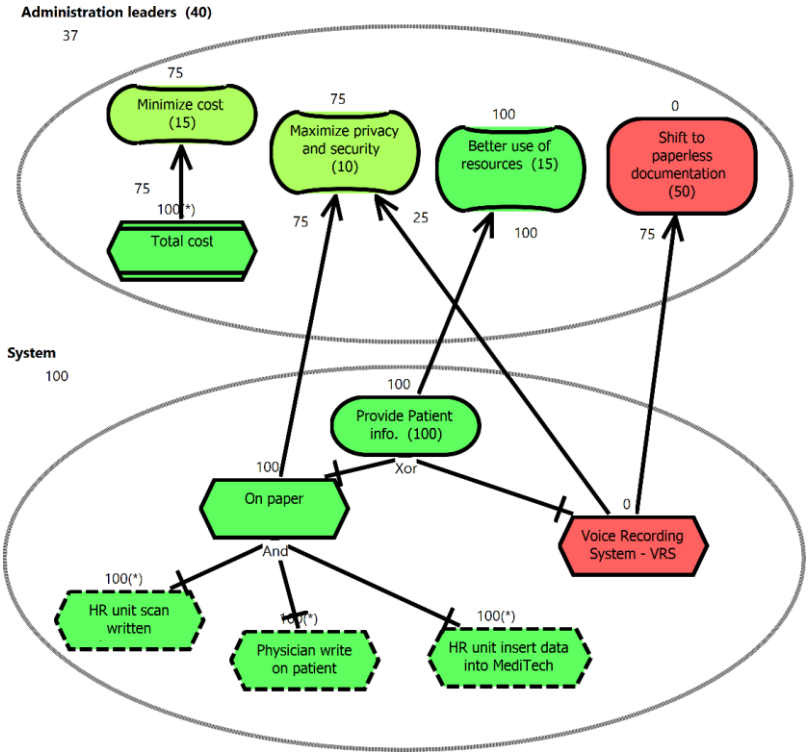


Figure 52 Strategy 2: On Paper – Propagation. From Amyot's material.

3. The third strategy seeks to analyze if it would be possible to avoid writing down the patient's data (represented by the task "Physician write on patient") but allow the use of complementary automatic tasks related to the fulfillment of the "On Paper" task. We will assume the indicator "Total Cost" will start evaluated as satisfied (see Figure 53). Figure 54 shows the performed analysis and propagation; the elements marked with (*) represent the elements with a starting value at the beginning of the strategy.

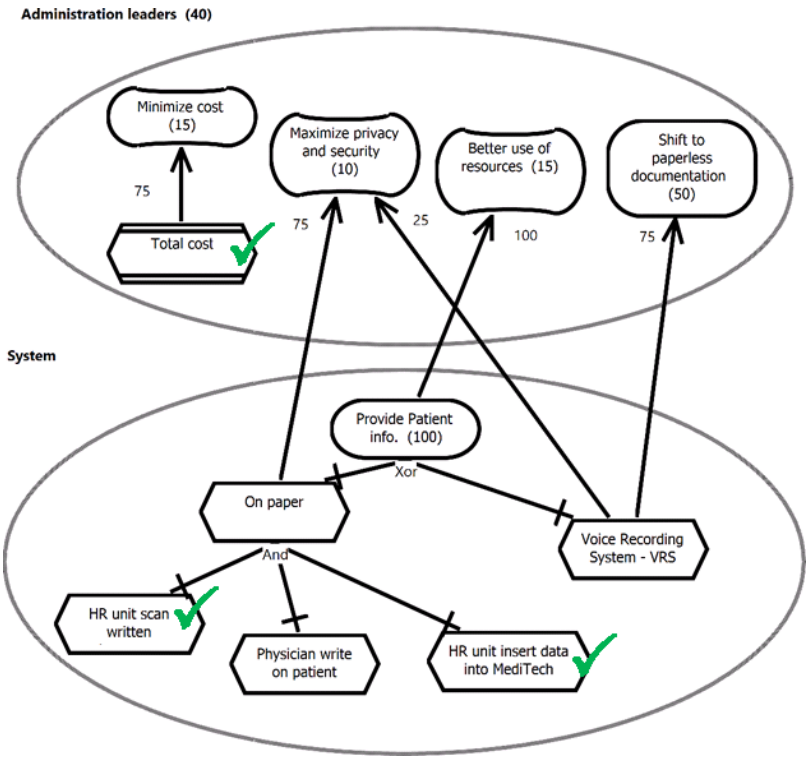


Figure 53 Strategy 3: No Physician Write on Patient. From Amyot's material.

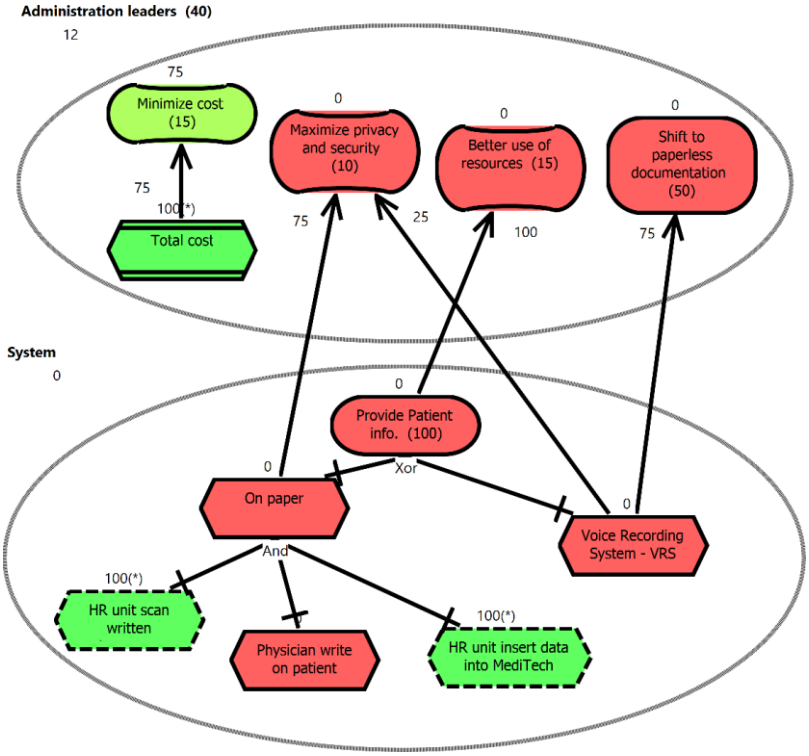


Figure 54 Strategy 3: No Physician Write on Patient - Propagation. From Amyot's material.

Finally, we compare and analyze the results by comparing the achievement of goals and softgoals within the actors; in this case, the most relevant actor in the model is "Administration leaders" with an importance value of 40.

In the first strategy, most softgoals are satisfied except for “Maximize privacy and security” with an evaluation value of 25 (remember that this value ranges between 0 and 100)”; The goal “Shift to paperless documentation” gets an evaluation of 75. In the second strategy, all softgoals are satisfied. However, the goal “Shift to paperless documentation” gets an evaluation of 0, i.e., it gets denied. In the final evaluated strategy, the only intentional element that gets close to being satisfied is the softgoal “Minimize cost,” the rest of the softgoals and the goal are all denied. With this first analysis, it can be concluded that the best alternative is strategy 1 (the VRS).

Finally, another analysis that can be used is based on the evaluation of the actor in each strategy: for strategy one, the evaluation value is 73, for strategy two is 37, and for strategy three is 12, confirming our first analysis, that the first strategy is the closest to achieve the goals of the actor.

For our second example, we will focus on the use of indicators and how they are calculated. This example was taken from [114].

The example is a simplified model of a hybrid car’s engine system and its goals. The model’s core is the *User’s* softgoals and how the *System* controls the engine’s performance.

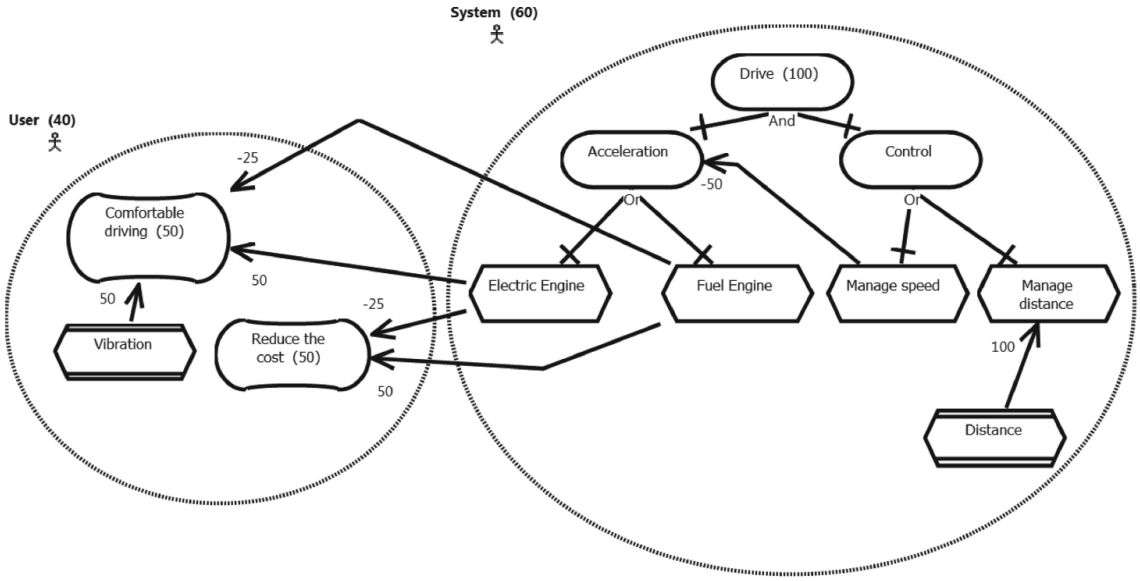


Figure 55 GRL model of a simple hybrid car system example [114].

Figure 55 shows a simplified view of the “*System”* and the “*User’s”* goals, tasks, and links. The system’s primary goal is “*Drive,”* which can be achieved through two sub-goals: “*Acceleration”* and “*Control.”* “*Acceleration”* can be satisfied by the engine (it may be *electric*, *fuel-based*, or a combination of the two, hence the type of decomposition). *Control* aims to regulate the car’s speed, managing the car’s Distance from surrounding objects. The *User’s* concerns are represented by softgoals (i.e., “*Comfortable driving”* and “*Reduce the cost”*). The *System* uses sensors to monitor its environment, modeled as indicators. They measure *Distance* and car *Vibration,* as explained before. This sensor measures and identifies important milestones using *target*, *threshold*, and *worst* value parameters (see Table 9). When the model’s satisfaction is evaluated, the idea is to decide which tasks the system selects, i.e., the system selects the task that better satisfies the system’s goal (*Drive*). At the same time, to a degree, achieve the User’s softgoals depending on the conditions captured by the sensors [114].

Indicator	***Target***	***Threshold***	***Worst***	***Unit***

Distance	25	10	5	Meter
Vibration	0	10	20	Hertz

Table 9 Indicator parameter values [114].

For this example, we will only cite the equations and evaluations required to quantitatively assess the model as described in previous sections, particularly to describe the use of indicators when evaluating the model.

Using equation (13), the function to assess the model is:

$$v(AdaptiveCar) = \frac{(v(User) \times 40 + v(System) \times 60)}{100} \quad (19)$$

By equations (14) and (9), the User is assessed as:

$$v(Actor) = \\ (Max\ (0, Min(100, (50 \times Fuel\ engine + -25 \times Electric\ engine)/100))\ \times\ 100 \\ + Max(0, Min(100, (50 \times v(Vibration) + 50 \times \\ Electric\ engine + -25 \times Fuel\ engine)/100)) \times 100) \Big/ 100 \quad (18)$$

The function $v(Vibration)$ must be evaluated using equation (4) (C is the current measured value, 0 the target, 20 the worst, and 10 the threshold value):

$$v(I) = \begin{cases} 100 & if\ C \leq 0 \\ 0 & if\ C \geq 20 \\ abs\left(\frac{C-10}{10-0}\right) \times 50 + 50 & if\ 0 < C \leq 10 \\ -abs\left(\frac{C-10}{10-20}\right) \times 50 + 50 & if\ 10 < C < 20 \end{cases} \quad (19)$$

As with the *User*, the System gets assessed using equations (5), (6), (7), and (14):

$$v(System) = v(Drive) \quad (20) \\ = Min(Max(Max(0, Min(100, (100 \times v(Distance)) \\ /100)), Manage\ speed), Max(0, Min(100, (-50 \\ \times Manage\ speed \\ + Max(Fuel\ engine, Electric\ engine)\ \times\ 100)/100))))$$

It is required to assess $v(Distance)$; thus, equation (3) is used since the target value is higher than the worst value:

$$v(I) = \begin{cases} 100 & if\ C \geq 25 \\ 0 & if\ C \leq 5 \\ abs\left(\frac{C-10}{25-10}\right) \times 50 + 50 & if\ 10 \leq C < 25 \\ -abs\left(\frac{C-10}{5-10}\right) \times 50 + 50 & if\ 5 < C < 10 \end{cases} \quad (21)$$

This example showed the arithmetic to evaluate the model and the actors, emphasizing the indicators; Strategies can be implemented to propagate specific values as in the first presented example.

3.2.7. Algorithms for GRL Evaluation of Strategies

It can be inferred from previous sections that strategies can be tested and propagated in different ways in a GRL model. In the context of methods and algorithms for goal model testing,

there is not a “best” algorithm but different algorithms with different results and ways of analyzing them [116]. In the case of GRL, the z.151 standard [111] defines three algorithms, which are also implemented as an Eclipse plugin [117]: jUCMNav [118], developed by the same research group at the University of Ottawa that developed the standard.

A GRL model is evaluated by creating strategies that assign initial satisfaction values to some of the model’s intentional elements; Satisfaction values are propagated to other intentional elements by employing the different types of links (decomposition, contribution, and dependency) [115]. Different types of algorithms and approaches can be applied to do so. In the GRL standard, algorithms are classified upon a series of characteristics and the way they operate and analyze the models [111], [115]:

a) Evaluation type: depending on the arithmetic used to assess the intentional elements:

- The **quantitative evaluation** uses quantitative contribution and the importance of Intentional elements and initial quantitative values defined in the strategies. It is recommended when measures associated with the domain being modeled are available.
- The **qualitative evaluation** uses the qualitative contribution and importance of intentional elements and initial qualitative values defined in the strategies. It is recommended when measures associated with the domain being modeled are not available.
- **Hybrid evaluation**: For this type of evaluation, a combination of the previous two is used in the three defined categories (contribution, importance, and intentional element evaluation value). It is recommended when partial knowledge of the domain is available.

b) Propagation direction: Depending on the intentional elements being initialized in the strategy and how their satisfaction values propagate, there are three propagation directions to be considered:

- Forward propagation: the strategy initializes *some* intentional elements and Indicators (source/leave nodes); the values are propagated bottom-up to the model's upper intentional elements and indicators (targets/roots). It seeks to answer the question of “what if?.” The results can be analyzed, and conflicts detected.
- Backward propagation: the strategy initializes *some* intentional elements and Indicators (target/root nodes); the values are propagated in a top-down way to lower intentional elements and indicators (sources/leaves) of the model. Its purpose is to find a set of alternatives that (if satisfied) would lead to the initial strategy assigned values. It helps to answer the question, “Is it possible?.”
- Mixed propagation: the strategy initializes intentional elements from the “middle” of the graph (neither leaves nor roots). Furthermore, both approaches, forward and backward, are applied to them.

c) Overall GRL model satisfaction: An algorithm may evaluate the model as a whole or not.

d) Actor satisfaction: An algorithm may evaluate actor evaluation levels or not.

e) Exceeding expectations: An algorithm may or may not consider evaluations exceeding expectations of intentional elements, actors, and the model.

f) Automation: An algorithm may be fully automatic or have human interaction (e.g., to resolve conflicts).

g) Cycles: An algorithm may handle cycles/buckles in models (entirely or partially) or require models to be acyclic.

h) Conflicts: An algorithm may determine multiple links (contributions, decompositions, or dependencies) targeting the same intentional elements or indicators that are conflicting or not. Also, if conflicts are detected, the algorithm can identify or classify the different types of conflicts.

i) Strategy consistency: An algorithm may allow inconsistent strategies or not. A strategy is inconsistent if intentional elements initialized propagate to elements with initially defined values, and the propagated value is inconsistent with the initialized one.

j) Evaluation overriding: An algorithm may allow to override arithmetic evaluations as part of a strategy or not.

k) Relation to UCM: The evaluation of the model may or may not affect UCM variables (although UCM will not be used in the context of this research).

l) Evaluation ordering for links: The links (decompositions, contributions, and dependencies) may be evaluated in different orders. An algorithm must either specify that order or mention that there is none.

m) Link evaluations: An algorithm may provide new arithmetic functions to compute the usages of the different types of links.

n) Tolerance: Specifically, for contribution links, an algorithm may define a tolerance to help decide when an intentional element becomes satisfied or just weakly satisfied (and respectively denied or just weakly denied).

Based on the mentioned attributes, the GRL standard defines three algorithms with the following shared characteristics: "…(b) Forward propagation; (c) Actor satisfaction is evaluated; (d) Fully automated; (e) Cycles in models are handled partially: a cycle will only be evaluated if one of its elements has a value initialized by the strategy; (g) Inconsistent evaluation strategies are allowed; (h) Evaluations defined as part of a strategy are not overridden; and (j) Element links are evaluated in the following order: decompositions, contributions, and dependencies…" [111], [115], and (m) Link evaluation functions defined and used as described previously (qualitatively and quantitatively). The general algorithm is: (1) choose a strategy and from it initialize the evaluation values of some GRL intentional elements, (2) forward propagate the initial satisfaction values (in a bottom-up way), and (3) evaluate the actors' satisfaction.

The specific algorithms are described profusely in the standard and use the arithmetic of actors, intentional elements, indicators, and links as described previously; Each algorithm is characterized as follows [111]:

1. Quantitative evaluation: (f) no conflict detection, (i) with relation to UCM, and (l) with tolerance,
2. Qualitative evaluation: (f) conflict detection, (i) without relation to UCM, and (l) without tolerance,
3. Hybrid evaluation: (f) no conflict detection, (i) with relation to UCM, and (l) with tolerance.

Chapter 4. Features and Requirements of the Proposed Model

This chapter describes the restrictions imposed by the environment for the development and testing of the proposed model. We also describe the research questions in terms of the desirable features of the resulting method and model, thus motivating the contributions of this thesis. The model is described in Chapter 5, and a case study applying it is presented in Chapter 6.

From this point on, the expression “the model” refers to both the model and the method to build it.

4.1. Restrictions and Limitations

Based on the possible uses of GRL, the knowledge areas of application, the thesis schedule, and the ways the case study organization perform its strategic planning, the following restrictions were identified for the development of the model and method:

- The case study cannot span a complete strategic planning and evaluation cycle since this process takes several years from beginning to end for the organization involved.
- The case study cannot be synchronized with the beginning of a cycle as the institution is currently finishing a strategic planning cycle.
- Even though the previous restrictions limit the scope of the case study, the organization facilitates access to the current strategic planning documents and the people who manage them both in the business and the IT unit.
- The model should cover an analysis of the strategy status based on current development indicators because the strategic planning cycle is in its final stages. We can perform a posteriori analysis of the defined business/IT strategic plans given the circumstances.
- The evaluation of the usability and utility of the model must be designed based on the previous restrictions.

The following restrictions were also stated in the thesis proposal:

- Our primary focus is analyzing the functional alignment between Business and IT at the strategic level.
- The model will only consider strategic goals and early requirements. Furthermore, the model will provide methods to analyze such elements that can be later used to negotiate and derive other requirements (i.e., system, software).
- The model might be influenced by the findings and context of the selected institution where the controlled experiment will be performed.
- Due to the complexity and size of strategic plans, perhaps a subset of strategic goals (Business and IT) should be selected.

4.2. The Process for Requirements Acquisition

The requirements and features for the proposed model were defined based on applying two different strategies; first, by conducting an exploratory case study in a university using Luftman’s SAM (Strategic Alignment Maturity Model) [29]. This case study investigated the dimensions and intentional elements of the organization’s strategic alignment. In addition, it

allowed us to familiarize ourselves with the organization, its members, and how strategic planning is conducted within both IT and business units. Second, as defined in the thesis proposal, a literature review was performed to collect and organize research materials from scientific papers, bibliographic databases, and other library resources from various knowledge areas. This literature review is presented in Chapter 1 and Chapter 2 of this thesis.

In this context, the research begins by observing the phenomena, i.e., strategic alignment and the social setting to identify, analyze and explain them. Then, based on the literature review outcomes and the studied concepts, we develop general principles and interpretations for the previous observations. These explorations allowed us to appraise the potential and capabilities of GRL and map central concepts identified in the literature review into its components. After that, we determine how the operationalizations of GRL and goal-oriented requirements analysis techniques can be used to address the problem at hand.

4.3. Requirements

Based on the objectives and scope defined, the literature review, and the restrictions and limitations mentioned above, the requirements of the model have been identified regarding the representation of strategic alignment between Business and IT using goal-oriented requirements engineering methods and specifically GRL as the visual language for representation and analysis.

Regarding the **Business and IT/IS Strategic Goals Analysis Model that can be used and applied in the context of IT Governance to support Business/IT Functional Alignment**, we have identified a set of requirements that are detailed as follows:

R1. Expressiveness based on the literature review concepts. Using GRL as a base language, the model must have a high level of expressiveness to capture strategic goals and relate them to other ones, such as tactical and operational. Furthermore, the model must also show the initiatives/projects by which such goals can be achieved.
Therefore, the model should be expressive concerning three dimensions: i) the representation of the motivational domain of both business and IT, ii) the representation of the behavioral domain, and iii) the representation of the interconnections between them. We detail the sub-requirements that each perspective should encompass as follows:

R1.1. Motivational Perspective. The model must allow assigning goals to the organization, business, and IT units and roles to trace responsibility, knowledge, and accountability for any given goal.

R1.2. Behavioral perspective. Due to the restrictions and limitations, the model cannot be time-bounded. The delivery times of initiatives or projects cannot be evaluated, meaning that initiatives and projects are evaluated as-is, i.e., with a given qualitative or quantitative evaluation value (see Section Arithmetic Semantics of GRL Models). Their contribution can be propagated to other intentional elements. Goals must have quantitative targets for their evaluation (e.g., as recommended by the Balanced Scorecard). In addition, activities in the form of initiatives/projects must also be assigned to the organization, business unit, or roles, allowing for better planning and assigning responsibilities in the strategic planning phase.

R1.3. Traceability between motivational and behavioral perspectives. The model must allow the use of the link types provided by GRL, including contribution, decomposition, and

dependency (see Section Links), which are the basis for the propagation of quantitative or qualitative evaluation values (see Section Arithmetic Semantics of GRL Models).

These sub-requirements ensure that the motivational aspects of both Business and IT are considered. Moreover, each intentional element in the model has a particular owner/responsible who can be consulted. His/her domain knowledge defines the indicators that measure the achievement of the goals. In this regard, simplicity and usability are essential for the model to be easy to understand, maintain and analyze in the development stages of strategic planning.

R2. Include a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem. In order to manage and build the model, it is necessary to define a sequence of steps to develop a GRL model or models, allowing to control, modify, and use them for the decision-making process of strategic planning in both Business and IT. To fulfill this requirement, the model must allow to i) identify and connect intentional elements (see Section Intentional elements) into the GRL model, ii) define a sequence of steps to follow while building it, and finally, iii) define how to use the resulting model's evaluation strategies to solve the given problem. We detail the sub-requirements that each perspective should encompass as follows:

R2.1 Support the identification of intentional elements, roles, actors, and relations in the problem's context and scope. The model must connect tasks, resources, and indicators so that the planners can use and analyze the model in the defined scenarios.

R2.2 Define a sequence of steps to follow while building the GRL model: It is fundamental to identify a recommended sequence of steps and guidelines for building, managing, analyzing, and using the GRL model in the defined context and scope.

R2.3 Support semi-automatic reasoning on the constructed models: the model must describe the analysis processes of the resulting GRL models utilizing a GRL tool (e.g., the jUCMNav tool [112], [119], [120]); this is useful for the users to facilitate analysis and management of strategies and alternatives.

Chapter 5. The Business and IT/IS Strategic Goals Analysis Model

To fulfill the requirements discussed in Chapter 4 Features and Requirements of the Proposed Model., this chapter introduces the "**Business and IT/IS Strategic Goals Analysis Model."** Based on the concepts of Goal-oriented Requirements Engineering and the GRL modeling language (see Chapter 3 Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL)); We provide methodological guidelines that help the model's users specify, refine, operationalize, and link (see Section Links) the intentional and motivational elements in the intended scope.

5.1. Concepts and Relations

The proposed model uses two notions to achieve expressiveness in motivational and behavioral perspectives **(R1)**. First, the intentional concepts described by the GRL language and the use of goals' hierarchies; second, the structure recommended by the management sciences about organizational goals at different levels, i.e., strategic, tactical, and operational. These levels are also based on the concepts and ontology of the Business Motivation Model, as presented in Chapter 2 Conceptual Framework. These descriptions guarantee that the model is coherent with the way GRL uses goals in general and how they contribute or are split into fine-grain goals at the lower levels, i.e., tactical or operational.

When using GRL in the specific context and scope that we aim for, it is crucial to map the concepts defined in Chapter 2 Conceptual Framework, and describe how to connect them using GRL concepts.

Based on the notions described in Chapter 2 Conceptual Framework, Table 10 maps the main concepts identified in the literature review into GRL concepts (**R1.1** and **R1.2**). It is essential to notice that the mentioned concepts are high-level descriptions with low-level relations to the organization's operation, projects, or initiatives that are not included in this analysis. However, that does not mean that they cannot be used in more complex contexts, for instance, when using the model in subsequent strategic planning or execution stages.

GRL Concept	Context Concept
Actor	• Higher level of abstraction: Organization, Management • Middle level of abstraction: Organizational unit, Business unit, IT unit, Board, • System to be developed
Goal – Soft goal	Mission, Vision, Goal, Operative goal, Strategic objective, Business Objective
Task	• Higher level of abstraction: Business strategy, IT strategy • Middle level of abstraction: Business processes, Business IT service, Project, Portfolio, Program
Resource	Enterprise architecture (and every asset within it), money, technology, systems
Indicator	Measure, Target

Table 10 Mapping of context concepts into GRL.

The links defined by GRL allow realizing the relationships between actors, intentional elements, and indicators. Furthermore, all the rules and definitions presented in Chapter 3 Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL) about contribution, decomposition, and dependency links remain valid at the reviewed level of abstraction (**R1.3**).

5.2. Methodological guidelines

This section outlines the guidelines for using the model and building, using, and analyzing it. Before describing the recommended steps, we characterize some preliminary issues to be considered.

5.2.1. The Way of Working with the Model

GORE models for problem-solving in academia are not new and have been in use for several decades. Several authors have contributed to defining, organizing, and enriching recommendations for its commercial use. In our case, the works of Horkoff based on i-star [37], [46], [116], [121]–[124] and Amyot based on GRL [38], [42]–[44], [111], [112], [114], [115], [119], [125]–[127] are the basis for the initial recommendations for the proposed model.

GRL Intentional Elements	
Construct	**Question Vocabulary**
Goal <goal-id>	the full realization/fulfillment of <goal-id>
Softgoal <softgoal-id>	the sufficient achievement of <softgoal-id>
Task <task-id>	the completion/execution of <task-id>
Resource <res-id>	uses <res-id>
Indicator <ind-id>	reaching the target of <ind-id>
Belief <text>	we believe that <text>
Actor <actor-id>	actor <actor-id> participates in
Actor with boundary <actor-id>	actor <actor-id> encloses
GRL Intentional Relations	
GRL Contribution Links	**Question Vocabulary**
Make	contributes positively and sufficiently to
SomePositive	has some positive contribution (with unknown extent) to
Help	helps (has a positive but insufficient contribution)
Unknown	has some contribution to (but the extent and the degree (positive or negative) are unknown)
Hurt	hurts (has a negative but insufficient contribution)
SomeNegative	has some negative contribution (with unknown extent) to
Break	contributes negatively and sufficiently to
GRL Correlation Links	**Question Vocabulary**
SomePositive	has some positive correlation (side-effect) on
SomeNegative	has some negative correlation (side-effect) on
GRL Decomposition Links	**Question Vocabulary**
Decomposition AND	The satisfaction of each of the sub-intentional elements is necessary to achieve the target
Decomposition OR	The satisfaction of one of the sub-intentional elements is sufficient to achieve the target, but many sub-intentional elements can be satisfied
Decomposition XOR	The satisfaction of one and only one of the sub-intentional elements is necessary to achieve the target

Table 11 GRL constructs and their corresponding vocabulary. Taken from [126].

The first issue to discuss when using the model is who the participants are, and their roles in the model's context and scope of use since the interactivity of stakeholders is a must in GORE modeling. For this purpose, the general approach found in the literature points out the use of **Round-Table Discussion and Consensus** (RTD&C) as the frequent and most recommended

method while using GORE models to ensure the user's participation and feedback [42], [116], [128]. Akhigbeal. [42] studied approaches of interaction with the stakeholders of the models to build and manage the characterization of the intentional elements and assign contribution values to links. According to Akhigbe et al. [42], the approaches with the most accurate results were when contact and discussion between the participants occur in a controlled environment, i.e., with direct participation of the analyst or researcher. Thus, the researcher controls the meetings, is the expert in the GRL notation, syntax, and grammar, and oversees the model's building based on the participants' **suggestions and arguments**. **Participants** contribute to the construction of the model with their knowledge of the context and domain. In this research, **participants** are people in the Business and IT units in charge of strategic planning who know and define the motivational aspects of the organization and possess decision-making power over the strategy, projects, initiatives, and resources of the organization.

The **researcher** must know concepts and frameworks for strategic planning, project management, and operations. Based on this knowledge and the discussions with the other participants, the **researcher** must design a questionnaire to help guide the discussions around the model. These questions and the moderation from the researcher must restrict the scope of the discussions. In the context of GRL, but also applicable to other GORE models, Hassine and Amyot developed a set of generic questions [125], [126] that can be adopted as the basis for a questionnaire to be used while building the GRL model or later to validate the results. Table 11 shows the constructs defined in the GRL syntaxis and the possible structure of a question. Naturally, some of the construct names can be changed according to the meaning in our defined domain and scope as defined in Table 10, thus, forming an enhanced questionnaire.

Based on their practical experience, Hassine and Amyot [125], [126] also recommend using quantitative values to identify the types of contributions, reducing the discussion time while agreeing on the types of contributions. Table 12 shows the ranges of recommended values for quantitative contribution types and their possible quantitative value.

Contribution Type	Quantitative Interval
Make	100
SomePositive	[50, 99]
Help	[1, 49]
Unknown	0
Hurt	[-49, -1]
SomeNegative	[-99, -50]
Break	-100

Table 12 Quantitative contribution intervals. Taken from [126].

5.2.2. Model Quality

To assess model quality, Horkoff [123] proposes two attributes that are affected by the development and analysis stages:

(1) **Accuracy**. Represents how well the model reflects the domain's perception of the modelers (analyst and participants) and the domain itself. A high-quality model is expected to fulfill both.
(2) **Comprehensibility**. How easy it is for the model's users to understand the intentional elements and their relationships. This attribute also encompasses the model's simplicity and level of detail applied according to its accuracy.

These two attributes are somewhat in conflict; when the model is more accurate, it is expected to have a higher level of detail, thus affecting the model's comprehensibility. From this perspective, a balance between accuracy and comprehension is expected. As explained in the previous section, it is essential that the analyst, when adding new knowledge to the model, always consults with the participants to assess the accuracy of the modification.

Iterative development of the model and its subsequent evaluation allows the modelers to question their knowledge and the nature of the domain being analyzed, updating it with new knowledge, ensuring its accuracy and comprehensibility [122].

5.3. The Method's Steps

This section introduces the method's steps and principles to use and build the GRL model. Most of the ideas are adapted from Yu et al. [129]. Their proposal uses the organization's intentional concepts to support an EA (Enterprise architecture) construction and evolution. The main goal is to ensure the traceability and analysis between the **how** (i.e., the EA, business processes, applications, data, infrastructure, resources, and initiatives) and the **why** (i.e., the organization's motivational aspects or high-level goals).

The general proposed steps to build a GORE model were first defined by Horkoff et al. [116], [128] and are complemented by our findings and learning during the case study application.

In general, the recommended steps are:

- **Step 1**: Build and identify the Organization's Motivational Model,
- **Step 2**: Build the Business and IT strategies iteratively,
- **Step 3**: Build and define GRL strategies to evaluate relationships and achievement of objectives and analyze the model,
- **Step 4**: Feed and update the model indicators according to the changes and updates while executing the strategic plans.

These steps can be performed sequentially or iteratively and can return to previous ones for refinement or revision.

5.3.1. Step 1: Build and Identify the Organization's Motivational Model

This step aims to answer the following questions: *What are the organization's mission and vision?* Furthermore, *why is the organization doing things the way it does?*

For this step, the primary source of information are the **institutional documents** and, if possible, documents or reports from previous **strategic planning exercises** performed within the organization. These documents must allow identifying the essential elements of motivation, such as:

- **Mission, Vision**,
- **Goals and objectives** related to them, and if possible, identify units responsible for their achievement,
- **Possible courses of action** taken or already in place in the form of strategies and tactics, programs, and projects.

Along with the motivational elements, it could be helpful to search for:

- SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis which organizes the organization's top strengths, weaknesses, opportunities, and threats into an organized list;
- Balanced Scorecard report of objectives, targets, and initiatives;
- Also, documents from current or previous strategic planning efforts usually include a structure based on the depuration of strategic goals into fine-grained and measurable goals assigned to programs or projects.

The researcher and participants can identify candidate intentional and motivational elements (as goals or softgoals) as well as current courses of action (programs, projects), allowing them to discuss the types of links (decompositions, contributions, or dependency) that propagate contribution values up to the motivational elements of the organization.

The Vision can be identified as a *softgoal* because it does not have a well-defined measure of achievement. Therefore, the Vision can be achieved by the Mission's contribution, and; the Mission can be identified as a *goal,* which in turn can be achieved through the specific goals in the strategic planning. However, to achieve this Mission (goal), the Business and IT units provide the actual execution of programs and projects (i.e., tasks) that will consume resources to fulfill it; this can be achieved by utilizing dependency links further in the modeling process (Step 2). For expressivity, we put together the identified motivational/intentional elements inside an actor representing the organization in its ideal form (i.e., its motivation); from this point on, we will refer to it as the *High-level Business or Organization* actor (See Figure 56).

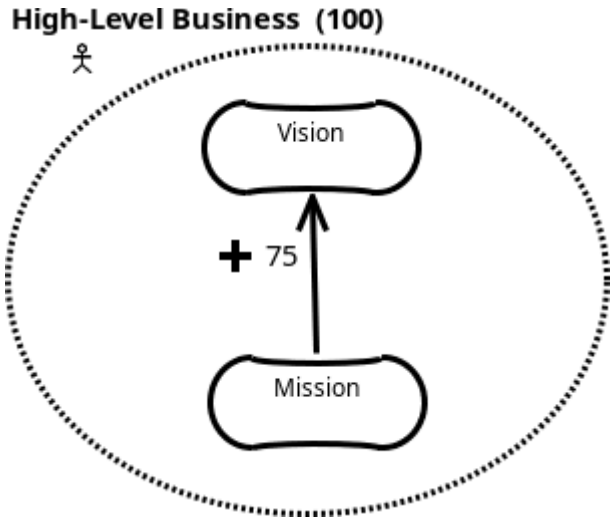


Figure 56 Example of a generic high-level business actor.

The result of this process, along with any existing documentation, should be a GRL definition of an actor representing the whole of the organization, its high-level goals based on its motivational aspects, and some initial links (decomposition and contributions) to fine-grained goals and intentional elements derived from the SWOT analysis.

5.3.2. Step 2: Build the Business and IT strategies iteratively

This step aims to answer the following questions: *What are the Business/IT goals that will help achieve the motivational aspects described before?* Furthermore, *how do the Business/IT goals relate to each other and the organization's motivation?*

Step 2.1. Identify Business and IT actors

Business and IT strategies can be developed using the same motivational elements of the organization. However, for larger organizations, it is expected that individual units also develop a motivational description of their strategy, which gives sustenance to that of the larger organization.

Two separate actors can be defined from this exercise, representing the Business and IT units, with their respective goals, intentions, and links:

- The Business unit represents the operational aspect of the business strategy, with fine-grain goals that can be represented by programs (characterized as goals) that manage several projects (characterized as tasks) that contribute to the achievement of the motivational aspects defined in Step 1, through contribution links.
- For the IT unit, this activity is similar in scope to Step 1. However, as stated before, particular motivational aspects can be identified for the unit, i.e., Mission and Vision, that contribute to the Mission/Vision of the Organization. These motivational elements can be achieved through contributions of high-level goals, which are achieved by implementing or executing strategic plans that can be operationalized by programs (characterized as goals) and specific projects (characterized as tasks).

Once the two new actors are defined, the researcher can identify possible relationships (contribution or dependency) between these actors and the High-level Organization. We found that the links that can be used are *contribution* or *dependency* since the boundaries between actors at this level are not too well established. In Programs, the actor's responsibilities to fulfill them can be shared. Figure 57 shows an example in which the two new actors (Business and IT) have two strategic goals that contribute to the high-level vision; each strategic goal has dependencies and contributions from projects within each unit; also, IT's strategic goal 01 (IT SG 01) contributes to the Business unit strategic goal 02 (BS SG 02).

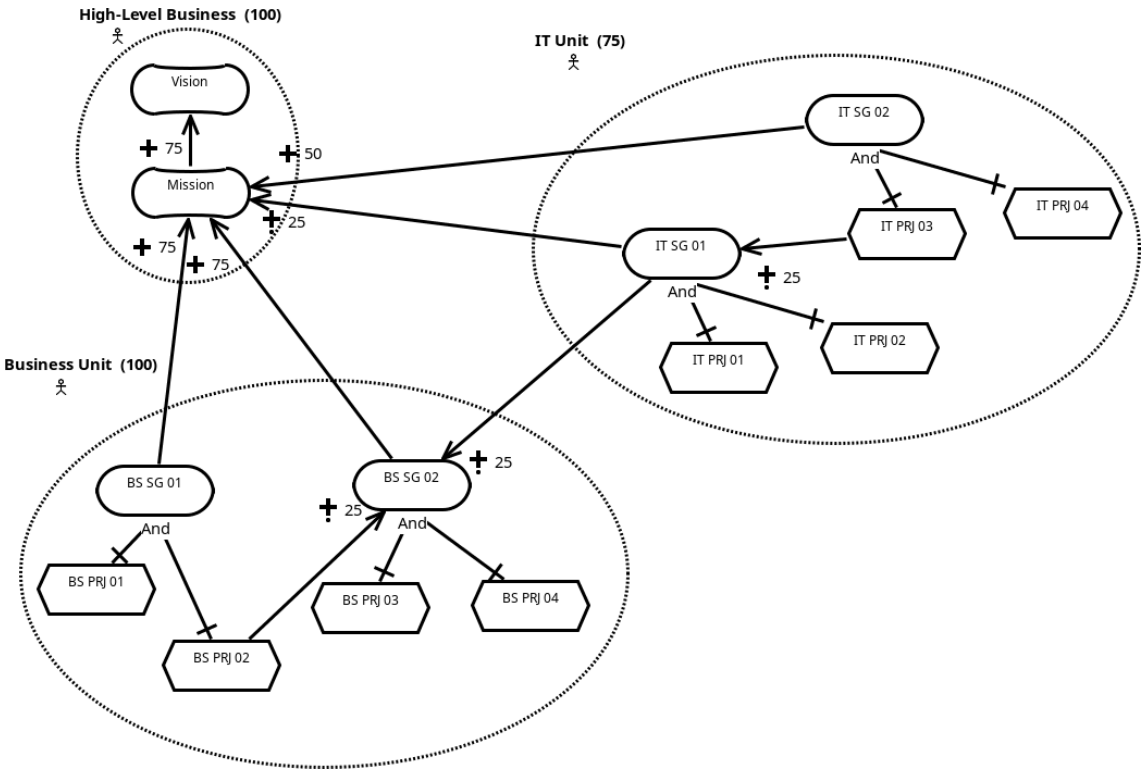


Figure 57 Actors view of an initial definition of business and IT strategies.

At this point, refinement can be performed by reviewing the links' qualitative or quantitative value and the levels of importance of the intentional elements. Also, it is essential to prioritize goals within both actors. These previous activities are essential for the researcher to make the most of the model when analyzing it.

Step 2.2. Refine and Add/Remove (New) Programs and Projects

The activities that the strategic management team performs are: to define new programs/projects to be added to the strategic plan, monitor and control the development and implantation of the projects' results into the organization's operational environment; and finally, remove projects or programs that are being developed but because of changes in the environment must be terminated or perhaps delayed. In order to manage the addition of new programs/projects into the strategy (Business or IT), the model provides us with a compelling set of tools to discuss the impacts and possibilities of these new projects by identifying intervening units responsible for the project or initiative.

The model can be updated as follows: Identify the **actors (units or individuals)** responsible for executing courses of action. Furthermore, identify the actor's **goals**, **tasks** (programs or projects), and **resources;** Connect those elements inside the actor using links (dependency or contribution). Discuss and characterize how the accomplishment of its intentional elements impact the context and scope of the strategic planning by **linking** the intentional elements within the new actor to other actors and the High-Level Organization. The researcher reviews the updated model after analyzing the answers and data collected during interviews iteratively. Identifying **dependencies** between the new actors and the **High-Level Organization, Business, IT, and other existing Actors** allows for tracing and formalizing the high-level expectations of the organization and the results expected from the Business/IT actors. Then, characterize **dependencies** between the **Business** and **IT** actors.

When using GRL to analyze **IT projects**, GRL recommends defining the project as an **actor**. In this way, each project is characterized by its own goals, softgoals, tasks, indicators, dependencies, and contributions allowing for the analysis of alternatives and contributions from the other actors. Figure 58 shows an example where *System X* supports some goals for *Business Unit X,* which in turn impacts the achievement of a strategic business goal (BS SG 02). The system has two alternatives being studied (A and B). The figure also shows the positive and negative contributions of such alternatives to *Business Unit X* and the *IT Unit*.

The first issue to discuss when using the model is who the participants are, and their roles in the model's context and scope of use since the interactivity of stakeholders is a must in GORE modeling. For this purpose, the general approach found in the literature points out the use of **Round-Table Discussion and Consensus** (RTD&C) as the frequent and most recommended method while using GORE models to ensure the user's participation and feedback [42], [116], [128]. Akhigbeal. [42] studied approaches of interaction with the stakeholders of the models to build and manage the characterization of the intentional elements and assign contribution values to links. According to Akhigbe et al. [42], the approaches with the most accurate results were when contact and discussion between the participants occur in a controlled environment, i.e., with direct participation of the analyst or researcher. Thus, the researcher controls the meetings, is the expert in the GRL notation, syntax, and grammar, and oversees the model's building based on the participants' **suggestions and arguments**. **Participants** contribute to the construction of the model with their knowledge of the context and domain. In this research,

participants are people in the Business and IT units in charge of strategic planning who know and define the motivational aspects of the organization and possess decision-making power over the strategy, projects, initiatives, and resources of the organization.

The **researcher** must design a questionnaire to help guide the discussions around the model. These questions and the moderation from the researcher must restrict the scope of the discussions. In the context of GRL, but also applicable to other GORE models, Hassine and Amyot developed a set of generic questions [125], [126] that can be adopted as the basis for a questionnaire to be used while building the GRL model or later to validate the results. Table 11 shows the constructs defined in the GRL syntaxis and the possible structure of a question. Naturally, some of the construct names can be changed according to the meaning in our defined domain and scope as defined in Table 10, thus, forming an enhanced questionnaire.

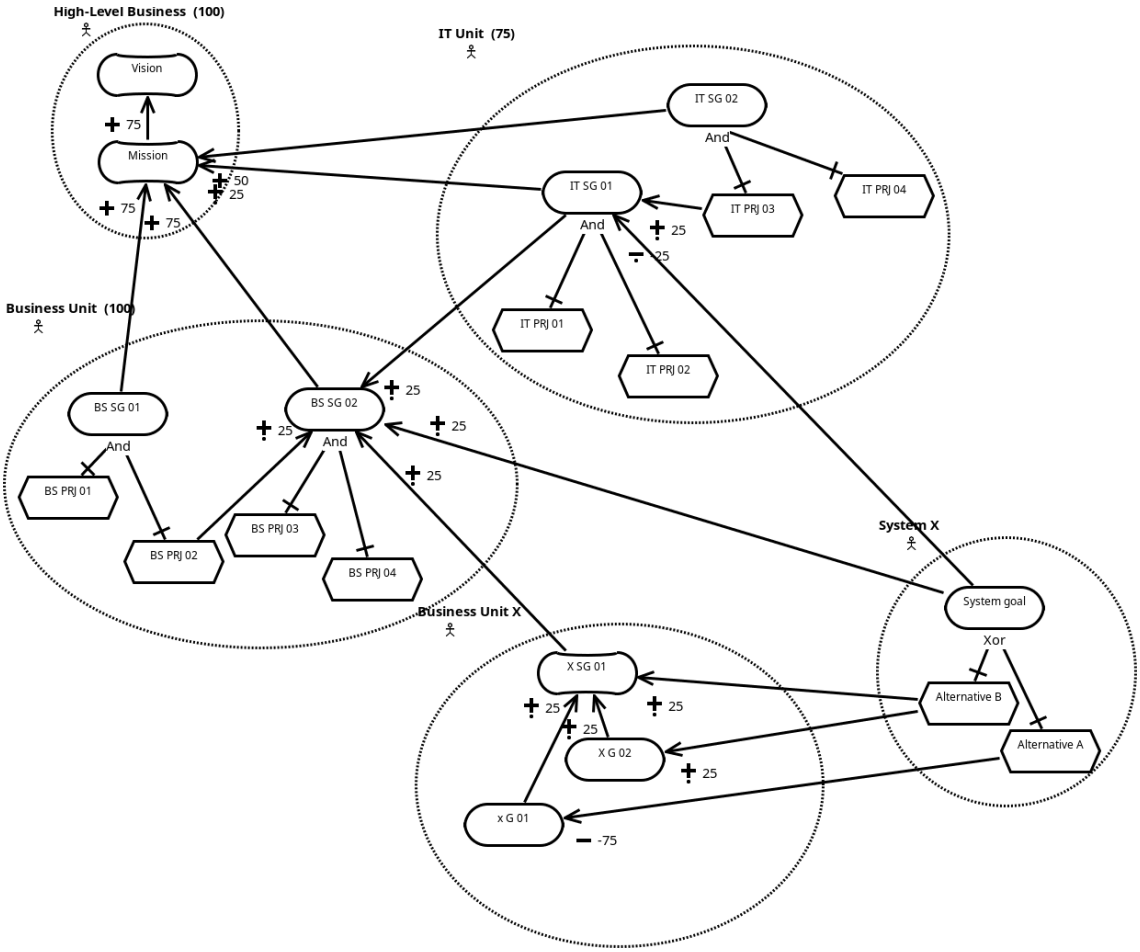


Figure 58 Defining a new system.

Once the project is approved, it can be included as a task in the general Business actor or IT, depending on its impact or the responsible unit; in this way, the project's status can be later updated to monitor the strategic plan. Figure 59 shows the new task (BS PRJ X) responsible for delivering System X; both contributions from *Business Unit X* and *System X* are represented by the decomposition link to the strategic business goal (BS SG 02).

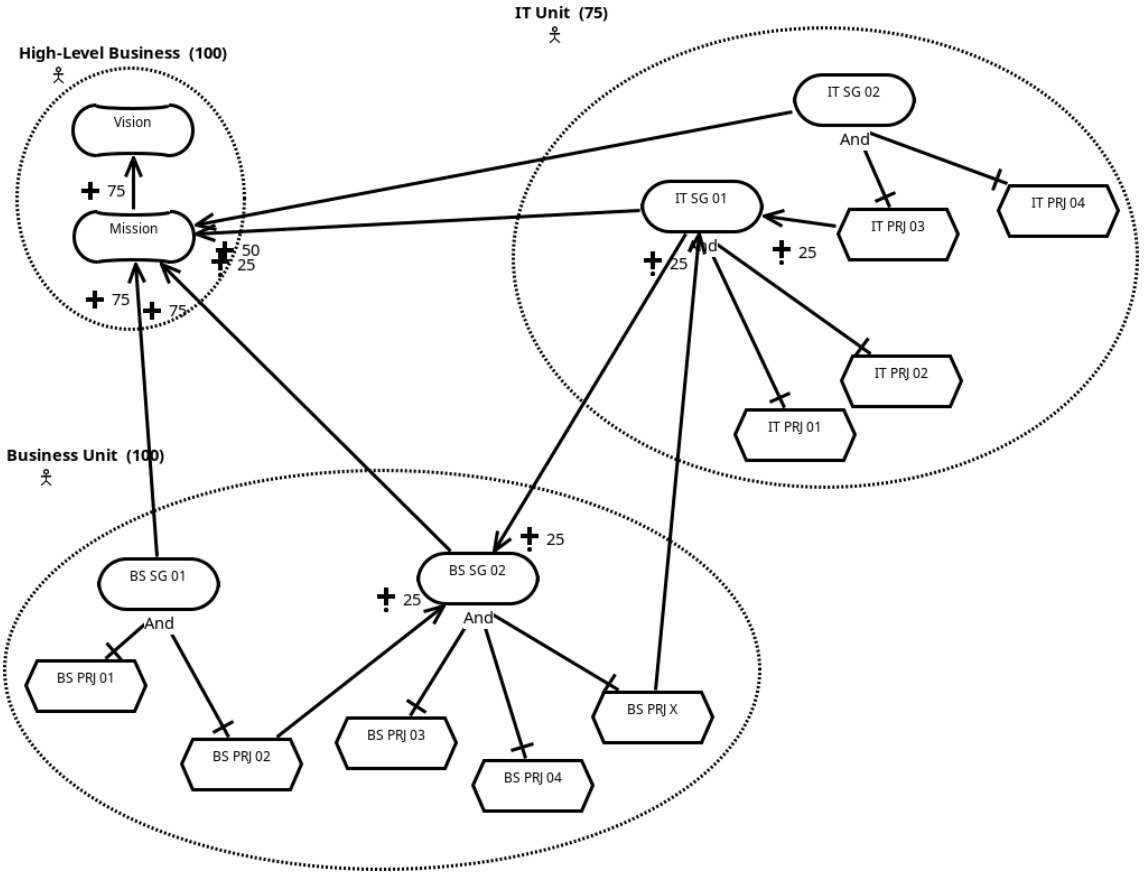


Figure 59 System X as Strategic Project X (BS PRJ X).

Finally, it is essential to **refine the links** between intentional elements **within** actors: i.e., identify if decompositions are fulfilled by AND, XOR, or OR type, and the identification of negative/positive contributions and their types of contributions (Make, Help, SomePositive, Unknown, SomeNegative, Hurt, Break). Ideally, no intentional elements should be isolated; this implies that another iteration must be performed to identify new intentional elements and links.

More straightforwardly, when **removing** projects or programs, they can be eliminated along with their contributions or decompositions; however, it is of utmost importance that the rationale behind such decisions is documented to keep track as a change management process for later stages of reporting.

This process results in a GRL diagram (or set of diagrams) with at least three actors representing the **High-level Organization** and its motivation, the **Business** and **IT** units and their respective strategic planning goals, and additional actors (units or roles) connected through **dependency and contribution links.** These actors show their internal intentional elements and how they can be achieved through tasks that can be analyzed to identify alternatives, as explained in Chapter 3 Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL)

5.3.3. Step 3: Build and Define GRL Strategies to Evaluate Relationships and Achievement of Objectives

This step aims to answer the following questions: *Which alternatives can help achieve the organization's goals? Which goals conflict? What (GRL) strategies can hurt or support business/IT goals and the organization's motivation?*

GRL is intended to capture the domain elements and the potential solutions or alternatives to achieve the domain's goals. Its focus is on the actor's interactions and understanding of the goals and links (decompostions, contributions, and dependencies) that motivate the developed alternatives. Moreover, it allows the discovery of new goals, which refines the researcher and participants' knowledge of the specific domain.

Once the model is stable, i.e., the participants have reached a consensus on the coverage and quality of the model, the next step is to analyze the alternatives using the GRL proposed evaluation algorithms; this also helps to test the structure of the model and identify isolated/unconnected intentions [128]. Horkoff and Yu [128] state that this initial analysis allows finding problems in the model related to the specific domain, in our case, strategic business and IT strategic planning domains. Once these problems and findings are discussed, a final refinement step can be performed. Finally, the evaluation process can be performed until all possible alternatives have been analyzed or enough knowledge on the problem has been reached.

For the researcher to perform the evaluation is necessary to specify sets of questions to analyze the model and identify possible alternatives for goal achievement. The types of questions that can be inferred to perform domain-driven analysis can be [116]:

- Which design options are the most viable? (Alternative analysis)
- Will a particular option work? For whom? (Goal achievement for an actor)
- Will the goals of a particular stakeholder be satisfied? (Actors' global satisfaction)
- Will a particular goal be satisfied?
- Can a set of particular goals be satisfied at the same time? (actors' satisfaction and, in perspective, possible alignment by satisfaction for both IT and Business).
- Even though we do not currently have the means to make "that" element has "this" value, what if we did have such means? (What-if scenario)

The following are the general steps for performing the analysis to seek an answer for each question [116], [128]:

1. **Initiation:** The researcher decides on an analysis question and applies corresponding initial evaluation labels to the model (as explained in Chapter 3 Goal-Oriented Requirements Engineering and the Goal-Oriented Requirements Language (GRL)). The initial labels are added to a set of labels to be propagated.
2. **Propagation**: The evaluation labels are propagated using the selected GRL algorithm through the model. The results are analyzed to determine which goals were achieved, which did not, and which alternatives (initial values) were responsible for the achievement or failure. This analysis can help identify other possible alternatives or intentional elements to which an initial value could be assigned and then repeat step 1 with the new initial values.
3. **Assessment**: The final results and the different sets of initial values are examined based on the initial analysis question. Further analysis and iterations will identify more issues

and new possibilities to be evaluated, leading to a more accurate model and better comprehension.

5.3.4. Step 4: Feed and Update the Model Indicators According to the Changes and Updates While Executing the Strategic Plans.

This step aims to answer the following questions: *How can the model be updated, maintained, and used to review the achievement of goals and the defined strategies (Step 3)?*

In order to discuss the first question, the model can be updated for every new or removed program or project that has a direct impact on the strategic goals (Business or IT). The business unit(s) stakeholders that contribute discuss the goals they seek to achieve with the proposed project or program and their impact on the high-level organization and IT unit. The researcher must update the model and inquiry about contributions (positive or negative) derived from the proposed new intentional elements (goals and tasks) or its elimination as described in Step 2.2. The new programs and projects are analyzed and later included as business or IT strategic projects. All decisions and conclusions from these updates must be documented for control management and future reporting purposes.

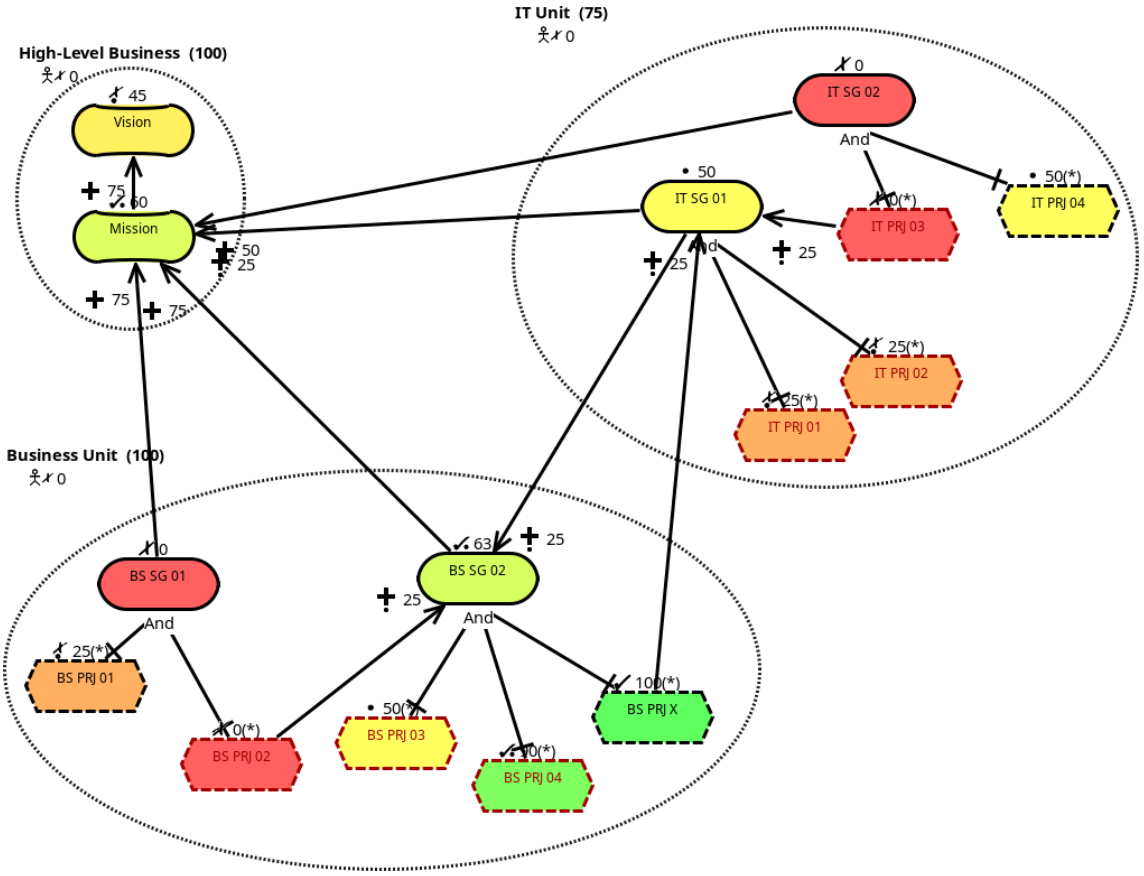


Figure 60 Example of the status and impact of the project on goals

On the other hand, participants can assess the current state of strategic goals, programs, and projects' achievement by creating a GRL strategy updated with the current percentage (%) of advancement of leaves (i.e., project status or achievement indicators if available). For example, Table 13 presents possible initial evaluation values a project could have. At this stage, indicators are recommended, and their values can be updated if the status of the project's contributions

to the operation changes. The example does not consider, for instance, projects that are falling behind schedule; in such a case, the researcher must assign a value below 50%.

Using strategy propagation algorithms, the researcher can propagate the projects' current state of development to the programs, actors' goals, and softgoals, allowing to estimate the level of achievement of strategic goals and actor's satisfaction (see Figure 60 for an example of the applied strategy) [120].

Finally, considering the definitions and uses of measurement and targets specified by the Balanced Scorecard (BSC) as they are assigned to initiatives and projects, we can use this concept to include indicators into the model once the projects have been deployed in a production environment. The measurements are being captured in real-time. Figure 61 shows an example of deployed projects; their status is updated based on indicators and measures captured once the project results are in production.

Possible Contribution	Meaning
0%	The project has not started its development
50%	The project is halfway in the development
90%	The project is being set in production
100%	The project has been delivered and is currently in operation

Table 13 Possible project contributions

The jUCMNav tool [112], [118]–[120], allows to export models to PDF, RTF, and HTML documents. Specifically, for GRL models, it shows the model's descriptions, documentation, and results of the execution of strategies.[2]

[2] **Annex 6** includes a generated report based on the example model presented in this chapter, and the generated report for the case study.

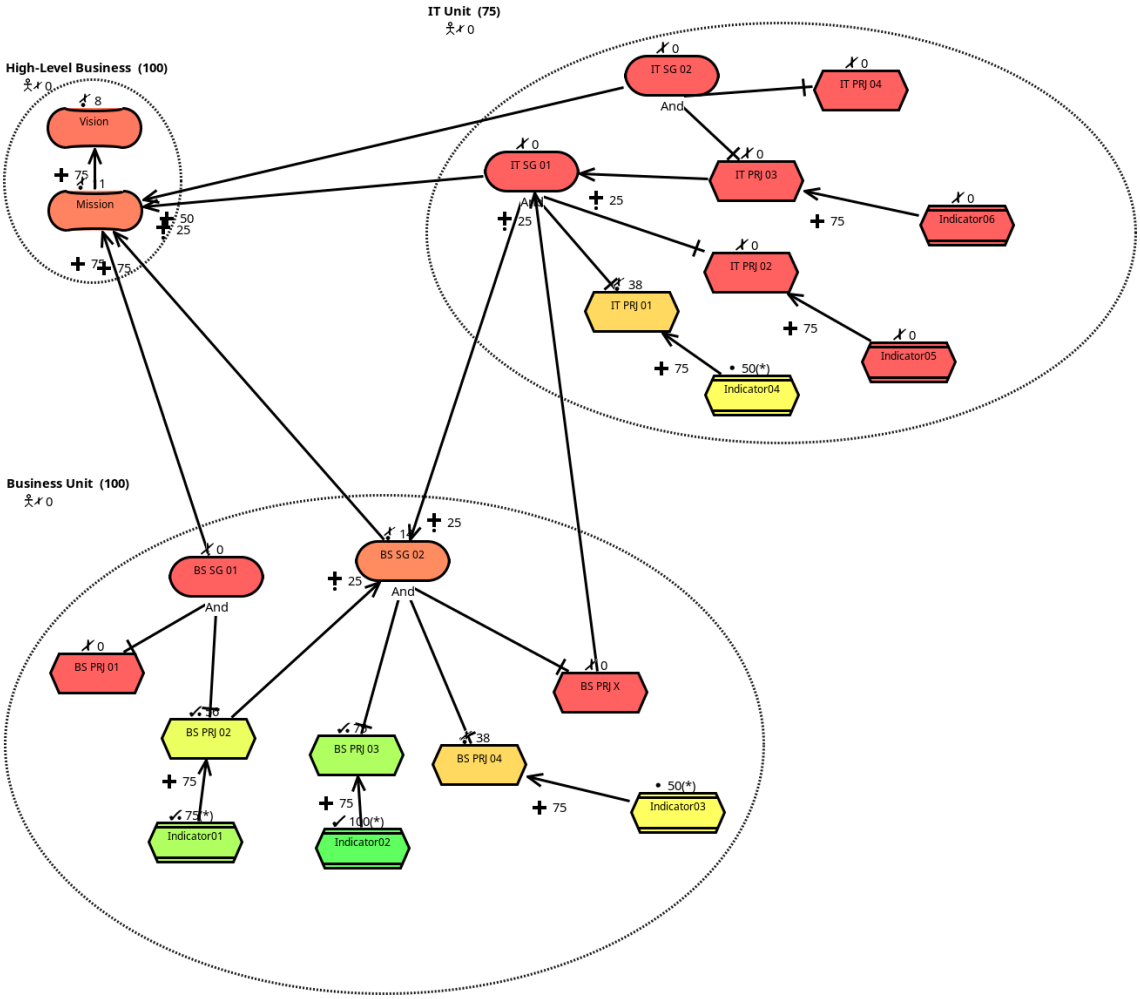


Figure 61 Example of goal fulfillment using Indicators of deployed projects.

Uses for the Proposed Model

Following the relevance cycle, i.e., reviewing the method and model proposal with experts and practitioners in a real-life setting, we concluded that the model could be applied and used in different settings and moments in business and IT strategic planning.

The following are the possible identified use scenarios:

- When the business organization is starting its strategic planning stages to build the business strategy and ensure its contributions to the motivational aspects of the organization,
- When the IT unit starts its strategic planning stages to build the IT strategy; ensuring its contributions to the motivational aspects of the organization and the strategic business plan (if it exists),
- When the business organization is starting its strategic planning stages and seeking strategic alignment with IT involves the IT unit, allowing for the identification of contributions to the motivational aspects of the organization, the business, and IT strategic plans,
- In later stages of the strategic cycle to assess the status of achievement of goals and actor's satisfaction either at the business or IT level or both,

Analyze the addition/removal of (new) projects (that involve both business and IT) to assess their impact on strategic planning and goals for both business and IT.

Chapter 6. Case Study

This chapter describes the organization selected for the case study, its structure, and how it performs its strategic planning process. Moreover, it presents how the proposed model was used based on its context and current strategic planning.

6.1. The Organization

The selected organization for the case study is Pontificia Universidad Javeriana (PUJ), one of the oldest academic institutions in Latin America, managed by the Society of Jesus. It was established in the colonial period; it operated from 1623 through 1767 when the Society of Jesus was expelled from Spanish territories, and then in 1930, it was reinstituted [130].

The PUJ is a private Colombian university comprised of two branches: the central headquarters in Bogotá and a sectional branch in Cali (Colombia). Each one of them works autonomously, according to the particular conditions of its environment and region. For this case study, the strategic planning observations and documents that we use are the ones of the central headquarters; however, some integration efforts are being developed as part of the strategic planning.

The organic structure of the University's central headquarters is composed, in the General Government, by [131] (See Figure 62):

- The University Board of Directors
- The Rector of the University
- The General Secretary
- The Academic Council
- The Administrative Council
- The Sectional Council of the University
- The Academic, Research, University, and Administrative Vice-Rectors

The government of each school is organized as follows:

- The School Council
- The Academic Dean
- The School Secretary
- The Department, Institute, Career, Specialization, Master, and Doctorate Program Directors.

In this structure, the faculty members are assigned to Departments or Institutes, and students are linked to the university through its undergraduate or graduate academic programs.

The university's Rector is the government authority in charge of the general direction of the university and acts as its legal representative. The Rectory has the following units: the General Secretariat, the Legal Directorate, the Communications Directorate, the Planning Secretariat, and the Private Secretariat.

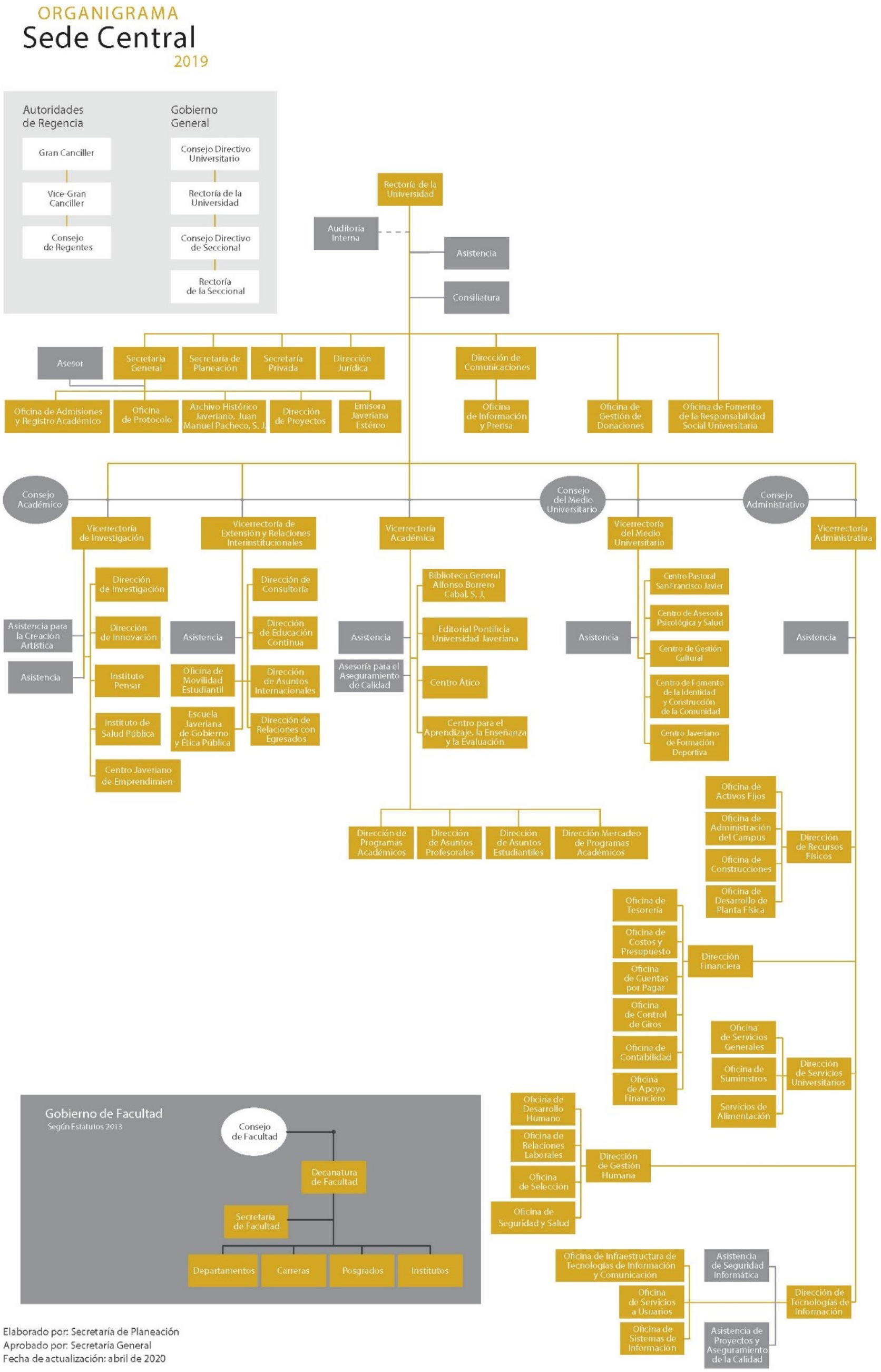


Figure 62 Organizational Structure. Taken from [131].

As of 2020, the headquarters had more than 1,500 administrative employees, 1,200 faculty members, and more than 24,000 graduate and undergraduate students [132].

6.2. The Organization's Strategic Planning

This section presents an overview of the strategic planning within the PUJ based on internal and public documents and refined through individual interviews with personnel of the Planning Secretariat and the Information Technology Directorate. The unit in charge of formulating and managing strategic business planning is the Planning Secretariat, under the supervision of the Rectory [133].

6.2.1. Strategic Business Planning

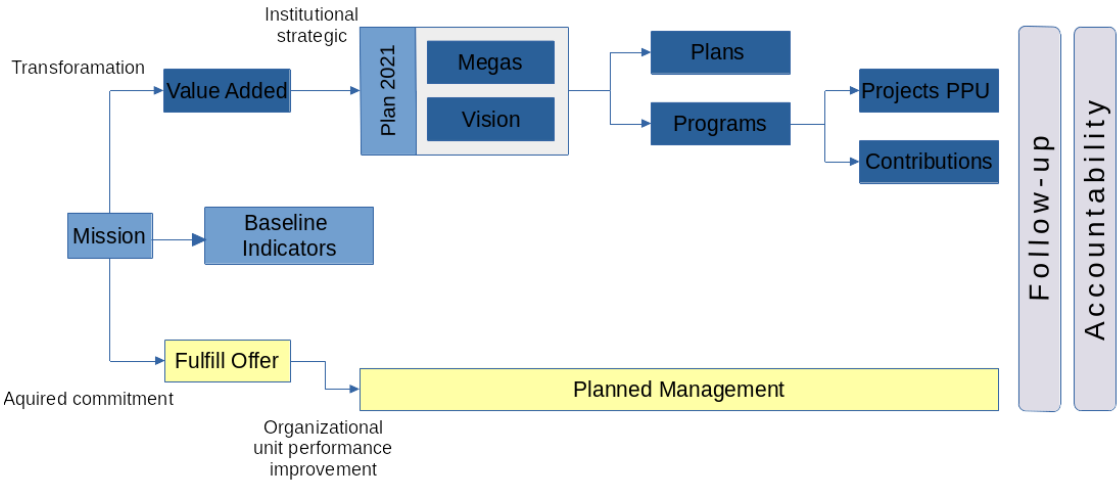


Figure 63 Strategic Business Planning. Adapted from [133].

Figure 63 outlines the process for defining and managing strategic planning from 2016 to 2021. In the first place, the Vision and Mission are jointly defined by the university community through various meetings and working groups [134], with direct coordination from the Rectory and in conjunction with its closest units. The management roles of the units, applying an iterative development throughout the process defined as *thinking*, *doing*, *learning*, and *reflecting*, define plans and programs for the foreseeable future.

The current **Mission** and **Vision** are as follows [134]:

"***Mission***: *The Pontificia Universidad Javeriana is a Catholic institution of higher education, founded and run by the Society of Jesus, committed to the educational principles and guidelines of the founding entity. It performs teaching, research, and service with excellence, as a university integrated into a country of regions, with a global and interdisciplinary perspective, and aims to:*

- the comprehensive training of people who stand out for their high human, ethical, academic, professional quality and their social responsibility; and,

- the creation and development of knowledge and culture from a critical and innovative perspective for achieving a just, sustainable, inclusive, democratic, supportive society and respectful of human dignity."

"***Vision****: In 2021, the PUJ will be a national and international benchmark for the coherence between its identity and its work, its educational proposal, its capacity for institutional learning,*

as well as its contribution to the transformation of Colombia, from a Catholic, innovative and ecological perspective. Integral."

From the previous definitions, two work branches are generated. On the one hand, the lower part of Figure 63 corresponds to *Planned Management*, ensuring the efficient work of daily operations and management of the eventual improvements identified during operations. On the other hand, the upper part of Figure 63 manages strategic planning based on the *Vision* and *Mission*. It defines what the organization calls *Megas* that represent challenging goals, reflecting the identity of the PUJ. They can be grouped and measured as follows [134]:

Megas:

1. "*Ensure that academic activities impact the dynamics of reconciliation in the country and with an innovative character.*
2. *Within our option of human and academic excellence, prioritize the dimensions of interculturality, internationalization, and care of the Common Home.*
3. *Ensure the integral sustainable development of the university, rooted in the university's wellbeing.*
4. *Transform the decision-making system so that they are effective, based on institutionally defined criteria, and oriented towards realizing the vision*."

Also derived from the previous orientations, the Higher University Council then defined six strategic programs and their performance measures [134]:

- "**STRENGTHENING THE EDUCATIONAL COMMUNITY** To ensure that the members of the educational community take ownership of the Javeriana identity, commit to the institution, express the educational project in their work, and ensure that the institutional interest is within the framework of individual and group interests.
- **CULTURE OF EXCELLENCE** To ensure a culture of human and academic excellence in the work of the Pontificia Universidad Javeriana, with an innovative perspective and thus contribute to the development of higher education.
- **INTEGRAL ECOLOGY** To integrate into academic, University, and administrative activities the guidelines on caring for the Common Home of the *Encyclical Laudato Si* [135].
- **RECONCILIATION FOR THE CONSTRUCTION OF PEACE** To achieve that, the Pontificia Universidad Javeriana, according to its university nature, participates effectively in the reconciliation processes to construct peace in the country.
- **IMPACT ON SOCIAL TRANSFORMATION** To ensure that the Pontificia Universidad Javeriana, in its substantive functions, contributes to citizenship training and overcomes injustice, indifference, and corruption.
- **GOOD GOVERNANCE** To ensure that the decisions, processes, resources, and organization ensure, within a framework of respect and promotion of all people, the coherence, transparency, effectiveness, and sustainability of the Pontifical Javeriana University."

Based on these programs, defined towards mid-2017, the institution defined various University Planning Projects (PPU) and Unit Contributions. Contributions are projects originated in the units (e.g., Rectory, Vice-rectories, or Schools) for institutional development in realizing a 2021 program, in one of its initiatives, with defined and executable budgets within one year.

Each Unit presented a maximum of two contribution proposals. The School Council considered these proposals in the schools, while the Rectory and Vice Rectories studied the other proposals.

Contributions are not developed to meet a particular Unit goal in the University Planning Program or solve its problems. In this sense, contributions belong to the planned management (Lower part of Figure 63), and each contribution must directly impact the university's strategic development. In contrast, the University Planning Projects (PPUs) are initiatives of an institutional nature in the medium and short term for achieving a 2021 strategic planning program. They involve various business units and have a defined and executable budget of one to four years.

In support of administrative aspects that are seen as transversal or support processes, the University defined three strategic plans, which seek to strengthen management capacities in IT, physical infrastructure, and faculty development:

- **The Technology Development Plan** is the basis for forming and supporting the IT Strategic Plan, managed by the Information Technology Directorate. It is described later in greater detail due to its relevance for this research project.
- **The Infrastructure Development Plan** considers changes in urban normativity, student growth projections, and the availability of financial resources. It seeks to build the most desirable campus to comply with the Institutional Educational Project. This plan runs from 2008 to 2028.
- **The Faculty Development Plan** began in 2014 and involved the headquarters and the sectional. It addresses the development strategies of the faculty members. It focuses on constructing a framework and base documents that update and modernize the advancement factors of the teaching profession.

There is a lack of public information on the last two plans; however, this issue does not affect the accomplishment of this thesis.

Performance Measures

From confidential documents provided by the Planning Secretariat, we identified forty (40) performance measures that the organization uses to assess its current performance (2019 or 2020, depending on the availability of the measurements) compared to the previous period assessed (2016). The measurements are not directly associated with motivational elements, i.e., Mission, Vision, and Megas, or strategic plans. Instead, the measures are defined around operational results and services provided by the organization, such as Research, Internationalization, Quality, Innovation, Culture, Regions, Positioning, Teachers, Students, among others (not shared because of confidentiality reasons). This is a problem for us since it is not possible to identify direct relation between the performance measures and the plans and projects in the strategic plan.

6.2.2. Strategic Technology Plan

This plan was created by the Information Technology Directorate (DTI by its acronym in Spanish – *Dirección de Tecnologías de Información*). This unit depends directly on the Administrative Vice-rectory. Due to its origin and role, it is seen as a supporting unit that helps meet the organization's needs. However, it has gradually gained a position on the Board of Directors due to the high impact and agility implied by the decisions made regarding the organization's operation and investments. The unit itself does not include motivational elements other than an objective that says: "*Support through innovative management of technologies, the fulfillment*

of the Mission and the achievement of the Vision of the University, within the framework of University Planning."

For confidentiality reasons, we present only the general structure of this plan, and then we describe how the GRL model has been defined based upon such a plan.

The plan is divided into four lines or high-level objectives. Each one has assigned a set of objectives that, in turn, are achieved by specific programs and projects. A high percentage of them have already finished successfully. Their results have been incorporated into the operational processes of both Business and DTI, while others, especially those of Line 4, are still under development.

Line 1 says, "Incorporate technologies in the teaching, learning, and evaluation processes." The following three specific objectives were derived:

- "Provide services supported by technologies that assist the processes and models of teaching, learning, evaluation, and curricular innovation, and that in turn make their access more flexible and straightforward.
- Provide information services that support the processes of analysis of the most sensitive factors of the academic management of the University.
- Enable the implementation of dynamic spaces for teaching, learning, and assessment through the adaptive incorporation of technologies."

Four programs involving seven projects were defined to achieve these objectives,

Line 2 says, "Support the processes of research, innovation and scientific, artistic and technological development by incorporating technologies." The following three specific objectives are derived from it:

- "Support these processes through the integrated management of the technological capabilities and robust equipment existing at the University.
- Implement at the University the technologies from centers of excellence and research projects, according to their relevance.
- Provide services supported by technologies for the processes of research, innovation, and scientific, artistic, and technological development."

Four programs involving four projects were defined to achieve these objectives.

Line 3 says, "Incorporate technologies for the efficient management of the processes of teaching, research, services, university, and administrative environment." The following three specific objectives are derived:

- "Manage the permanent review and update of the information and communication technology platforms to guarantee their relevance and availability.
- Support information platforms that support data analysis processes for decision-making.
- Evaluate and lead the implementation of new technologies that generate greater operational efficiencies."

Six programs involving nine projects were defined to achieve these objectives.

Finally, **Line 4** says, "Optimize the Technology Governance model." From it, the following four strategic objectives are derived:

- "Lead the definition of plans for exploration, acquisition, operation, maintenance, continuous improvement, and renewal of technologies, incorporating relevant industry trends.
- Develop and implement policies, guidelines, and standards that guide the articulated, integrated, and efficient use of the different capacities and technologies existing at the University.
- Lead the definition of an institutional information security strategy based on risk management, in line with the pace of new threats and security challenges.
- Promote the development of human capital that manages and consumes technologies at the University to promote digital culture."

Two programs involving nine projects were defined to achieve these objectives.

6.3. Case Study

This section describes the process and decisions made when modeling the organization's business and IT strategic plans, represented in the model built using GRL and the proposed method.

6.3.1. High-level Motivational Elements

In the first iteration, to define the high-level motivational elements (Mission and Vision and Megas), we examine the public document titled *Elements for Planning 2016-2021* [134]. At first glance, the most evident difficulty is using *softgoals* or *goals* for the motivational elements. Considering that the *Mission* is a goal that is not necessarily achievable and measurable, it is defined as a *softgoal*. As defined by the strategists, the Mission can be achieved by the Vision; however, since both are aspirational and other external influences can also affect the Mission's achievement, the contribution from the Vision is assigned at 75. The *Vision* and the *Megas* are defined as goals considering that they are achieved through projects, and comparable indicators can be measured. All the *Megas* at this level of abstraction have the same level of importance; therefore, the importance value of the intentional elements was not included in the GRL model (see Figure 64). Their contribution to attaining the Vision was connected using *And-Decomposition* links. Moreover, the *Mission* is achieved if the *Vision* is achieved but not with 100% certainty.

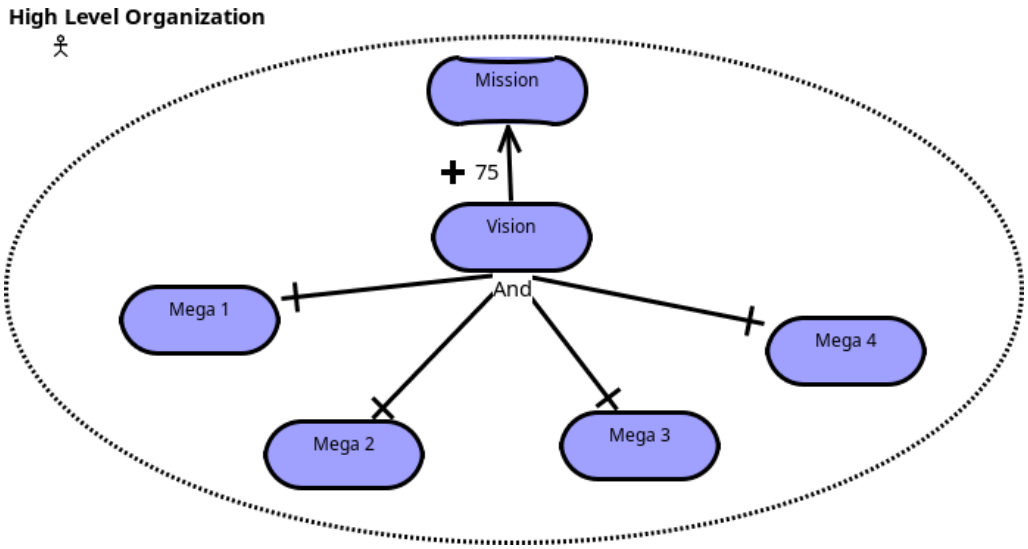


Figure 64 Initial GRL Model for the motivational aspects.

6.3.2. Strategic Business Plan

Once the motivational elements have been defined, we have relied on two primary documents to carry out the first iteration. The first one, provided by the General Secretariat, presents the diagnosis and status of university planning from 2016 to 2021. The Rectory was responsible for the other one as part of its management report for 2021 [133]. Both documents describe the projects and contributions approved and developed during the mentioned period. For clarity and separation of the motivational elements from the strategic ones, a new actor (*Business*) was defined, representing the strategic business planning. Six *Strategic Programs* were included in it. As they are too broad rather than activities themselves, they were defined as *goals*. PPUs were defined as *tasks* associated with the *Strategic Programs* based on their definition in the documents. PPUs were connected to the *Strategic Plans* using the *And-Decomposition* link since all intentional elements (PPUs) are necessary to achieve the *Strategic Program* (goal). The "Impact on Social Transformation" and "Good Government" programs did not have associated PPUs. Instead, they had contributions from different units that were not included in our case study because of their short-lived nature. We have only considered the PPUs because they are under the direct control of the Rectory and Vice-rectories. Finally, programs were connected to the *Megas* using *Contribution* links with a *Help-type* influence; this was discussed in various interviews with practitioners. It is clear that the programs influence the motivational aspects, but they are not the only contributors; other projects, initiatives, and operational improvements also contribute, but it is too complex for the practitioners to keep track of each of them due to the size of the organization.

Figure 65 shows the updated GRL model, where the purple-filled intentional elements correspond to the motivational aspects of the organization, i.e., *Mission*, *Vision*, and *Megas*. The cyan-filled goals are the strategic programs, and the white-filled tasks are the PPUs that achieve them. The reviewed documents do not provide specific goals or explanations for the existence of each project; they only briefly describe the expected results and the organizational units responsible; because of that, it is not possible to assign indicators to projects or programs.

6.3.3. Strategic Technology Plan

As explained before, the DTI (Information Technology Directorate) has only one goal that is too broad and difficult to measure. Based on the same premise and assumptions we made for the Strategic Business Plan, we decided to define it as a softgoal. This softgoal contributes to the Vision of the High-level Organization with an initial *help-type* influence.

The Strategic Technology Plan influences the motivational goal of the organization directly through a contribution link. The plan has a structure that can be seen as a Program in the context of project management, and we decided to mark it as a goal to be consistent with the business strategy. It is achieved once the four lines have achieved their objectives. In turn, the four lines in which the Strategic Technology Plan is divided were defined as softgoals, while the goals associated with each line were defined as goals since the projects directly impact them. The goals of the lines are connected using *And-dependency* links.

Following the same logic, the programs that support each line were defined as goals, and they, in turn, are related to the projects (tasks) that connect them through *And-decomposition* links.

The importance value of intentional elements was not assigned since the reviewed documents do not prioritize or assign measurements for comparison. However, the organization's practitioners agree that some projects have higher priority than others depending on the role and power of the project's sponsor.

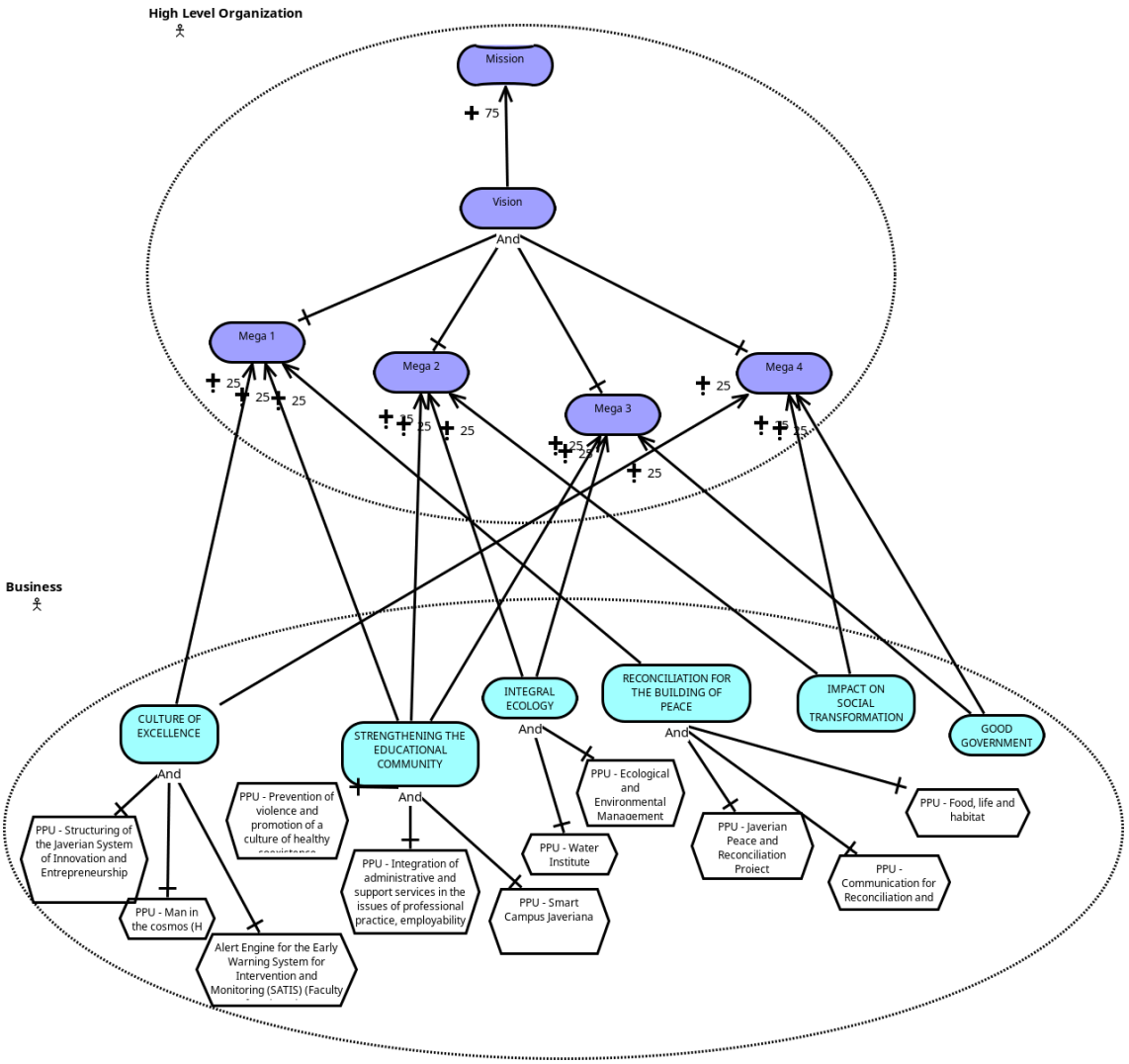


Figure 65 First iteration, including Motivational elements and Strategic Business Plan.

Figure 66 shows the updated GRL model for the DTI. The purple-filled intentional elements correspond to the motivational aspects of the unit, i.e., Strategic Goals. The cyan-filled goals are the lines, the brown-filled intentional elements are the goals associated with each line, the dark blue-filled elements are the programs, and the white-filled tasks are the projects that achieve them.

Finally, Figure 67 shows the full GRL model with the three identified actors.

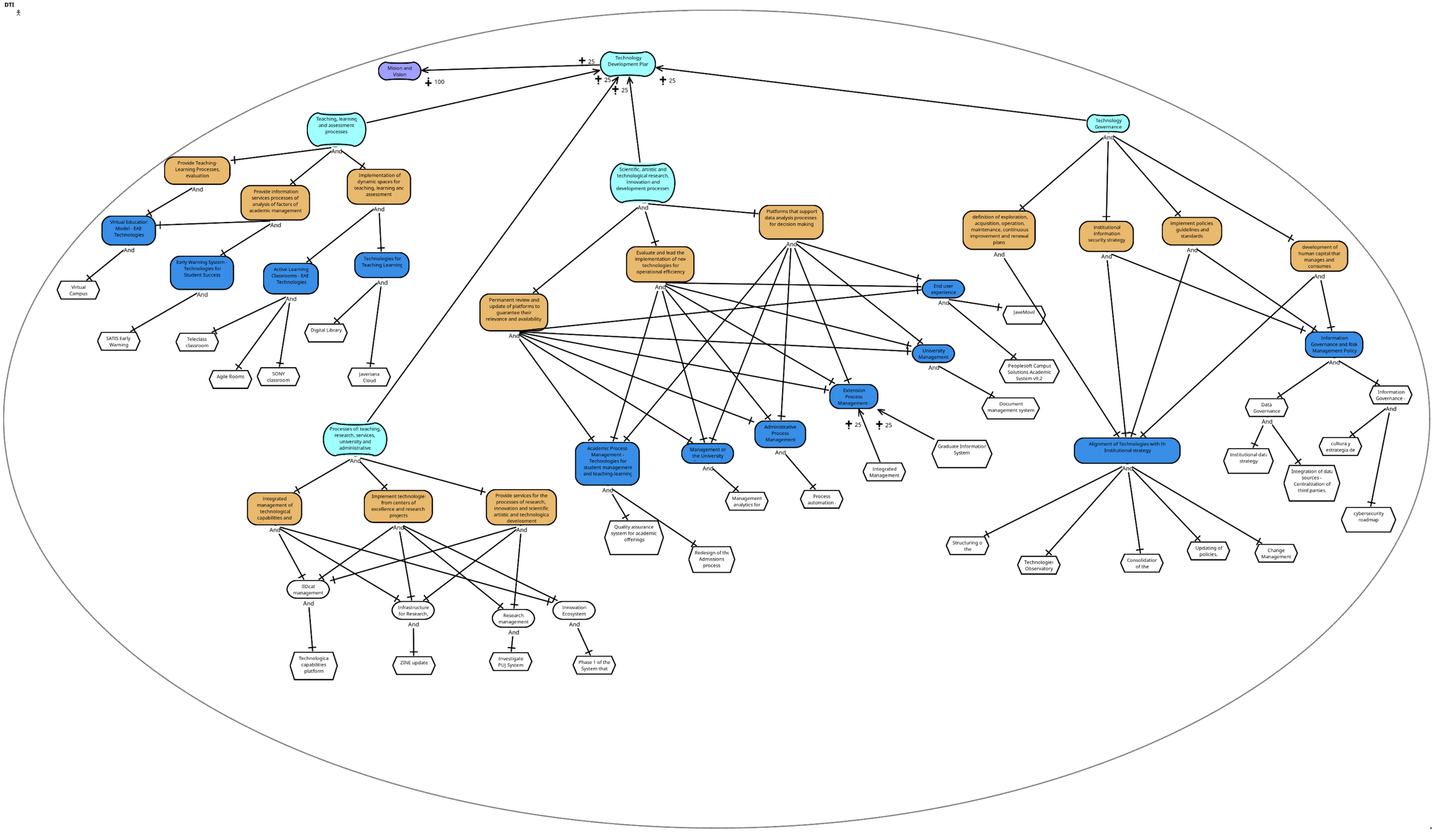


Figure 66 DTI Strategic Technology Plan.

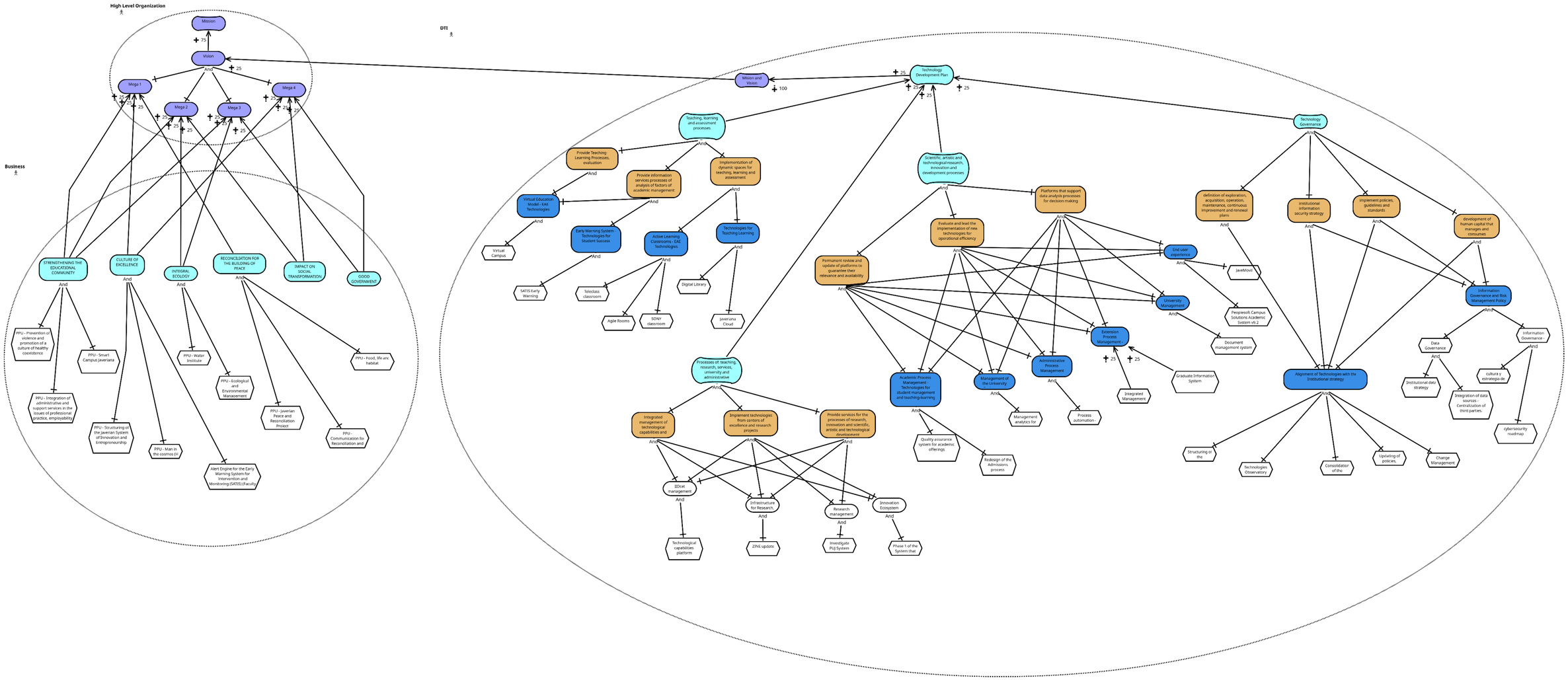


Figure 67 GRL model depicting the motivational and intentional elements of the Strategic Business and Technology Plan.

6.3.4. Analyzing and Updating the Model

The following section was built upon **hypothetical** examples and cases defined to show the possible uses of the model and from recommendations and feedback collected during meetings with the practitioners within the case study organization. The purpose of these examples is explicative and does not represent the actual use of the model.

Assessing Goal Achievement

Once the GRL model was developed, the projects' evaluation value could be updated when a quick view of goal achievement was required. For this purpose, the model was updated using the GRL tool (jUCMNav Eclipse plugin) [112], with initial evaluation values of projects ranging from 0% to 100%. This model and its use were presented to the practitioners in the IT unit. The discussion led to updating Steps 3 and 4 of the method and, in particular, how to use and understand the meaning of evaluation percentages for projects (see Figure 68). The use of GRL indicators was shown and explained to the practitioners; they agree that this is a better way to model projects' status and contributions. It could feed real-life measurements of the project's result if the business or IT were using the BSC (which they do not), giving more reliable information for practitioners.

Adding and Removing (New) Programs and Projects

A critical aspect of strategic planning for practitioners is to update the plan accordingly when projects must be eliminated or when new business requirements appear. In this context, the contributions that the eliminated project made to the original model must be reviewed to analyze the impact on goal achievement when removing projects or initiatives. On the other hand, new projects or initiatives should be studied and analyzed first to decide if they impact the motivational or strategic goals and then analyze their contributions to other intentional elements within the model.

We presented the proposed model and methodology to the practitioners several times. From those conversations, we concluded that whenever a new project needs to be added to the model, both the involved business units (responsible/affected) and the project should be added to the model as separate actors—allowing the researcher to study and refine their intentional elements and contributions. As described in Chapter 3, the model could be used to define and refine functional and non-functional requirements in system and software development.

In the case study context, the analysis of adding a new project could not be applied due to time restrictions and the amount of personnel required to perform it. Instead, we designed an example of use and analysis for the practitioners to discuss based on GRL examples and descriptions. Figure 69 and Figure 70 show the two alternatives designed. To perform the comparison, we used the concepts presented in Chapter 3 when a new system was proposed. For this example, two actors were added, one intervening business unit and the analyzed system; within the system, two alternatives were defined and analyzed. In this way, the researcher can study the goals, contributions, and alternatives. Once a decision has been made on an alternative and its requirements, the project was included in the strategic business plan as a task (see Figure 71). The business units could be represented in the GRL model; however, it would only increase the model's complexity without adding relevant information, at least at the strategic level.

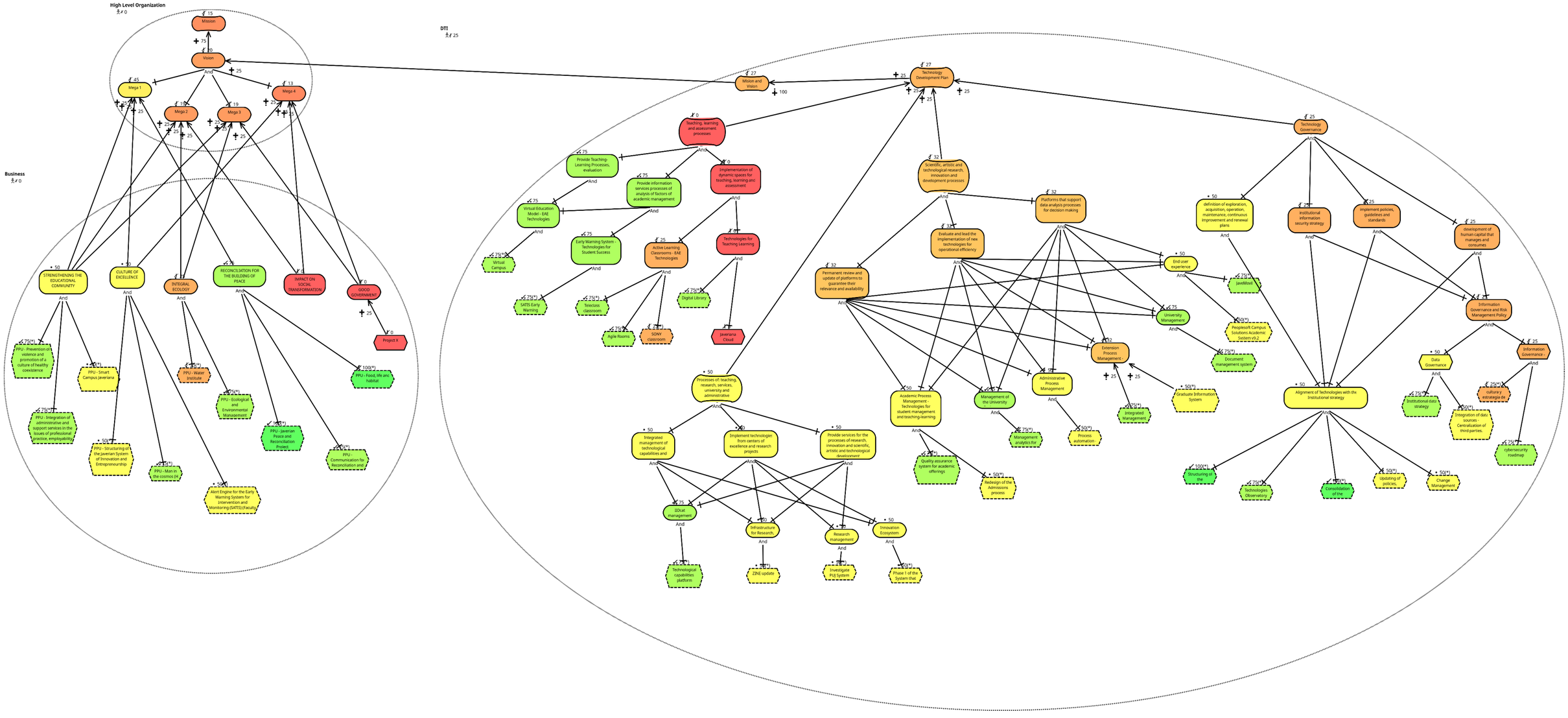


Figure 68 Projects status and impact on goals

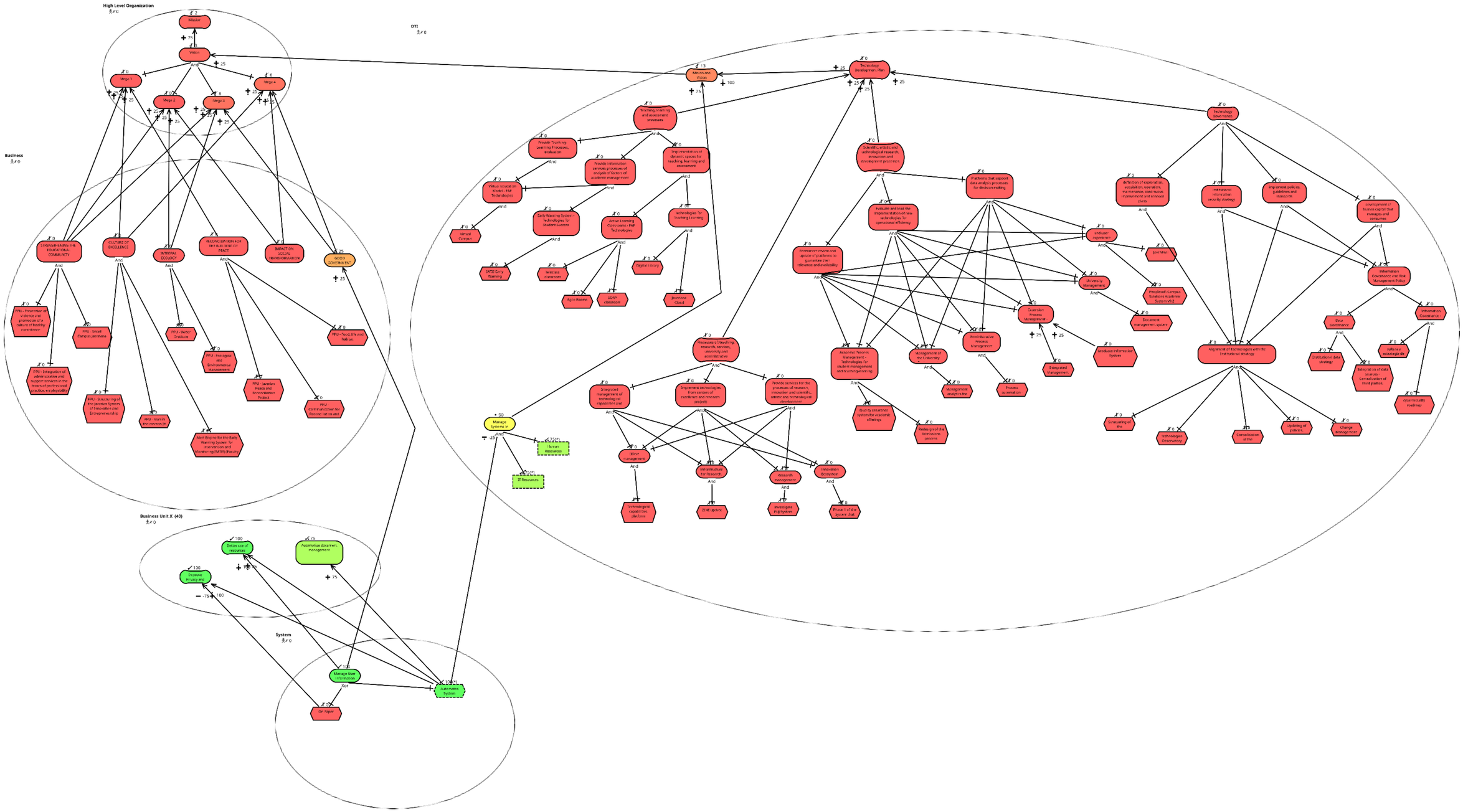


Figure 69 Evaluating two alternatives and their contributions to other actors. Alternative 1.

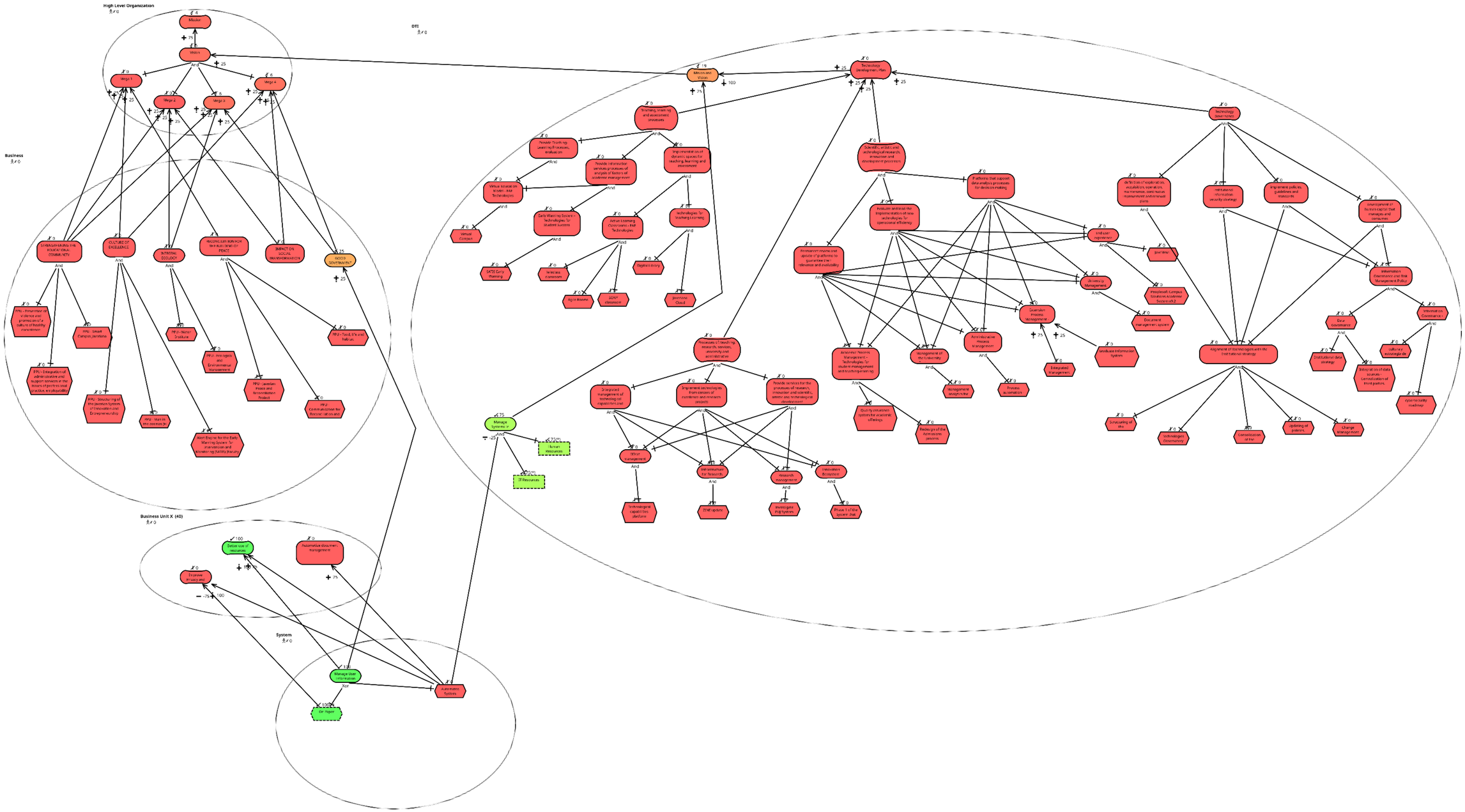


Figure 70 Evaluating two alternatives and their contributions to other actors. Alternative 2.

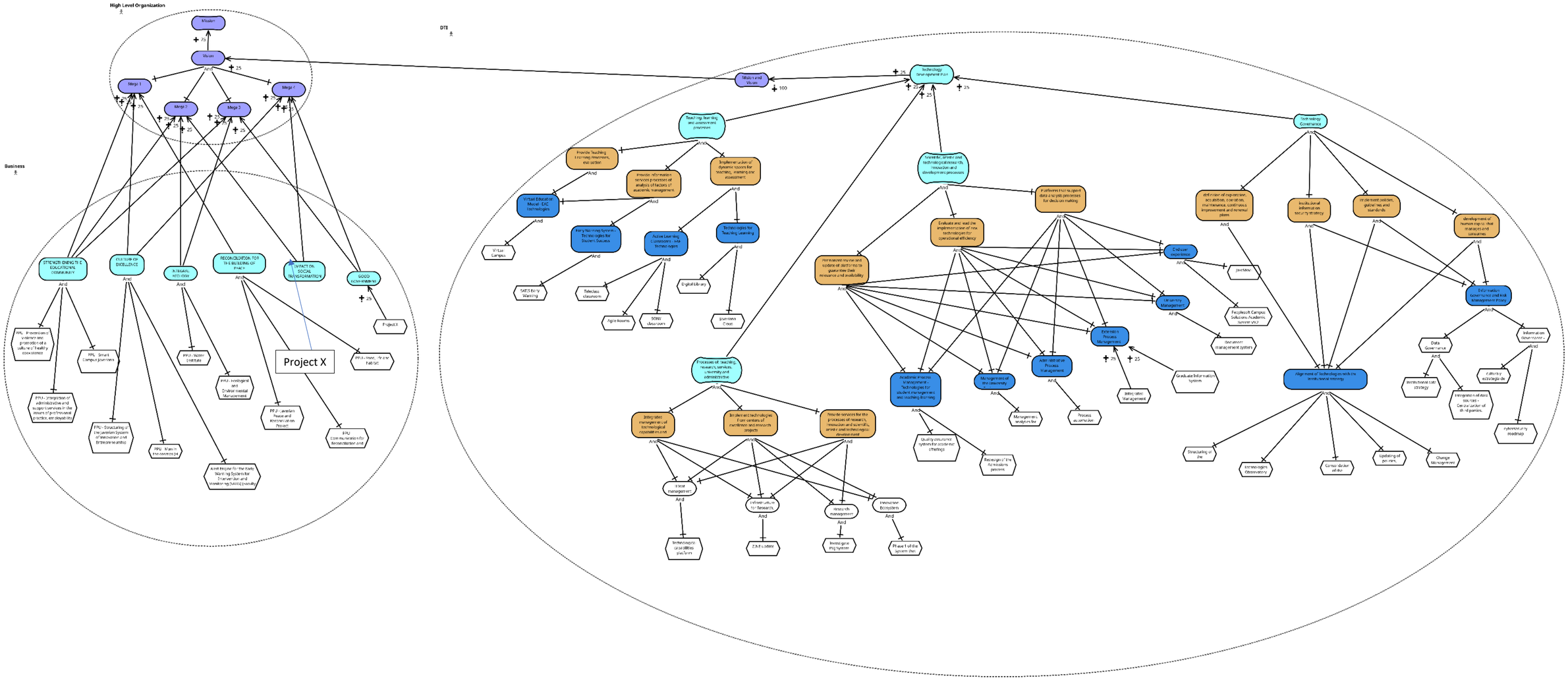


Figure 71 Project X was added after evaluation of the alternatives.

Chapter 7. Evaluation of the Proposed Model

As described in the Methodology section, Design Science (DS) produces artifacts that seek to attain a goal; the criteria must assess such artifacts based on value or utility [56]. The validation is performed based on an evaluation of how well it completes the tasks it is supposed to perform within the specified context [136]. For Design Science (DS), this can be performed utilizing what some authors call "instantiations," allowing to assess the artifact and refine its development or identify new gaps or opportunities for the future by applying a **Relevance cycle** [52], [56]**;** this is presented in Chapter 6. On the other hand, after demonstrating the model, it must be evaluated from a summative and formative point of view. In this regard, the *Unified Theory of Acceptance and Use of Technology* (UTAUT) [59] has been used to determine the potential usage effects of artifacts generated from a DS perspective.

7.1. Technology Acceptance

Several models for technology acceptance assessment have been proposed. For instance, Davis proposed TAM in 1989 [137]. TAM has become the basis for other acceptance models whose purpose is to measure and predict the use of an artifact (e.g., an information system or application in the context of information technology). The used model in our case is an artifact consisting of two sets of questions that seek to assess two theoretical constructs defined as determinants for system use: **Perceived usefulness** is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [137], while **perceived ease of use** refers to "the degree to which a person believes that using a particular system would be free of effort" [137].

In 2003 Venkatesh et al. [59] presented *the Unified Theory of Acceptance and Use of Technology* (UTAUT), where they discussed and empirically compared eight (8) models of user acceptance (TAM and TAM2, a revision also made by Davies were included) rooted in information systems, psychology, and sociology. Based on their findings, they proposed the UTAUT model that integrates elements across the eight models. As well as TAM, it defines a set of theoretical core determinants of intention and usage [59]:

- **Performance Expectancy** is the degree to which an individual believes that using the system will help her attain gains in job performance. It is equivalent to perceived usefulness in TAM,
- **Effort Expectancy** is defined as the degree of ease associated with using the system. It is equivalent to perceived ease of use in TAM,
- **Social Influence** is defined as the degree to which an individual perceives that her colleagues believe they should use the new system, assuming that the individual's behavior is influenced by how they believe others will view them due to having used the technology. It is equivalent to subjective norm TAM2,
- **Facilitating Conditions** are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system.

The questionnaire is applied to users or experts in the artifact (system) domain (Annex 3 presents a set of recommended questions for each determinant). As a recommendation, the questionnaires must be adapted for the assessment context [138]. Originally Davis [137] proposed that each question be assessed using a Likert scale of 7 points (from "extremely

disagree" to "extremely agree"); however, recent studies show that using a five-point Likert scale has no statistical differences [139].

7.2. Study design

This study aims to evaluate the **Business and IT/IS Strategic Goals Analysis Model** and its **usability** in the scope of IT Governance to support Business/IT Functional Alignment.

Based on the guidelines proposed by Gonzalez et al.[56], and Johannesson et al. [52], we have configured the assessment process of an artifact as defined in Design Science by identifying the following elements:

1. the *objective of the assessment* is to evaluate **the artifact and the process** which describes how to build and maintain it; this evaluation seeks to assess the **usability** in the context defined and the **fulfillment** of the artifact's requirements,
2. the *type of artifact* is a **method** that provides guidelines and processes to solve the problem and a **model** that represents its solution [52],
3. the *context of the evaluation* defines the constraints for the evaluation. We took into account that the evaluators do not have enough time to see the full capabilities of the model and method; in this regard, the researcher created a presentation covering the most relevant characteristics and requirements, and the case study resulting model to show some examples of use,
4. the *approach used* to perform the assessment, which in our case was both **quantitative,** utilizing a UTAUT assessment survey, **and qualitative** through the use of open-ended interviews to experts and practitioners (focus groups) inside and outside the case study organization,
5. the *artifact focus* which could be technical, organizational, or strategic. In our case, the type was **strategic**; since the *function of the artifact* is to support the processes to **build**, **manage** and **control knowledge** of the strategic planning of both business and IT,
6. the position of the evaluation was **internal,** based on concepts of action research, where the researcher was also part of the experiment and acted as the expert on the product and process,
7. the reference point for the evaluation was **artifact against real-world** where the artifact was first developed by applying the case study and, finally,
8. the time in which the evaluation took place was ***ex-ante,*** i.e., the researcher performed the case study with feedback from the stakeholders but based on previously developed strategic plans (both business and IT); the interviewees had not had previous experience with the method and model.

The case study described in previous chapters and the resulting models and refined process were used to guide the discussions during the focus group meetings and the application of the UTAUT survey [59].

7.2.1. The Interviewees - Evaluators

There were two groups of interviewees—first, a group of practitioners and experts from the case study organization. Second, a group composed of practitioners and academics external to the case study organization. In both cases, the participants are expected to be part of strategic plans' development and management teams, either for business or IT. The academic experts have background and experience in strategic planning, IT governance, and management sciences.

Within the case study organization, we interviewed five (5) practitioners; three (3) from the strategic business planning unit and two (2) from the DTI unit, which oversees strategic IT planning. On the other hand, we interviewed four (4) external experts. Two (2) are academics with recognized professional careers and knowledge in strategic planning and governance; the other two (2) are practitioners from two multinational IT services companies. Table 14 shows detailed stratification data of the interviewees, and Table 15 lists the interviewees' roles within their current organizations.

Highest academic level	
PhD	2
Master	7

Professional Role	
Case study Organization	5
External	4

Years of academic and professional experience	
5 to 10	3
10 to 15	1
15 or more	5

Table 14 Stratification data from interviewees.

Case Study Organization	**External**
Planning Secretary	Assistant Professor
Head of the office of projects and quality assurance - DTI	Assistant Professor
Demand manager - DTI	Corporate director development of IT services
Project Manager – Planning office	Delivery Unit Manager
General secretary of the rectory	

Table 15 Interviewees' roles within the organization.

7.2.2. Usability and Intention of Use – Quantitative Analysis

UTAUT [59] was selected as the evaluation framework to assess the model's usability. The *Social Influence* and *Facilitating Conditions* dimensions were not included in the assessment since their evaluation does not relate to the goal and scope of this study and assumes that the evaluated system is already in use and operating within the organization (which in our case is not true). Interviewees had no direct contact with the model or method before the assessment. Instead, they got familiar with the method, model, and theory behind it, through a presentation by the researcher at the beginning of the interview. The group of organization practitioners from the DTI had previous contact with the model. They were part of the focus groups and participated in the discussions while developing the model.

The UTAUT questions were translated to Spanish, and an introduction to the questionnaire was included describing the goals of the assessment, and especially making it clear that the scope of evaluation was the method and model and not the tool (i.e., jUCMNav [112], [119], [120], [140]). [3]

7.2.3. Interview – Requirements Fulfillment – Quantitative Analysis

As mentioned before, the interview was performed after the general presentation by the researcher. The goal of the interview is to assess the degree to which the model fulfilled the specified requirements.

The questions for this part of the assessment were constructed based on the defined requirements for the model. The questions are close-ended and assess the perceived degree of

[3] See Anex 3 for the original UTAUT questions, Anex 4 (English) and 5 (Spanish) presents the used UTAUT questionnarie and the questions defined for the specific requirements.

achievement of the requirements; each question had a complementary question for expressing an opinion on the matter.

7.3. Analysis of the Interviews

The interviews were performed using the Microsoft Teams Tool; the interviews were performed individually over the lapse of one month. Each interview was divided into two stages:

1. The researcher's presentation included BITA concepts, strategic planning, IT and corporate governance, balanced scorecard, enterprise architecture, business process management, and project management; then the description of the problem and the GORE concepts applied while building the model. After that, the researcher presents examples of using the model and the case study as a real-world example using images and the analysis algorithms with the jUCMNav plugin [112], [119], [120], [140].
2. The interviewee was presented with a Microsoft Forms questionnaire divided into three sections: demographic data of the interviewee (name, academic formation, years of experience, current job position), UTAUT questionnaire assessing *Performance Expectancy* and *Effort Expectancy*, and finally, the specific questions about the perceived achievement of the model's proposed requirements. It is worth mentioning that some UTAUT questions were omitted because of the scope of the evaluation.

In the final stage, in addition to resolving the interviewee's concerns, if the interviewee required it, the presentation, content, and operation of the plugin were reviewed. At this point, we insist that the evaluation focuses on the context of use and not the plugin itself.

The interviewee's responses and comments were formative and helpful for the researcher to improve some minor details of the model, its structure, steps, and the presentation itself. They are also summative and useful to assess the actual result allowing to discuss uses, cases, examples, and possibilities for the model in other related contexts. We discuss these topics further in the following sections.

All quantitative analyses were conducted in Microsoft Excel because of the size of the sample. For all questionnaire items, heat maps facilitated the analysis of results.

7.3.1. UTAUT Analysis

A heat map of the answers from all nine (9) interviewees is shown in Table 16. It presents the two evaluated factors and the questions (Performance Expectancy and Effort Expectancy).

	Strongly disagree	Somewhat disagree	Neutral	Partially agree	Totally agree
Performance expectancy					
1. I would find the **model** useful in my job.	0	0	0	3	6
2. Using the **model** enables me to accomplish tasks more quickly.	0	0	1	5	3
3. Using the **model** increases my productivity.	0	0	2	1	6
4. If I use the **model**, I will increase my chances of getting a raise.	2	1	3	2	1
Effort expectancy					
1. My interaction with the **model** would be clear and understandable.	0	0	0	4	5
2. It would be easy for me to become skillful at using the **model**.	0	0	0	2	7
3. I would find the **model** easy to use.	0	0	1	1	7
4. Learning to operate the **model** is easy for me.	0	0	0	3	6

Table 16 Heat map of eight (8) items assessing technology acceptance.

For the Performance Expectancy factor, nine (9) interviewees (100%) agreed or strongly agreed that the model would be useful in their job. Eight (8) interviewees (89%) agreed or strongly agreed that the model would enable them to accomplish tasks more quickly. Seven (7) interviewees (78%) agreed or strongly agreed that the model would increase productivity. Opinions about the chance of getting a raise were mixed since the context of the question was not entirely clear to the interviewees.

For the Effort Expectancy factor, nine (9) interviewees (100%) agreed or strongly agreed that the interaction with the model would be clear and understandable. Eight (8) interviewees (89%) agreed or strongly agreed that they found the model easy to use. Nine (9) interviewees (100%) agreed or strongly agreed that it would be easy to become skillful at using the model. Finally, nine (9) interviewees (100%) agreed or strongly agreed that learning to operate the model is easy for them.

Overall, interviewees rated the Performance Expectancy and Effort Expectancy positively, with a high standard deviation on Performance Expectancy due to the fourth question (if I use the model, I will increase my chances of getting a raise) (see Table 17).

	Items (n)	**Mean**	**Std.Dev.**
Performance expectancy	4	4,6	1,15
Effort expectancy	4	5,3	0,55

Table 17 Mean responses to the factors of technology acceptance for the model.

7.3.2. Requirements Fulfillment

A heat map of the answers from all nine (9) interviewees is shown in Table 18. It presents the six questions evaluated for the perception of requirements achievement.

Specific Questions - Requirements	Strongly disagree	Somewhat disagree	Neutral	Partially agree	Totally agree	Average	Std. Dev
The **model** allows assigning **goals** to the **organization**, business, and IT units and roles to trace responsibility, knowledge, and accountability for any given goal.	0	1	0	3	5	4,6	0,52
The proposed **model** captures strategic goals and relates them to other ones such as tactic and operational goals using the link types provided by GRL, including contribution, decomposition, and dependency.	0	0	0	3	6	4,6	0,52
The **model** relates strategic goals to initiatives/projects by which such goals can be achieved.	0	0	0	1	8	4,9	0,35
The **model** supports the identification of intentional elements, roles, actors, and relations in the problem's context and scope.	0	0	1	2	6	4,6	0,74
The **model** includes a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem.	0	0	0	1	8	4,9	0,35
The **model** describes the analysis processes of the resulting GRL models utilizing a GRL tool.	0	0	2	2	5	4,5	0,76

Table 18 Heat map of six (6) questions assessing requirement achievement.

The most notable results of the quantitative evaluation are the following:

- Eight (8) interviewees (89%) agreed or strongly agreed that (**R1.1.**) the **model** allows assigning **goals** to the **organization**, business, and IT units and roles to trace responsibility, knowledge, and accountability for any given goal.
- Nine (9) interviewees (100%) agreed or strongly agreed that (**R1. R1.3.)** the proposed **model** captures strategic goals and relates them to other ones such as tactic and operational goals using the link types provided by GRL, including contribution, decomposition, and dependency.
- Nine (9) interviewees (100%) agreed or strongly agreed that (**R1. R1.2.**) the **model** relates strategic goals to initiatives/projects by which such goals can be achieved.
- Eight (8) interviewees (89%) agreed or strongly agreed that (**R2.1.**) The **model** supports identifying intentional elements, roles, actors, and relations in the problem's context and scope.
- Nine (9) interviewees (100%) agreed or strongly agreed that (**R2.2.**) the **model** includes a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem.
- Seven (7) interviewees (78%) agreed or strongly agreed that (**R2.3.**) The **model** describes the analysis processes of the resulting GRL models utilizing a GRL tool.

Overall, interviewees rated the fulfillment of the requirements positively with the lowest average value of 4.5 (Questionnaire items were rated from 1 (negative/low) to 5 (positive/high)) and a highest standard deviation of 0.76.

7.3.3. Qualitative Analysis

This section discusses the qualitative data, i.e., the opinions and perceptions of the interviewees expressed during the individual meetings. First, the specific comments are presented based on the Microsoft Form requirements filled by the interviewees. Then, we present the general comments and perceptions about using the model.

Comments on Specific Requirements

This section collects the comments about the given assertions based on the defined requirements that the model must fulfill.[4]

[4] All the sentences were translated from Spanish.

(R1.1.) the model allows assigning goals to the organization, business, and IT units and roles to trace responsibility, knowledge, and accountability for any given goal

Various interviewees agreed that the model:

- "By assigning weights, promotes discussions, at the team level, about the level of priority/impact and, consequently, establishing accountabilities. That inevitably induces people to focus on meeting their goals."
- "Visually facilitates identifying relationships between entities and between the different elements of a planning cascade. This would make it easier to define tasks (objectives) in these entities."
- "... conforms to a global organizational model and would allow me to trace the strategic objectives by business unit."
- "Given the granular level at which the analysis is carried out and the possibility of simulating different paths, it would be possible to assign these goals."
- One interviewee indicates that the model supports accountability, but that is not that straight forward when assigning strategic goals.

One interviewee from the case study organization asserts that the model allows to assign goals to different actors in the organization, "however, in the PUJ at the institutional planning level, a large part is static (Megas)." For the case study organization and the constructed example, "Contributions and PPUs obey to the dynamics of the different units that attend to the Megas."

(R1. R1.3.) the proposed model captures strategic goals and relates them to other ones, such as tactic and operational goals, using the link types provided by GRL, including contribution, decomposition, and dependency

Interviewees agree that the model captures the different links that characterize the planning process. The model supports "the appearance of external contingencies that would imply reviewing the model (again) to modify impacts, " which happens in real life. Thus, the model supports the constant verification and actualization of strategic planning.

One interviewee also indicates that links allow the strategist to monitor specific business areas and their assigned goals (tactical and operational).

One interviewee asserts that "the greatest value of the model is being able to assign planning components at different levels of complexity."

(R1. R1.2.) the model relates strategic goals to initiatives/projects by which such goals can be achieved

Interviewees assert that the model allows identifying the relationships between projects/initiatives and goals

- "The mapping is direct since it establishes the impact of the projects on the strategic objectives. The incorporation of indicators and discussions about the impact (and how they are included to add value) creates an ecosystem and a method of discussions of 'alignment' between corporate strategy and IT strategy that is key."
- "The model allows you to visualize the connections of objectives, tactical objectives, and projects to execute them. It is effortless to understand the relationship and the chain."
- "...the model would allow me to measure whether an effort (really) satisfies my strategic objectives."

(R2.1.) The model supports identifying intentional elements, roles, actors, and relations in the problem's context and scope

Interviewees commented that the model:

- "...supports the identification of elements that allow the development of relationships and interactions."
- "The model describes the main (and internal) actors associated with the fulfillment of the strategy. It does not contemplate, at the observed level, external actors such as government entities, boards of directors (among others). However, for the alignment exercise, the guidelines derived from these stakeholders are transformed into boundary conditions that do not necessarily have to be modeled in GRL."

Regarding the use of individual business units, the interviewees say:

- "It is more difficult because it begins with large actors. Units of work can be displayed, but not individualities."
- "Grounded in my reality, I would use the model in an incremental, iterative context. In this way, it could identify actors in a dynamic context of strategy, and this identification would allow me to go deeper into the model."

(R2.2.) the model includes a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem

Interviewees agreed that the process for building and analyzing the model are:

- "…clear and facilitate step-by-step development."
- "… clear to carry out the identification and mapping of the business and IT strategies."

(R2.3.) The model describes the analysis processes of the resulting GRL models utilizing a GRL tool

Interviewees recognize that the model:

- "... lands the principles, and the purpose of strategic planning is (clearly) measurable and quantifiable strategies (based on previously agreed premises between the different participants in the construction and monitoring of the strategy)."
- "Yes, the analysis is easy to do. The form of connection between projects, objectives, and the weights assigned for participation or incidence allows this analysis to be easily carried out."
- "The model is implemented in a tool that makes its use easy and intuitive."

General Comments

The general perception of the model is that it is helpful within the desired context. Interviewees also highlight that the model facilitates a better decision-making process based on parameters and indicators that are hard to negotiate with stakeholders. Such a feature is of utmost importance for strategists. Finally, they point out that the model improves strategy management and could positively impact tactical and operational strategies.

Chapter 8. Contributions, Limitations, and Future Work

In this chapter, we review the requirements for developing the Business and IT/IS Strategic Goals Analysis Model and the challenges to its development. Subsequently, we enumerate the main contributions of this thesis, including a discussion about the limitations and future work around the proposed model.

8.1. Motivations Summary

In Chapter 4, we have introduced the Business and IT/IS Strategic Goals Analysis Model requirements. They describe the desired characteristics and components to be addressed by the model. Such characteristics have been derived from our analysis of strategic management, strategic alignment, corporate and IT governance, and in general, business and IT management literature that describes the needs for supporting the overall process of strategic management and planning of organizations. Therefore, such properties are the desired characteristics embedded in our modeling approach to support strategic planning and alignment within the business and IT.

In simple terms, the strategic management literature defines that an organization's strategic planning process is structured into three general activities or phases, namely, formulation, implementation, and evaluation. On the other hand, the main focus of our research was to improve strategic alignment between the business and IT. Alignment can be achieved through the definition processes and instruments that allow for building strategic plans for both business and IT that consider each other's goals and the motivational aspects of the central organization (i.e., Mission and Vision). In practice, strategic planning consists of defining the motivational aspects of the organization and around them, setting the goals the company wishes to achieve, followed by allocating actions and resources intended to achieve such goals.

To support Business and IT/IS Strategic Goals Analysis, the proposed model should be able to capture the conceptualization inherent to this phenomenon. The model must have a high level of expressiveness to capture strategic goals and relate them to other ones, such as tactical and operational. Furthermore, the model must also show the initiatives/projects that can achieve such goals. Therefore, the model should be expressive concerning three dimensions: a) the representation of the motivational domain of both business and IT, b) the representation of the behavioral domain, and c) the representation of the interconnections between them.

Finally, the model must Include a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem, allowing it to control, modify, and use for the decision-making process of strategic planning in business and IT.

In order to provide support for the representation and analysis of strategic goals, several approaches exist from different areas of computer and managerial sciences. Specifically, motivational modeling is mainly addressed by Goal-Oriented Requirements Engineering (GORE) and Corporate and IT governance. In contrast, behavioral modeling is mainly addressed by Business Process Management (BPM) and Project Management (PM).

In this context and the scope of motivational modeling, various kinds and levels of granularity of goals have been defined in the Business Motivation Model (BMM). GORE approaches recognize the importance of goals to capture stakeholders' requirements and expected quality attributes

of a target system. However, different goals are treated similarly, but they can be represented as being achieved by contributions for smaller grained ones; even though GORE cannot explicitly differentiate between types of goals, it can represent such differences. In contrast, the behavioral aspects can be mapped within GORE models when they represent actions and resources needed to perform such actions that contribute to achieving stakeholders' goals. For this thesis, the level of detail associated with goal analysis was restricted to strategic and high-level operative to keep the models simple and easy to manage.

The use of GRL as a modeling language and its analysis algorithms allowed us to map and represent the most relevant concepts of strategic planning and its different levels of detail for strategic means (e.g., mission, strategies, tactics, plans) and ends (e.g., vision, objective, goal).

8.2. Contributions

This thesis strived to improve the support for the analysis of joint business and IT strategies in searching for strategic alignment. We proposed using an existing standard language (GRL) and a method for reasoning, managing, and monitoring strategic plans. Below, we review the contributions of the model.

Our main goal was to define a model that allowed for business and IT alignment. By understanding GRL's use possibilities, we built a model to seek strategic alignment between business and IT. We found that GRL can be used in general to build strategic plans in the business unit.

We have presented the **Business and IT/IS Strategic Goals Analysis Model**, which defines motivational and intentional aspects of the organization and behavioral elements to analyze strategies, levels of achievement of goals, and alternative selection. Overall, the proposed model supports the development of strategic plans.

We have designed a goal-model methodology to create, analyze, and support strategic goal analysis for Business and IT Strategic Alignment. The model captures strategic, tactical, and operational goals for the main interacting actors, i.e., business and IT. Moreover, the model aids in representing relationships between these goals, initiatives, and projects. Our methodology and its usage guidelines support iteration and interaction with stakeholders. Moreover, it allows for revealing unknown information, increasing completeness and knowledge of business and IT joint strategic planning. The model was built based on the principles and purpose of strategic planning, creating measures for quantification and goal satisfaction.

As in GORE methods, our approach is appropriate for early requirements phases and high-level analysis, as they do not require quantitative information beyond what is captured by the model.

Our experiences with GORE modeling and GRL show that helping alternatives evaluation within the proposed context of use assists the process of iterative modeling, resulting in an overall better understanding of the model and the possible alternatives of implementation in the studied domain.

Based on the experience gained applying the methodology to the case study and the experts' evaluations, we concluded that the model helps to discuss the priority level and impact of projects and initiatives. It allows us to identify accountabilities within the strategic planning and specifically in the initiatives or projects, which can be studied individually to identify implementation alternatives and functionalities using GRL as intended initially by its creators.

Based on the possibilities provided by GRL, the initial obtained results were expected, and our work was centered on mapping the scope and context definitions within GRL. The comments and views of the experts allowed us to understand that the model is indeed useful beyond the visual representation. In fact, it allows the strategists to discuss and understand business, and IT's points of view and interactions based on strategic planning, thus achieving goal alignment through knowledge sharing.

As an additional contribution, an evaluation of the state of alignment between IT and the business was carried out based on the SAMM (Strategic alignment maturity model) instrument of Luftman [29]. The same evaluation was also applied to a private hospital in the city of Villavicencio as part of a master's thesis. Such evaluation delivers quantitative and qualitative results that allow the organization to have elements of judgment to look for strategies that help improve the state of alignment. In the case of the Javeriana University, based on said analysis, the corporate government this year has launched the DIGITAL TRANSFORMATION unit, which seeks to manage the strategic plans associated with information technologies. On the other hand, the visualization of the resulting GRL models allowed the organization to review its strategic plans and, in particular, they defined a new Mega in its motivational elements. This new Mega is in charge of strategic programs associated with IT. The organization also extended the life cycle of its strategic planning for two more years until 2023. The organization is currently relating the strategic plans and programs with specific operational indicators to better evaluate the impact of the implemented initiatives.

Last but not least, we found several previous approaches that seek alignment, not at the strategic level but at the functional and internal levels, i.e., between process and systems, and both depend directly on the business strategy. In this regard, our work is different because it takes IT's strategy into account. Examples of such cases are B-SCP[15], which also maps the strategy to iStar and relates the new modeled system to such strategic goals. Another example of GORE methods usage is Marosin et al. [141], which present a method for formalizing and modeling Enterprise Architecture principles using GRL. This model does not directly consider either business or IT strategies, even though the EA's principles are built upon such strategic plans. A more complex proposal is the one from Cardoso et al., who developed a complete framework and language to model strategic enterprise architectures (Azzurra and SIENNA) [33], [142]. As with the B-SCP, this framework is perhaps too complex to be used in a real-life context [143]. Most alignment frameworks seek to align the business strategy to the organization's systems and EA, with little to no regard for IT's strategy. Based on these comparisons, we argue that even though our work does not have such a broad reach, covering the strategic, tactical, operational, and even the systems development levels, in the spectrum of systems alignment, our model contributes to the construction and management of a joint strategy between business and IT.

8.3. Limitations

We have introduced the **Business and IT/IS Strategic Goals Analysis Model**. We have contributed to advancing the state-of-the-art in using GORE methods for representing strategic plans and, in particular, using them in the context of BITA. However, our approach has some limitations that we discuss in this section.

Further testing and use within the case study organization. Several limitations arose while executing the case study, such as the lack of time and access to analyze IT projects that had a strategic impact. Two meetings and discussions with the Project Management team of the IT

Unit were executed to reduce the impact of this limitation. They allowed us to define the examples of use and refine the method. It also allowed us to discuss the types of used links, i.e., contributions, dependencies, and decompositions. Their actual contribution values could not be tested; even though the literature is rich in managing the interactions and negotiation among stakeholders, we based our examples on Hassinne and Amyot [126], [144], [145].

Requirements completeness. Chapter 4 described the Business and IT/IS Strategic Goals Analysis Model requirements. Although we believe that such requirements convey the most critical model features, they may not be necessarily complete in all settings or contexts of use. To be more precise, new requirements may be necessary depending on other types of organizations and domains. As specified in the constraints and restrictions, we were restricted by how the case study organization performs its strategic planning. However, we still believe that the defined requirements reach an adequate level of generalization because they have been based on Management and GORE literature.

Limitations on the specific strategic planning model. We have provided methodological guidelines on building the business and IT strategies based on general strategic planning concepts. However, our model does not consider the different strategy formation schools in management literature [146]. Therefore, new methodological guidelines should be developed, considering such specific strategy formation processes. Although, from a practical point of view, the model can be extended and applied to other organizations regardless of the philosophical model they use since constructs based on motivational elements are common in strategic planning.

Model maintenance and further use. We also found that once the model is updated, it must be reviewed in its entirety to check satisfaction of goals and impact of indicators or project's achievement, which can be tedious if the model is too complex. In that sense, the GRL Tool allows selecting specific elements from a model to create a smaller one; in such a case, it can be analyzed more thoroughly. However, it must be carefully constructed to ensure that all relevant elements for the assessment are present in the new model.

Indicators and measurements. We could not evaluate the use of indicators within the case study organization since they do not use strategic indicators. However, they use operational indicators as reported in Chapter 6.

8.4. Future Work

Based on the qualitative and quantitative assessment results, we have identified some future directions for our work described in this section.

Further validation. We have applied the proposed model in one institutional scenario, i.e., a private university. Although we believe that the model has considerably advanced the use of GORE Modeling in other contexts (i.e., BITA and strategic planning), it still needs to undergo further validation beyond the application in the scenario mentioned above. We believe that the application in other examples and types of organizations might reveal additional ways of using the model, new methodological guidelines, and different ways of reasoning. Furthermore, other organizations (e.g., government, for-profit) could also enrich the method based on specific strategic methods. Finally, perform an entire case study following the interviewing methods within brainstorming sessions, either at the business or IT level. This is followed by an analysis and discussion of alternatives for a given project, allowing not only to build the GRL model but also the documentation that traces such decisions.

Additional GRL features. In GRL and, more specifically, in iStar, a large community of users uses the language in a different context and, in most cases, proposes new elements to use within models and new algorithms for evaluation [147]. In that sense, we can improve our model by reviewing the extensions defined by the community and thinking of ways to include them when new strategic, tactical, or operational elements could not be currently represented.

Exploration in different contexts of strategic planning. From the discussion with the evaluators, two interesting research ideas appeared. The first potential use involves conglomerates or ecosystems of companies that may have shared strategic units. The model would allow exploring more levels of corporate strategic character (upwards); conversely, clusters or ecosystems of companies could be included within the analysis to identify common goals and possible directions in which the joint venture could go. The second research idea involves allowing coordination between business units to execute the strategic projects; for example, using a separate GRL model that details strategic goals and their relations with the involved unit's goals (tactical and operational). It can be used to prioritize and check the status of the projects being developed.

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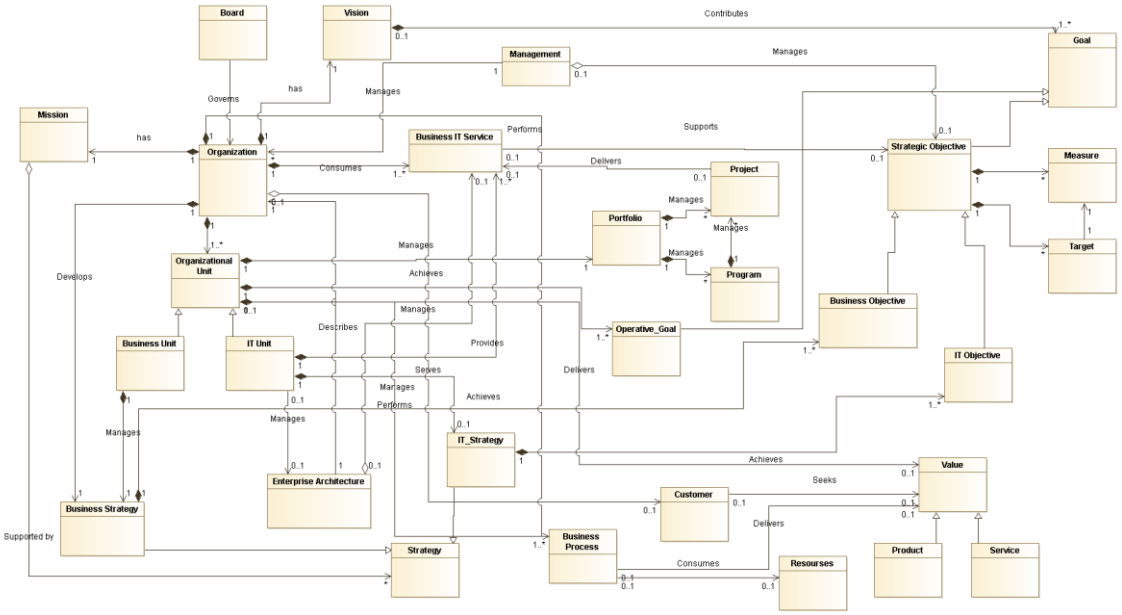
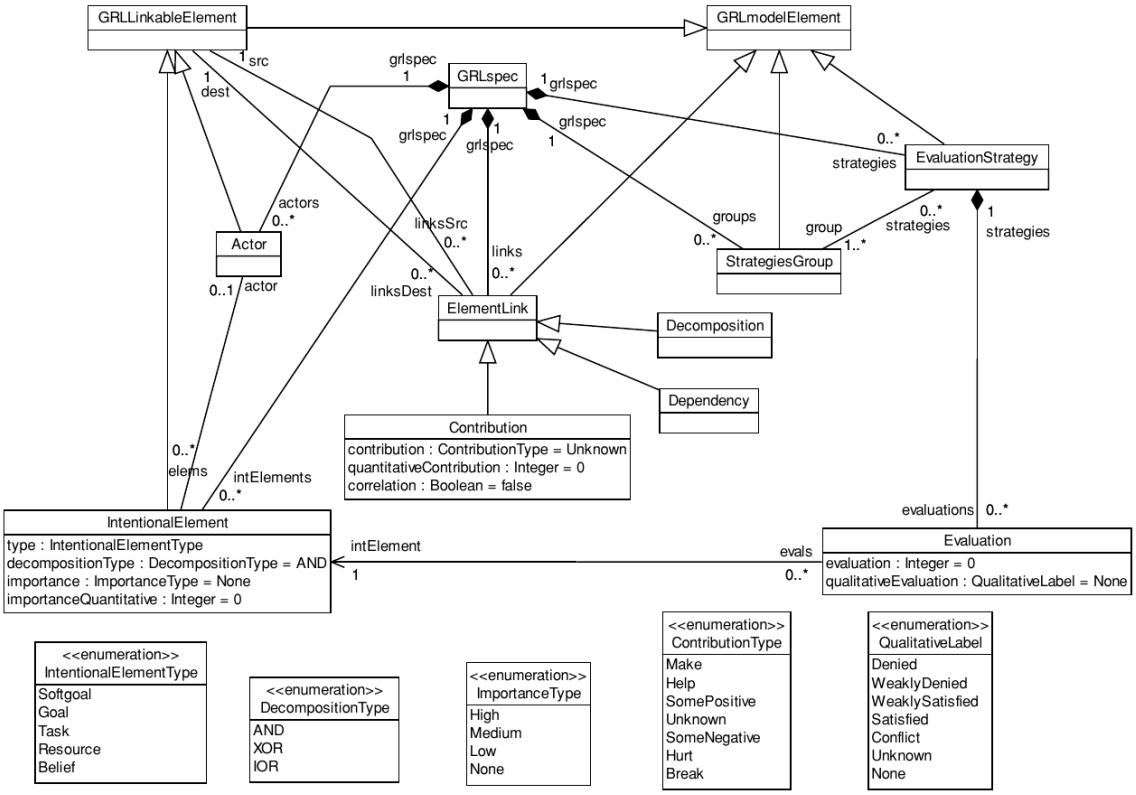
Annexes

1. Conceptual Meta-Model

The Following Meta-model was developed to connect the high-level concepts described in Chapter 2 of this work. It presents the most relevant relationships between concepts.



2. GRL Abstract Grammar [115]



3. Questions associated with the determinants of intention and usage Venkatesh et al. [59]

Performance expectancy

1. I would find the system useful in my job.
2. Using the system enables me to accomplish tasks more quickly.
3. Using the system increases my productivity.
4. If I use the system, I will increase my chances of getting a raise.

Effort expectancy

1. My interaction with the system would be clear and understandable.
2. It would be easy for me to become skillful at using the system.
3. I would find the system easy to use.
4. Learning to operate the system is easy for me.

Social influence

1. People who influence my behavior think that I should use the system.
2. People who are important to me think that I should use the system.
3. The senior management of this business has been helpful in the use of the system.
4. In general, the organization has supported the use of the system.

Facilitating conditions

1. I have the resources necessary to use the system.
2. I have the knowledge necessary to use the system.
3. The system is not compatible with other systems I use.
4. A specific person (or group) is available for assistance with system difficulties.

4. Assessment Questionnaire - English

The questionnaire was developed in Microsoft's Forms tool.

The purpose of this questionnaire is to evaluate the ease of use, expectation of use and compliance with the requirements defined for the **model of analysis of strategic business objectives and IT / IS.**

The model was designed and built during the doctoral training process of the researcher Ing. Miguel E. Torres who will also present the model, its main characteristics and some examples of use for you to carry out the evaluation.

The questionnaire is applied to experts with recognized academic and professional trajectory in specific topics such as strategic planning and organization management. In this sense, two groups of interviewees have been defined, firstly people who actively participate in the design or execution of strategic business and IT planning processes in the case study Organization (Pontificia Universidad Javeriana), and on the other hand, practitioners and academic experts outside the organization.

It is estimated that the work of this session will take around 2 hours, where a first part will consist of the presentation of the model by the researcher and on the other hand the review and completion of the questionnaire that is divided into two (2) parts:

Evaluation of Performance Expectation and Effort Expectation of the model based on the UTAUT evaluation. Composed of eight (8) mandatory closed questions, and

Evaluation of compliance with the defined requirements of the model. Composed of eight (8) compulsory closed questions, and nine (9) optional open questions.

Your responses will be anonymous and then tabulated for the purpose of presentation and analysis of results.

General Data of the Interviewee

1. Interviewee's name
2. Highest academic level [Undergraduate | Masters | Doctorate]
3. Years of academic and professional experience in the areas related to the model (technology management, strategic planning, technology governance, corporate governance) [0 to 5 years | 5 to 10 years | 10 to 15 | 15 or more]
4. Name of your current job role

UTAUT - Usability and Perception of Use - Venkatesh et al [59]

The next section evaluates the **Performance Expectancy** and the **Effort Expectancy** of the model based on the UTAUT evaluation.

To carry out the following evaluation, keep in mind that the term **model** refers to the resulting figures in GRL language and the proposed **method** (steps to develop and analyze the model).

All questions are evaluated using a five (5) point Likert scale [Strongly disagree | Somewhat disagree | Neutral | Partially agree | Totally agree].

How strongly do you agree or disagree with this statements?

Performance expectancy

1. I would find the **model** useful in my job.

2. Using the **model** enables me to accomplish tasks more quickly.
3. Using the **model** increases my productivity.
4. If I use the **model**, I will increase my chances of getting a raise.

Effort expectancy

1. My interaction with the **model** would be clear and understandable.
2. It would be easy for me to become skillful at using the **model**.
3. I would find the **model** easy to use.
4. Learning to operate the **model** is easy for me.

Specific Questions - Requirements

The following questions are intended to assess your perception of compliance with the defined requirements that the model should meet.

To carry out the following evaluation, keep in mind that the term **model** refers to the resulting figures in GRL language and the proposed **method** (steps to develop and analyze the model).

All questions are evaluated using a five (5) point Likert scale [Strongly disagree | Somewhat disagree | Neutral | Partially agree | Totally agree].

How strongly do you agree or disagree with these statements?

- R1.1. The **model** allows assigning **goals** to the **organization**, business, and IT units and roles to trace responsibility, knowledge, and accountability for any given goal.
- R1. R1.3. The proposed **model** captures strategic goals and relates them to other ones such as tactic and operational goals using the link types provided by GRL, including contribution, decomposition, and dependency.
- R1. R1.2. The **model** relates strategic goals to initiatives/projects by which such goals can be achieved.
- R2.1. The **model** supports identifying intentional elements, roles, actors, and relations in the problem's context and scope.
- R2.2. The **model** includes a recommended process for building, using, and analyzing the GRL model in the context and scope of the problem.
- R2.3. The **model** describes the analysis processes of the resulting GRL models utilizing a GRL tool.

All the above questions include an open question to justify or argue.

5. Cuestionario de Evaluación - Español

El cuestionario fue desarrollado en la herramienta Forms de Microsoft.

El presente cuestionario tiene como fin evaluar la facilidad de uso, expectativa de uso y cumplimiento de los requisitos definidos para el **Modelo de análisis de objetivos estratégicos de Negocio y de TI/SI.**

El modelo fue diseñado y construido durante el proceso de formación doctoral del investigador Ing. Miguel E. Torres quien además presentará a usted el modelo, sus principales características y algunos ejemplos de uso para que pueda usted realizar la evaluación.

El cuestionario se aplica a personas expertas y con reconocida trayectoria académica y profesional en temas específicos como son planeación estratégica y gestión de organizaciones. En ese sentido se han definido dos grupos de entrevistados, en primer lugar personas que participan activamente del diseño o ejecución de procesos de planeación estratégica de negocio y de TI en la Organización caso de estudio (Pontificia Universidad Javeriana), y por otra parte practicantes y expertos académicos externos a la organización.

Se estima que el trabajo de esta sesión tomará alrededor de 2 horas, donde una primera parte consistirá en la presentación del modelo por parte del investigador y por otra parte la revisión y diligenciamiento del cuestionario que se encuentra dividido en dos (2) partes:

1. Evaluación de **Expectativa de Rendimiento** y **Expectativa de Esfuerzo** del modelo basado en la evaluación UTAUT. Compuesta por ocho (8) preguntas cerradas obligatorias, y
2. Evaluación de cumplimiento de los requisitos definidos del modelo. Compuesta por ocho (8) preguntas cerradas obligatorias, y nueve (9) preguntas abiertas opcionales.

Sus respuestas serán anónimas y luego tabuladas para el propósito de presentación y análisis de resultados.

Datos Generales del Entrevistado

1. Nombre del entrevistado
2. Máximo nivel de formación [Pregrado|Maestría|Doctorado]
3. Experiencia académica y profesional en las áreas relacionadas al modelo (gestión de tecnología, planeación estratégica, gobierno de tecnología, gobierno corporativo) [0 a 5 años | 5 a 10 años | 10 a 15 | 15 o más]
4. Nombre de su rol laboral actual

UTAUT – Usabilidad y Percepción de Uso - Venkatesh et al [59]

La siguiente sección evalúa la Expectativa de Rendimiento y la Expectativa de Esfuerzo del modelo basado en la evaluación UTAUT.

Para realizar la siguiente evaluación tenga en cuenta que el término **modelo** hace referencia a las figuras resultantes en lenguaje GRL y el método protpuesto (pasos para desarrollar y analizar el modelo).

Todas las preguntas son evaluadas usando una escala Likert de cinco (5) puntos [Muy en desacuerdo | Algo en desacuerdo | Neutral | Parcialmente de acuerdo | Totalmente de acuerdo].

¿En qué medida está de acuerdo o en desacuerdo con estas declaraciones?

Expectativa de rendimiento

1. El **modelo** me resultaría útil en mi trabajo.
2. El uso del **modelo** me permitiría realizar tareas más rápidamente.
3. Usar el **modelo** aumentaría mi productividad.
4. Si utilizo el **modelo**, aumentaré mis posibilidades de obtener un aumento.

Expectativa de esfuerzo

1. Mi interacción con el **modelo** sería clara y comprensible.
2. Sería fácil para mí volverme hábil en el uso del **modelo**.
3. El **modelo** me resultará fácil de usar.
4. Aprender a manejar el **modelo** me resultara fácil.

Preguntas específicas: requisitos

Las siguientes preguntas tienen como objetivo evaluar su percepción de cumplimiento de los requisitos definidos que el modelo debería cumplir.

Para realizar la siguiente evaluación tenga en cuenta que el término **modelo** hace referencia a las figuras resultantes en lenguaje GRL y el método protpuesto (pasos para desarrollar y analizar el modelo).

Todas las preguntas son evaluadas usando una escala Likert de cinco (5) puntos [Muy en desacuerdo | Algo en desacuerdo | Neutral | Parcialmente de acuerdo | Totalmente de acuerdo].

¿En qué medida está de acuerdo o en desacuerdo con estas declaraciones?

- R1.1. El **modelo** permite asignar **objetivos** a la **organización**, el negocio y las unidades y roles de TI para rastrear la responsabilidad, el conocimiento y la rendición de cuentas para cualquier objetivo dado.
- R1. R1.3. El **modelo** propuesto captura los objetivos estratégicos y los relaciona con otros, como los objetivos tácticos y operativos, utilizando los tipos de enlaces proporcionados por GRL, incluida la contribución, la descomposición y la dependencia.
- R1. R1.2. El **modelo** relaciona los objetivos estratégicos con las iniciativas / proyectos mediante los cuales se pueden alcanzar dichos objetivos.
- R2.1. El **modelo** apoya la identificación de elementos, roles, actores y relaciones intencionales en el contexto y alcance del problema.
- R2.2. El **modelo** incluye un proceso recomendado para construir, usar y analizar el modelo GRL en el contexto y alcance del problema.
- R2.3. El **modelo** describe los procesos de análisis de los modelos GRL resultantes utilizando una herramienta GRL.

Todas las preguntas anteriore incluyen una pregunta abierta para justificar o argumentar.

6. jUCMNav Report – Generic Case and Case Study Organization

jUCMNav Report

http://softwareengineering.ca/jucmnav

UCM Scenario Groups documentation

- ScenarioGroup5:
  1. ScenarioDef6

Intentional Elements

1. Mission
2. Vision
3. IT SG 01
4. IT SG 02
5. BS SG 01
6. BS SG 02
7. BS PRJ 01
8. BS PRJ 02
9. IT PRJ 01
10. IT PRJ 02
11. IT PRJ 03
12. IT PRJ 04
13. BS PRJ 03

14. BS PRJ 04
15. System goal
16. Alternative A
17. Alternative B
18. X SG 01
19. x G 01
20. X G 02
21. BS PRJ X
22. Indicator04
23. Indicator05
24. Indicator06
25. Indicator01
26. Indicator02
27. Indicator03

Actors

1. High-Level Business
2. IT Unit
3. Business Unit
4. Business Unit X
5. System X

Strategy Legend for Group "ProjectsStatus"

1:EvaluationStrategy4

Note: Trend calculated based on last 3 strategies

	Strategy Evaluations
	1
High-Level Business (A)	0
IT Unit (A)	0
Business Unit (A)	0
Business Unit X (A)	0
System X (A)	0
Mission	43
Vision	58
IT SG 01	50
IT SG 02	0
BS SG 01	0
BS SG 02	62
BS PRJ 01	25
BS PRJ 02	0
IT PRJ 01	25
IT PRJ 02	25
IT PRJ 03	0
IT PRJ 04	50
BS PRJ 03	50
BS PRJ 04	90

	Strategy Evaluations
System goal	0
Alternative A	0
Alternative B	0
X SG 01	0
x G 01	0
X G 02	0
BS PRJ X	100
Indicator04	0
Indicator05	0
Indicator06	0
Indicator01	0
Indicator02	0
Indicator03	0

Strategy Legend for Group "DeployedProjectsIndicators"

1:EvaluationStrategy413

Note: Trend calculated based on last 3 strategies

	Strategy Evaluations
	1
High-Level Business (A)	0
IT Unit (A)	0
Business Unit (A)	0
Business Unit X (A)	0
System X (A)	0
Mission	7
Vision	10
IT SG 01	0
IT SG 02	0
BS SG 01	0
BS SG 02	14
BS PRJ 01	0
BS PRJ 02	56
IT PRJ 01	37
IT PRJ 02	0
IT PRJ 03	0
IT PRJ 04	0
BS PRJ 03	75
BS PRJ 04	37

	Strategy Evaluations
System goal	0
Alternative A	0
Alternative B	0
X SG 01	0
x G 01	0
X G 02	0
BS PRJ X	0
Indicator04	50
Indicator05	0
Indicator06	0
Indicator01	75
Indicator02	100
Indicator03	50

Evaluating Alternatives Example

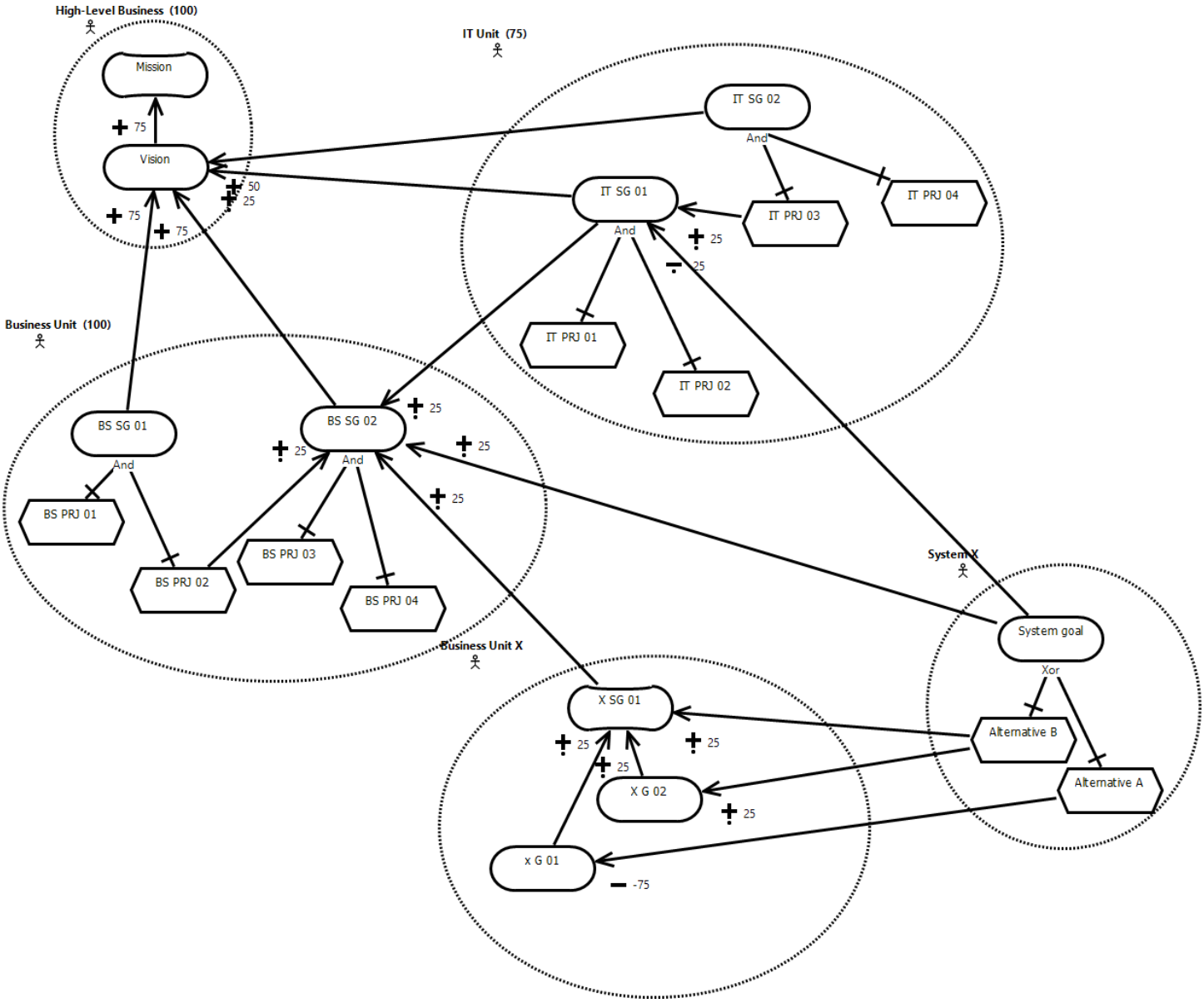


Figure 1 - Evaluating Alternatives Example

Intentional Elements

Mission

Vision

Metadata: "_addAggregate" = "disable"

IT SG 01

Metadata: "_addAggregate" = "disable"

IT SG 02

Metadata: "_addAggregate" = "disable"

BS SG 01

Metadata: "_addAggregate" = "disable"

BS SG 02

Metadata: "_addAggregate" = "disable"

BS PRJ 01

BS PRJ 02

Metadata: "_addAggregate" = "disable"

IT PRJ 01

IT PRJ 02

IT PRJ 03

Metadata: "_addAggregate" = "disable"

IT PRJ 04

BS PRJ 03

BS PRJ 04

System goal

Metadata: "_addAggregate" = "disable"

Alternative A

Metadata: "_addAggregate" = "disable"

Alternative B

Metadata: "_addAggregate" = "disable"

X SG 01

Metadata: "_addAggregate" = "disable"

x G 01

Metadata: "_addAggregate" = "disable"

X G 02

Metadata: "_addAggregate" = "disable"

High-Level Business View

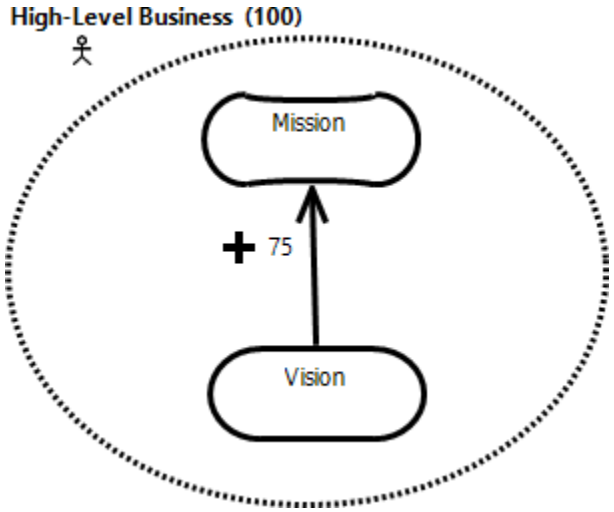


Figure 2 - High-Level Business View

Intentional Elements

Mission

Vision

Metadata: "_addAggregate" = "disable"

System X as Strategic Project

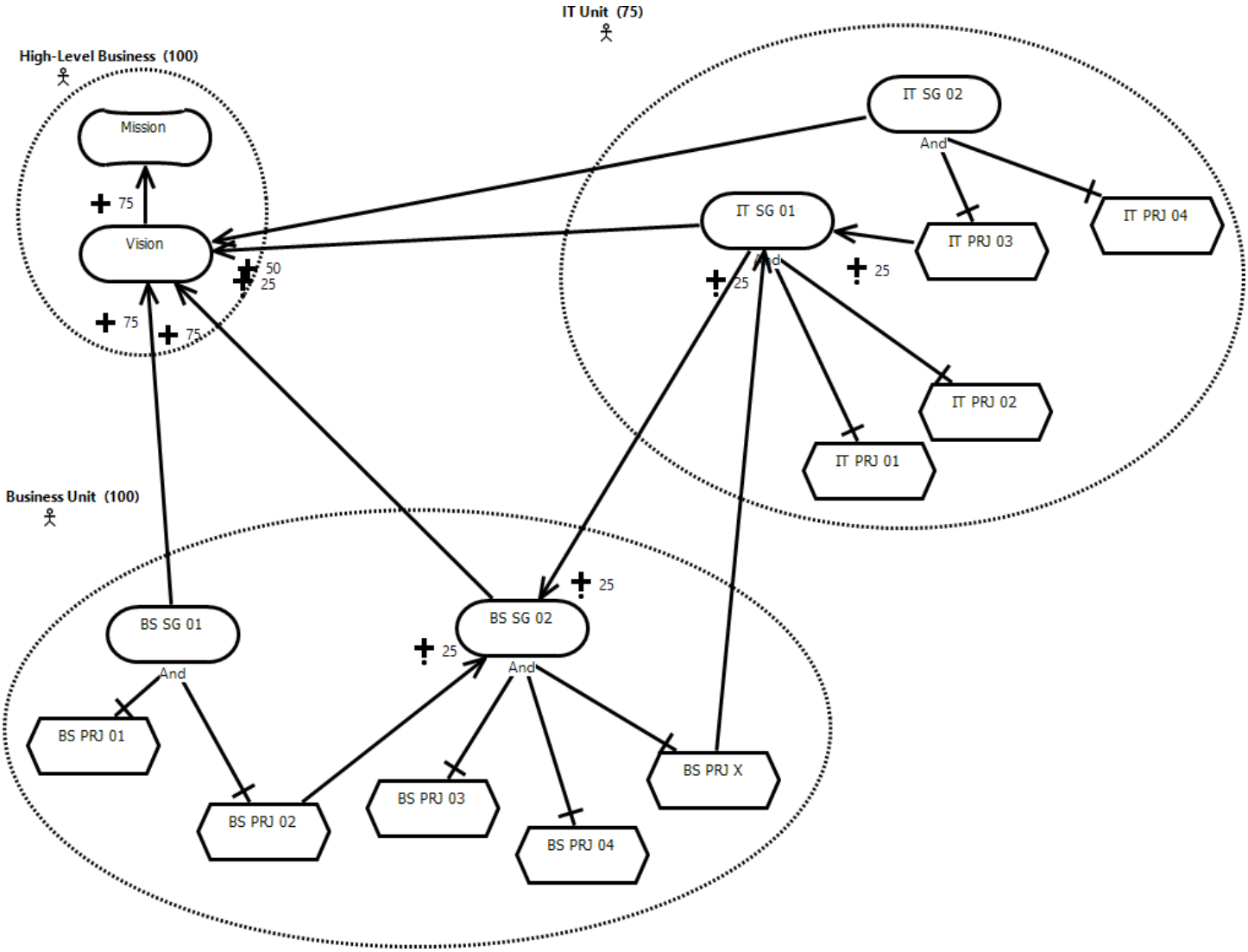


Figure 3 - System X as Strategic Project

Intentional Elements

Mission

Vision

Metadata: "_addAggregate" = "disable"

IT SG 01

Metadata: "_addAggregate" = "disable"

IT SG 02

Metadata: "_addAggregate" = "disable"

BS SG 01

Metadata: "_addAggregate" = "disable"

BS SG 02

Metadata: "_addAggregate" = "disable"

BS PRJ 01

BS PRJ 02

Metadata: "_addAggregate" = "disable"

IT PRJ 01

IT PRJ 02

IT PRJ 03

Metadata: "_addAggregate" = "disable"

IT PRJ 04

BS PRJ 03

BS PRJ 04

BS PRJ X

Metadata: "_addAggregate" = "disable"

Actors View

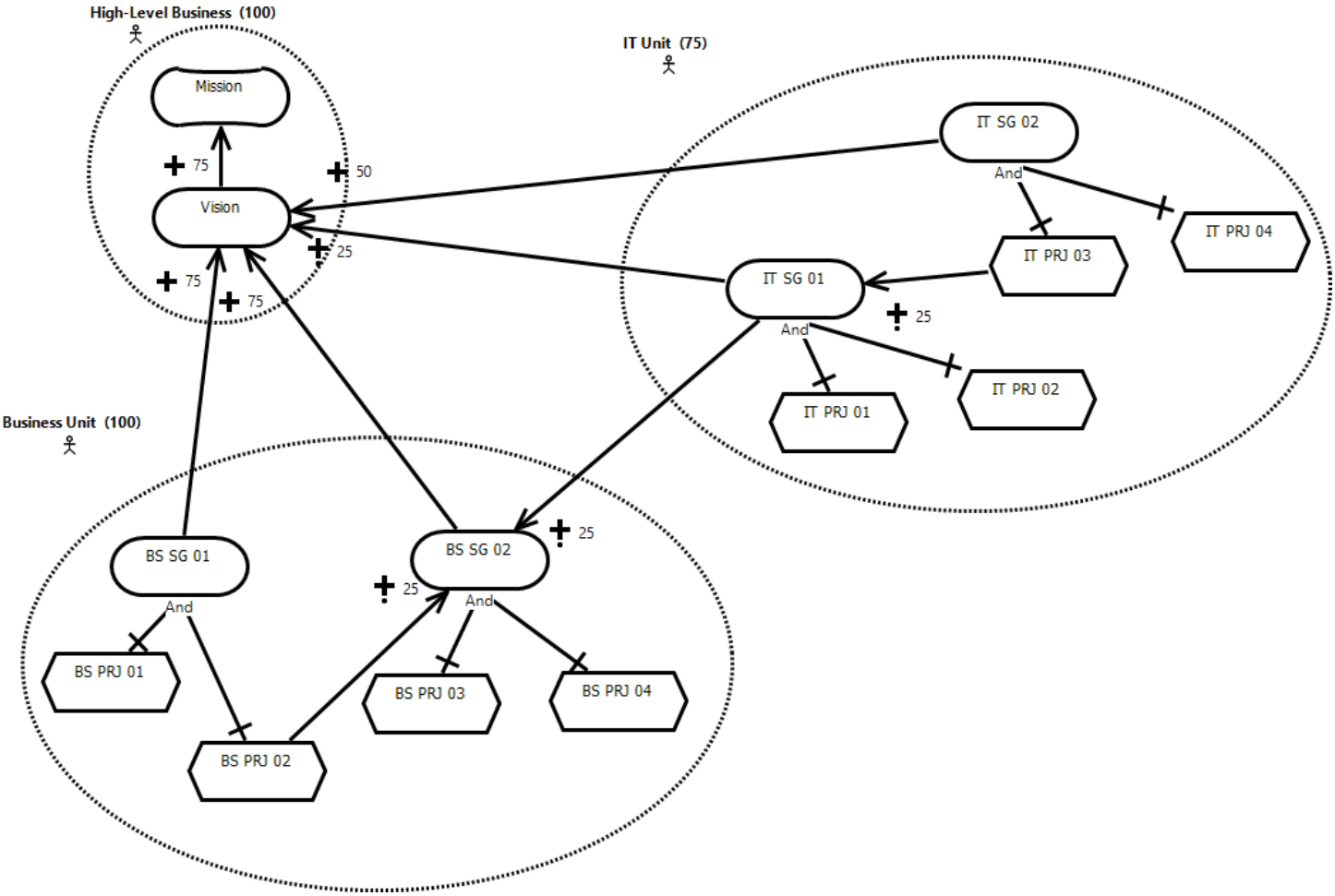


Figure 4 - Actors View

Intentional Elements

Mission

Vision

Metadata: "_addAggregate" = "disable"

IT SG 01

Metadata: "_addAggregate" = "disable"

IT SG 02

Metadata: "_addAggregate" = "disable"

BS SG 01

Metadata: "_addAggregate" = "disable"

BS SG 02

Metadata: "_addAggregate" = "disable"

BS PRJ 01

BS PRJ 02

Metadata: "_addAggregate" = "disable"

IT PRJ 01

IT PRJ 02

IT PRJ 03

Metadata: "_addAggregate" = "disable"

IT PRJ 04

BS PRJ 03

BS PRJ 04

Exampleof Indicators

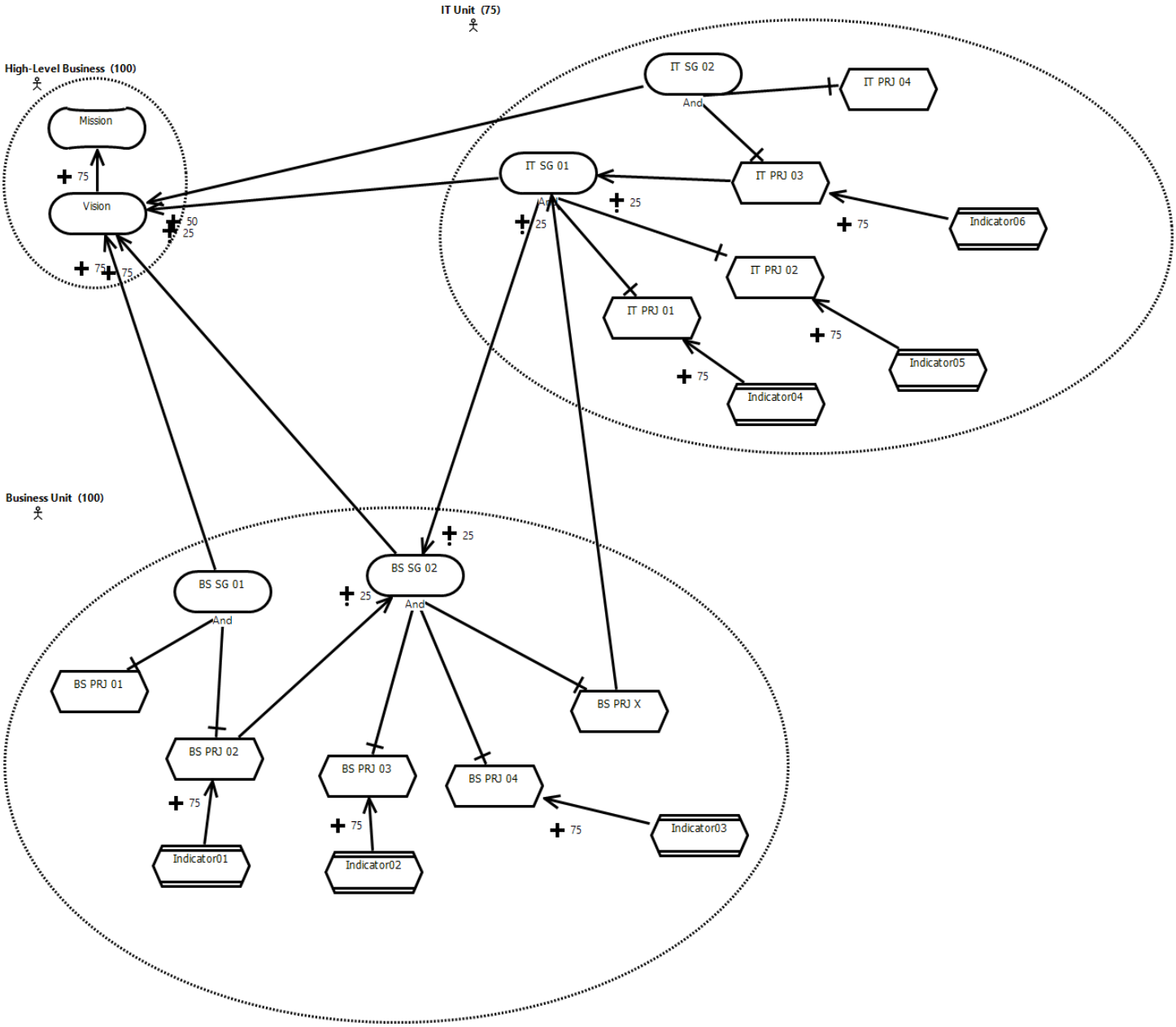


Figure 5 - Exampleof Indicators

Intentional Elements

Mission

Vision

Metadata: "_addAggregate" = "disable"

IT SG 01

Metadata: "_addAggregate" = "disable"

IT SG 02

Metadata: "_addAggregate" = "disable"

BS SG 01

Metadata: "_addAggregate" = "disable"

BS SG 02

Metadata: "_addAggregate" = "disable"

BS PRJ 01

BS PRJ 02

Metadata: "_addAggregate" = "disable"

IT PRJ 01

IT PRJ 02

IT PRJ 03

Metadata: "_addAggregate" = "disable"

IT PRJ 04

BS PRJ 03

BS PRJ 04

BS PRJ X

Metadata: "_addAggregate" = "disable"

Indicator04

Metadata: "_addAggregate" = "disable"

Indicator05

Metadata: "_addAggregate" = "disable"

Indicator06

Metadata: "_addAggregate" = "disable"

Indicator01

Metadata: "_addAggregate" = "disable"

Indicator02

Metadata: "_addAggregate" = "disable"

Indicator03

Metadata: "_addAggregate" = "disable"

Scenario Documentation

Scenario Execution Summary

Group ScenarioGroup5 (ID:5)

Scenario	Result	Message(s)
ScenarioDef6 (ID: 6)	FAILED	No start points defined! Nothing to execute!

Scenario Information

Group ScenarioGroup5 (ID: 5)

Scenario ScenarioDef6 (ID: 6)

jUCMNav Report

http://softwareengineering.ca/jucmnav

UCM Scenario Groups documentation

- ScenarioGroup5:
  1. ScenarioDef6

Intentional Elements

1. Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:
   - la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
   - la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

   Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.
2. Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.
3. Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

4. Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario
5. Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.
6. Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador
7. CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.
8. FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.
9. ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.
10. RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.
11. IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.
12. BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica Universidad Javeriana.
13. Plan de Desarrollo de Tecnologías
14. Procesos de enseñanza, aprendizaje y evaluación
15. Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías
16. Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico
17. Procesos de: docencia, investigación, servicios, medio universitario y administrativos
18. PPU - Prevención de la violencia y promoción de una cultura de sana convivencia
19. PPU - Smart Campus Javeriana
20. PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones con egresados en la Universidad Javeriana
21. PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento
22. PPU - Hombre en el cosmos (H@C)
23. PPU - Instituto del Agua
24. PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central
25. PPU - Proyecto Javeriano de Paz y Reconciliación
26. PPU - Comunicación para la reconciliación y la salud mental
27. PPU - Alimento, vida y hábitat
28. Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)
29. Misión y Visión: Apoyar a través de la gestión innovadora de tecnologías, el desarrollo de la Misión y la consecución de la Visión de la Universidad, en el marco de la Planeación Universitaria.

30. Modelo de Educación Virtual - Tecnologías de EAE
31. Aulas de Aprendizaje Activo - Tecnologías de EAE
32. Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil
33. Tecnologías para Enseñanza Aprendizaje
34. Campus Virtual
35. Salas Ágiles
36. Aula de Teleclase
37. Aula SONY
38. SATIS Sistema de Alertas Tempranas Intervención y Seguimiento
39. Biblioteca Digital
40. Nube Javeriana
41. Proveer Procesos Enseñanza-Aprendizaje, evalaución: Proveer servicios soportados en tecnologías que asistan los procesos y modelos de enseñanza, aprendizaje, evaluación e innovación curricular, y que a su vez flexibilicen y faciliten su acceso
42. Disponer servicios de información procesos de análisis de factores de la gestión académica: Disponer servicios de información que soporten los procesos de análisis de los factores más sensibles de la gestión académica de la Universidad.
43. Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación: Habilitar la implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación mediante la incorporación adaptativa de tecnologías.
44. Gestión integrada de capacidades tecnológicas y equipos robustos: Apoyar estos procesos mediante la gestión integrada de las capacidades tecnológicas y equipos robustos existentes en la Universidad.
45. Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación: Implementar en la Universidad las tecnologías provenientes de centros de excelencia y proyectos de investigación, según su pertinencia
46. Proveer servicios para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico: Proveer servicios soportados en tecnologías para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico
47. Plataforma de capacidades tecnológicas: Plataforma de capacidades tecnológicas en funcionamiento
48. Gestión IIDcat: Gestión integrada de capacidades tecnológicas para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
49. Sistema de gestión de la Investigación - Tecnologías para Investigación : Sistema de gestión de la Investigación - Tecnologías para Investigación
50. Sistema Investigar PUJ: Sistema Investigar PUJ
51. Ecosistema de Innovación: Ecosistema de Innovación
52. Fase 1 del Sistema que soporte el Ecosistema de Innovación: Fase 1 del Sistema que soporte el Ecosistema de Innovación
53. Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat: Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
54. Actualización de ZINE: Actualización de ZINE
55. Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad: Gestionar la permanente revisión y actualización de las plataformas de tecnologías de información y comunicación para garantizar su pertinencia y disponibilidad

56. Plataformas que soporten procesos de análisis de datos para toma de decisiones: Soportar plataformas de información que soporten los procesos de análisis de datos para toma de decisiones
57. Evaluar y liderar implementación de nuevas tecnologías para eficiencia operacional: Evaluar y liderar la implementación de nuevas tecnologías que generen mayores eficiencias operacionales
58. Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje: Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje
59. Gestión del Medio Universitario: Gestión del Medio Universitario
60. Gestión de Procesos Administrativos: Gestión de Procesos Administrativos
61. Sistema de aseguramiento de la calidad de la oferta académica: Sistema de aseguramiento de la calidad de la oferta académica
    Programas académicos (Creación, Registro Calificado y Acreditación de alta calidad)
62. Rediseño del proceso de Admisiones: Rediseño del proceso de Admisiones
63. Analíticos de gestión para el Sistema XIE: Analíticos de gestión para el Sistema XIE
64. Automatización de procesos - Robot: Automatización de procesos - Robot
65. Gestión de Procesos Extensión - CRM: Gestión de Procesos Extensión - CRM
66. Gestión Universitaria -Integración digital: Gestión Universitaria -Integración digital
67. Experiencia de usuario final: Experiencia de usuario final
68. Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil: Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil
69. Sistema de Información de Egresados: Sistema de Información de Egresados
70. Sistema de Gestión Documental: Sistema de Gestión Documental
71. Sistema Académico Peoplesoft Campus Solutions v9.2: Sistema Académico Peoplesoft Campus Solutions v9.2
72. JaveMóvil: JaveMóvil
73. definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación: Liderar la definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación de tecnologías, incorporando tendencias de la industria que sean pertinentes
74. estrategia de seguridad de información institucional: Liderar la definición de una estrategia de seguridad de información institucional basada en la gestión de riesgo, acorde con el ritmo de las nuevas amenazas y retos de seguridad.
75. implementar las políticas, directrices y estándares: Desarrollar e implementar las políticas, directrices y estándares que orienten el uso articulado, integrado y eficiente de las diferentes capacidades y tecnologías existentes en la Universidad
76. desarrollo del capital humano que gestiona y consume tecnologías: Promover el desarrollo del capital humano que gestiona y consume tecnologías en la Universidad, para fomentar la cultura digital
77. Alineación de las Tecnologías con la estrategia Institucional: Alineación de las Tecnologías con la estrategia Institucional
78. Política de Gobierno de Información y Gestión de Riesgos: Política de Gobierno de Información y Gestión de Riesgos
79. Estructuración de modelo de colaboración con Centros de Excelencia: Estructuración de modelo de colaboración con Centros de Excelencia
80. Observatorio de Tecnologías: Estructuración e implementación del Observatorio de Tecnologías: Participación en redes de colaboración (nacionales e internacionales) para la innovación tecnológica y Análisis periódico comparativo de usos de tecnologías en otras instituciones u organizaciones.

81. Consolidación de modelo de gobierno de tecnología con la Seccional: Consolidación de modelo de gobierno de tecnología con la Seccional
82. Actualización de políticas, lineamientos, metodologías y procedimientos: Actualización de políticas, lineamientos, metodologías y procedimientos relacionados con las tecnologías y su uso.
83. Programa de Gestión de Cambio: Estructuración e implementación de un programa de Gestión de Cambio para la apropiación de las tecnologías y el fomento a la Cultura Digital
84. Gobierno de Datos: Gobierno de Datos
85. Gobierno de información - Ciberseguridad: Gobierno de información - Ciberseguridad
86. Estrategia institucional de datos: Desarrollo de estrategia institucional de datos que generen directrices respecto a su calidad, acceso, administración y cumplimiento.
87. Integración de fuentes de datos - Centralización de terceros.: Integración de fuentes de datos - Centralización de terceros.
88. cultura y estrategia de ciberseguridad: Articulación de una apropiada cultura y estrategia de ciberseguridad que sirva como habilitador de la planeación universitaria y de las estrategias digitales de la Universidad, y alineado con la gestión de riesgo.
89. hoja de ruta de ciberseguridad: Construcción de la hoja de ruta de ciberseguridad con los programas de seguridad de como proteger y compartir información sobre las diferentes opciones tecnológicas que la Universidad adopte.
90. Improve Privacy and Security
91. Better use of resources
92. Automatize document management
93. Manage User Information
94. On Paper
95. Automated System
96. Manage Systems In Organization
97. Human Resources
98. IT Resources
99. Project X

Actors

1. Alto Nivel Organización
2. Negocio Operativo
3. DTI
4. System
5. Business Unit X

Strategy Legend for Group "StrategiesGroup3"

1:Information system

2:On Paper

Note: Trend calculated based on last 3 strategies

	Strategy Evaluations	
	1	2
Alto Nivel Organización (A)	0	0
Negocio Operativo (A)	0	0
DTI (A)	0	0
System (A)	0	0
Business Unit X (A)	0	0
Misión	2	3
Visión	3	4
Mega 2	0	0
Mega 3	6	6
Mega 4	6	6
Mega 1	0	0
CULTURA DE LA EXCELENCIA	0	0
FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA	0	0
ECOLOGÍA	0	0

	Strategy Evaluations	
INTEGRAL		
RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ	0	0
IMPACTO EN LA TRANSFORMACIÓN SOCIAL	0	0
BUEN GOBIERNO	25	25
Plan de Desarrollo de Tecnologías	0	0
Procesos de enseñanza, aprendizaje y evaluación	0	0
Gobierno de Tecnología	0	0
Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico	0	0

	Strategy Evaluations	
Procesos de: docencia, investigación, servicios, medio universitario y administrativos	0	0
PPU - Prevención de la violencia y promoción de una cultura de sana convivencia	0	0
PPU - Smart Campus Javeriana	0	0
PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones	0	0

	Strategy Evaluations	
con egresados en la Universidad Javeriana		
PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento	0	0
PPU - Hombre en el cosmos (H@C)	0	0
PPU - Instituto del Agua	0	0
PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central	0	0
PPU - Proyecto Javeriano de Paz y Reconciliación	0	0

	Strategy Evaluations	
PPU - Comunicación para la reconciliación y la salud mental	0	0
PPU - Alimento, vida y hábitat	0	0
Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)	0	0
Misión y Visión	12	18
Modelo de Educación Virtual - Tecnologías de EAE	0	0
Aulas de Aprendizaje Activo - Tecnologías de EAE	0	0

	Strategy Evaluations	
Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil	0	0
Tecnologías para Enseñanza Aprendizaje	0	0
Campus Virtual	0	0
Salas Ágiles	0	0
Aula de Teleclase	0	0
Aula SONY	0	0
SATIS Sistema de Alertas Tempranas Intervención y Seguimiento	0	0
Biblioteca Digital	0	0
Nube Javeriana	0	0
Proveer Procesos Enseñanza-	0	0

	Strategy Evaluations	
Aprendizaje, evalaución		
Disponer servicios de información procesos de análisis de factores de la gestión académica	0	0
Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación	0	0
Gestión integrada de capacidades tecnológicas y equipos robustos	0	0
Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación	0	0
Proveer servicios para	0	0

	Strategy Evaluations	
los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico		
Plataforma de capacidades tecnológicas	0	0
Gestión IIDcat	0	0
Sistema de gestión de la Investigación - Tecnologías para Investigación	0	0
Sistema Investigar PUJ	0	0
Ecosistema de Innovación	0	0
Fase 1 del Sistema que soporte el Ecosistema de Innovación	0	0
Infraestructura para la	0	0

	Strategy Evaluations	
Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat		
Actualización de ZINE	0	0
Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad	0	0
Plataformas que soporten procesos de análisis de datos para toma de decisiones	0	0
Evaluar y liderar implementación de nuevas tecnologías para eficiencia	0	0

	Strategy Evaluations	
operacional		
Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje	0	0
Gestión del Medio Universitario	0	0
Gestión de Procesos Administrativos	0	0
Sistema de aseguramiento de la calidad de la oferta académica	0	0
Rediseño del proceso de Admisiones	0	0
Analíticos de gestión para el Sistema XIE	0	0
Automatizaci	0	0

	Strategy Evaluations	
ón de procesos - Robot		
Gestión de Procesos Extensión - CRM	0	0
Gestión Universitaria - Integración digital	0	0
Experiencia de usuario final	0	0
Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil	0	0
Sistema de Información de Egresados	0	0
Sistema de Gestión Documental	0	0
Sistema Académico Peoplesoft Campus	0	0

	Strategy Evaluations	
Solutions v9.2		
JaveMóvil	0	0
definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación	0	0
estrategia de seguridad de información institucional	0	0
implementar las políticas, directrices y estándares	0	0
desarrollo del capital humano que gestiona y consume tecnologías	0	0
Alineación de las Tecnologías con la	0	0

	Strategy Evaluations	
estrategia Institucional		
Política de Gobierno de Información y Gestión de Riesgos	0	0
Estructuración de modelo de colaboración con Centros de Excelencia	0	0
Observatorio de Tecnologías	0	0
Consolidación de modelo de gobierno de tecnología con la Seccional	0	0
Actualización de políticas, lineamientos, metodologías y procedimientos	0	0
Programa de Gestión de	0	0

	Strategy Evaluations	
Cambio		
Gobierno de Datos	0	0
Gobierno de información - Ciberseguridad	0	0
Estrategia institucional de datos	0	0
Integración de fuentes de datos - Centralización de terceros.	0	0
cultura y estrategia de ciberseguridad	0	0
hoja de ruta de ciberseguridad	0	0
Improve Privacy and Security	100	0
Better use of resources	100	100
Automatize document	75	0

	Strategy Evaluations	
management		
Manage User Information	100	100
On Paper	0	100
Automated System	100	0
Manage Systems In Organization	50	75
Human Resources	75	75
IT Resources	75	75
Project X	0	0

Strategy Legend for Group "Avance"

1:EvaluationStrategy2358

Note: Trend calculated based on last 3 strategies

	Strategy Evaluations
	1
Alto Nivel Organización (A)	0
Negocio Operativo (A)	0
DTI (A)	25
System (A)	0
Business Unit X (A)	0
Misión	13
Visión	18
Mega 2	18
Mega 3	18
Mega 4	12
Mega 1	42
CULTURA DE LA EXCELENCIA	50
FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA	50
ECOLOGÍA	25

	Strategy Evaluations
INTEGRAL	
RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ	75
IMPACTO EN LA TRANSFORMACIÓN SOCIAL	0
BUEN GOBIERNO	0
Plan de Desarrollo de Tecnologías	25
Procesos de enseñanza, aprendizaje y evaluación	0
Gobierno de Tecnología	25
Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico	30

	Strategy Evaluations
Procesos de: docencia, investigación, servicios, medio universitario y administrativos	50
PPU - Prevención de la violencia y promoción de una cultura de sana convivencia	75
PPU - Smart Campus Javeriana	50
PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones	75

	Strategy Evaluations
con egresados en la Universidad Javeriana	
PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento	50
PPU - Hombre en el cosmos (H@C)	75
PPU - Instituto del Agua	25
PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central	75
PPU - Proyecto Javeriano de Paz y Reconciliación	100

	Strategy Evaluations
PPU - Comunicación para la reconciliación y la salud mental	75
PPU - Alimento, vida y hábitat	100
Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)	50
Misión y Visión	25
Modelo de Educación Virtual - Tecnologías de EAE	75
Aulas de Aprendizaje Activo - Tecnologías de EAE	25

	Strategy Evaluations
Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil	75
Tecnologías para Enseñanza Aprendizaje	0
Campus Virtual	75
Salas Ágiles	75
Aula de Teleclase	75
Aula SONY	25
SATIS Sistema de Alertas Tempranas Intervención y Seguimiento	75
Biblioteca Digital	75
Nube Javeriana	0
Proveer Procesos Enseñanza-	75

	Strategy Evaluations
Aprendizaje, evalaución	
Disponer servicios de información procesos de análisis de factores de la gestión académica	75
Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación	0
Gestión integrada de capacidades tecnológicas y equipos robustos	50
Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación	50
Proveer servicios para	50

	Strategy Evaluations
los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico	
Plataforma de capacidades tecnológicas	75
Gestión IIDcat	75
Sistema de gestión de la Investigación - Tecnologías para Investigación	50
Sistema Investigar PUJ	50
Ecosistema de Innovación	50
Fase 1 del Sistema que soporte el Ecosistema de Innovación	50
Infraestructura para la	50

	Strategy Evaluations
Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat	
Actualización de ZINE	50
Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad	30
Plataformas que soporten procesos de análisis de datos para toma de decisiones	30
Evaluar y liderar implementación de nuevas tecnologías para eficiencia	30

	Strategy Evaluations
operacional	
Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje	50
Gestión del Medio Universitario	75
Gestión de Procesos Administrativos	50
Sistema de aseguramiento de la calidad de la oferta académica	75
Rediseño del proceso de Admisiones	50
Analíticos de gestión para el Sistema XIE	75
Automatizaci	50

	Strategy Evaluations
ón de procesos - Robot	
Gestión de Procesos Extensión - CRM	30
Gestión Universitaria - Integración digital	75
Experiencia de usuario final	50
Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil	75
Sistema de Información de Egresados	50
Sistema de Gestión Documental	75
Sistema Académico Peoplesoft Campus	50

	Strategy Evaluations
Solutions v9.2	
JaveMóvil	75
definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación	50
estrategia de seguridad de información institucional	25
implementar las políticas, directrices y estándares	25
desarrollo del capital humano que gestiona y consume tecnologías	25
Alineación de las Tecnologías con la	50

	Strategy Evaluations
estrategia Institucional	
Política de Gobierno de Información y Gestión de Riesgos	25
Estructuración de modelo de colaboración con Centros de Excelencia	100
Observatorio de Tecnologías	75
Consolidación de modelo de gobierno de tecnología con la Seccional	100
Actualización de políticas, lineamientos, metodologías y procedimientos	50
Programa de Gestión de	50

	Strategy Evaluations
Cambio	
Gobierno de Datos	50
Gobierno de información - Ciberseguridad	25
Estrategia institucional de datos	75
Integración de fuentes de datos - Centralización de terceros.	50
cultura y estrategia de ciberseguridad	25
hoja de ruta de ciberseguridad	75
Improve Privacy and Security	0
Better use of resources	0
Automatize document	0

	Strategy Evaluations
management	
Manage User Information	0
On Paper	0
Automated System	0
Manage Systems In Organization	0
Human Resources	0
IT Resources	0
Project X	0

High level Business and DTI

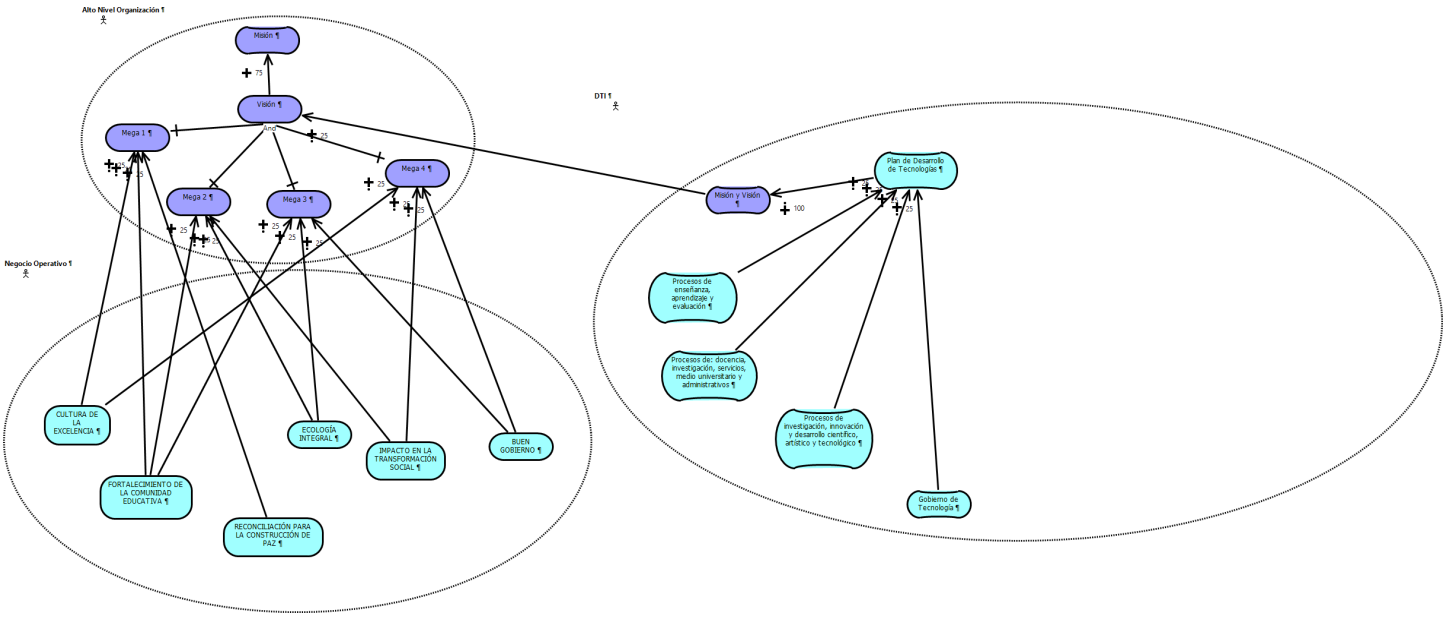


Figure 1 - High level Business and DTI

Intentional Elements

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario

Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.

CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.

Metadata: "_addAggregate" = "disable"

FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.

Metadata: "_addAggregate" = "disable"

ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.

Metadata: "_addAggregate" = "disable"

RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.

Metadata: "_addAggregate" = "disable"

IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.

Metadata: "_addAggregate" = "disable"

BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica Universidad Javeriana.

Metadata: "_addAggregate" = "disable"

Misión y Visión: Apoyar a través de la gestión innovadora de tecnologías, el desarrollo de la Misión y la consecución de la Visión de la Universidad, en el marco de la Planeación Universitaria.

Metadata: "_addAggregate" = "disable"

Plan de Desarrollo de Tecnologías

Metadata: "_addAggregate" = "disable"

Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías

Metadata: "_addAggregate" = "disable"

Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Metadata: "_addAggregate" = "disable"

Procesos de enseñanza, aprendizaje y evaluación

Metadata: "_addAggregate" = "disable"

Procesos de: docencia, investigación, servicios, medio universitario y administrativos

Metadata: "_addAggregate" = "disable"

DTI

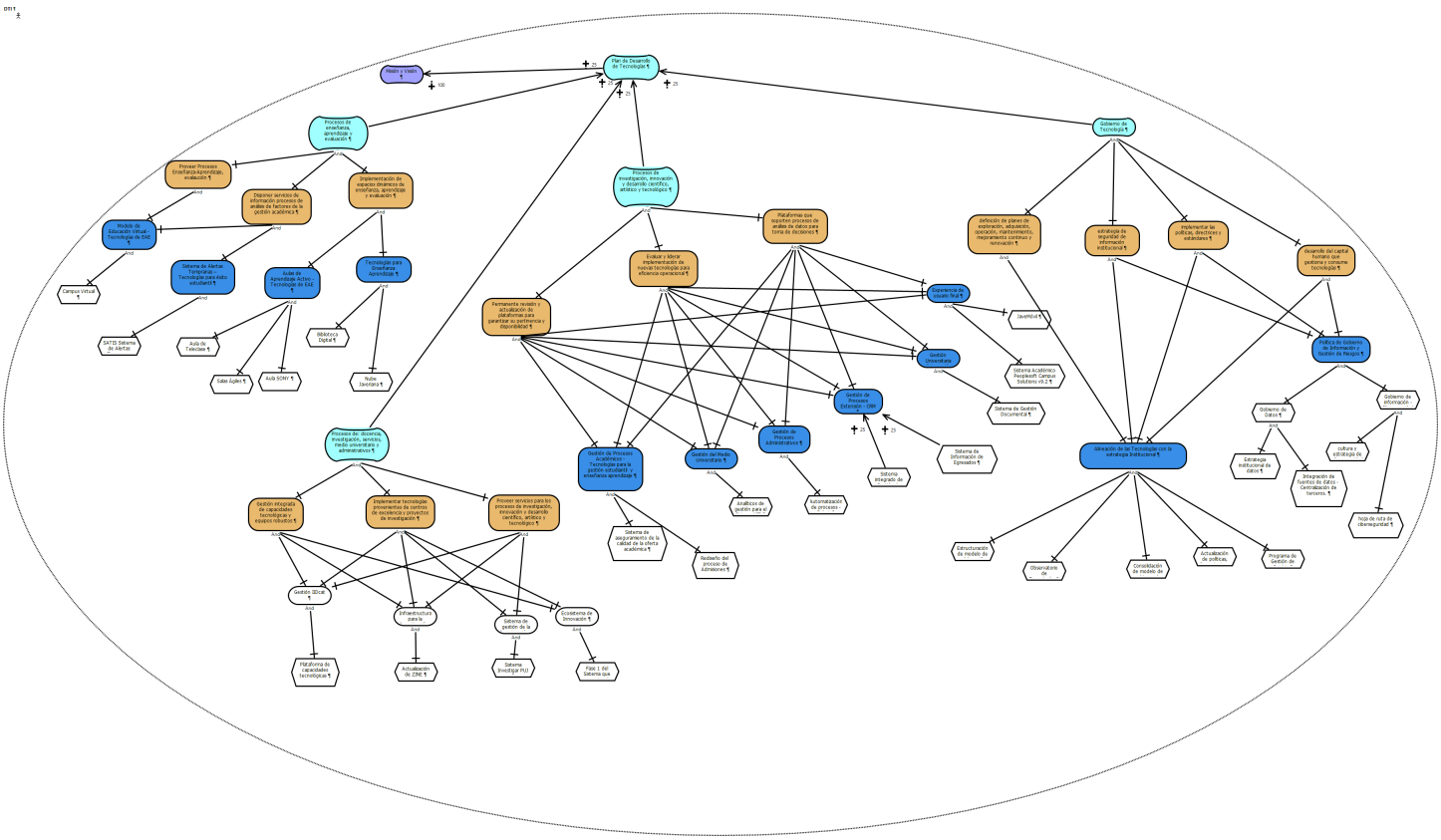


Figure 2 - DTI

Intentional Elements

Plataforma de capacidades tecnológicas: Plataforma de capacidades tecnológicas en funcionamiento

Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil: Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil

Metadata: "_addAggregate" = "disable"

JaveMóvil: JaveMóvil

Plan de Desarrollo de Tecnologías

Metadata: "_addAggregate" = "disable"

Observatorio de Tecnologías: Estructuración e implementación del Observatorio de Tecnologías: Participación en redes de colaboración (nacionales e internacionales) para la innovación tecnológica y Análisis periódico comparativo de usos de tecnologías en otras instituciones u organizaciones.

Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje: Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje
Gestión de Procesos Administrativos: Gestión de Procesos Administrativos
Política de Gobierno de Información y Gestión de Riesgos: Política de Gobierno de Información y Gestión de Riesgos

implementar las políticas, directrices y estándares: Desarrollar e implementar las políticas, directrices y estándares que orienten el uso articulado, integrado y eficiente de las diferentes capacidades y tecnologías existentes en la Universidad

Programa de Gestión de Cambio: Estructuración e implementación de un programa de Gestión de Cambio para la apropiación de las tecnologías y el fomento a la Cultura Digital

Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías
    Metadata: "_addAggregate" = "disable"
Sistema de gestión de la Investigación - Tecnologías para Investigación : Sistema de gestión de la Investigación - Tecnologías para Investigación

Estrategia institucional de datos: Desarrollo de estrategia institucional de datos que generen directrices respecto a su calidad, acceso, administración y cumplimiento.

Biblioteca Digital
Gestión IIDcat: Gestión integrada de capacidades tecnológicas para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
Modelo de Educación Virtual - Tecnologías de EAE
Integración de fuentes de datos - Centralización de terceros.: Integración de fuentes de datos - Centralización de terceros.

Sistema de Gestión Documental: Sistema de Gestión Documental

Sistema Investigar PUJ: Sistema Investigar PUJ

SATIS Sistema de Alertas Tempranas Intervención y Seguimiento
Evaluar y liderar implementación de nuevas tecnologías para eficiencia operacional: Evaluar y liderar la implementación de nuevas tecnologías que generen mayores eficiencias operacionales

Sistema de Información de Egresados: Sistema de Información de Egresados

Metadata: "_addAggregate" = "disable"

Plataformas que soporten procesos de análisis de datos para toma de decisiones: Soportar plataformas de información que soporten los procesos de análisis de datos para toma de decisiones

Gestión de Procesos Extensión - CRM: Gestión de Procesos Extensión - CRM

Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación: Habilitar la implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación mediante la incorporación adaptativa de tecnologías.

Aula SONY

Ecosistema de Innovación: Ecosistema de Innovación

Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Metadata: "_addAggregate" = "disable"

estrategia de seguridad de información institucional: Liderar la definición de una estrategia de seguridad de información institucional basada en la gestión de riesgo, acorde con el ritmo de las nuevas amenazas y retos de seguridad.

Aula de Teleclase

Experiencia de usuario final: Experiencia de usuario final

Consolidación de modelo de gobierno de tecnología con la Seccional: Consolidación de modelo de gobierno de tecnología con la Seccional

Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat: Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat

Nube Javeriana

Gestión del Medio Universitario: Gestión del Medio Universitario

Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación: Implementar en la Universidad las tecnologías provenientes de centros de excelencia y proyectos de investigación, según su pertinencia

Disponer servicios de información procesos de análisis de factores de la gestión académica: Disponer servicios de información que soporten los procesos de análisis de los factores más sensibles de la gestión académica de la Universidad.

Campus Virtual

cultura y estrategia de ciberseguridad: Articulación de una apropiada cultura y estrategia de ciberseguridad que sirva como habilitador de la planeación universitaria y de las estrategias digitales de la Universidad, y alineado con la gestión de riesgo.

Gobierno de Datos: Gobierno de Datos

Procesos de: docencia, investigación, servicios, medio universitario y administrativos

Metadata: "_addAggregate" = "disable"

Tecnologías para Enseñanza Aprendizaje

hoja de ruta de ciberseguridad: Construcción de la hoja de ruta de ciberseguridad con los programas de seguridad de como proteger y compartir información sobre las diferentes opciones tecnológicas que la Universidad adopte.

Aulas de Aprendizaje Activo - Tecnologías de EAE

Analíticos de gestión para el Sistema XIE: Analíticos de gestión para el Sistema XIE

Salas Ágiles

Actualización de ZINE: Actualización de ZINE

Sistema de aseguramiento de la calidad de la oferta académica: Sistema de aseguramiento de la calidad de la oferta académica

Programas académicos (Creación, Registro Calificado y Acreditación de alta calidad)

Misión y Visión: Apoyar a través de la gestión innovadora de tecnologías, el desarrollo de la Misión y la consecución de la Visión de la Universidad, en el marco de la Planeación Universitaria.

Metadata: "_addAggregate" = "disable"

Proveer Procesos Enseñanza-Aprendizaje, evalaución: Proveer servicios soportados en tecnologías que asistan los procesos y modelos de enseñanza, aprendizaje, evaluación e innovación curricular, y que a su vez flexibilicen y faciliten su acceso

Rediseño del proceso de Admisiones: Rediseño del proceso de Admisiones

Automatización de procesos - Robot: Automatización de procesos - Robot

Fase 1 del Sistema que soporte el Ecosistema de Innovación: Fase 1 del Sistema que soporte el Ecosistema de Innovación

Actualización de políticas, lineamientos, metodologías y procedimientos: Actualización de políticas, lineamientos, metodologías y procedimientos relacionados con las tecnologías y su uso.

Gestión Universitaria -Integración digital: Gestión Universitaria -Integración digital

Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad: Gestionar la permanente revisión y actualización de las plataformas de tecnologías de información y comunicación para garantizar su

pertinencia y disponibilidad
Estructuración de modelo de colaboración con Centros de Excelencia: Estructuración de modelo de colaboración con Centros de Excelencia

definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación: Liderar la definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación de tecnologías, incorporando tendencias de la industria que sean pertinentes

Gestión integrada de capacidades tecnológicas y equipos robustos: Apoyar estos procesos mediante la gestión integrada de las capacidades tecnológicas y equipos robustos existentes en la Universidad.

Sistema Académico Peoplesoft Campus Solutions v9.2: Sistema Académico Peoplesoft Campus Solutions v9.2

Proveer servicios para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico: Proveer servicios soportados en tecnologías para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Gobierno de información - Ciberseguridad: Gobierno de información - Ciberseguridad

Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil
desarrollo del capital humano que gestiona y consume tecnologías: Promover el desarrollo del capital humano que gestiona y consume tecnologías en la Universidad, para fomentar la cultura digital

Procesos de enseñanza, aprendizaje y evaluación
Metadata: "_addAggregate" = "disable"
Alineación de las Tecnologías con la estrategia Institucional: Alineación de las Tecnologías con la estrategia Institucional

Business - High-Level

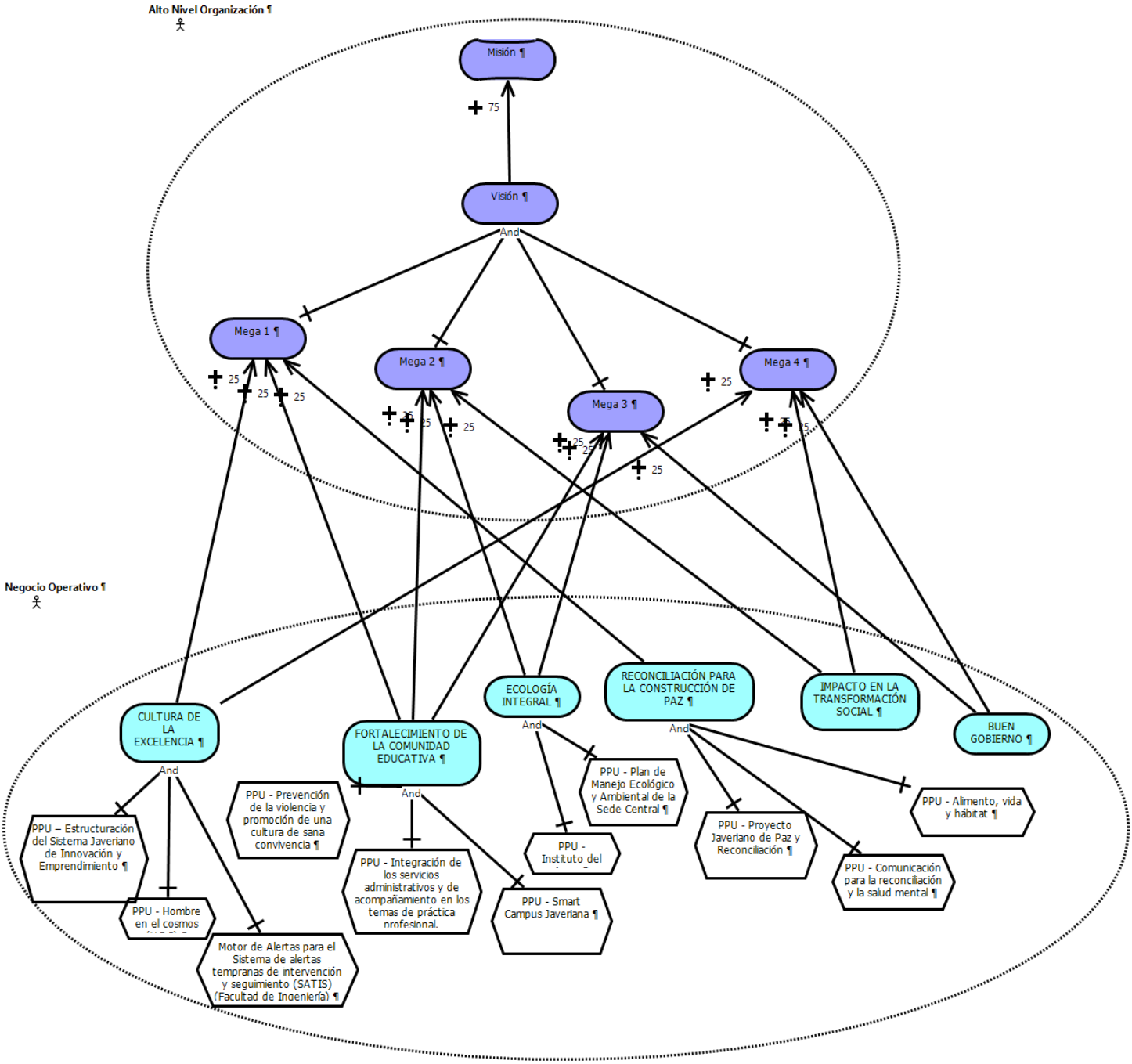


Figure 3 - Business - High-Level

Intentional Elements

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la

Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario

Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.

FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.

Metadata: "_addAggregate" = "disable"

CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.

Metadata: "_addAggregate" = "disable"

ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.

Metadata: "_addAggregate" = "disable"

RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.

Metadata: "_addAggregate" = "disable"

IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.

Metadata: "_addAggregate" = "disable"

BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica

Universidad Javeriana.

Metadata: "_addAggregate" = "disable"

PPU - Prevención de la violencia y promoción de una cultura de sana convivencia

PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones con egresados en la Universidad Javeriana

PPU - Smart Campus Javeriana

PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento

PPU - Hombre en el cosmos (H@C)

Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)

PPU - Instituto del Agua

PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central

PPU - Proyecto Javeriano de Paz y Reconciliación

PPU - Comunicación para la reconciliación y la salud mental

PPU - Alimento, vida y hábitat

Business

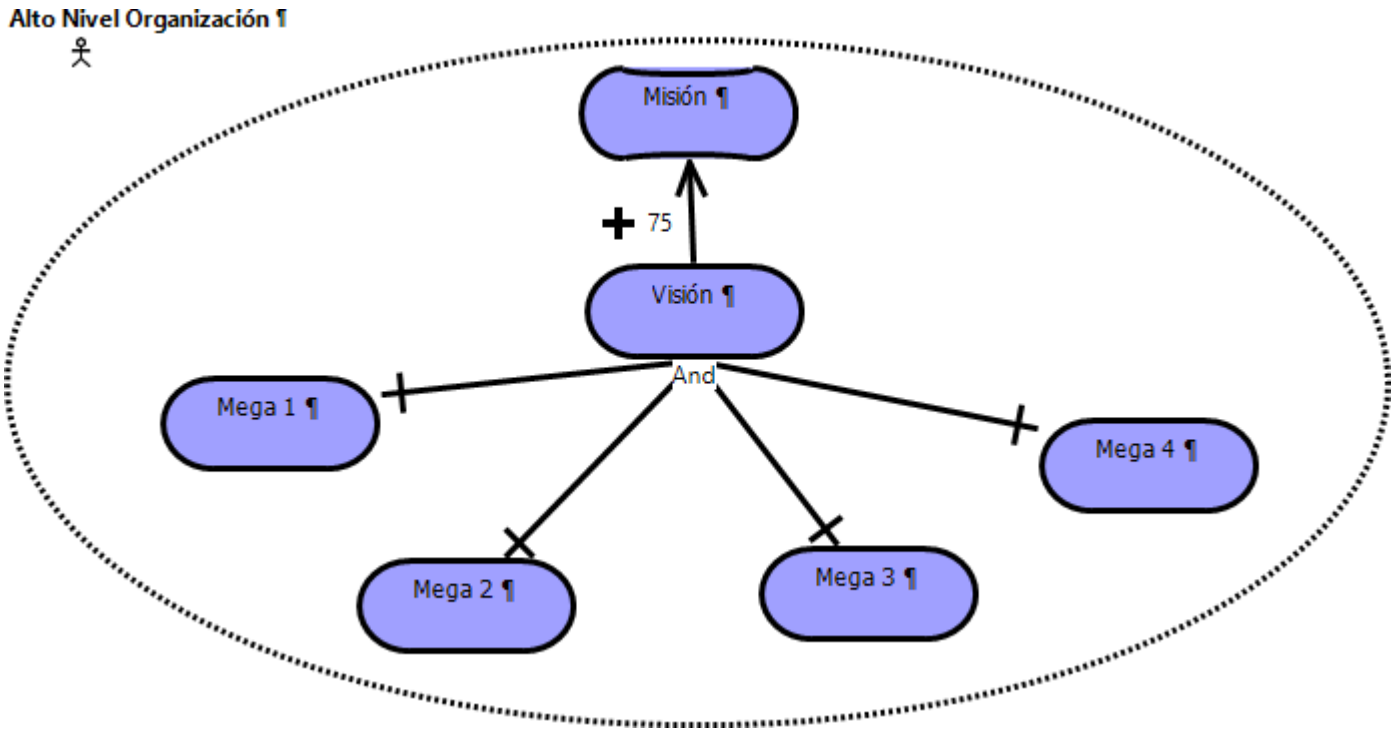


Figure 4 - Business

Intentional Elements

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad,

internacionalización y cuidado de la casa común.

Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario

Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.

PUJ Inicial

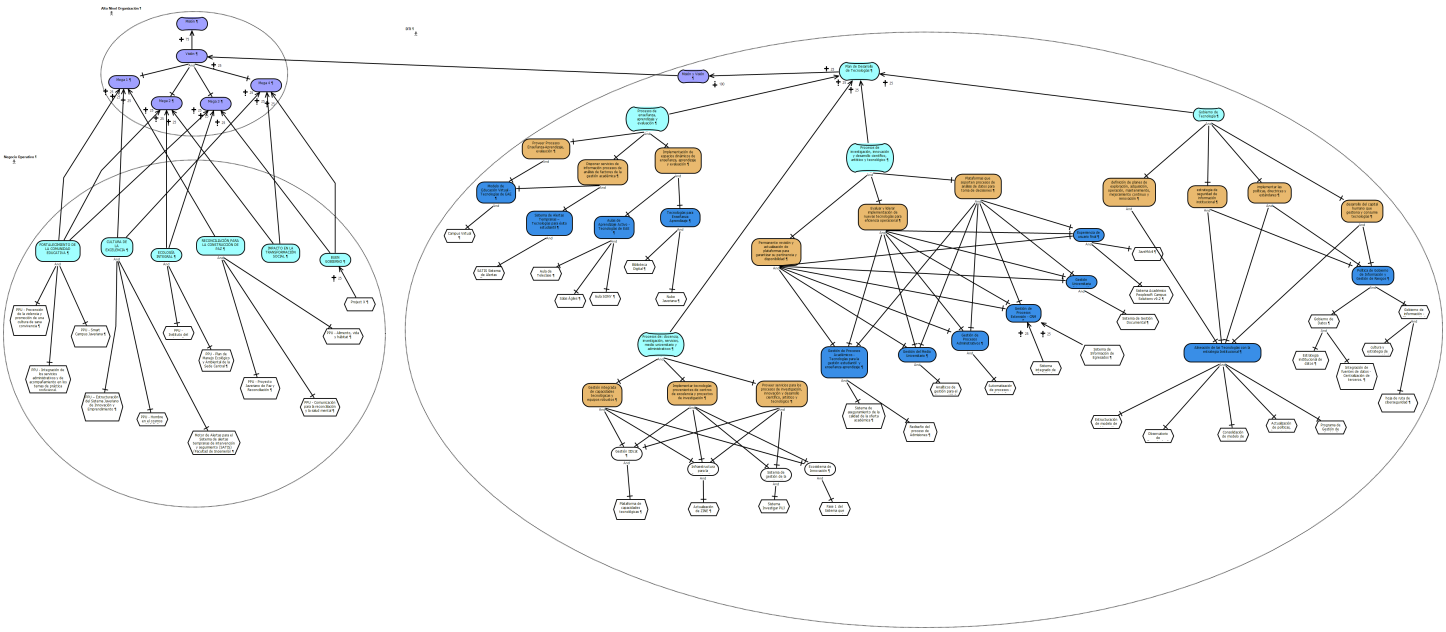


Figure 5 - PUJ Inicial

Intentional Elements

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario

Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos

institucionalmente y orientadas a la realización de la visión.

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.

Metadata: "_addAggregate" = "disable"

FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.

Metadata: "_addAggregate" = "disable"

ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.

Metadata: "_addAggregate" = "disable"

RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.

Metadata: "_addAggregate" = "disable"

IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.

Metadata: "_addAggregate" = "disable"

BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica Universidad Javeriana.

Metadata: "_addAggregate" = "disable"

Plan de Desarrollo de Tecnologías

Metadata: "_addAggregate" = "disable"

Procesos de enseñanza, aprendizaje y evaluación

Metadata: "_addAggregate" = "disable"

Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías

Metadata: "_addAggregate" = "disable"

Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Metadata: "_addAggregate" = "disable"

Procesos de: docencia, investigación, servicios, medio universitario y administrativos

Metadata: "_addAggregate" = "disable"

PPU - Prevención de la violencia y promoción de una cultura de sana convivencia

PPU - Smart Campus Javeriana

PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones con egresados en la Universidad Javeriana
PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento
PPU - Hombre en el cosmos (H@C)
PPU - Instituto del Agua
PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central
PPU - Proyecto Javeriano de Paz y Reconciliación
PPU - Comunicación para la reconciliación y la salud mental
PPU - Alimento, vida y hábitat
Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)
Misión y Visión: Apoyar a través de la gestión innovadora de tecnologías, el desarrollo de la Misión y la consecución de la Visión de la Universidad, en el marco de la Planeación Universitaria.

Metadata: "_addAggregate" = "disable"
Modelo de Educación Virtual - Tecnologías de EAE
Aulas de Aprendizaje Activo - Tecnologías de EAE
Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil
Tecnologías para Enseñanza Aprendizaje
Campus Virtual
Salas Ágiles
Aula de Teleclase
Aula SONY
SATIS Sistema de Alertas Tempranas Intervención y Seguimiento
Biblioteca Digital
Nube Javeriana
Proveer Procesos Enseñanza-Aprendizaje, evalaución: Proveer servicios soportados en tecnologías que asistan los procesos y modelos de enseñanza, aprendizaje, evaluación e innovación curricular, y que a su vez flexibilicen y faciliten su acceso
Disponer servicios de información procesos de análisis de factores de la gestión académica: Disponer servicios de información que soporten los procesos de análisis de los factores más sensibles de la gestión académica de la Universidad.

Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación: Habilitar la implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación mediante la incorporación adaptativa de tecnologías.

Gestión integrada de capacidades tecnológicas y equipos robustos: Apoyar estos procesos mediante la gestión integrada

de las capacidades tecnológicas y equipos robustos existentes en la Universidad.

Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación: Implementar en la Universidad las tecnologías provenientes de centros de excelencia y proyectos de investigación, según su pertinencia

Proveer servicios para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico: Proveer servicios soportados en tecnologías para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Plataforma de capacidades tecnológicas: Plataforma de capacidades tecnológicas en funcionamiento
Gestión IIDcat: Gestión integrada de capacidades tecnológicas para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
Sistema de gestión de la Investigación - Tecnologías para Investigación : Sistema de gestión de la Investigación - Tecnologías para Investigación

Sistema Investigar PUJ: Sistema Investigar PUJ

Ecosistema de Innovación: Ecosistema de Innovación
Fase 1 del Sistema que soporte el Ecosistema de Innovación: Fase 1 del Sistema que soporte el Ecosistema de Innovación
Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat: Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
Actualización de ZINE: Actualización de ZINE
Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad: Gestionar la permanente revisión y actualización de las plataformas de tecnologías de información y comunicación para garantizar su pertinencia y disponibilidad
Plataformas que soporten procesos de análisis de datos para toma de decisiones: Soportar plataformas de información que soporten los procesos de análisis de datos para toma de decisiones

Evaluar y liderar implementación de nuevas tecnologías para eficiencia operacional: Evaluar y liderar la implementación de nuevas tecnologías que generen mayores eficiencias operacionales

Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje: Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje
Gestión del Medio Universitario: Gestión del Medio Universitario
Gestión de Procesos Administrativos: Gestión de Procesos Administrativos

Sistema de aseguramiento de la calidad de la oferta académica: Sistema de aseguramiento de la calidad de la oferta académica
Programas académicos (Creación, Registro Calificado y Acreditación de alta calidad)

Rediseño del proceso de Admisiones: Rediseño del proceso de Admisiones

Analíticos de gestión para el Sistema XIE: Analíticos de gestión para el Sistema XIE

Automatización de procesos - Robot: Automatización de procesos - Robot

Gestión de Procesos Extensión - CRM: Gestión de Procesos Extensión - CRM

Gestión Universitaria -Integración digital: Gestión Universitaria -Integración digital

Experiencia de usuario final: Experiencia de usuario final
Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil: Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil

Metadata: "_addAggregate" = "disable"
Sistema de Información de Egresados: Sistema de Información de Egresados

Metadata: "_addAggregate" = "disable"
Sistema de Gestión Documental: Sistema de Gestión Documental

Sistema Académico Peoplesoft Campus Solutions v9.2: Sistema Académico Peoplesoft Campus Solutions v9.2

JaveMóvil: JaveMóvil
definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación: Liderar la definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación de tecnologías, incorporando tendencias de la industria que sean pertinentes

estrategia de seguridad de información institucional: Liderar la definición de una estrategia de seguridad de información institucional basada en la gestión de riesgo, acorde con el ritmo de las nuevas amenazas y retos de seguridad.

implementar las políticas, directrices y estándares: Desarrollar e implementar las políticas, directrices y estándares que orienten el uso articulado, integrado y eficiente de las diferentes capacidades y tecnologías existentes en la Universidad

desarrollo del capital humano que gestiona y consume tecnologías: Promover el desarrollo del capital humano que gestiona y consume tecnologías en la Universidad, para fomentar la cultura digital

Alineación de las Tecnologías con la estrategia Institucional: Alineación de las Tecnologías con la estrategia Institucional

Política de Gobierno de Información y Gestión de Riesgos: Política de Gobierno de Información y Gestión de Riesgos

Estructuración de modelo de colaboración con Centros de Excelencia: Estructuración de modelo de colaboración con Centros de Excelencia

Observatorio de Tecnologías: Estructuración e implementación del Observatorio de Tecnologías: Participación en redes de colaboración (nacionales e internacionales) para la innovación tecnológica y Análisis periódico comparativo de usos de tecnologías en otras instituciones u organizaciones.

Consolidación de modelo de gobierno de tecnología con la Seccional: Consolidación de modelo de gobierno de tecnología con la Seccional
Actualización de políticas, lineamientos, metodologías y procedimientos: Actualización de políticas, lineamientos, metodologías y procedimientos relacionados con las tecnologías y su uso.

Programa de Gestión de Cambio: Estructuración e implementación de un programa de Gestión de Cambio para la apropiación de las tecnologías y el fomento a la Cultura Digital

Gobierno de Datos: Gobierno de Datos
Gobierno de información - Ciberseguridad: Gobierno de información - Ciberseguridad

Estrategia institucional de datos: Desarrollo de estrategia institucional de datos que generen directrices respecto a su calidad, acceso, administración y cumplimiento.

Integración de fuentes de datos - Centralización de terceros.: Integración de fuentes de datos - Centralización de terceros.

cultura y estrategia de ciberseguridad: Articulación de una apropiada cultura y estrategia de ciberseguridad que sirva como habilitador de la planeación universitaria y de las estrategias digitales de la Universidad, y alineado con la gestión de riesgo.

hoja de ruta de ciberseguridad: Construcción de la hoja de ruta de ciberseguridad con los programas de seguridad de como proteger y compartir información sobre las diferentes opciones tecnológicas que la Universidad adopte.

Project X

Metadata: "_addAggregate" = "disable"

Aternatives' Evaluation

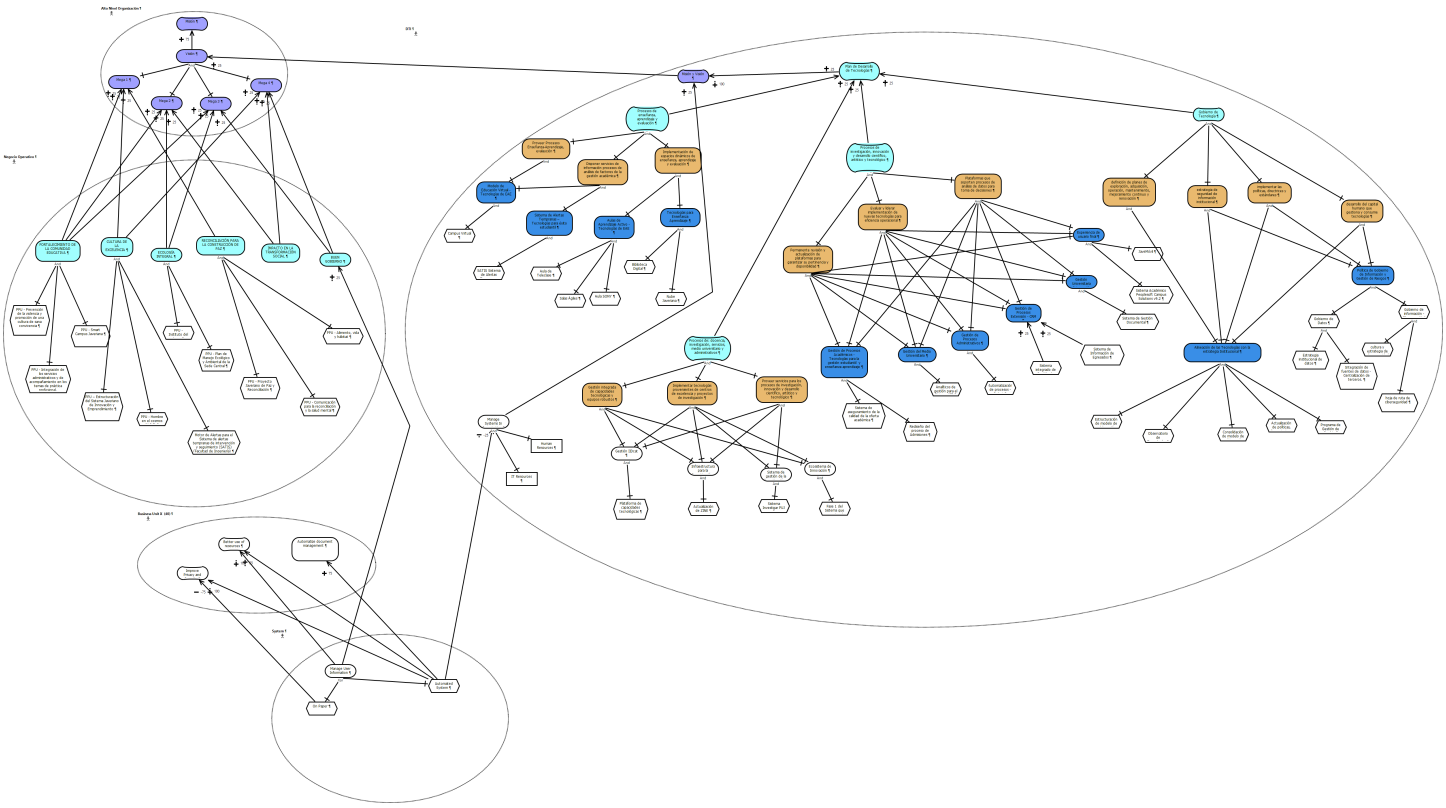


Figure 6 - Aternatives' Evaluation

Intentional Elements

Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación: Habilitar la implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación mediante la incorporación adaptativa de tecnologías.

Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat: Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat

Proveer Procesos Enseñanza-Aprendizaje, evalaución: Proveer servicios soportados en tecnologías que asistan los procesos y modelos de enseñanza, aprendizaje, evaluación e innovación curricular, y que a su vez flexibilicen y faciliten su acceso

estrategia de seguridad de información institucional: Liderar la definición de una estrategia de seguridad de información institucional basada en la gestión de riesgo, acorde con el ritmo de las nuevas amenazas y retos de seguridad.

Sistema Académico Peoplesoft Campus Solutions v9.2: Sistema Académico Peoplesoft Campus Solutions v9.2

Política de Gobierno de Información y Gestión de Riesgos: Política de Gobierno de Información y Gestión de Riesgos

Procesos de enseñanza, aprendizaje y evaluación

Metadata: "_addAggregate" = "disable"

Gestión Universitaria -Integración digital: Gestión Universitaria -Integración digital

Actualización de políticas, lineamientos, metodologías y procedimientos: Actualización de políticas, lineamientos, metodologías y procedimientos relacionados con las tecnologías y su uso.

PPU - Alimento, vida y hábitat

Biblioteca Digital

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones con egresados en la Universidad Javeriana

Modelo de Educación Virtual - Tecnologías de EAE

PPU - Prevención de la violencia y promoción de una cultura de sana convivencia

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

Sistema de gestión de la Investigación - Tecnologías para Investigación : Sistema de gestión de la Investigación - Tecnologías para Investigación

RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.

Metadata: "_addAggregate" = "disable"

PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central

Plataformas que soporten procesos de análisis de datos para toma de decisiones: Soportar plataformas de información que soporten los procesos de análisis de datos para toma de decisiones

Observatorio de Tecnologías: Estructuración e implementación del Observatorio de Tecnologías: Participación en redes de colaboración (nacionales e internacionales) para la innovación tecnológica y Análisis periódico comparativo de usos de tecnologías en otras instituciones u organizaciones.

Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación: Implementar en la Universidad las tecnologías provenientes de centros de excelencia y proyectos de investigación, según su pertinencia

Automatización de procesos - Robot: Automatización de procesos - Robot

Nube Javeriana
Gobierno de información - Ciberseguridad: Gobierno de información - Ciberseguridad

Aula SONY
desarrollo del capital humano que gestiona y consume tecnologías: Promover el desarrollo del capital humano que gestiona y consume tecnologías en la Universidad, para fomentar la cultura digital

JaveMóvil: JaveMóvil
Evaluar y liderar implementación de nuevas tecnologías para eficiencia operacional: Evaluar y liderar la implementación de nuevas tecnologías que generen mayores eficiencias operacionales

FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.
    Metadata: "_addAggregate" = "disable"
Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.
Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías
    Metadata: "_addAggregate" = "disable"
Gestión IIDcat: Gestión integrada de capacidades tecnológicas para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
Sistema de aseguramiento de la calidad de la oferta académica: Sistema de aseguramiento de la calidad de la oferta académica
Programas académicos (Creación, Registro Calificado y Acreditación de alta calidad)

Estrategia institucional de datos: Desarrollo de estrategia institucional de datos que generen directrices respecto a su

calidad, acceso, administración y cumplimiento.

ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.

Metadata: "_addAggregate" = "disable"

Procesos de: docencia, investigación, servicios, medio universitario y administrativos

Metadata: "_addAggregate" = "disable"

Estructuración de modelo de colaboración con Centros de Excelencia: Estructuración de modelo de colaboración con Centros de Excelencia

Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Metadata: "_addAggregate" = "disable"

Sistema Investigar PUJ: Sistema Investigar PUJ

Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad: Gestionar la permanente revisión y actualización de las plataformas de tecnologías de información y comunicación para garantizar su pertinencia y disponibilidad

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

Gestión de Procesos Extensión - CRM: Gestión de Procesos Extensión - CRM

Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil: Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil

Metadata: "_addAggregate" = "disable"

Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil

Salas Ágiles

Proveer servicios para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico: Proveer servicios soportados en tecnologías para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Fase 1 del Sistema que soporte el Ecosistema de Innovación: Fase 1 del Sistema que soporte el Ecosistema de Innovación

CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.

Metadata: "_addAggregate" = "disable"

Alineación de las Tecnologías con la estrategia Institucional: Alineación de las Tecnologías con la estrategia Institucional

Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)
Misión y Visión: Apoyar a través de la gestión innovadora de tecnologías, el desarrollo de la Misión y la consecución de la Visión de la Universidad, en el marco de la Planeación Universitaria.

Metadata: "_addAggregate" = "disable"
PPU - Smart Campus Javeriana
Gobierno de Datos: Gobierno de Datos
PPU - Proyecto Javeriano de Paz y Reconciliación
BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica Universidad Javeriana.

Metadata: "_addAggregate" = "disable"
Consolidación de modelo de gobierno de tecnología con la Seccional: Consolidación de modelo de gobierno de tecnología con la Seccional
Disponer servicios de información procesos de análisis de factores de la gestión académica: Disponer servicios de información que soporten los procesos de análisis de los factores más sensibles de la gestión académica de la Universidad.

SATIS Sistema de Alertas Tempranas Intervención y Seguimiento
definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación: Liderar la definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación de tecnologías, incorporando tendencias de la industria que sean pertinentes

Experiencia de usuario final: Experiencia de usuario final
Ecosistema de Innovación: Ecosistema de Innovación
Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario
PPU - Instituto del Agua
Aulas de Aprendizaje Activo - Tecnologías de EAE
Tecnologías para Enseñanza Aprendizaje
Aula de Teleclase
Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje: Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje
Actualización de ZINE: Actualización de ZINE
cultura y estrategia de ciberseguridad: Articulación de una apropiada cultura y estrategia de ciberseguridad que sirva

como habilitador de la planeación universitaria y de las estrategias digitales de la Universidad, y alineado con la gestión de riesgo.

Programa de Gestión de Cambio: Estructuración e implementación de un programa de Gestión de Cambio para la apropiación de las tecnologías y el fomento a la Cultura Digital

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

implementar las políticas, directrices y estándares: Desarrollar e implementar las políticas, directrices y estándares que orienten el uso articulado, integrado y eficiente de las diferentes capacidades y tecnologías existentes en la Universidad

PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento

Plan de Desarrollo de Tecnologías

Metadata: "_addAggregate" = "disable"

PPU - Hombre en el cosmos (H@C)

Rediseño del proceso de Admisiones: Rediseño del proceso de Admisiones

IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.

Metadata: "_addAggregate" = "disable"

Plataforma de capacidades tecnológicas: Plataforma de capacidades tecnológicas en funcionamiento

hoja de ruta de ciberseguridad: Construcción de la hoja de ruta de ciberseguridad con los programas de seguridad de como proteger y compartir información sobre las diferentes opciones tecnológicas que la Universidad adopte.

Analíticos de gestión para el Sistema XIE: Analíticos de gestión para el Sistema XIE

Campus Virtual

Gestión integrada de capacidades tecnológicas y equipos robustos: Apoyar estos procesos mediante la gestión integrada de las capacidades tecnológicas y equipos robustos existentes en la Universidad.

Sistema de Información de Egresados: Sistema de Información de Egresados

Metadata: "_addAggregate" = "disable"

PPU - Comunicación para la reconciliación y la salud mental

Gestión de Procesos Administrativos: Gestión de Procesos Administrativos

Gestión del Medio Universitario: Gestión del Medio Universitario

Sistema de Gestión Documental: Sistema de Gestión Documental

Integración de fuentes de datos - Centralización de terceros.: Integración de fuentes de datos - Centralización de terceros.

Improve Privacy and Security

Better use of resources

Automatize document management

Manage User Information

    Metadata: "_addAggregate" = "disable"

On Paper

    Metadata: "_addAggregate" = "disable"

Automated System

    Metadata: "_addAggregate" = "disable"

Manage Systems In Organization

    Metadata: "_addAggregate" = "disable"

Human Resources

IT Resources

Example Goal Advancement

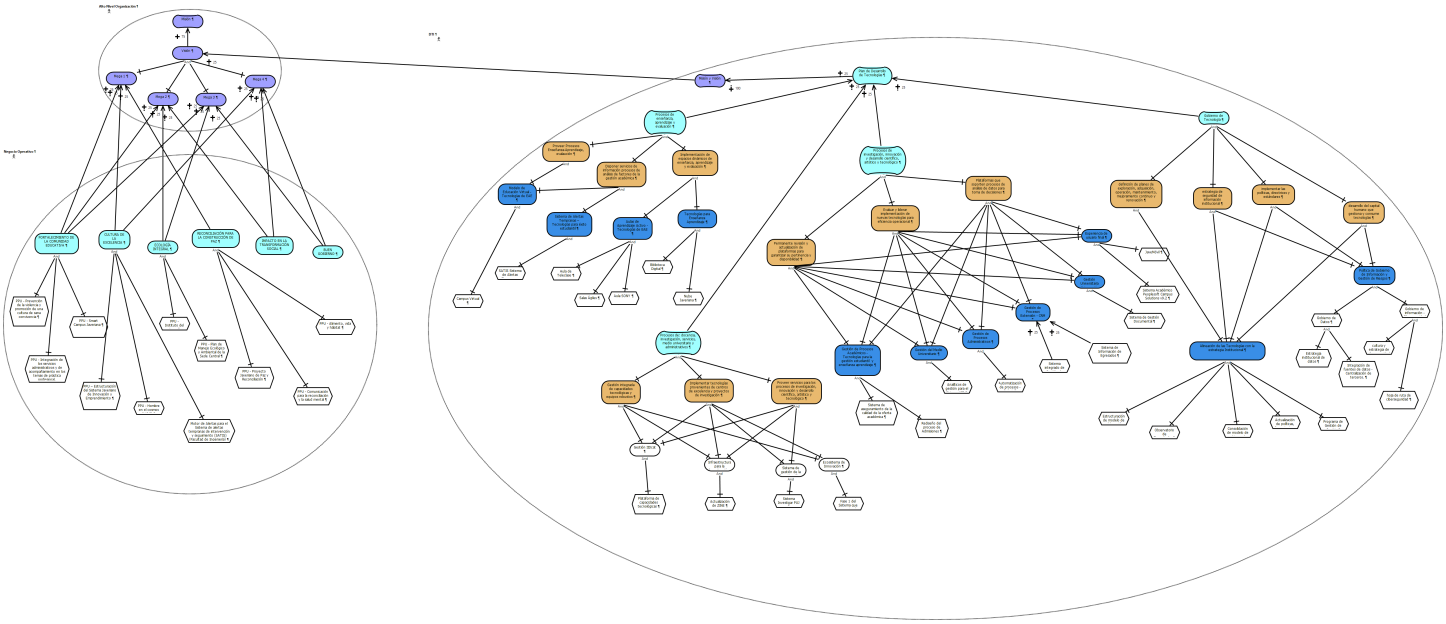


Figure 7 - Example Goal Advancement

Intentional Elements

Implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación: Habilitar la implementación de espacios dinámicos de enseñanza, aprendizaje y evaluación mediante la incorporación adaptativa de tecnologías.

Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat: Infraestructura para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat

Proveer Procesos Enseñanza-Aprendizaje, evalaución: Proveer servicios soportados en tecnologías que asistan los procesos y modelos de enseñanza, aprendizaje, evaluación e innovación curricular, y que a su vez flexibilicen y faciliten su acceso

estrategia de seguridad de información institucional: Liderar la definición de una estrategia de seguridad de información institucional basada en la gestión de riesgo, acorde con el ritmo de las nuevas amenazas y retos de seguridad.

Sistema Académico Peoplesoft Campus Solutions v9.2: Sistema Académico Peoplesoft Campus Solutions v9.2

Política de Gobierno de Información y Gestión de Riesgos: Política de Gobierno de Información y Gestión de Riesgos

Procesos de enseñanza, aprendizaje y evaluación

Metadata: "_addAggregate" = "disable"

Gestión Universitaria -Integración digital: Gestión Universitaria -Integración digital

Actualización de políticas, lineamientos, metodologías y procedimientos: Actualización de políticas, lineamientos, metodologías y procedimientos relacionados con las tecnologías y su uso.

PPU - Alimento, vida y hábitat

Biblioteca Digital

Misión: La Pontificia Universidad Javeriana es una institución católica de educación superior, fundada y regentada por la Compañía de Jesús, comprometida con los principios educativos y las orientaciones de la entidad fundadora. Ejerce la docencia, la investigación y el servicio con excelencia, como universidad integrada a un país de regiones, con perspectiva global e interdisciplinar, y se propone:

- la formación integral de personas que sobresalgan por su alta calidad humana, ética, académica, profesional y por su responsabilidad social; y,
- la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora,

Para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana.

PPU - Integración de los servicios administrativos y de acompañamiento en los temas de práctica profesional, empleabilidad y relaciones con egresados en la Universidad Javeriana

Modelo de Educación Virtual - Tecnologías de EAE

PPU - Prevención de la violencia y promoción de una cultura de sana convivencia

Mega 2: Priorizar en nuestra opción de excelencia humana y académica, las dimensiones de interculturalidad, internacionalización y cuidado de la casa común.

Sistema de gestión de la Investigación - Tecnologías para Investigación : Sistema de gestión de la Investigación - Tecnologías para Investigación

RECONCILIACIÓN PARA LA CONSTRUCCIÓN DE PAZ: Lograr que la Pontificia Universidad Javeriana, de acuerdo con su naturaleza universitaria, participe con acciones efectivas en los procesos de reconciliación para la construcción de paz en el país.

Metadata: "_addAggregate" = "disable"

PPU - Plan de Manejo Ecológico y Ambiental de la Sede Central

Plataformas que soporten procesos de análisis de datos para toma de decisiones: Soportar plataformas de información que soporten los procesos de análisis de datos para toma de decisiones

Observatorio de Tecnologías: Estructuración e implementación del Observatorio de Tecnologías: Participación en redes de colaboración (nacionales e internacionales) para la innovación tecnológica y Análisis periódico comparativo de usos de tecnologías en otras instituciones u organizaciones.

Implementar tecnologías provenientes de centros de excelencia y proyectos de investigación: Implementar en la Universidad las tecnologías provenientes de centros de excelencia y proyectos de investigación, según su pertinencia

Automatización de procesos - Robot: Automatización de procesos - Robot

Nube Javeriana
Gobierno de información - Ciberseguridad: Gobierno de información - Ciberseguridad

Aula SONY
desarrollo del capital humano que gestiona y consume tecnologías: Promover el desarrollo del capital humano que gestiona y consume tecnologías en la Universidad, para fomentar la cultura digital

JaveMóvil: JaveMóvil
Evaluar y liderar implementación de nuevas tecnologías para eficiencia operacional: Evaluar y liderar la implementación de nuevas tecnologías que generen mayores eficiencias operacionales

FORTALECIMIENTO DE LA COMUNIDAD EDUCATIVA: Lograr que los miembros de la comunidad educativa se apropien de la identidad Javeriana, se comprometan con la institución, expresen en su quehacer el proyecto educativo y aseguren que el interés institucional sea el marco de los intereses individuales y de grupo.
    Metadata: "_addAggregate" = "disable"
Mega 4: Transformar el sistema de toma de decisiones para que sean efectivas, fundamentadas en criterios definidos institucionalmente y orientadas a la realización de la visión.
Gobierno de Tecnología: Optimizar el modelo de Gobierno de Tecnologías
    Metadata: "_addAggregate" = "disable"
Gestión IIDcat: Gestión integrada de capacidades tecnológicas para la Investigación, Innovación y el desarrollo científico, artístico y tecnológico IIDcat
Sistema de aseguramiento de la calidad de la oferta académica: Sistema de aseguramiento de la calidad de la oferta académica
Programas académicos (Creación, Registro Calificado y Acreditación de alta calidad)

Estrategia institucional de datos: Desarrollo de estrategia institucional de datos que generen directrices respecto a su calidad, acceso, administración y cumplimiento.

ECOLOGÍA INTEGRAL: Integrar en las actividades académicas, del medio universitario y administrativas las orientaciones sobre el cuidado de la casa común de la Encíclica Laudato Si`.

Metadata: "_addAggregate" = "disable"

Procesos de: docencia, investigación, servicios, medio universitario y administrativos

Metadata: "_addAggregate" = "disable"

Estructuración de modelo de colaboración con Centros de Excelencia: Estructuración de modelo de colaboración con Centros de Excelencia

Procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Metadata: "_addAggregate" = "disable"

Sistema Investigar PUJ: Sistema Investigar PUJ

Permanente revisión y actualización de plataformas para garantizar su pertinencia y disponibilidad: Gestionar la permanente revisión y actualización de las plataformas de tecnologías de información y comunicación para garantizar su pertinencia y disponibilidad

Mega 1: Asegurar actividades académicas con impacto en la dinámica de reconciliación del país y con carácter innovador

Gestión de Procesos Extensión - CRM: Gestión de Procesos Extensión - CRM

Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil: Sistema integrado de Gestión de Convenios de Intercambio y Movilidad Estudiantil

Metadata: "_addAggregate" = "disable"

Sistema de Alertas Tempranas – Tecnologías para éxito estudiantil

Salas Ágiles

Proveer servicios para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico: Proveer servicios soportados en tecnologías para los procesos de investigación, innovación y desarrollo científico, artístico y tecnológico

Fase 1 del Sistema que soporte el Ecosistema de Innovación: Fase 1 del Sistema que soporte el Ecosistema de Innovación

CULTURA DE LA EXCELENCIA: Asegurar una cultura de la excelencia humana y académica en el quehacer de la Pontificia Universidad Javeriana, con una perspectiva innovadora y contribuir así, al desarrollo de la educación superior.

Metadata: "_addAggregate" = "disable"

Alineación de las Tecnologías con la estrategia Institucional: Alineación de las Tecnologías con la estrategia Institucional

Motor de Alertas para el Sistema de alertas tempranas de intervención y seguimiento (SATIS) (Facultad de Ingeniería)

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Metadata: "_addAggregate" = "disable"

PPU - Smart Campus Javeriana

Gobierno de Datos: Gobierno de Datos

PPU - Proyecto Javeriano de Paz y Reconciliación

BUEN GOBIERNO: Lograr que las decisiones, los procesos, los recursos y la organización, aseguren en un marco de respeto y promoción de todas las personas, la coherencia, transparencia, efectividad y sostenibilidad de la Pontifica Universidad Javeriana.

Metadata: "_addAggregate" = "disable"

Consolidación de modelo de gobierno de tecnología con la Seccional: Consolidación de modelo de gobierno de tecnología con la Seccional

Disponer servicios de información procesos de análisis de factores de la gestión académica: Disponer servicios de información que soporten los procesos de análisis de los factores más sensibles de la gestión académica de la Universidad.

SATIS Sistema de Alertas Tempranas Intervención y Seguimiento

definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación: Liderar la definición de planes de exploración, adquisición, operación, mantenimiento, mejoramiento continuo y renovación de tecnologías, incorporando tendencias de la industria que sean pertinentes

Experiencia de usuario final: Experiencia de usuario final

Ecosistema de Innovación: Ecosistema de Innovación

Mega 3: Asegurar el desarrollo sostenible integral de la universidad, arraigado en el medio universitario

PPU - Instituto del Agua

Aulas de Aprendizaje Activo - Tecnologías de EAE

Tecnologías para Enseñanza Aprendizaje

Aula de Teleclase

Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje: Gestión de Procesos Académicos - Tecnologías para la gestión estudiantil y enseñanza aprendizaje

Actualización de ZINE: Actualización de ZINE

cultura y estrategia de ciberseguridad: Articulación de una apropiada cultura y estrategia de ciberseguridad que sirva como habilitador de la planeación universitaria y de las estrategias digitales de la Universidad, y alineado con la gestión de riesgo.

Programa de Gestión de Cambio: Estructuración e implementación de un programa de Gestión de Cambio para la

apropiación de las tecnologías y el fomento a la Cultura Digital

Visión: En el 2021, la PUJ será referente nacional e internacional por la coherencia entre su identidad y su obrar, su propuesta educativa, su capacidad de aprendizaje institucional, así como la contribución a la transformación de Colombia, desde una perspectiva católica, innovadora y de ecología integral.

Metadata: "_addAggregate" = "disable"

implementar las políticas, directrices y estándares: Desarrollar e implementar las políticas, directrices y estándares que orienten el uso articulado, integrado y eficiente de las diferentes capacidades y tecnologías existentes en la Universidad

PPU – Estructuración del Sistema Javeriano de Innovación y Emprendimiento

Plan de Desarrollo de Tecnologías

Metadata: "_addAggregate" = "disable"

PPU - Hombre en el cosmos (H@C)

Rediseño del proceso de Admisiones: Rediseño del proceso de Admisiones

IMPACTO EN LA TRANSFORMACIÓN SOCIAL: Lograr que la Pontificia Universidad Javeriana, en el ejercicio de las funciones sustantivas, contribuya a la formación en ciudadanía y a superar la injusticia, la indiferencia, y la corrupción.

Metadata: "_addAggregate" = "disable"

Plataforma de capacidades tecnológicas: Plataforma de capacidades tecnológicas en funcionamiento

hoja de ruta de ciberseguridad: Construcción de la hoja de ruta de ciberseguridad con los programas de seguridad de como proteger y compartir información sobre las diferentes opciones tecnológicas que la Universidad adopte.

Analíticos de gestión para el Sistema XIE: Analíticos de gestión para el Sistema XIE

Campus Virtual

Gestión integrada de capacidades tecnológicas y equipos robustos: Apoyar estos procesos mediante la gestión integrada de las capacidades tecnológicas y equipos robustos existentes en la Universidad.

Sistema de Información de Egresados: Sistema de Información de Egresados

Metadata: "_addAggregate" = "disable"

PPU - Comunicación para la reconciliación y la salud mental

Gestión de Procesos Administrativos: Gestión de Procesos Administrativos

Gestión del Medio Universitario: Gestión del Medio Universitario

Sistema de Gestión Documental: Sistema de Gestión Documental

Integración de fuentes de datos - Centralización de terceros.: Integración de fuentes de datos - Centralización de terceros.

Scenario Documentation

Scenario Execution Summary

Group ScenarioGroup5 (ID:5)

Scenario	Result	Message(s)
ScenarioDef6 (ID: 6)	FAILED	No start points defined! Nothing to execute!

Scenario Information

Group ScenarioGroup5 (ID: 5)

Scenario ScenarioDef6 (ID: 6)