FEDERAL UNIVERSITY OF PERNAMBUCO
SOCIAL APPLIED SCIENCES CENTRE
POSTGRADUATE PROGRAM IN ADMINISTRATION – PROPAD

TATIANE DA COSTA TORRES DE ANDRADE

PROPOSAL OF A METHOD FOR ALIGNING BUSINESS VALUES IN BPMN PROCESS MODELS

Recife

2025

TATIANE DA COSTA TORRES DE ANDRADE

PROPOSAL OF A METHOD FOR ALIGNING BUSINESS VALUES IN BPMN PROCESS MODELS

Thesis presented to the Postgraduate Program in Administration at the Federal University of Pernambuco, as a complementary requirement for obtaining the title of Doctor in Administration.

Focus Area: Information Technology

Supervisor: Denis Silva da Silveira
Associate Professor: Federal University of Pernambuco

Co supervisor: Emilio Insfran
Full Professor: Universitat Politècnica de València

Recife

2025

.Catalogação de Publicação na Fonte. UFPE - Biblioteca Central

Andrade, Tatiane da Costa Torres de.
Proposal of a method for aligning business values in BPMN process models / Tatiane da Costa Torres de Andrade. - Recife, 2025.
162f.: il.

Tese (Doutorado) - Universidade Federal de Pernambuco, Centro de Ciências Sociais Aplicadas, Programa de Pós-Graduação em Administração, 2025.
Orientação: Denis Silva da Silveira.
Coorientação: Emilio Insfran.
Inclui referências e apêndices.

1. Process Modeling; 2. BPMN; 3. Business Values; 4. Fuzzy Logic; 5. Empirical Evaluation. I. Orientação: Silveira, Denis Silva da. II. Coorientação: Insfran, Emilio. III. Título.

UFPE-Biblioteca Central

Pedro e Maria.

ACKNOWLEDGEMENTS

À Maria, por dar significado às conquistas.

À Pedro, por estar Sempre!

À painho e à mainha, por acreditarem.

Ao Mangue, por ser casa.

À Maelyson, por ser escuta.

À Dan, pela surpresa da amizade.

Aos que sonham comigo: Bruna, Dani, Debs, Duda, Gaby, Lara, Lysa, Mari, Marília, Mayara, Mila, Poli e Rubens.

Aos que aliviaram o peso da jornada, Rodrigo, Carol, Rennan, Jazmin, Nico, Isabel, Diógenes e Lenylda.

Ao professor Denis, pela orientação e direcionamento.

Aos professores Emilio e Silvia, pela orientação e hospitalidade.

À CAPES e à FACEPE, pelo financiamento concedido.

"Gracias a la vida que me ha dado tanto."

— Violeta Parra, *Gracias a la vida*, 1966.

ABSTRACT

Ensuring the strategic alignment of an organization's business values is essential for its success. However, achieving this alignment requires effectively embedding these values in to process models to drive strategic objectives. A recurring challenge, nonetheless, is the misalignment between process models and core business values, which can undermine the organization's mission. This study addresses this gap by validating the graphical representation of business values exchanged between the organization and its partners within process models. To achieve this, an empirical validation method is proposed, based on real-world instances, to examine the value specifications embedded in Business Process Model and Notation (BPMN) diagrams. Measuring the perception of business value, however, poses significant challenges due to its subjective and intangible nature, influenced by factors such as *quality*, *price*, *emotional*, and *social* elements. To tackle these challenges, this study suggests employing *fuzzy* logic as an analytical tool to evaluate and better understand the impact of these multifaceted variables. By leveraging *fuzzy* logic, the study seeks to mitigate the subjectivity, imprecision, and ambiguity inherent in human reasoning, providing a more accurate analysis of stakeholders' value perceptions. Through this approach, the study aims to determine whether perceived values are aligned with those specified in BPMN models, thus promoting a more robust alignment with organizational objectives.

Keywords: Process Modeling. BPMN. Business Values. *Fuzzy* Logic. Empirical Evaluation.

RESUMO

Garantir o alinhamento estratégico dos valores de negócio de uma organização é fundamental para o seu sucesso. No entanto, alcançar esse alinhamento requer uma integração eficaz desses valores nos modelos de processo, de modo a impulsionar efetivamente os objetivos estratégicos. Ainda assim, um desafio recorrente é o desalinhamento entre os modelos de processo e os valores fundamentais de negócio, o que pode comprometer a missão da organização. Este estudo aborda essa lacuna ao validar a representação gráfica dos valores de negócio trocados entre a organização e seus parceiros nos modelos de processo. Para isso, propõe-se um método de validação empírica, baseado em instâncias reais, com o objetivo de examinar as especificações de valor incorporados em diagramas BPMN. Entretanto, medir a percepção de valor de negócio representa um desafio significativos, dada a natureza subjetiva e intangível dessa percepção, influenciada por fatores como *qualidade*, *preço*, *elementos emocionais* e *sociais*. Para enfrentar esses desafios, este estudo propõe o uso de lógica *fuzzy* como ferramenta analítica para avaliar e entender melhor o impacto dessas variáveis multifacetadas. Ao empregar a lógica *fuzzy*, busca-se mitigar a subjetividade, a imprecisão e as ambiguidades inerentes ao raciocínio humano, proporcionando uma análise mais precisa das percepções de valor dos *stakeholders*. Por meio dessa abordagem, o estudo visa determinar se os valores percebidos estão alinhados com aqueles especificados nos modelos BPMN, promovendo, assim, um alinhamento mais robusto com os objetivos organizacionais.

Palavras-chaves: Modelagem de Processo. BPMN. Valores de Negócio. Lógica *Fuzzy*. Avaliação Empírica.

LIST OF FIGURES

Figure 1 – Conceptual Process Model. 22
Figure 2 – Process Model Example. 23
Figure 3 – Contrasting the concept of the set and the principle of dichotomy itself versus a relaxation of the concept of complete inclusion and exclusion. . . . 34
Figure 4 – A set as a collection of numeric values located in corresponding intervals . 35
Figure 5 – *Fuzzy* set A defined in a discrete universe X. 37
Figure 6 – Membership function of a triangular fuzzy number $\tilde{A} = (a_1, a_2, a_3)$ 39
Figure 7 – Technology Transfer Model. 44
Figure 8 – Overview of the Experiment Process. 46
Figure 9 – Proposed Method. 49
Figure 10 – Online Shopping. 57
Figure 11 – Simulation interface used. 63
Figure 12 – Quantified Online Shopping - Spain. 90
Figure 13 – Violin Plots of Quality Perceived Value. 103
Figure 14 – Violin Plots of Price Perceived Value. 104
Figure 15 – Violin Plots of Emotional Perceived Value. 106
Figure 16 – Violin Plots of Social Perceived Value. 106

LIST OF TABLES

Table 1 – List of publications and project. 20
Table 2 – Objectives with the corresponding goals 47
Table 3 – Quality Dimension Analysis Attributes. 52
Table 4 – Modeled Values. 61
Table 5 – Quantified Individual Value Perceived in Scenario 0. 69
Table 6 – Quantified Individual Value Perceived in Scenario 1. 70
Table 7 – Quantified Individual Value Perceived in Scenario 2. 71
Table 8 – Quantified Individual Value Perceived in Scenario 3. 72
Table 9 – Quantified Group Value Perceived in Scenario 0. 73
Table 10 – Quantified Group Value Perceived in Scenario 1. 74
Table 11 – Quantified Group Value Perceived in Scenario 2. 75
Table 12 – Quantified Group Value Perceived in Scenario 3. 76
Table 13 – Scenario 0. 84
Table 14 – Scenario 1. 85
Table 15 – Scenario 2. 86
Table 16 – Scenario 3. 87
Table 17 – Descriptive analysis of Spain 104
Table 18 – Descriptive analysis of Brazil 105
Table 19 – Hypotheses testing (Spain 1). 111
Table 20 – Hypotheses testing (Spain 2). 112
Table 21 – Hypotheses testing (Spain 3). 112
Table 22 – Hypotheses testing (Brazil 1). 112
Table 23 – Hypotheses testing (Brazil 2). 113
Table 24 – Hypotheses testing (Brazil 3). 113
Table 25 – Summary of Related Works. 123

LIST OF ABBREVIATIONS AND ACRONYMS

ARIS	Architecture of Integrated Information Systems
ATL	Atlas Transformation Language
BPM	Business Process Management
BPML	Business Process Modeling Languages
BPMN	Business Process Model and Notation
CPV	Consumer Perceived Value
CSR	Corporate Social Responsibility
DFD	Data Flow Diagram
EPC	Event Process Chain
ERP	Enterprise Resource Planning
FST	Fuzzy System Theory
GDPR	General Data Protection Regulation
IDEF	Integrated Definition Language
LGPD	General Data Protection Law
OMG	Object Management Group
PERVAL	Consumer Perceived Value
RAD	Role Activity Diagram
REA	Resource-Event-Agents
SD	Standard Deviation
STRIM	Systematic Technique for Role and Interaction Modeling
TFN	Triangular *Fuzzy* Number
UML	Unified Modeling Language
UMM	UN/CEFACT's Modeling Methodology

LIST OF SYMBOLS

$\in$	Belongs
$\notin$	Does not belong
δ	Delta
α	Alpha
$\neg$	Negation

CONTENTS

1 INTRODUCTION 15
1.1 CONTEXT 15
1.2 MOTIVATION 17
1.3 OBJECTIVES 18
1.3.1 General Objective 18
1.3.2 Specific Objectives 18
1.4 MAIN CONTRIBUTIONS 19
1.5 THESIS STRUCTURE 20
2 BACKGROUND 22
2.1 BUSINESS PROCESS 22
2.1.1 Business Process Modeling Languages 24
2.2 VALUE 27
2.2.1 Stakeholders Value Perception Measure 29
2.2.1.1 PERVAL Scale 31
2.3 *FUZZY* LOGIC 33
2.3.1 Basic Notations 36
2.3.2 Sets 38
2.3.3 Fuzzy Numbers 38
3 METHODOLOGICAL PROCEDURES 40
3.1 PARADIGMATIC POSITIONING 40
3.2 RESEARCH NATURE 41
3.3 RESEARCH METHOD 42
3.4 RESEARCH STRATEGY 43
3.4.1 Experimentation 45
4 PROPOSED METHOD 49
4.1 STAGE 1: ANALYSIS AND IDENTIFICATION OF BUSINESS VALUES IN THE BPMN MODEL 49
4.2 STAGE 2: QUANTIFICATION OF PERCEIVED VALUE 51
4.3 STAGE 3: ALIGNMENT OF MODELED VALUE AND PERCEIVED VALUE 54
4.3.1 Alignment Analysis by Dimension 54

4.3.2 Alignment Analysis by Value Statements . . . 55
4.4 SCALABILITY OF THE METHOD . . . 55
5 APPLICATION OF THE METHOD - ONLINE SHOPPING . . . 57
5.1 STAGE 1: ANALYSIS AND IDENTIFICATION OF BUSINESS VALUES IN THE BPMN MODEL . . . 58
5.2 STAGE 2: QUANTIFICATION OF PERCEIVED VALUE . . . 62
5.3 STAGE 3: ALIGNMENT OF MODELED VALUE AND PERCEIVED VALUE 77
6 EMPIRICAL EVALUATION . . . 91
6.1 GOAL . . . 91
6.2 CONTEXT OF THE STUDY . . . 92
6.3 EXPERIMENT PLANNING . . . 94
6.4 OPERATION . . . 99
6.5 DATA ANALYSIS . . . 100
6.5.1 Descriptive Analysis of Dependent Variables . . . 101
6.5.1.1 Perceived Quality Value . . . 102
6.5.1.2 Perceived Price Value . . . 102
6.5.1.3 Emotional Perceived Value . . . 103
6.5.1.4 Social Perceived Value . . . 105
6.5.1.5 Discussion of Results . . . 107
6.5.2 Tests of Normality and Homogeneity . . . 109
6.5.3 Hypotheses Testing . . . 110
6.5.4 Practical Significance Using Cliff's Estimation . . . 110
6.5.5 Discussion . . . 111
6.5.5.1 Spain . . . 112
6.5.5.2 Brazil . . . 113
6.6 THREATS TO VALIDITY . . . 114
6.6.1 Internal validity . . . 115
6.6.2 External Validity . . . 115
6.6.3 Construct Validity . . . 116
7 RELATED WORK . . . 117
8 CONCLUSIONS . . . 124
8.1 FUTURE WORK . . . 125
REFERENCES . . . 127

APPENDIX A – SYSTEMATIC MAPPING PROTOCOL 136
APPENDIX B – CONSENT FORM IN SPANISH 143
APPENDIX C – DEMOGRAPHIC FORM IN SPANISH 144
APPENDIX D – QUESTIONNAIRE (SCENARIO 0) IN SPANISH 145
APPENDIX E – QUESTIONNAIRE (SCENARIO 1) IN SPANISH 150
APPENDIX F – QUESTIONNAIRE (SCENARIO 2) IN SPANISH 155
APPENDIX G – QUESTIONNAIRE (SCENARIO 3) IN SPANISH 159

1 INTRODUCTION

This thesis is built on three main pillars: Business Process Modeling, Business Value, and Empirical Validation. The effectiveness of business process modeling is intrinsically linked to its ability to align organizational strategies with operational execution. However, process models do not always reflect organizational objectives, which can compromise both their effectiveness and strategic coherence.

A key aspect of addressing this challenge is accurately evaluating the adequacy of value in BPMN models, considering the subjective and imprecise nature of value.

In this context, this thesis proposes a systematic method to aligning an organization's business values with its BPMN process models. The proposed method involves identifying value exchanges, estimating stakeholders' perceptions of value, quantifying these perceptions using fuzzy logic, and evaluating their alignment with specified business values.

This introductory chapter presents the research context and motivation, outlines the primary objectives and contributions of the study, and concludes with an overview of the structure of the subsequent chapters.

1.1 CONTEXT

Business models play a pivotal role in the strategic positioning of organizations, offering a competitive edge within their respective industries. These models function as conceptual frameworks, articulating an organization's core business logic by defining the value proposition offered to clients and the network of partners engaged in sustainable and cost-effective exchanges (OSTERWALDER; PIGNEUR; TUCCI, 2005). By aligning organizational goals with operational processes, business models serve as essential tools for strategic planning and decision-making.

At the core of any business model lies the concept of value, encompassing the creation, enhancement, and exchange of value among stakeholders (SOUZA et al., 2018). This dynamic guides negotiations between entities, involving the exchange of goods, services, and other forms of value, but does not specify how these exchanges should be carried out (HOTIE; GORDIJN, 2019). In contrast, process models aim to operationalize an organization's value proposition. They detail how processes should be executed, specifying the activities to be performed and the

sequence in which they should occur to deliver value to the stakeholders involved. Consequently, when process models adequately incorporate specified values, they become powerful tools for understanding, evaluating, managing, and communicating the fundamental principles of a business (KHARMOUM et al., 2023; WEIGAND et al., 2007). Therefore, ensuring alignment between process models and organizational objectives is paramount for effective strategic execution.

This study investigates the feasibility of a method to examine the alignment between an organization's business values and its process models, based on stakeholders' perceptions of value during the execution of models specified in BPMN. The analysis uses stakeholders' perceived value as a reference, as process models should reflect the business values of the organization. Moreover, one of their primary functions is to create value through the execution of their activities. Thus, it is expected that process models, when properly aligned with organizational values, will generate value in a way that is clear and perceptible to users.

The selection of the BPMN language (Object Management Group, 2014) is justified by its robustness and versatility in process modeling (RECKER et al., 2009). BPMN has achieved widespread adoption in practice (HARMON; WOLF, 2011), primarily due to its ability to clearly represent complex business processes, including the creation, delivery, and capture of values within process models (HOTIE; GORDIJN, 2019; KHARMOUM et al., 2019).

However, the concept of value extends beyond monetary aspects, encompassing relative usefulness or importance (BOEHM, 2006), as well as intangible and subjective factors such as *quality*, *price*, *emotional*, and *social* dimensions. As a result, evaluating the adequacy of value representation in BPMN models poses a considerable challenge. This study addresses this complexity by utilizing *fuzzy* logic to handle the subjectivity and imprecision often inherent in stakeholder evaluations (ZADEH, 1965; ALMEIDA; MORAIS, 2021).

Fuzzy logic is particularly suited for aggregating subjective knowledge from individuals, making it a valuable tool for data collection and analysis in larger sample sizes(SANTOS-NETO; COSTA, 2023). Additionally, it allows for the modeling of linguistic variables, enabling nuanced interpretations of value dimensions. Recognizing the practical limitations of exhaustive validation for larger datasets, this study adopts an empirical validation approach that balances methodological rigor with usability.

1.2 MOTIVATION

In today's competitive business environment, organizations face increasing pressure to align their strategic objectives with operational processes to ensure efficiency and value creation. Misalignment between business values and process models can lead to inefficiencies, misunderstandings among stakeholders, and suboptimal decision-making.

Although the integration of process models with organizational values is widely recognized as essential for effectively executing an organization's value proposition, it also presents significant challenges, as highlighted by several authors (FATEMI; SINDEREN; WIERINGA, 2010; GORDIJN; WIERINGA, 2003; HOTIE; GORDIJN, 2019; KHARMOUM et al., 2023; KHARMOUM et al., 2019; SCHUSTER et al., 2010; BROCKE; RECKER; MENDLING, 2010; WEIGAND et al., 2007; WIERINGA et al., 2008; WIERINGA; GORDIJN, 2005; ZLATEV; WOMBACHER, 2005). The literature includes various research efforts aimed at achieving this alignment, offering approaches designed to facilitate such integration. However, gaps still persist, particularly regarding the treatment of the subjective and multifaceted nature of value, as most studies focus predominantly on monetary values.

Considering organizational value exclusively through the lens of economic profit is a narrow and limiting perspective. Business value encompasses more than financial considerations, extending to social, environmental, and other intangible dimensions. These additional dimensions involve subjective and imprecise factors, such as attitudes, opinions, and uncertainties of stakeholders, reflecting the complex and multifaceted nature of value in organizations (LAPIERRE, 2000; BABIN; DARDEN; GRIFFIN, 1994; PARASURAMAN; GREWAL, 2000; DROGE, 1998; ZEITHAML, 1988).

Given this context, the central research question of this study arises:

How can organization business values be effectively aligned with BPMN process models?

1.3 OBJECTIVES

This section outlines the general and specific objectives that will guide the development of this investigation. The general objective defines the overarching aim of the study, while the specific objectives detail the essential steps required to achieve this aim, providing a structured roadmap for the research.

1.3.1 General Objective

The primary aim of this research is to develop a systematic method that enables the alignment of an organization's business values with its BPMN process models.

1.3.2 Specific Objectives

To achieve the general objective, the following specific objectives have been defined, detailing the methodological and practical steps necessary to address the research problem:

1. Map the Literature:

   Identify and review existing approaches for aligning business values with BPMN models based on a comprehensive analysis of the literature.

2. Design a Method for Value Alignment:

   Propose a structured method that incorporates alignment principles, enabling the explicit representation and reconciliation of business values in BPMN models while addressing ambiguities and inconsistencies in the value specification.

3. Implement an Automated Solution:

   Develop and implement an automated version of the proposed method, leveraging computational tools to enhance usability, efficiency, and scalability in real-world applications.

4. Validate the Proposed Method Empirically:

   Conduct empirical validation of the proposed method through controlled experiments or case studies, assessing its effectiveness in aligning business values with BPMN process models and its impact on stakeholder comprehension and decision-making.

1.4 MAIN CONTRIBUTIONS

The primary contribution of this study is the development of an empirically validated method to evaluate the alignment between an organization's business values and its BPMN process models. This method identifies potential gaps and proposes measures to enhance alignment between the organization's strategic objectives and the outcomes generated by the execution of processes modeled in BPMN. It supports more informed decision-making and optimizes resource utilization.

Specifically, the main contributions of this thesis are:

1. The Automation of the Method using Excel Macros:
    - The automation significantly improves efficiency and reduces errors associated with manual execution.
    - It eliminates the need for users to have expertise in BPMN and *Fuzzy* Logic (an important feature, given the challenge of finding specialists in both areas).
    - With automation, the quantification and aggregation processes using *fuzzy* logic are executed automatically by the tool.
2. Development of an Excel-Based Tool to Improve the Representation of Values in BPMN models Based on Stakeholder Perception:
    - The process begins by inputting the BPMN model to be analyzed.
    - The tool extracts all business values embedded in the provided model.
    - After stakeholder analysis, the user inputs the performance ratings for each value (*e.g.*, *very good*, *good*, *regular*, *poor*, and *very poor*) into the spreadsheet.
    - The tool then generates an updated BPMN model.
3. Enhanced Visualization of Results:
    - The resulting BPMN model visually represents values identified using distinct colors: green for *very good*, blue for *good*, yellow for *regular*, orange for *poor*, and red for *very poor*. This visual approach improves clarity and facilitates the interpretation of results.

Table 1 presents the publications and project directly associated with this thesis.

Table 1 – List of publications and project.

Paper	Towards a Method for Aligning Organization Business Values with their BPMN Process Models. In: Virtues and Values in Requirements Engineering 2024 Workshop (VIVA RE'24), 2024, Switzerland.
Abstract	The strategic alignment of an organization's business values is crucial for success, necessitating seamless integration within process models to advance strategic objectives effectively. This study addresses the challenge of process models deviating from fundamental business values, leading to a disconnect with the organization's mission. By validating graphical representations of exchanged business values, this study proposes an approach to scrutinize value specifications in BPMN process models. Obstacles in measuring business value perception, due to its subjective and intangible nature influenced by factors such as quality, price, and emotional elements, are addressed using *fuzzy* logic. Through this, the study aims to mitigate subjectivity and ambiguity, providing a more precise understanding of stakeholders' value perceptions. The analysis seeks to determine alignment between perceived values and those specified in BPMN models, aiming for a robust alignment with organizational objectives.
Paper	On the Quantification of Stakeholder's Perceived Value in BPMN Process Models. In: Jornadas de la Sociedad de Ingeniería de Software y Tecnologías de Desarrollo de Software, 2024, Coruña - Spain.
Abstract	Business models are crucial for organizations, providing competitive advantages and differentiation within sectors. However, it is common to observe a lack of alignment between the values specified in process models and those perceived by customers, resulting in a mismatch with the organization's strategic mission. This work addresses the need to measure the perceived value from the stakeholders, subsequently examining its alignment with the organizational value proposition. It proposes an approach to quantify the value perceived by stakeholders, yet this poses an considerable challenge due to the influence of intangible and subjective factors such as quality, price, emotional, and social elements. In response to these challenges, this study suggests the use of *fuzzy* logic to measure and reason about the influence of these factors. This approach aims to mitigate subjectivity, imprecision, and vagueness in the responses obtained from surveyed individuals, providing a more nuanced and accurate understanding of stakeholders' perceptions of value.
Project	An Infrastructure to Derive Requirements from Business Models. Approved under the following funding calls: FACEPE/APQ (No. 0867-6.02/22), CNPq Universal (No. 421085/2023-1), and MCTI/CNPq (No. 16/24).
Abstract	Currently, the importance of business models is a fundamental concept for any organization. This happens because business model is an efficient tool to identify who is offering what to whom and is expects what in return. Not forgetting that they also must be expressed in the requirements models, as they are useful to understand how a business is organized, who interacts with whom, what objectives and strategies are being pursued; that is, what work the business performs and how it performs that work.Thus, business models have received special attention from two communities, namely: business administration and computer science. Due to the increasingly important role of information systems in the performance of business models, a mutual understanding for better interaction between these communities is essential. However, due to the different perspectives, the interaction between these two communities is rarely perfect, resulting in difficulties when it comes to understanding these models and the requirements they represent. In that event, this project focuses on an approach to systematize the design and possible derivations of business models up to the requirements of information systems, surely going over process models.

Source: The Autor (2024)

1.5 THESIS STRUCTURE

The remainder of this document is structured as follows: Chapter 2 provides an overview of the theoretical foundation necessary to conduct this research, while Chapter 3 outlines the methodological procedures to be followed. Chapter 4 introduces the proposed method. Chapter 5 discusses the results of the method's application in Spain and Brazil. Chapter 6 details the empirical evaluation process. Chapter 7 presents related works, and finally, Chapter

8 concludes the study and offers suggestions for future research.

2 BACKGROUND

This chapter highlights some of the main concepts in the literature considered fundamental for the foundation and development of this doctoral thesis. Thus, this chapter is structured into three main sections: 2.1 Business Processes, 2.2 Value and 2.3 *Fuzzy* Logic.

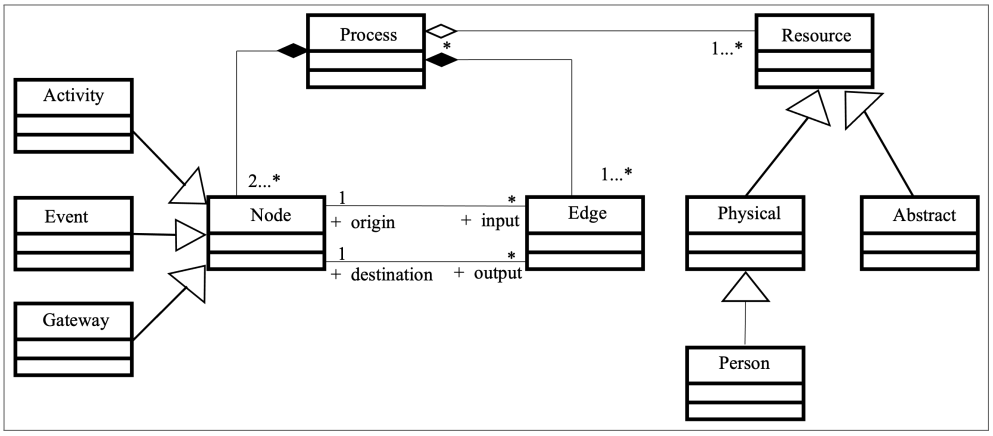
2.1 BUSINESS PROCESS

In (DUMAS et al., 2018), the term 'business process' is discussed under various definitions. However, in this project, the following definition was adopted: a business process is a collection of related tasks that produce a specific service or product to meet one or more objectives of a specific actor or set of actors, with the optimal use of resources (WESKE, 2019).

To better illustrate this definition, Figure 1 presents a fragment of the conceptual model, highlighting the key elements involved in defining a process, namely:

- Nodes, which represent activities, events, and gateways;
- Edges, which represent the control flows between nodes, where each edge must be associated with exactly two nodes, relating them in a specific order; and
- Resources, which represent services and/or products, and can be human, physical, or abstract resources.

Figure 1 – Conceptual Process Model.

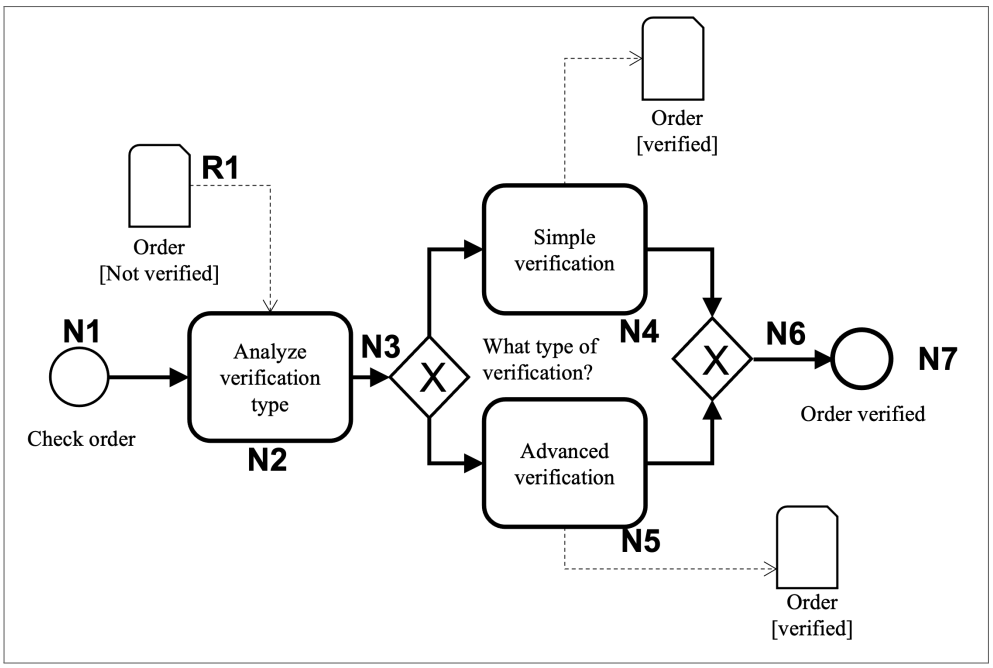


Source: Adapted from (ERIKSSON; PENKER, 2000)

Figure 2 illustrates a process model in BPMN based on the conceptual model presented in Figure 1, where, to facilitate the discussion, both the resource and the nodes are marked

with identifiers. The process model represents the verification of an order. The process begins with an initial event model node (N1), represented by a circle, indicating the occurrence of a relevant state for the start of the process. In this case, an order, yet to be verified, is received and needs to be checked. Once this event occurs, it is directed by the edge that connects the event node N1 to the activity 'Analyze Verification Type' (N2), which is responsible for performing the verification. This order is represented by the resource 'Order' (R1), which must be verified at this activity node.

Figure 2 – Process Model Example.



Source: Adapted from (WESKE, 2019)

After analyzing the type of verification, a gateway node is used to decide whether a simple (N4) or advanced (N5) verification is required. Once the chosen verification activity is completed, another gateway (N6) is activated, and the process concludes with the final event (N7). In this case, it is worth noting that the 'Order' resource changes its status to 'verified.'

Business process models graphically represent business processes (INDULSKA et al., 2009). They are considered the primary interface for process implementation and serve as fundamental tools to support business and IT managers in understanding real processes, facilitating improvements (HILL et al., 2006).

Thus, unequivocally understanding this flow within an organization is an essential activity for Business Process Management (BPM). Due to its importance for businesses, business processes have been gaining increasing attention in the BPM context (BROCKE; ROSEMANN, 2014)

in the pursuit of enhancing customer satisfaction, improving product quality, and optimizing operations (ELZINGA et al., 1995).

The BPM lifecycle consists of the phases of analysis, design, configuration, enactment, and evaluation (WESKE, 2019). All phases are important, but the design phase, in which the process is designed, deserves special attention. A poorly designed process can trigger problems in the subsequent phases of BPM.

In the context of process modeling, which is performed during the design phase, it benefits from interdisciplinary characteristics, encompassing paradigms and methodologies from various fields, such as organizational management theory, computer science, business management, information technology, among others (KO, 2009). Process modeling is an essential tool for describing, understanding, evaluating, analyzing, and improving business processes ((VERGIDIS; TURNER; TIWARI, 2008); (XU, 2011); (VIRIYASITAVAT; XU; MARTIN, 2012)).

Given the importance of process modeling in the design phase, it becomes essential to adopt appropriate modeling languages that effectively capture and represent the complexity of business processes. In the following section, we will explore some Business Process Modeling Languages (BPML), which offer distinct notations and methodologies to support the specification, analysis, and improvement of business processes.

2.1.1 Business Process Modeling Languages

A process modeling language provides the necessary syntax and semantics to specify business process requirements, supporting their verification, validation, simulation, and automation (LU; SADIQ, 2007). These languages enable organizations to visualize, analyze, and optimize workflows, ensuring alignment with business goals and operational strategies. BPML are broadly classified into four categories: traditional modeling languages, object-oriented languages, dynamic modeling languages, and process integration languages (EID-SABBAGH; DIJKMAN; WESKE, 2012).

The primary BPML identified in the literature include BPMN, Data Flow Diagram (DFD), Event Process Chain (EPC), Unified Modeling Language (UML), and Integrated Definition Language (IDEF) (ENTRINGER; FERREIRA; NASCIMENTO, 2021; TEIXEIRA; SANTOS; MACHADO, 2018). Each language offers unique features and capabilities to address specific modeling needs:

1. **BPMN**, developed by the Object Management Group (OMG), provides a graphical notation for specifying internal business processes. Similar to UML activity diagrams, BPMN facilitates effective communication of business processes among stakeholders. The most recent version, BPMN 2.0, released in 2011, introduces three main submodels:

   - Processes (Private and Public): Represent workflows within or across organizations.
   - Choreography Diagrams: Depict interactions between participants.
   - Collaboration Diagrams: Focus on message exchanges between processes.

   BPMN organizes its elements into five categories:

   - Flow Objects: Events, activities, and gateways.
   - Data Elements: Inputs, outputs, and data objects.
   - Connecting Objects: Sequence flows, message flows, and associations.
   - Swimlanes: Pools and lanes for organizing responsibilities.
   - Artifacts: Annotations and groups for additional information.

   BPMN is widely recognized as the standard language for process modeling (ENTRINGER; FERREIRA; NASCIMENTO, 2021; KOCBEK et al., 2015). Its design focuses on readability and accessibility, making it suitable for both technical and non-technical stakeholders. It provides a robust framework applicable to general and specialized processes, supporting execution and automation. (ENTRINGER; FERREIRA; NASCIMENTO, 2021).

2. DFD is primarily used in systems analysis to represent the flow of data within a system:

   - Processes;
   - External Entities;
   - Data Stores;
   - Data Flows.

   DFD emphasize data movements rather than process sequences, making them effective for illustrating information exchange.

3. EPC, as part of the Architecture of Integrated Information Systems (ARIS) framework, focus on modeling business processes by combining functional, organizational, and data perspectives. They highlight:

- Events and states as triggers;
- Functions and decisions;
- Organizational units and resources.

EPC provide a holistic view, ideal for Enterprise Resource Planning (ERP) systems.

4. UML serves as a versatile language for software design and process modeling. It employs various diagrams, including:
   - Activity Diagrams for workflows;
   - Class Diagrams for structural modeling;
   - Sequence and Statechart Diagrams for dynamic behaviors.

   UML's adaptability makes it suitable for modeling both business processes and system behaviors.

5. IDEF includes multiple methodologies for process and data modeling:
   - IDEF0: Functional modeling for process analysis;
   - IDEF3: Scenario-based process descriptions;
   - IDEF1 and IDEF1X: Data modeling techniques.

   IDEF provides structured approaches to capture complex systems and their interdependencies.

6. Role Activity Diagram (RAD), part of the Systematic Technique for Role and Interaction Modeling (STRIM) methodology, is based on Petri nets. It models:
   - Functions and actors;
   - Activities and interactions;
   - Responsibilities across processes.

   RAD emphasizes process elicitation and analysis, offering precise modeling of task flows.

BPMN has emerged as the most widly used and comprehensive process modeling language (ENTRINGER; FERREIRA; NASCIMENTO, 2021; RECKER et al., 2009). Its extensive adoption stems from several advantages:

- Comprehensiveness: BPMN supports functional, dynamic, informational, and organizational perspectives.
- Versatility: It is suitable for descriptive, analytical, and executable process models (TEIXEIRA; SANTOS; MACHADO, 2018).
- Accessibility: Designed for clarity, it is easily understood by both technical and business stakeholders.
- Integration Capabilities: BPMN facilitates integration with process execution engines, enabling simulation and automation.

Given BPMN's rich syntax, semantic expressiveness, and broad adoption, it was selected as the modeling language for this study. BPMN's ability to address diverse modeling requirements—ranging from high-level process descriptions to executable workflows—aligns with the goals of this research. Furthermore, its support for process automation and analysis ensures scalability and adaptability, making it an ideal choice for evaluating perceived value in business process scenarios.

2.2 VALUE

Unlike process models, which describe "*how*" processes should be carried out and by "*whom*" (GORDIJN; AKKERMANS; VLIET, 2000) business models in organizations aim to identify "*who*" offers "*what*" to "*whom*" and "*what*" is expected in return (GORDIJN; AKKERMANS; VLIET, 2000). Thus, the central concept of a business model is "*value*", which, according to (HELFAT; PETERAF, 2003), is calculated as the difference between the perceived benefits gained by the buyers of the product or service and the economic cost of the venture. This understanding emphasizes value as a fundamental metric for determining business success, aligning with the economic principles of exchange and profitability.

In this context, (MEIRELLES, 2019) points out that the concept of value encompasses the merging of at least two distinct perspectives. The first perspective, rooted in classical economists, argues that value is intrinsically linked to the amount of labor required to produce a product or service. On the other hand, neoclassical economists, as describe by (MEIRELLES, 2019), present a different approach in which value is determined by the utility perceived by consumers in the product or service. This approach focuses on the subjective preferences

of consumers and the marginal utility derived from consumption, rather than the cost of production.

However, regardless of the perspective, it is clear that some values can be easily quantified in monetarily terms, such as money and stocks, while others, like intellectual property or brand value, are more difficult to measure. This definition underscores the dual nature of value: its quantitative aspect, which is of great relevance from a commercial standpoint, and its qualitative dimension, which reflects the subjective experience and perception of value (WEIGAND et al., 2006). While the former is essential for assessing profitability and exchange, the latter is equally significant for understanding consumer satisfaction and loyalty, as well as the broader social and emotional impact of a product or service.

In (GORDIJN; AKKERMANS; VLIET, 2000) view, a value object is something that holds economic value for at least one of the parties involved, and it can be a service, a product, or even an experience (first perspective). This definition highlights that value objects are not limited to material goods or monetary transactions but encompass a range of possibilities. This broader understanding of value objects aligns with the shift towards more experience-based economies, where the value proposition extends beyond the tangible to include emotional, relational, and experiential dimensions.

On the other hand, (HOLBROOK, 1999) emphasizes a more consumer-centric perspective, focusing on consumer-perceived value (second perspective). In this context, value is not a fixed property of an object or transaction, but rather it is based on the consumption experience itself. This approach suggests that value is dynamic and context-dependent, shaped by the individual consumer's expectations, preferences, and emotional responses during the consumption process. In this sense, anything can be considered value, as consumer value is based not only on the product or service itself but also on the holistic experience surrounding its consumption.

However, according to (RINTAMÄKI; KUUSELA; MITRONEN, 2007), value only becomes relevant to the consumer when their needs are adequately met. These needs may be categorized into different types: economic needs, related to price and cost-efficiency; functional needs, linked to perceived utility and problem-solving capabilities; emotional needs, reflecting personal feelings or experiences during consumption; and symbolic needs, which express identity, status, or personal values. Simply satisfying sufficient to ensure the creation of value. It is crucial that these needs be incorporated into process models, which establish principles and practices that not only identify value but also recognize stakeholders' roles and interactions.

Through such models, businesses can align their activities with mutually satisfactory objectives, ensuring that the value provided to consumers and other stakeholders is both perceived and experienced as meaningful. This multi-faceted view of value underscores the importance of integrating both objective and subjective dimensions into the design of business processes and models. It also highlights the need for businesses to understand and address the diverse and often conflicting needs of stakeholders, ensuring that the creation of value is both holistic and sustainable in the long term.

2.2.1 Stakeholders Value Perception Measure

The concept of *Perceived Value*, which emerged as a central issue in business during the 1990s, has increasingly prominence as a key factor in the strategic management of organizations (MIZIK; JACOBSON, 2003; SPITERI; DION, 2004). However, despite this growing interest, (KHALIFA, 2004), argues that the concept of *value* remains one of the most misused and misunderstood in the field, with several competing definitions existing in the literature. Notable examples of these definitions are those by (ZEITHAML, 1988; WOODRUFF, 1997; HOLBROOK, 1999), though no consensus has been reached. The lack of agreement on how to conceptualize and measure *perceived value* can be attributed to its inherently ambiguous nature (DASTANE; GOI; RABBANEE, 2023), which has been described in the literature as complex (LAPIERRE, 2000), multifaceted (BABIN; DARDEN; GRIFFIN, 1994), dynamic (PARASURAMAN; GREWAL, 2000; DROGE, 1998)), and subjective (ZEITHAML, 1988).

There are two main research approaches to operationalizing *perceived value*. The first approach conceives *perceived value* as a unidimensional construct. According to this view, *perceived value* is a single concept that can be measured by a self-reported item (or set of items) that assesses the consumer's perception of value (*e.g.*, (CHANG; WILDT, 1994; DODDS, 1991; HARTLINE; JONES, 1996; KERIN; JAIN; HOWARD, 1992; BRADY; ROBERTSON, 1999; SWEENEY; SOUTAR; JOHNSON, 1999; AGARWAL; TEAS, 2002). This perspective admits the possibility that this unidimensional construct could be influenced by multiple antecedents, but it does treat value as an aggregate concept composed of multiple components.

The second approach, which aligns with present investigation, conceives *perceived value* as a multidimensional construct. This perspective suggests that *perceived value* consists of several interrelated attributes or dimensions that form a holistic representation of a complex phenomenon (*e.g.*, (BABIN; DARDEN; GRIFFIN, 1994; HOLBROOK, 1994; HOLBROOK, 1999; MATTS-

SON, 1991; SETH; NEWMAN; GROSS, 1991; WILLIAMS; SOUTAR, 2000; SWEENEY; SOUTAR, 2001).

This research adopts an adapted version of the Consumer Perceived Value (PERVAL) scale (SWEENEY; SOUTAR, 2001), which measures *perceived value* through the consideration of four interrelated dimensions: emotional value, social value, functional value (subdivided into price value and quality value), and overall perceived value. The development of the PERVAL scale marked a significant advancement in the research on Consumer Perceived Value (CPV), particularly in its ability to distinguish between different types of value and provide a more nuanced measurement framework (DASTANE; GOI; RABBANEE, 2023). This scale is widely regarded as one of the most comprehensive and widely accepted tools for assessing perceived value, and it has been applied in various contexts, including services and goods (GALLARZA et al., 2017) and replicated in numerous studies (WALSH; SHIU; HASSAN, 2014).

In addition to the PERVAL scale, other important contributions to measuring CPV have emerged, such as the SERVE-PERVAL scale (PETRICK, 2002), the GLOVAL scale (SÁNCHEZ-FERNÁNDEZ; INIESTA-BONILLO, 2007), and the M-VAL (DASTANE; GOI; RABBANEE, 2023), among others. These scales offer alternative frameworks for measuring CPV and will be described in more detail below.

The SERVE-PERVAL scale, developed by (PETRICK, 2002), was based on (ZEITHAML, 1988) definition of perceived value and specifically designed for the service sector. The dimensions of this scale include quality, emotional responses, reputation, monetary price, and behavioral price. However, one limitation of the SERVE-PERVAL scale is the lack of clarity in the distinctions between dimensions, such as between behavioral price (sacrifices) and monetary price, which can lead to potential confusion in its application.

The GLOVAL scale, developed by (SÁNCHEZ-FERNÁNDEZ; INIESTA-BONILLO, 2007), was originally designed to measure tourist perceptions in the tourism sector and was later replicated by (ROIG et al., 2006) in the banking sector. This scale measures six dimensions: establishment, personnel, product, price, emotional value, and social value. While praised for its simplicity and generalizability, the GLOVAL model has been criticized for its limited applicability outside the service sector.

In (HELKKULA; KELLEHER; PIHLSTRÖM, 2012) work, the authors introduced the concept of value in context, considering the service industry as a whole. In (CHEN; DUBINSKY, 2003), the authors expanded the theoretical framework of CPV, especially in the e-commerce context. In (OVERBY; LEE, 2006), they identified CPV dimensions in e-commerce, categorizing them

into utilitarian and experiential dimensions. This shift emphasizes the contextual nature of perceived value, particularly in virtual environments where the experience and interaction with a service or product can differ significantly from traditional contexts.

In (BAI et al., 2016), a *perceived value* scale was developed for e-commerce, specifically focusing on online clothing brands. Already in (VARSHNEYA; DAS, 2017), they explored subjective dimensions of experiential value, while in (WILLIAMS; GAZLEY; ASHILL, 2021), they conceptualized child CPV, creating a 25-item scale to measure value through emotional, social (friends), social (parents), curiosity, and monetary dimensions. These contributions highlight the growing recognition of the diverse and complex nature of CPV, expanding its scope to different demographics and sectors.

More recently, in (DASTANE; GOI; RABBANEE, 2023) the M-VAL scale was proposed, a 25-item tool designed to assess consumer perception in mobile commerce (m-commerce). The M-VAL scale comprises three primary dimensions: utilitarian value, interaction value, and credibility value) and, with nine subdimensions: information, economic, convenience, interface, visual, gamification, personalization, system credibility, and social credibility. This scale represents an important advancement in measuring CPV in the rapidly growing m-commerce sector, emphasizing the role of technological interactions and consumer trust.

The decision to adapt the PERVAL scale for this research is supported by its widespread use and validation in various studies across different contexts. Notable examples include studies on technology acceptance in Canada (TUREL; SERENKO; BONTIS, 2007), securities services in China (WANG et al., 2004), financial services in Spain (ROIG et al., 2006), tourism in Australia (WILLIAMS; SOUTAR, 2009), private label context in Germany (WALSH et al., 2010), and risk perception in Australian franchises (GRACE; WEAVEN, 2011). These adaptations demonstrate the PERVAL scale's flexibility and effectiveness across different contexts. Furthermore, the PERVAL scale's construct validity and its applicability to international populations further reinforcs its suitability for this investigation (WALSH et al., 2010).

2.2.1.1 PERVAL Scale

In (SWEENEY; SOUTAR, 2001), the authors developed the PERVAL scale using Australian data, subjecting it to extensive validation procedures and initially testing it in the context of durable goods such as furniture, car stereos, and household appliances.

Unlike previous unidimensional measures, the PERVAL scale acknowledges that consumer

evaluations involve both rational and emotional factors. This distinction is important, as (MACKAY, 1999) highlighted that a product or service appeal is an “amalgam of rational and emotional factors", where “emotions play a part in every purchase decision, but very few purchases are entirely emotional”. This multidimensional perspective underscores the complexity of consumer decision-making processes and highlights the necessity of capturing value across diverse dimensions.

In (SWEENEY; SOUTAR, 2001), they demonstrated that employing multiple value dimensions offers a more robust and nuanced explanation of consumer behavior compared to relying solely on a single measure such as "*value for money*". By incorporating functional, emotional, and social dimensions, the PERVAL scale offers a comprehensive framework for understanding consumption value and decision-making processes.

The PERVAL scale assesses how cusromers evaluate products not only in functional terms, such as expected performance, value for money, and versatility, but also based on emotional gratification and the social implications. Specifically, it measures how products influence feelings of enjoyment (emotional value) and enhance social self-image (social value). The scale's reliability and validity were confirmed for both pre-purchase expectations and post-purchase evaluations.

The original PERVAL scale consists of 19 items distributed across four dimensions:

1. Emotional Value: Utility derived from the feelings or affective states a generated by the product.

2. Social Value (enhancement of social self-concept): Utility derived from the product's ability to enhance one's social image and acceptance.

3. Functional Value (price/value for money): Utility derived from the product's capacity to reduce perceived short-term and long-term costs.

4. Functional Value (performance/quality): Utility derived from the perceived quality and expected performance of the product.

Building upon this foundational work, in (WALSH et al., 2010), the authors conducted a study aimed at refining and validating a shorter version of PERVAL scale. Leveraging, which exhibited strong psychometric properties. Using the original data from (SWEENEY; SOUTAR, 2001) along with data from three additional countries, they proposed 12-item and 8-item versions of the

scale. The key contribution of their research lies in offering shorter, psychometrically robust versions of the scale, making it more practical for use in surveys and empirical studies. This streamlined approach enhances accessibility for practitioners and facilitates the use of public opinion polls as sources of empirical data on customer perceived value.

In (WALSH et al., 2010), they concluded that both the 8-item and 12-item PERVAL-Short scales provide viable alternatives to the original 19-item version. However, the 12-item scale demonstrated stronger psychometric properties and is recommended as the preferred choice for researchers and practitioners. Notably, the PERVAL scale, with slight modifications, can also be adapted for measuring perceived value in service sectors and non-durable product categories. his adaptability underscores its potential for widespread application across international retail and service environments.

Based on the findings of (WALSH et al., 2010), this study opted to adopt the 12-item version of the PERVAL-Short scale. This version is particularly suited for gathering benchmark data on customer *perceived value* and tracking improvements across the measured dimensions. Practitioners can leverage the scale to assess overall *perceived value* and evaluate performance within each dimension. By focusing on individual PERVAL dimensions, manufacturers and service providers can identify strengths and weaknesses in their value propositions, enabling them to address targeted issues and develop targeted solutions.

2.3 *FUZZY* LOGIC

Conceptually and algorithmically, *fuzzy* sets are one of the most fundamental and influential notions in science and engineering (PEDRYCZ; EKEL; PARREIRAS, 2011). This notion is highly intuitive and transparent, as it essentially captures the way the real world is perceived and described in everyday activities (PEDRYCZ; EKEL; PARREIRAS, 2011).

Fuzzy System Theory (FST) is defined as the theory of a class of objects with continuous degrees of membership ranging between the interval [0,1]. A degree of zero (0) indicates complete absence or non-membership of the element in the set, while a degree of one (1) represents absolute certainty of the element's membership (ZADEH, 1965). The development of *fuzzy* logic arose from the need for a conceptual framework to address issues of uncertainty and linguistic imprecision, which are prevalent in human reasoning and common sense (ZADEH, 1992). Therefore, it is widely used to represent models of imprecise reasoning in rational decision-making environments with uncertainties and imprecisions (ROSS, 2005).

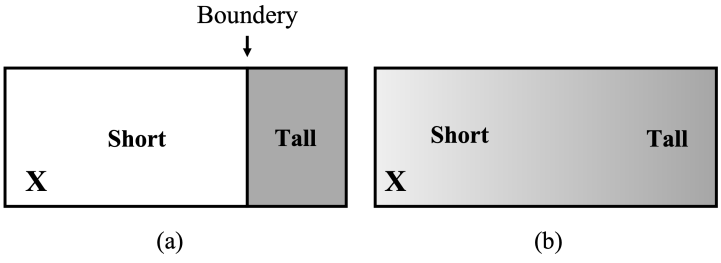
There are countless examples where elements are found whose allocation to a desired concept can only be satisfied to a certain extent. The gradual transition from full membership to total exclusion is a fundamental characteristic of the physical world and natural systems (PEDRYCZ; EKEL; PARREIRAS, 2011). For example, an individual who is 1 meter tall is considered short, while a person who is 1.90 meters tall is perceived as tall. However, a person who is 1.89 meters tall is very likely still perceived as tall, just as a person who is 1.05 meters is considered short.

Considering a height of 1.45 meters, it would intuitively be perceived as somewhere between tall and short; that is, the value of 1.45 meters is partially compatible with both the terms tall and short at the same time. This categorization is not instantaneous and sharp but rather a gradual shift in perception between categories as one moves along the height range.

Due to the nature of these concepts, a single number cannot be used, as the transition between the notions of tall and short is not abrupt (ROSS, 2005); (NGUYEN; WALKER; WALKER, 2018). Given that common sense knowledge is lexically imprecise and non-categorical, approaches based on first-order logic and classical probability theory are not suitable for representing it, as they do not provide an appropriate conceptual framework for handling this type of knowledge (MOORE, 1982; MOORE, 1984); (ZADEH, 1987; ZADEH, 1992).

Thus, *fuzzy* logic can be classified as non-binary or multivalent logic (MAGALHÃES, 2012), since, from its derived abilities, it is possible to obtain conclusions that yield data with vague, ambiguous, incomplete, and imprecise content. Such data cannot be simply classified as low or high according to the classical binary system, but rather as a gray zone with gradual transition from low to high, as can be seen in Figures 3(a) and 3(b) (SIMÕES; SHAW, 2007).

Figure 3 – Contrasting the concept of the set and the principle of dichotomy itself versus a relaxation of the concept of complete inclusion and exclusion.

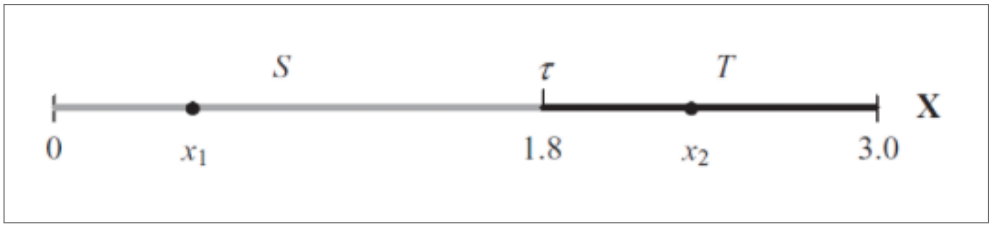


Source: (SIMÕES; SHAW, 2007)

Fuzzy sets and their corresponding membership functions provide a mathematically rigorous and effective framework for formalizing imprecise concepts (PEDRYCZ; EKEL; PARREIRAS,

2011). For example, when describing the height distribution of Brazilians, a universe of possible heights can be defined in the interval [0,3] meters, where this range serves as the domain for categorizing individuals as "*tall*". Within this universe of discourse, the height variable can be either continuous or discrete: the closed interval [0,3] represents a continuous and bounded set, whereas the set of natural numbers, $N = \{0, 1, 2, ...\}$, forms a discrete, countable, yet unbounded set. If we define a threshold $\tau = 1.8$ meters, we obtain two sets $S = \{x \in X | 0 < x < 1.8\}$ representing heights below meters and $T = \{x \in X | 1.8 \leq x \leq 3.0\}$ representing heights at or above this threshold, as shown in Figure 2.3.

Figure 4 – A set as a collection of numeric values located in corresponding intervals



Source: (PEDRYCZ; EKEL; PARREIRAS, 2011)

Each element of the universe that satisfies the same property generates a set equivalent to a list of elements in the universe that belong to the set. When considering a specific value in X, the process of dichotomization (binarization) results in a binary classification decision: to accept or reject the value as belonging to a given collection. For example, considering the set S shown in Figure 4, point x1 belongs to S while x2 does not, i.e., x1 $\in$ S and x2 $\notin$ S. Similarly, for set T, we have x1 $\notin$ T and x2 $\in$ T. The acceptance decision is represented by 1 and the rejection decision by 0, briefly.

Thus, the classification (assignment) decision for x $\in$ X is made through a characteristic function as follows:

$$S(x) = \left\{ \begin{array}{lll} 1 & if & x \in S \\ 0 & if & x \notin S \end{array} \right\}$$

$$T(x) = \left\{ \begin{array}{lll} 1 & if & x \in T \\ 0 & if & x \notin T \end{array} \right\}$$

In general, a characteristic function of set A defined in X takes the following form:

$$A(x) = \left\{ \begin{array}{lll} 1 & if & x \in A \\ 0 & if & x \notin A \end{array} \right\}$$

The empty set has a characteristic function that is identically equal to zero, i.e., A(x) = 0 for all x within X. Conversely, the universe X has a characteristic function that is identically equal to one, i.e., X(x) = 1 for all x within X. Additionally, a singleton A = a, which is a set with only one element, has a characteristic function such that A(x) = 1 if x = a and A(x) = 0 otherwise.

Characteristic functions A: X $\rightarrow \{0, 1\}$ establish well-defined boundaries on elements of the universe X that can be assigned to set A. The fundamental idea of a *fuzzy* set is to relax this requirement, allowing for intermediate degrees of class membership (PEDRYCZ; EKEL; PARREIRAS, 2011). Thus, we can assign values between 0 and 1 to quantify our perception of how compatible these values are with the class. A value of 0 indicates incompatibility (complete exclusion), and a value of 1 indicates compatibility (complete membership). Membership values, therefore, express the degrees to which each element of the universe is compatible with the distinctive properties of the class. Intermediate membership values mean there is no "natural" threshold, and elements of the universe can be members of a class while also belonging to other classes to varying degrees. Allowing for gradual, less strict degrees of membership is at the core of *fuzzy* sets (BOTELHO, 2012); (PEDRYCZ; EKEL; PARREIRAS, 2011).

These membership functions can be represented by triangles, trapezoids, or Gaussian curves, depending on the nature of the problem ((LAMRHARI; ELGHAZI; FAKER, 2019);(WU et al., 2021);(MELO et al., 2023)). *Fuzzy* system theory is increasingly being applied in a variety of studies and investigations, including systems engineering (applied in the modeling of complex systems, enabling a more flexible and realistic representation of requirements).

2.3.1 Basic Notations

Formally, a *fuzzy* set A is described by a membership function that maps elements of a universe X to the unit interval [0,1] (ZADEH, 1965):

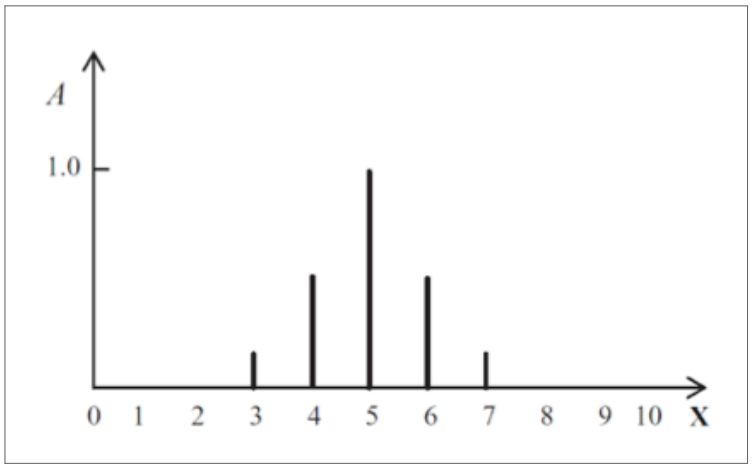
$$A{:}X \rightarrow [0,1]$$

Membership functions are conceptually equivalent to *fuzzy* sets, as they extend characteristic functions in the same way that *fuzzy* sets generalize classical sets (PEDRYCZ; EKEL; PARREIRAS, 2011).

A *fuzzy* set can also be represented as a collection of ordered pairs in the form $\{x, A(x)\}$, where x is an element of X and $A(x)$ denotes its corresponding degree of membership. For

a finite universe of discourse $X = \{x_1, x_2, ..., x_n\}$, the *fuzzy* set A can be expressed as an n-dimensional vector $A = [a_1, a_2, ..., n_a]$, where each elements $a_1 = A(xi)$ represents the membership degree of x_i in A. Figure 5 illustrates a *fuzzy* set that captures the concept of an integer “close to 5" in a finite universe containing 10 integers. The corresponding *fuzzy* set can be represented as $A = [0, 0, 0, 0.2, 0.5, 1.0, 0.5, 0.2, 0, 0, 0]$. Alternatively, an equivalent notation is $A = \{0/1, 0/2, 0/3, 0.2/4, 0.5/4, ..., 0/10\}$.where each pair a_i/x_i indicates the degree of membership a_i assigned to element x_i in the *fuzzy* set A.

Figure 5 – *Fuzzy* set A defined in a discrete universe X.



Source: (PEDRYCZ; EKEL; PARREIRAS, 2011)

The choice of the unit interval for the values of degrees of membership is generally a matter of convenience. Detailing association values with many decimal digits is not crucial and can be counterproductive. The goal is to reflect the order of elements in a *fuzzy* set in terms of belonging (DUBOIS; PRADE, 1980). *Fuzzy* sets serve as elastic constraints imposed on the elements of a universe (ZADEH, 1992). *Fuzzy* sets deal with elasticity, gradualness, and the absence of well-defined boundaries, as opposed to crisp sets, which have rigid boundaries and binary membership (PEDRYCZ; EKEL; PARREIRAS, 2011).

In a 1992 paper, Zadeh presented some basic characteristics of *fuzzy* logic, including:

- Precise reasoning is seen as an extreme case of approximate reasoning;
- Knowledge is interpreted as an expandable collection, and *fuzzy* logic restricts this to a collection of variables;
- Everything is a matter of degree;
- Inference is viewed as a process of propagating constraints; and

- Any logical system can be converted to *fuzzy* logic.

According to (ZIMMERMANN; ZIMMERMANN, 1996), the process of applying a *fuzzy* method can be performed in three steps: (i) fuzzification, where input data (fixed numerical or linguistic terms without uncertainty or imprecision) are transformed into *fuzzy* sets; (ii) inference, applying predefined rules to produce *fuzzy* output results; and (iii) defuzzification, converting *fuzzy* results into crisp outputs (SANTOS-NETO; COSTA, 2023).

2.3.2 Sets

In classical sets, the transition from membership to non-membership in a given set is abrupt and well-defined, referred to as crisp. However, in *fuzzy* sets, this transition can be gradual. The variation of membership degrees can be understood by considering that the boundaries of *fuzzy* sets are vague and ambiguous. Thus, the membership of an element in the universe to a *fuzzy* set is measured by a function that attempts to describe imprecision and ambiguity.

A *fuzzy* set, therefore, contains elements with varying degrees of membership. This approach contrasts with classical sets, also known as crisp sets, where an element is considered a member of the set only if its association is complete. In contrast, elements of a *fuzzy* set can have incomplete membership, meaning they can also belong to other fuzzy sets in the same universe (ROSS, 2005). This flexibility of compatibility makes *fuzzy* sets a powerful tool for dealing with situations where membership boundaries are not clearly defined.

2.3.3 Fuzzy Numbers

In conventional mathematics, numbers represent precise quantitative information. However, in many practical situations, numerical values are inherently imprecise due to factors such as measurement instrument limitations, human error, or intrinsic variability in the measured object. In such cases, rather than considering a single real number $a \in R$, it is often more appropriate to employ a *fuzzy* set $A \in F(R)$, which encapsulates the notion of “approximately a" or “around a". This specific class of *fuzzy* sets is referred to as *fuzzy* numbers.

A *fuzzy* number is a special *fuzzy* subset of real number line, where the membership function is a continuous mapping from R to the closed interval $[0, 1]$. This property allows *fuzzy* numbers to model uncertainty in numerical data more effectively than crisp values.

Fuzzy numbers can take various forms, which are generally classified into three primary categories. The most fundamental types include triangular, trapezoidal, and bell-shaped *fuzzy* numbers (MA; KANDEL; FRIEDMAN, 1998; PRASAD; SINHA, 2022). More advanced formulations have been introduced for specialized applications: for instance, (APPADOO, 2006) proposed O(m,n)-trapezoidal *fuzzy* numbers and left-right *fuzzy* numbers for financial derivative pricing, whereas (BAYARAA, 2016) developed *fuzzy* numbers with curved and non-linear sides. More recent, (PATHINATHAN; SANTHOSHKUMAR, 2018) introduced novel structures such as perfect pentagonal *fuzzy* numbers and quadrilateral *fuzzy* numbers.

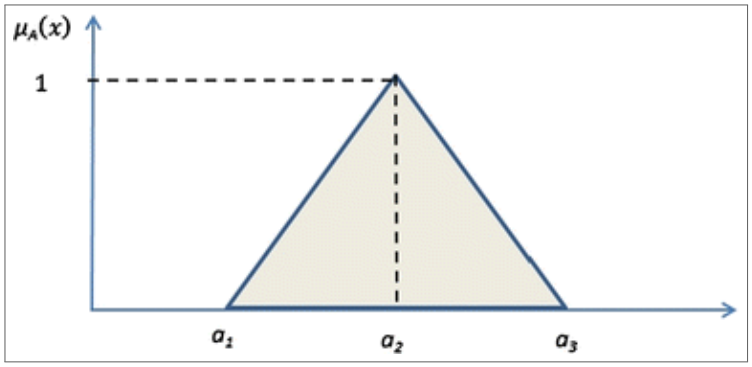
Among these forms mentioned, triangular and trapezoidal *fuzzy* numbers are widely recognized as foundational in the literature (SILVA; COSTA, 2014). In particular, the triangular *fuzzy* number is often favored due to its computational simplicity and efficiency (PEDRYCZ, 1994). Consequently, this study adopts the triangular *fuzzy* number as the primary representation of fuzzy numerical uncertainty.

A triangular fuzzy number is formally defined by the triplet (a, b, c), where $a \leq b \leq c$, as illustrated in Figure 6. The corresponding membership function $\mu_A(x)$ is given by:

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a}, & \text{if } a \leq x \leq b, \\ \frac{c-x}{c-b}, & \text{if } b \leq x \leq c, \\ 0, & \text{otherwise.} \end{cases}$$

This function ensures a piecewise linear transition from 0 to 1 and back to 0, capturing the gradual nature of membership in a way that aligns with the principles of *fuzzy* set theory.

Figure 6 – Membership function of a triangular fuzzy number $\tilde{A} = (a_1, a_2, a_3)$



Source: (CARVALHO et al., 2016)

3 METHODOLOGICAL PROCEDURES

This chapter presents the methodological procedures adopted in this study, aligning them with the proposed objectives. It discusses the paradigmatic positioning, the nature of the research, and the specific research methods employed.

3.1 PARADIGMATIC POSITIONING

Research methodology is intrinsically tied to philosophical conceptions that shape the study's approach and influence its execution. Recognizing and articulating these conceptions is essential for ensuring coherence between the theoretical framework and methodological choices (CRESWELL; CLARK, 2015). In (NEUMAN, 2014), the author classifies these philosophical orientations into three primary paradigms: positivist or post-positivist, social interpretive, and critical. These paradigms not only reflect divergent epistemological and ontological perspectives but also guide the design and interpretation of research across disciplines, including the social sciences.

The positivist paradigm, grounded the methodologies of natural sciences, emphasizes the discovery of causal laws through empirical observation and objectivity. This approach prioritizes replicability, generalizability, and value-free inquiry. However, the limitations of rigid positivist assumptions (especially when applied to the complexities of human behavior) led to the development of post-positivism. Post-positivism acknowledges the impossibility of attaining absolute truth, particularly in social contexts, and instead emphasizes the falsification of hypotheses, rigorous empirical testing, and probabilistic reasoning (CRESWELL; CRESWELL, 2017). In this paradigm, researchers strive to reduce complex phenomena into a manageable set of variables, which are systematically analyzed to identify patterns and relationships.

In contrast, the social interpretive paradigm focuses on the subjective and socially constructed nature of reality. This approach prioritizes the understanding of social phenomena thorough the lenses of the individuals involved. It entails an in-depth examination of meanings, values, and interactions, recognizing that reality is co-created through social processes (RICHARDSON et al., 1985). Researchers operating within this paradigm adopt an immersive stance, seeking to uncover the rich, contextual layers that shape human experiences. The interpretive approach often employs qualitative methods to capture the nuances of social phe-

nomena, enabling a comprehensive understanding of complex realities.

The critical paradigm is distinct in its activist stance, societal. This paradigm emphasizes reflexivity, transformative action, and the pursuit of social justice (NEUMAN, 2014). It views research as a tool for fostering emancipation and addressing systemic inequities, encouraging researchers to adopt a politicized and engaged approach to inquiry.

Research on the empirical evaluation of business process models predominantly aligns with the post-positivist paradigm. Process models, such as those created using BPMN, are inherently shaped by designers' perceptions and subjective interpretations (SCHUETTE; ROTTHOWE, 1998). Despite efforts to achieve inter subjectivity, these models are prone to issues such as control flow errors, structural inconsistencies, and cognitive challenges that hinder their comprehensibility (MENDLING; STREMBECK, 2008; LEOPOLD; MENDLING; GUENTHER, 2016). In (SOUZA et al., 2024), the author further underscores that such issues can significantly impact the utility and effectiveness of these models in practice.

For these reasons, this research adopts the post-positivist paradigm. Having emphasized this point, the next section presents the nature of this research, elaborating on its epistemological stance and methodological strategies.

3.2 RESEARCH NATURE

The nature of research can be broadly classified into three primary categories: exploratory, descriptive, and explanatory. These categories guide the objectives, scope, and methodologies of a study, ensuring alignment between its purpose and approach. Next, each category is detailed along with its theoretical underpinnings and practical applications.

Exploratory studies are particularly useful when there is limited knowledge about a given subject. They aim to provide an initial understanding, clarify ambiguous problems, or uncover new perspectives. Such studies are characterized by their flexible design, which allows researchers planning and seek to adapt methods as new insights about the phenomenon emerge (PRESTES, 2012). By identifying patterns or generating hypotheses, exploratory research often serves as a precursor to more structured investigations. It typically employs qualitative methods such as interviews, literature reviews, and case studies to develop a broad and nuanced understanding of the research problem.

Descriptive studies aim to systematically observe, record, analyze, and classify phenomena without interfering with their natural occurrence. Often used to characterize specific popu-

lations, processes, or events, these studies provide a detailed portrayal of attributes (RICHARDSON et al., 1985). They can rely on either quantitative or qualitative approaches, frequently employing surveys, censuses, or observational techniques to generate statistical or thematic profiles. For example, descriptive research may estimate attitudes, opinions, or behaviors within a population, thereby establishing baseline data crucial for future investigations.

Explanatory studies go beyond observation and description by identifying the underlying causes and relationships among variables. This research type deepens the understanding of phenomena by addressing why and how they occur (PRESTES, 2012). By analyzing causal links and determining contributing factors, explanatory research often employs experimental or quasi-experimental designs supported by statistical analyses. Its objective is to move from correlation to causation, offering actionable insights and advancing theoretical frameworks.

In this study, the research nature is explanatory, as it seeks to clarify the representativeness of business values specified in BPMN process models. With this nature established, the next section will discuss the method to be employed.

3.3 RESEARCH METHOD

The choice of a research method is fundamental for ensuring that the objectives of a study are appropriately addressed. In the literature, methods are typically categorized into three main approaches: qualitative, quantitative, and mixed-methods, each with distinct characteristics, strengths, and limitations.

Qualitative research seeks to explore and understands the meaning individuals or groups assign to social or human phenomena. It focuses on subjective dimensions such as motivations, aspirations, beliefs, values, and attitudes, often in contexts where phenomena are complex or insufficiently understood (MINAYO; SANCHES, 1993). This approach is inherently **interpretive** and **inductive**, with researchers analyzing data to identify patterns and themes, moving from specific observations to broader generalizations (FLICK, 2022). Common methods include interviews, focus groups, case studies, and ethnographic observations. These techniques allow for a rich, detailed understanding of the research problem but often limit generalizability due to smaller sample sizes and context-specific insights.

Quantitative research emphasizestesting objective theories by examining the relationships between **measurable variables**. These variables are operationalized through instruments such as surveys, experiments, and structured observations, which enable statistical

analysis(NEUMAN, 2014). The goal is to achieve **precision**, **reliability**, and **replicability**, minimizing distortions in data collection and interpretation (RICHARDSON, 1999). This method is particularly suited to studies requiring hypothesis testing, causal inference, or the generalization of findings to larger populations. However, it may oversimplify complex social phenomena by reducing them to quantifiable metrics.

Mixed-methods research integrates qualitative and quantitative approaches to leverage their strengths and mitigate their weaknesses (CRESWELL; CLARK, 2015; CRESWELL, 2010). This approach provides a **comprehensive view of phenomena**, enabling researchers to explore subjective experiences while also testing hypotheses and validating results. For instance, qualitative data may provide context and depth, while quantitative analysis ensures rigor and objectivity. Mixed-methods research is increasingly valued in fields where complex phenomena require multidimensional exploration, offering both **breadth** and **depth** in findings.

This study adopts a quantitative approach, which is well-suited to its objectives of analyzing the representation of multidimensional business value in BPMN process models. Specifically, the study applies *fuzzy* set theory to address the inherent imprecision of linguistic concepts, such as "*value creation*" and "*value capture*".

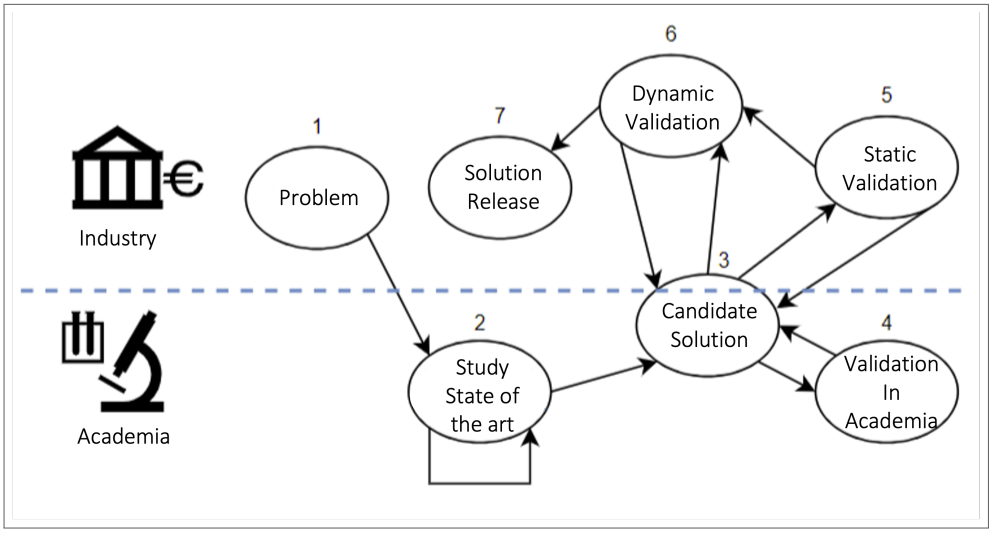
3.4 RESEARCH STRATEGY

The research activities underpinning this doctoral thesis were structured using an extended version of the **Technology Transfer Model** proposed by (GORSCHEK et al., 2006). This model is designed to bridge the gap between academic research and industrial needs by incorporating iterative evaluation and observation activities. Its structured framework ensures that the development of solutions is both practical and aligned with industry requirements, thus enhancing the relevance and applicability of academic contributions.

This model consists of seven interrelated activities, forming a cyclical process where potential solutions are iteratively formulated and empirically validated. The iterative nature of the model emphasizes the refinement of solutions through continuous feedback, helping to ensure their real-world feasibility. The seven activities are described below and represented in Figure 7:

1. **Problem:** The process begins with identifying a specific problem or challenge occurring in the industry. The problem may be emerge directly from collaboration with a

Figure 7 – Technology Transfer Model.



Source: (GORSCHEK et al., 2006)

company or through independent observation and critical analysis of current practices. By grounding the research in real-world issues, this step ensures the study's practical relevance.

2. **State-of-the-Art Review:** A critical review of the literature and existing solutions is conducted to evaluate the extent to which the identified problem has been addressed. This involves assessing past and present attempts to solve the issue, identifying gaps in current knowledge, and defining the research's unique contribution. This step strengthens the theoretical foundation of the study while justifying the need for further investigation.

3. **Candidate Solution:** One or more potential solutions are proposed to address the identified problem. These solutions are formulated based on insights from the state-of-the-art review and are designed to be iteratively refined through subsequent evaluation activities (4, 5, and 6).

4. **Academic Validation:** The candidate solution undergoes preliminary evaluation in an academic environment, such as controlled experiments, simulations or case studies involving students, domain experts, or industry professionals. This phase allows researchers to identify issues, weaknesses or limitations in the proposed solution without consuming industry resources. Moreover, it provides an opportunity to refine the solution prior to industry-level testing.

5. **Static Validation:** The static validation phase evaluates the candidate solution in an

industrial setting without embedding it into live projects. Industry professionals review and analyze the proposed method, technique, or tool using real-world artifacts. Feedback gathered during this "offline" assessment informs necessary adjustments, ensuring the solution is contextually relevant and implementable.

6. **Dynamic Validation:** In this phase, the solution is applied in real-world industrial contexts, typically through pilot projects. Professionals utilize the method, technique, or tool to address practical problems, and their experiences provide critical feedback. This phase enables the assessment of the solution's efficacy under realistic conditions, facilitating further refinement.

7. **Solution Release:** Once the iterative process has been completed and the solution sufficiently validated, the final step involves preparing the solution for widespread implementation in industrial contexts. This includes creating tools, documentation, and training materials to support adoption and application.

This doctoral thesis specifically addresses the first four phases the Technology Transfer Model: Problem Identification, State-of-the-Art Review, Candidate Solution Development, and Academic Validation. These phases were selected because the research aimed to develop and validate a theoretical and methodological solution in an academic context before progressing to industrial testing.

The initial focus on academic validation ensures that the proposed solution is theoretically sound and capable of addressing the identified problem. However, future work could extend the research to include static and dynamic validations, thereby bridging the gap between academic findings and practical industrial applications.

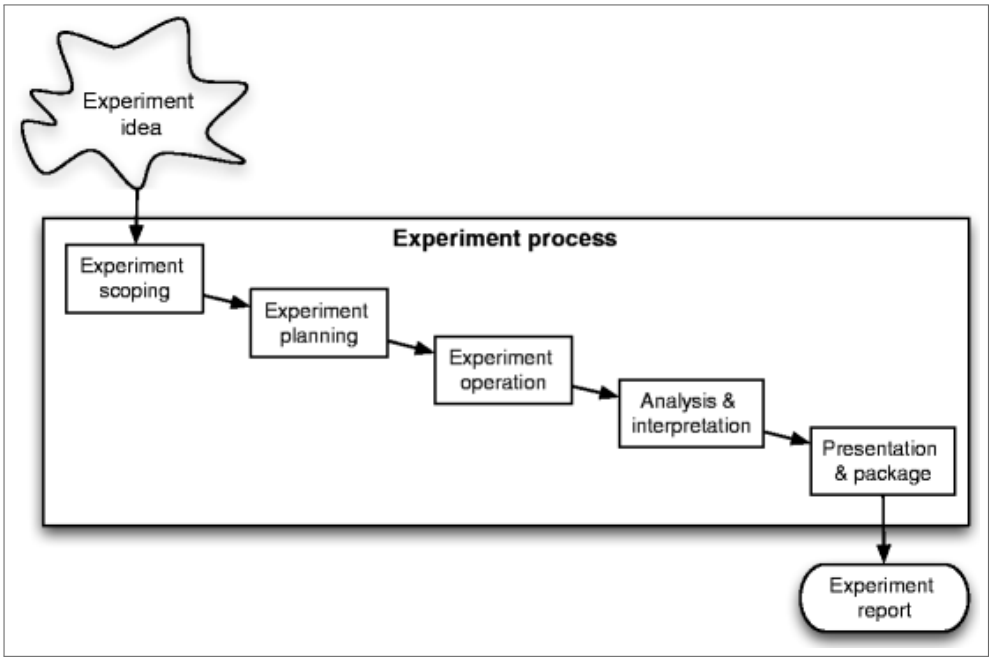
3.4.1 Experimentation

To validate the proposed method, experiments were conducted as an established strategy in scientific research for testing theories, confirming hypotheses, evaluating model accuracy, and validating measurement methods (BASILI; SHULL; LANUBILE, 1999). Experiments, particularly in applied fields, are essential for systematically exploring cause-effect relationships and generating empirical evidence (WOHLIN et al., 2012). Furthermore, the replication of experiments plays an important role in addressing broader issues beyond individual experiments. Replications allow

for the generalization of findings, enhancing the reliability of results, and providing robust evidence to confirm or refute specific hypotheses (BASILI; SHULL; LANUBILE, 1999).

Given the absence of a standard or widely accepted method in the industry for aligning business values with BPMN process models, it was not feasible to conduct a fully controlled experiment, which typically requires a control group. Instead, the study employed a *quasi*-experiment, a suitable empirical method when certain constraints—such as the inability to randomize participants or establish strict experimental controls—are present. This quasi-experiment was carefully designed following the experimental framework widely adopted in Software Engineering (WOHLIN et al., 2012).

Figure 8 – Overview of the Experiment Process.



Source: (WOHLIN et al., 2012)

The quasi-experiment followed the structured process suggested by (WOHLIN et al., 2012), as illustrated in Figure 8. This process consists of five key activities, described below:

1. **Scope:** The initial step involves defining the scope. While formal hypotheses may not be established at this stage, it is essential to clearly outline the experiment's objectives and goals. These objectives are derived from the problem statement and are designed to ensure alignment between the research focus and measurable outcomes. Table 2 presents the objectives with the corresponding goals used in this study.

Table 2 – Objectives with the corresponding goals

Analyze	What is the object of study (product, process, model, technique, theory, etc.)?
With the purpose of	What is the intention (evaluate, predict, control, estimate, etc.)?
In terms of	What is the quality approach (effectiveness, cost, maintainability, stability, etc.)?
From the perspective of	What is the point of view of interest (developer, maintainer, project manager, user, etc.)?
In the context of	Where does the study take place, on what artifacts, and with what type of participants?

Source: (SOLINGEN et al., 2002)

2. **Experiment Planning:** During the planning activity, the experimental design is defined in detail. This includes:

   - **Context Definition**: Detailing the environment in which the experiment will take place and profiling the participants (*e.g.*, domain experts, students, or industry professionals).
   - **Hypothesis Specification:** Formulating both null hypotheses (to test the absence of effect) and alternative hypotheses (to test the expected effect).
   - **Variable Identification:** Defining independent variables (inputs manipulated during the experiment) and dependent variables (outputs measured to assess effects).
   - **Experimental Design:** Deciding on key factors such as whether trials will be conducted online or offline, participant randomization methods, and the overall structure of the study.
   - **Instrumentation:** Preparing the tools and materials necessary for data collection, such as surveys, software, or simulation environments.
   - **Validity Considerations:** Addressing potential threats to internal, external, construct, and conclusion validity to ensure the reliability and generalizability of results.

3. **Operation:** This phase focuses on executing the experiment as per the planning phase. Key activities include:

   - **Data Preparation:** Ensuring all instruments and environments are ready for execution.
   - **Experiment Execution:** Conducting the experiment in adherence to the predefined plan, ensuring consistent data collection procedures.
   - **Data Validation:** Checking the collected data for completeness and correctness to ensure it accurately reflects the experimental conditions.

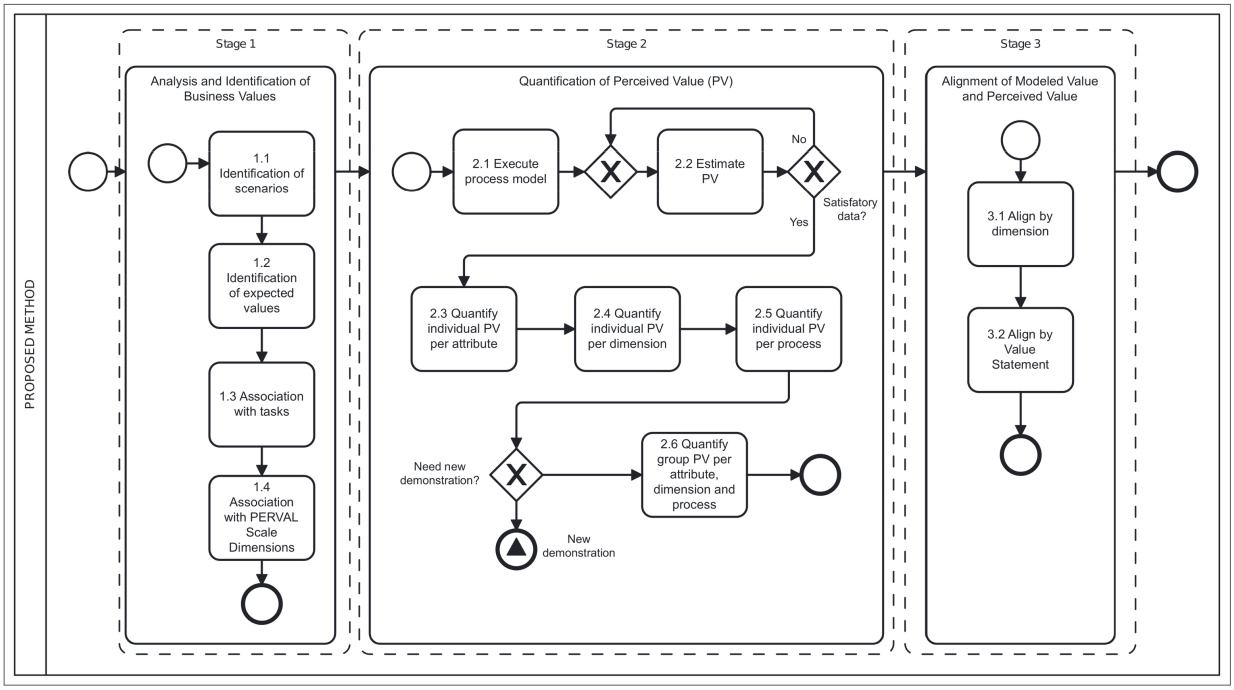
4. **Analysis and Interpretation:** In this phase, the validated data is analyzed to draw meaningful conclusions. Steps include:
    - **Descriptive Analysis:** Using statistical techniques to provide an initial understanding of the data.
    - **Data Reduction:** Identifying and eliminating redundant variables or outliers that may skew results.
    - **Hypothesis Testing:** Conducting appropriate statistical tests based on the scale of measurement and the nature of the variables. These tests determine whether the null hypotheses can be rejected and evaluate the influence of independent variables on dependent variables.
    - **Result Interpretation:** Translating statistical findings into practical insights about the proposed method's effectiveness and applicability.
5. **Presentation and Packaging:** The final activity involves documentating and disseminating the results. This may take the form of:
    - **Research Papers:** Publishing findings in academic journals or conferences to share insights with the broader community.
    - **Laboratory Packages:** Preparing comprehensive materials for experiment replication, including detailed methodologies, data sets, and analysis procedures, thereby enabling reproducibility and further validation.

This study adhered to the first four phases of the experimental process, ensuring rigorous design, execution, and analysis within an academic context. The quasi-experiment was specifically tailored to address the challenge of aligning business values with BPMN process models, leveraging theoretical constructs and practical experimentation to validate the proposed method. The details results and findings are presented in Chapter 6 (Empirical Evaluation), where the outcomes are critically discussed.

4 PROPOSED METHOD

The method outlined in this study aims to align an organization's business values with its process models. It is designed to facilitate the evaluation of any BPMN process model and is structured into three distinct stages, as illustrated in Figure 9.

Figure 9 – Proposed Method.



Source: The Author (2024)

4.1 STAGE 1: ANALYSIS AND IDENTIFICATION OF BUSINESS VALUES IN THE BPMN MODEL

The initial stage of this method focuses on identifying and cataloging the business values expected by the organization through the execution of a specific BPMN process model. It comprises four key steps, each designed to enhance the systematic mapping of values within the process:

1. **Identification of Scenarios**: This step entails a thorough analysis of the BPMN model provided by the organization. Researchers examine various scenarios and paths embedded within the model, assessing their potential to influence user perceptions of value— both positively and negatively. Scenarios are defined as distinct sequences of activities that

may unfold during the execution of the process. These scenarios represent potential pathways that can impact the stakeholders' perception of value. It is important to note that the analysis is not exhaustive, *i.e.*, are analyzed those that have a substantial impact on the delivery and capture of value. This selective approach ensures that the analysis prioritizes key areas of interest while acknowledging that not every possible path needs to be considered.

2. **Identification of expected values**: Following the BPMN model analysis and the identification of relevant scenarios, researchers meet with organization leaders to identify the business values that are expected to be perceived by stakeholders throughout the process execution. Accurate identification of these values is crucial, as only the values recognized at this stage will be taken into account in the subsequent phases of the method. The omission of key values may lead to an underestimation of perceived value, which in turn could skew the organization's understanding of how its business processes are interpreted by stakeholders. Such underestimations could jeopardize strategic alignment by distorting the feedback loop between process outcomes and organizational expectations. Thus, this step involves a detailed dialogue aimed at aligning business expectations with the operational realities of process execution, ensuring that all significant values are captured.

3. **Association with tasks**: In this step, the identified business values are linked to specific tasks within the process that generate or influence these values when executed. For example, in a "*Vehicle Rental*" BPMN model, a situation may arise where a reserved car is unavailable. If the company offers an upgrade as compensation (allowing the customer to rent a higher-category vehicle for the same price), this task might generate values such as "*compensation for inconvenience*", "*ability to correct mistakes*", and "*commitment to customer satisfaction*". This task-value association is vital for effective process management and continuous improvement in service delivery, as it enables the precise identification of process elements that are positively perceived by stakeholders, as well as areas that may require improvement.

4. **Association with PERVAL Scale Dimensions**: The final step in this stage involves categorizing the expected values within the dimensions of the PERVAL scale—*Quality*, *Price*, *Emotion*, and *Social*. Each identified value is mapped to its corresponding dimen-

sion based on its inherent characteristics. For example, "*Customer Satisfaction*" might be categorized under the Quality dimension, while "*Fair Price*" could be associated with the *Price* dimension. This categorization provides a structured framework for assessing value perceptions, linking them to broader value dimensions that have been empirically validated in customer value literature.

4.2 STAGE 2: QUANTIFICATION OF PERCEIVED VALUE

This stage is subdivided into six distinct steps: (*i*) execution of process model; (*ii*) estimation of perceived value; (*iii*) quantification of individual perceived value per attribute; (*iv*) quantification of individual perceived value per dimension; (*v*) quantification of individual perceived value per process; and (*vi*) quantification of group perceived value per attribute, dimension and process. The steps are outlined in detail below.

1. **Execution of the process model**: this step requires stakeholders to engage directly with the process model under evaluation, allowing them to experience the process first-hand. The aim is for stakeholders to form a perception of the value generated by the process based on their interactions and observations during its execution.

2. **Estimation of perceived value**: in this step, the PERVAL scale, as adapted from (SWEENEY; SOUTAR, 2001), is used to assess the perceived value from the stakeholders. This questionnaire-based instrument evaluates four key dimensions of perceived value:

   a) *quality*: encompassing perceived performance and expected quality;

   b) *price*: referring to perceptions of cost-effectiveness, both in the short and long term;

   c) *emotional*: pertaining to the affective states and feelings generated by the process;

   d) *social*: linked to how the process enhances the individual's social self-concept.

   Each dimension includes several general attributes for analysis, as well as specific attributes tailored to the scenario under study. Respondents evaluate each attribute using a 5-point Likert scale, with the following options: "*Totally Disagree (TD)*", "*Disagree (DG)*", "*Indifferent (IND)*", "*Agree (AG)* and "*Totally Agree (TA)*". A sample of the questionnaire format is presented in Table 3, showcasing the organization of attributes under the *quality* dimension, with the other dimensions following the same structure.

Table 3 – Quality Dimension Analysis Attributes.

General Attributes	TD	DG	IND	AG	TA
QG.1) The overall process is perceived as consistent					
QG.2) The steps of the process are perceived as well designed					
QG.3) The level of quality is perceived as satisfactory					

Source: Adapted from (SWEENEY; SOUTAR, 2001)

3. **Quantification of individual perceived value per attribute**: this step utilizes *fuzzy* logic to quantify individual perceived values for each attribute identified. Responses to the questionnaire are transformed into Triangular *Fuzzy* Number (TFN), which correspond to the linguistic terms used in the PERVAL scale. In this case, a 50% association function will be used, as recommended for applications with satisfactory control (AQUINO et al., 2019). *Fuzzy* logic is employed because human perceptions are inherently continuous, even though responses on a questionnaire. The TFN help bridge this gap by assigning degrees of membership to each response, allowing for more accurate representation of subjective judgments. For example, TFN are assigned as follows:

   a) "*Totally Disagree*" = (0, 0.2, 0.4)

   b) "*Disagree*" = (0.2, 0.4, 0.6)

   c) "*Indifferent*" = (0.4, 0.6, 0.8)

   d) "*Agree*" = (0.6, 0.8, 1)

   e) "*Totally Agree*" = (0.8, 1, 1)

   Using this approach, individual perceptions are quantified for each attribute within the four dimensions under analysis. The next step applies a knowledge aggregation process to these attributes to calculate dimension-level perceived values.

4. **Quantification of individual perceived value per dimension**: in this step, knowledge aggregation is performed using the properties defined by *fuzzy* logic Equations 4.1 and 4.2. These equations aggregate the individual attribute values, resulting in a TFN that reflects the perceived value for each dimension (*quality*, *price*, *emotional*, *social*). This procedure ensures that stakeholder perceptions at the attribute level are synthesized to

provide a dimension-level assessment. The same procedure is repeated for each of the four dimensions.

$$(a_1, b_1, c_1) + ... + (a_n, b_n, c_n) = (a_1 + ... + a_n, b_1 + ... + b_n, c_1 + ... + c_n) \quad (4.1)$$

$$\frac{(a_1 + ... + a_n, b_1 + ... + b_n, c_1 + ... + c_n)}{n} = (\frac{a_1 + ... + a_n}{n}, \frac{b_1 + ... + b_n}{n}, \frac{c_1 + ... + c_n}{n}) \quad (4.2)$$

5. **Quantification of individual perceived value per process**: the quantification of perceived value at the process level builds upon the work done in the previous step. Here, the aggregated TFN for each of the four dimensions are further combined to produce a single TFN representing the individual's perceived value for the entire process. This step follows a similar knowledge aggregation methodology but focuses on dimensions rather than attributes, providing a holistic view of the perceived value generated by the process as a whole.

6. **Quantification of group perceived value per attribute, dimension and process**: finally, this step aggregates individual perceptions to quantify the group-level perceived value across attributes, dimension, and the overall process. Equations 4.1, 4.2, and 4.3 are applied to combine individual responses into a group consensus. The process replicates the methodology used in Steps 3, 4, and 5 but considers the input from multiple stakeholders. Once group-level values have been calculated for attributes and dimensions, defuzzification is performed to convert the *fuzzy* numbers into real, discrete values, facilitating clearer interpretation by managers (SIMÕES; SHAW, 2007)(SANTOS-NETO; COSTA, 2023).

$$x.(a, b, c) = x.a; x.b; x.c \quad (4.3)$$

The centroid method is employed for defuzzification, as it offers high accuracy by taking into account both the maximum membership value and the distribution of membership across the entire *fuzzy* set (ZHAO; HWANG; LOW, 2013). This final step yields a single value that represents the group's perceived value for the entire process, offering a clear and actionable insight for decision-makers. Equation 4.4 is applied for this purpose.

$$Mi = \frac{a + b + c}{3} \tag{4.4}$$

4.3 STAGE 3: ALIGNMENT OF MODELED VALUE AND PERCEIVED VALUE

In this stage, the objective is to assess the alignment between the values modeled by the organization, as identified in Stage 1 4.1, and the values perceived by stakeholders, as identified in Stage 2 4.2. This comparative analysis is conducted at two levels: first, by examining the alignment at the dimension level (a general perspective), and second, by focusing on specific statements of perceived value (a more specific perspective).

4.3.1 Alignment Analysis by Dimension

This phase focuses on evaluating whether each dimension of value, as targeted during the process modeling, is perceived positively by stakeholders—primarily the customers. Positive perception of these dimensions suggests effective execution of the value proposition across various attributes, dimensions, or processes. The deffuzified number of the TFN is used as a reference for this evaluation, representing the central value of perceived quality for each dimension. The evaluation scale is structured as follows(AQUINO et al., 2019):

1. **Very Poor**: *Mi* between 0 and 0.2;
2. **Poor**: *Mi* between 0.2 and 0.4;
3. **Regular**: *Mi* between 0.4 and 0.6;
4. **Good**: *Mi* between 0.6 to 0.8;
5. **Very Good**: *Mi* between 0.8 to 1.

This analysis involves evaluating each scenario separately to understand the specific value perceived by stakeholders in each case. It provides insights into how stakeholders perceive value within each unique context and helps identify how well the process delivers its intended value proposition under different operational conditions.

4.3.2 Alignment Analysis by Value Statements

In this more granular approach, the focus is on evaluating whether each specific value targeted during process modeling is perceived positively by stakeholders. As in the previous analysis, the deffuzified number of the TFN - Mi serves as a reference for assessing the alignment between modeled and perceived values (AQUINO et al., 2019).

This detailed analysis at both the dimension and specific value statement levels offers a comprehensive understanding of how effectively the process model delivers on its value proposition and identifies areas where strategic improvements can enhance stakeholder satisfaction and process efficiency.

4.4 SCALABILITY OF THE METHOD

The scalability of the proposed method is an essential consideration, especially when applied to extensive and complex process models that involve numerous activities and decision points. As the complexity of a process model increases, so does the number of potential paths and scenarios, which can substantially impact the time and effort required for the method's application. In such cases, separate questionnaires would need to be developed for each scenario, incorporating a sufficient number of questions to assess all identified values. This could pose challenges in terms of both execution and resource allocation.

Despite this complexity, it is important to note that an increase in the number of activities does not necessarily correspond to a proportional rise in the number of values to be evaluated. A significant portion of these activities may be internal to the organization and may not directly affect stakeholders' perception of value. Hence, focusing on activities that have a tangible influence on stakeholders can streamline the analysis.

To further address scalability concerns, one potential solution is the consolidation of related scenarios into broader categories. By grouping distinct but closely related scenarios under a single umbrella, the method can maintain its effectiveness while minimizing the need for excessive questionnaires and reducing operational complexity. This approach not only simplifies the process but also enhances the practicality and efficiency of applying the method to larger and more intricate BPMN models.

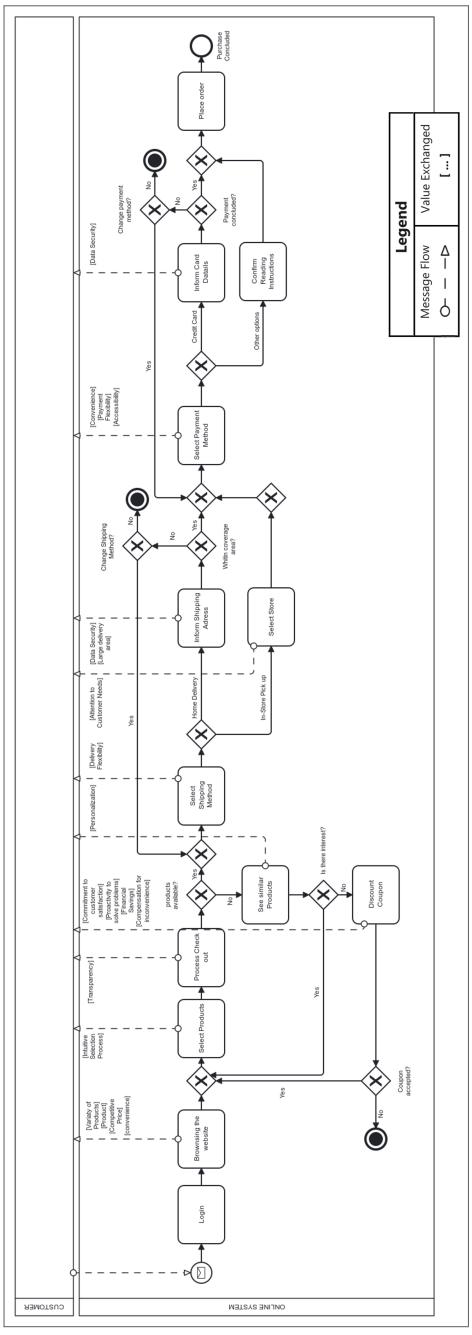
From a theoretical standpoint, this grouping strategy aligns with process optimization practices, where redundancy is minimized, and efficiency is prioritized. Additionally, this strategy

allows for a more generalized but still accurate representation of stakeholder value perceptions, ensuring that the key dimensions of value are adequately captured without overwhelming the evaluation process. Thus, the scalability of the method can be preserved without compromising its analytical rigor.

5 APPLICATION OF THE METHOD - ONLINE SHOPPING

In this study, we examined a BPMN model representing an "*Online Shopping*" process (see Fig. 10), which illustrates the sequence of interconnected tasks and the exchange of values between the customer and the online shop in the context of purchasing a product. For this analysis, the primary stakeholder is the customer, whose perceived value is quantified based on data collected from 96 customers, 45 from Spain () and 51 from Brazil ().

Figure 10 – Online Shopping.



Source: The Author (2024)

5.1 STAGE 1: ANALYSIS AND IDENTIFICATION OF BUSINESS VALUES IN THE BPMN MODEL

As outlined in Section 4.1, the first stage of the study is dedicated to analyzing and identifying the key business values embedded within the "*Online Shopping*" process modeled in BPMN. This stage involves a thorough investigation of the BPMN model to uncover the business values most critical to the customer experience, as well as understanding how these values influence customer perceptions and decision-making.

1. **Identification of Scenarios**: Upon a comprehensive analyzing of the "*Online Shopping*" BPMN model, three distinct scenarios emerged as particularly relevant to customer value perception. These scenarios highlight critical touch points within the process where interaction between the customer and the online shop can either enhance or diminish perceived value:

   Scenario 1 – Stock Availability Issues

   - *Characteristics*: This scenario occurs when a customer attempts to purchase a product that is out of stock.
   - *Solution*: In response to stock issue, the online shop offers the customer a discount coupon, allowing them to purchase similar products instead.
   - *Specific Modeled Values*:
     - Commitment to customer satisfaction - *Quality* Dimension
     - Proactivity in problem-solving - *Quality* Dimension
     - Possibility of financial savings - *Price* Dimension
     - Compensation for inconvenience - *Emotional* Dimension
     - Personalization of customer service - *Emotional* Dimension
   - *Motivation/Context*:

     Stock shortages are a prevalent issue in e-commerce, often leading to negative customer perceptions by frustrating expectations, which can result in dissatisfaction and abandonment of the purchase. However, providing a discount coupon for similar products can minimize disappointment and transform this situation into an opportunity to strengthen the customer relationship. This solution not only demonstrates a commitment to customer satisfaction and proactivity in problem-solving

but also offers tangible compensation that can convert a negative experience into a positive one. Additionally, by offering financial savings, the company reinforces the perceived value for the customer, thereby increasing the likelihood of future purchases.

Scenario 2 – Delivery Issues

- *Characteristics*: Lack of home delivery coverage.
- *Solution*: Offer in-store pickup as an alternative.
- *Specific Modeled Values*:
  - Flexibility and adaptability - *Quality* Dimension
  - Proactivity in problem-solving - *Quality* Dimension
  - Attention to customer needs - *Emotional* Dimension
- *Motivation/Context*:

  Delivery coverage limitations are a common issue in e-commerce, particularly affecting customers in remote or underserved areas. These limitations often lead to frustration and may prompt customer to abandon their purchases, negatively impacting their overall perception of the service. However, by offering an alternative solution—such as in-store pickup— the company demonstrates flexibility and adaptability. This approach not only enables customers to continue with their transactions but also signals that the company is attuned to their unique needs and preferences of its customers. Providing this alternative reflects a proactive approach to problem-solving, which can help mitigate the initial inconvenience. Moreover, it addresses the emotional aspect of the customer experience by showing attentiveness to individual needs, thereby fostering a stronger emotional connection. By effectively resolving a common logistical challenge, the company enhances perceived value and strengthens customer trust, contributing to long-term loyalty and positive brand perception.

Scenario 3 - Payment Issues

- *Characteristics*: Credit card payment failure.
- *Solution*: Offer alternative payment methods to complete the transaction.
- *Specific Modeled Values:*

  - Proactivity in problem-solving - *Quality* Dimension
  - Flexibility and adaptability - *Quality* Dimension
  - Convenience - *Emotional* Dimension

- *Motivation/Context*:

  Payment failures, particularly in credit card transactions, are a frequent issue in e-commerce and can lead to significant customer frustration. If these issues are not resolved promptly, they may result in purchase abandonment and a diminished level of trust in the company. To counteract this, offering alternative payment methods demonstrates both flexibility and a customer-oriented approach, ensuring that the transaction can still be completed without unnecessary disruption. This solution reflects a commitment to customer convenience and highlights the company's dedication to resolving issues efficiently.

  By addressing these challenges proactively, the company not only resolves an immediate problem but also enhances the customer's overall experience. This approach signals a deep concern for customer satisfaction, reinforcing positive perceptions of the company's value proposition. By minimizing obstacles and ensuring continuity in the purchasing process, the company fosters long-term customer loyalty and strengthens the relationship, which is vital in maintaining a competitive edge in the market.

The three scenarios selected (*Stock Availability Issues*, *Delivery Issues*, and *Payment Issues*) were chosen because they represent critical situations that significantly impact the online shopping experience. Additionally, **Scenario 0**, which represents an error-free process, serves as the baseline for comparing customer value perception across the different scenarios. The aim of this analysis is to identify areas where customer value perception could be compromised by potential disruptions and to implement targeted strategies that transform customer frustration into opportunities for enhanced satisfaction.

2. **Identification of Expected Values**: The initial analysis of the BPMN model, in conjunction with the definition of key scenarios, enabled the identification of the business values that managers intend for customers to experience during the process execution. These values reflect the organization's strategic goals of delivering high-quality service, fostering positive customer interactions, and proactively addressing potential issues that

may arise throughout the purchasing process. These values are presented in the "*Value*" column of Table 4, which serves as a foundational for their representation of the organization's aspirations in shaping the customer experience.

3. **Association of Value with Tasks**: After identifying the expected business values, the subsequent step involves associating these values with specific tasks within the process. This stage is crucial in determining where and how these values are realized during the execution of the BPMN model, as it provides a clear mapping of business objectives to operational activities. Table 4 illustrates this relationship in the "*Value*" and "*Task*" columns, showcasing the alignment of business objectives with specific operational activities.

4. **Association with PERVAL Scale Dimensions**: In the final step, the identified business values are mapped to the dimensions of the PERVAL scale, which categorizes customer value perception into four primary dimensions: *quality*, *price*, *emotion*, and *social* dimensions. In Table 4, the "*Value*" and "*Dimension*" columns reflect this association. This mapping provides a structured approach for analyzing how well the business values align with customer perceptions across these multiple dimensions.

Table 4 – Modeled Values.

Dimension	Code	Value	Task	Scenario
Quality	QE0.1	Variety of Products	Browsing the Website	0
	QE0.2	Intuitive Selection Process	Select Products	0
	QE0.3	Security and Privacy	Inform Shipping Details	0
	QE0.4	Security and Privacy	Inform Payment Details	0
	QE0.5	Product	Browsing the Website	0
	QE1.1	Commitment to customer satisfaction	Offer discount coupon	1
	QE1.2	Proactivity in problem-solving	Offer discount coupon	1
	QE2.1	Proactivity in problem-solving	Change delivery method	2
	QE2.2	Flexibility and Adaptability	Change delivery method	2
	QE3.1	Proactivity in problem-solving	Change Payment method	3
	QE3.2	Flexibility and Adaptability	Change Payment method	3
Price	PE0.1	Transparency - Price and Fee breakdown	Checkout	0
	PE1.1	Financial savings	Buy discounted products	1
Emotional	EE0.1	Convenience	Browsing the Website	0
	EE1.1	Compensation for inconvenience	Offer discount coupon	1
	EE1.2	Personalization of customer service	See similar products	1
	EE2.1	Attention to customer needs	Indicate nearby stores	2
	EE3.1	Convenience	Change Payment method	3
Social	SE0.1	Extensive Delivery Coverage	Inform Shipping Details	0
	SE0.2	Delivery Flexibility	Select delivery method	0
	SE0.3	Payment Flexibility	Select payment method	0
	SE0.4	Accessibility	Select payment method	0

Source: The Autor (2024)

5.2 STAGE 2: QUANTIFICATION OF PERCEIVED VALUE

As outlined in Section 4.2, the methodology for quantifying the perceived value of customers in the "*Online Shopping*" process is structured into six key steps:

1. **Execution of the process model**: The first step involves executing the "*Online Shopping*" process model (Figure 10). The model represents a detailed sequence of tasks that map the customer journey, starting from customer's initial intention to make a purchase. The process begins when the customer accesses the company's online platform and proceeds through the following stages: "*Access the* Online System", "*Logs in*", "*Browsing the Website*", "*Selects Products*", and "*Inform Shipping Details*".

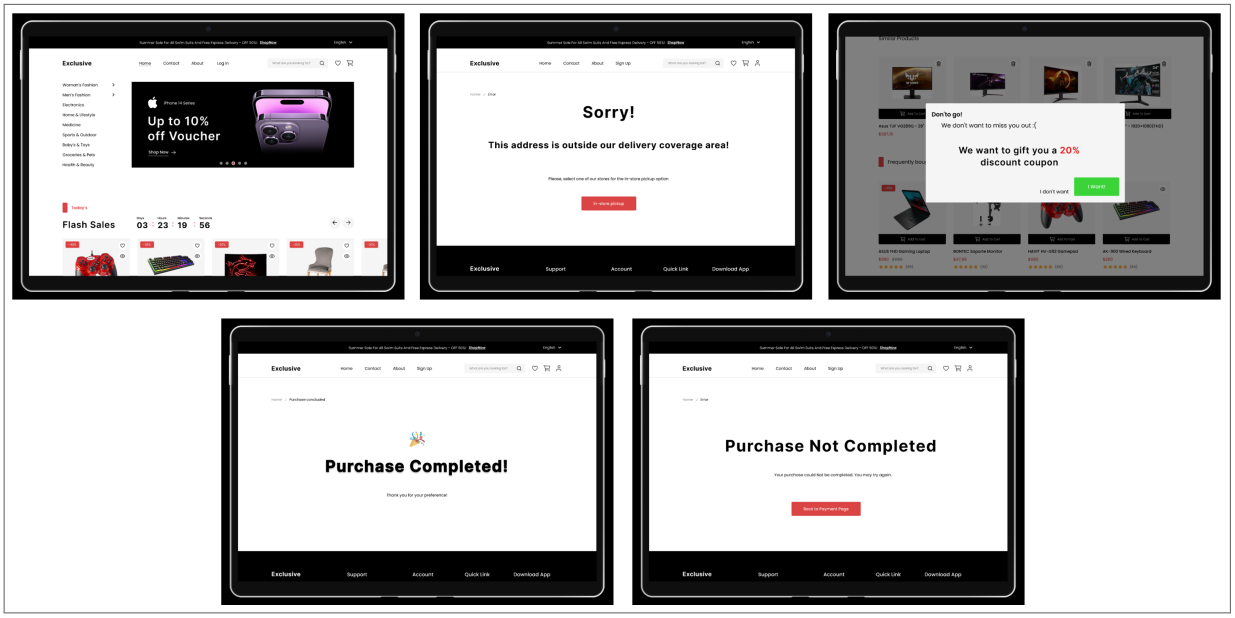
   A critical decision point arises during the "*Provide Shipping Details*" task. If the entered address falls outside the company's delivery coverage area, the system automatically triggers a contingency mechanism: the "*In-store Pickup Option*". This alternative presents customers with a list of nearby store locations, allowing them to choose the most convenient pickup option. The inclusion of this adaptive feature demonstrates the company's commitment to mitigating potential negative perceptions of value caused by service limitations, such as the lack of home delivery. By offering this flexibility, the company not only addresses logistical constraints but also reinforces its customer-centric operational approach, aligning with principles of service adaptability and value co-creation.

   Similar adaptive mechanisms are throughout other stages of the process. For this study, the process model was performed using a simulation interface specifically designed for each scenario under analysis. Figure 11 shows some of the interfaces used.

2. **Estimation of perceived value**: The estimation of perceived value constitutes a critical step in understanding how customers evaluate their experiences with the process model. Following their interaction with the "*Online Shopping*" BPMN model, customers are invited to complete a structured questionnaire designed to measure their perceived value across four dimensions: *quality*, *price*, *emotional*, and *social* (see Table 3).

   To ensure the reliability and validity of the measurement, the questionnaire is tailored to the specific attributes and operational nuances of each scenario under analysis. This customization not only enhances the contextual relevance of the questionnaire but also

Figure 11 – Simulation interface used.



Source: The Author (2024)

ensures that the value estimation process is sensitive to the specific interactions and perceptions triggered by each scenario.

The goal of this step is to capture data that can be used to quantify perceived value systematically.

3. **Quantification of Individual Perceived Value Attribute**: This step focuses on the quantification of perceived value for each attribute, utilizing the fuzzification procedure detailed in step 3. The approach involves transforming the responses from the customer questionnaire into *fuzzy* numbers, thereby enabling a nuanced representation of subjective perceptions. The fuzzification scale applied is as follows:

   a) Responses marked as "*Totally Disagree*" are transformed into the *fuzzy* number (0, 0.2, 0.4);

   b) "*Disagree*" responses are transformed into (0.2, 0.4, 0.6);

   c) "*Indifferent*" responses are transformed into (0.4, 0.6, 0.8);

   d) "*Agree*" responses are transformed into (0.6, 0.8, 1);

   e) "*Totally Agree*" responses are transformed into (0.8, 1, 1).

   By converting ordinal responses into *fuzzy* numbers, the method ensures a more robust and flexible representation of perceived value attributes, facilitating subsequent

computational analysis.

For the execution of this step, data were collected from customer samples in two countries—Spain and Brazil. In Spain, 45 customers participated in Scenario 0, while Scenarios 1, 2, and 3 each involved 15 participants. Similarly, in Brazil, data were gathered from 51 customers for Scenario 0, and 17 customers for each of Scenarios 1, 2, and 3. The quantification results for each scenario are presented in the "*Value by Attribute*" columns of Tables 5, 6, 7, and 8, which illustrate the perceived value of individual customers across the various scenarios modeled in the "*Online Shopping*" process.

The coding system adopted for these results is systematically organized to provide clarity and consistency. For example:

- The code QE0.1 represents Specific Value 1 within the *Quality* Dimension for Scenario 0;
- The code QG.1 denotes General Value 1 within the same Dimension.

This structured coding approach is uniformly applied across all dimensions (*Quality*, *Price*, *Emotional*, and *Social*) and scenarios, ensuring coherence in the analysis and enabling straightforward interpretation of the results.

To demonstrate the practical application of this methodology, consider a scenario where a customer evaluates the attribute QE0.1 as "*Indifferent*". According to the fuzzification scale, this response is converted into the *fuzzy* number (0.4, 0.6, 0.8). This procedure is applied to all attributes and responses, ensuring consistency and enabling the effective quantification of perceived value across diverse customer interactions.

4. **Quantification of Individual Perceived Value per Dimension:** To quantify the perceived value for each dimension, a systematic aggregate of *fuzzy* numbers associated with the relevant analysis attributes is performed using Equations 4.1 and 4.2. This process enables a comprehensive evaluation of the customer's perceived value across multiple dimensions, integrating specific and general attributes to derive an overall score.

   For instance, the *Quality* dimension in Scenario 0 (Spain) is quantified by aggregating the *fuzzy* numbers corresponding to the following attributes: QE0.1, QE0.2, QE0.3, QE0.4, QE0.5, QG.1, QG.2, and QG.3. The aggregation process, illustrated in Equation 5.1, synthesizes these attributes into a unified *fuzzy* representation, capturing the nuances of customer perception for this specific dimension.

$$a = 0.4 + 0.6 + 0.6 + 0.4 + 0.2 + 0.6 + 0.6 + 0.6$$

$$b = 0.6 + 0.8 + 0.8 + 0.6 + 0.4 + 0.8 + 0.8 + 0.8$$

$$c = 0.8 + 1 + 1 + 0.8 + 0.6 + 1 + 1 + 1$$

$$\frac{(a, b, c)}{8} = (0.5, 0.7, 0.9) \tag{5.1}$$

This methodology is uniformly applied to all other dimensions (*Price*, *Emotional*, and *Social*) as well as to all scenarios under analysis. Each dimension is assessed by aggregating its respective *fuzzy* numbers, ensuring consistency and comparability across dimensions and scenarios. The results of these calculations are systematically presented in the "*Value by Dimension*" columns of Tables 5, 6, 7, and 8, corresponding to Scenarios 0, 1, 2, and 3, respectively.

5. **Quantification of Individual Perceived Value for the Entire Process**: To calculate the overall perceived value for the process as a whole, the aggregated values of the four dimensions (*Quality*, *Price*, *Emotional*, and *Social*) are integrated using Equations 4.1 and 4.2, as exemplified in Equation 5.2 for Scenario 0 (Spain). This procedure is systematically replicated across the remaining three scenarios for both Spain and Brazil, ensuring consistency and comparability in the analytical approach. The resulting aggregated values are presented in the "*Value by Process*" column of Tables 5, 6, 7, and 8, respectively.

   At this stage, the perceived value has been quantified at three distinct levels:

   a) Individual Attributes: Capturing the granularity of specific factors that influence customer perceptions.

   b) Dimensions: Aggregating the attributes into broader categories that reflect overarching aspects of value.

   c) Entire Process: Synthesizing the dimensions to evaluate the overall perceived value delivered by the process as a whole.

   This hierarchical structure of analysis enables a detailed understanding of how individual customers perceive value at multiple levels, offering a nuanced view of the process's performance.

While the method effectively captures individual assessments, its ultimate goal extends beyond isolated customer evaluations. It aims to provide a comprehensive understanding of perceived value across the customer group, offering deeper insights into how effectively the process aligns with the collective perceptions of all customers. This holistic evaluation will facilitate the identification of areas for improvement, ensuring that the process better serves its intended value propositions and enhances overall customer satisfaction.

By aggregating customer responses, the method offers insights into collective perceptions, which are critical for identifying patterns, trends, and potential discrepancies in value delivery. For example, variations in the perceived value across different scenarios or dimensions may indicate misalignments that require process optimization.

$$
\begin{aligned}
a &= 0.5 + 0.35 + 0.4 + 0.34 \\
b &= 0.7 + 0.55 + 0.6 + 0.54 \\
c &= 0.9 + 0.75 + 0.8 + 0.74 \\
\frac{(a, b, c)}{4} &= (0.4, 0.6, 0.8)
\end{aligned} \tag{5.2}
$$

6. **Quantification of Group Perceived Value by Attribute, Dimension, and Process:** In this step, the aggregated survey responses are analyzed to determine the collective perception of value across the group of customers in Spain and Brazil for each scenario under investigation. For Spain, data were collected from 45 customers for Scenario 0 and from 15 customers for each of Scenarios 1, 2, and 3. Similarly, for Brazil, the analysis incorporates data from 51 customers for Scenario 0 and 17 customers for each of Scenarios 1, 2, and 3. This approach ensures a comprehensive evaluation of perceived value at the group level, allowing for cross-scenario and cross-country comparisons.

   For Spain Scenario 0, the evaluation of attribute QE0.1 revealed the following distribution of customer responses:

   - Six customers rated this attribute as "*Totally Agree*", corresponding to the *fuzzy* number (0.8, 1, 1);
   - Twenty-nine customers rated it as "*Agree*", corresponding to (0.6, 0.8, 1);
   - Five customers rated it as "*Indifferent*", corresponding to (0.4, 0.6, 0.8);

- Four customers rated it as "*Disagree*", corresponding to (0.2, 0.4, 0.6);
- One customer rated it as "*Totally Disagree*", corresponding to (0.0, 0.2, 0.4).

The responses were aggregated using Equation 5.3 which computes the resultant *fuzzy* number for this attribute by applying *fuzzy* arithmetic to the weighted distribution of individual responses. This process normalizes the group's perceptions, creating a composite representation of the perceived value for attribute QE0.1.

The same procedure is systematically applied to all other attributes within Scenario 0, ensuring consistency and methodological rigor. The aggregated results for Spain and Brazil are presented in the "*Value by Attribute*" column of Table 9 for Scenario 0. For Scenarios 1, 2, and 3, the results are similarly computed and shown in Tables 10, 11, and 12, respectively.

$$ta = (0.8, 1, 1)$$

$$ag = (0.6, 0.8, 1)$$

$$ind = (0.4, 0.6, 0.8)$$

$$dg = (0.2, 0.4, 0.6)$$

$$td = (0.0, 0.2, 0.4)$$

$$\frac{(6 * ta) + (29 * ag) + (5 * ind) + (4 * dg) + (1 * td)}{45} = (0.56, 0.76, 0.93) \qquad (5.3)$$

The next phase is aggregating the values at the dimension level, following the systematic procedure outlined in Step 4. This step consolidates the *fuzzy* values computed for each attributes within each dimension, providing an aggregated representation of perceived value at the dimension level. The results for Spain and Brazil are presented in the "*Value by Dimension*" column of the respective tables, enabling a comparative evaluation across scenarios and dimensions.

Subsequently, using the procedure described in Step 5, the dimension-level values are further aggregated to compute the overall perceived value for the process as a whole. This final step integrates the multidimensional perspective into a single value, capturing the holistic perception of value delivered by the process. The aggregated results are presented in the "*Value by Process*" column of each table, offering a comprehensive view of the customer-perceived value across all scenarios in both countries.

To facilitate interpretation of the aggregated *fuzzy* values, Equation 4.4 is applied to defuzzify the results. This defuzzification process translates the *fuzzy* numbers into crisp values, enabling a more intuitive understanding of the perceived value. For instance, the defuzzification of the *Value by Quality Dimension* for Spain in Scenario 0 is exemplified in Equation 5.4.

This approach is consistently applied across all dimensions and the overall process for both Spain and Brazil, ensuring methodological uniformity. The final defuzzified results are presented in the "Mi" column of Tables 9,10,11 and 12, offering a clear and interpretable representation of the perceived value in each scenario.

$$Mi = \frac{0.63 + 0.83 + 0.95}{3} = (0.80) \tag{5.4}$$

This detailed analysis of group perceptions in both Spain and Brazil provides a nuanced understanding of how business processes are being perceived by the customer base in each country. It also offers valuable insights into potential areas for improvement and optimization.

The aggregated perceived value of the participating customers is assessed through the defuzzified number "Mi" derived from the TFN. This approach provides a precise and quantifiable representation of customer sentiment across various dimensions of value perception.

At this step, the group's perceived value for each attribute, dimension, and the overall process was quantified. Subsequently, the alignment between the modeled business values and those perceived by customers during the process execution will be examined.

Table 5 – Quantified Individual Value Perceived in Scenario 0.

Country	Dimension	Code	Value by Attribute	Value by Dimension	Value by Process
		QE.1	(0.4, 0.6, 0.8)		
		QE0.2	(0.6, 0.8, 1.0)		
		QE0.3	(0.6, 0.8, 1.0)		
	Quality	QE0.4	(0.4, 0.6, 0.8)	(0.50, 0.70, 0.90)	
		QE0.5	(0.2, 0.4, 0.6)		
		QG0.1	(0.6, 0.8, 1.0)		
		QG0.2	(0.6, 0.8, 1.0)		
		QG0.3	(0.6, 0.8, 1.0)		
		PE.1	(0.2, 0.4, 0.6)		
	Price	PG.1	(0.4, 0.6, 0.8)	(0.35, 0.55, 0.75)	
Spain		PG.2	(0.4, 0.6, 0.8)		(0.40, 0.60, 0.80)
		PG.3	(0.4, 0.6, 0.8)		
		EE.1	(0.6, 0.8, 1.0)		
	Emotional	EG.1	(0.6, 0.8, 1.0)	(0.40, 0.60, 0.80)	
		EG.2	(0.4, 0.6, 0.8)		
		EG.3	(0.0, 0.2, 0.4)		
		SE0.1	(0.2, 0.4, 0.6)		
		SE0.2	(0.6, 0.8, 1.0)		
		SE0.3	(0.6, 0.8, 1.0)		
	Social	SE0.4	(0.4, 0.6, 0.8)	(0.34, 0.54, 0.74)	
		SG0.1	(0.2, 0.4, 0.6)		
		SG0.2	(0.2, 0.4, 0.6)		
		SG0.3	(0.2, 0.4, 0.6)		
Country	**Dimension**	**Code**	**Value by Attribute**	**Value by Dimension**	**Value by Process**
		QE0.1	(0.4, 0.6, 0.8)		
		QE0.2	(0.6, 0.8, 1.0)		
		QE0.3	(0.6, 0.8, 1.0)		
	Quality	QE0.4	(0.6, 0.8, 1.0)	(0.55, 0.75, 0.95)	
		QE0.5	(0.4, 0.6, 0.8)		
		QG.1	(0.6, 0.8, 1.0)		
		QG.2	(0.6, 0.8, 1.0)		
		QG.3	(0.6, 0.8, 1.0)		
		PE0.1	(0.6, 0.8, 1.0)		
	Price	PG.1	(0.4, 0.6, 0.8)	(0.45, 0.65, 0.85)	
Brazil		PG.2	(0.4, 0.6, 0.8)		(0.46, 0.68, 0.88)
		PG.3	(0.4, 0.6, 0.8)		
		EE0.1	(0.4, 0.6, 0.8)		
	Emotional	EG.1	(0.4, 0.6, 0.8)	(0.40, 0.60, 0.80)	
		EG.2	(0.4, 0.6, 0.8)		
		EG.3	(0.4, 0.6, 0.8)		
		SE0.1	(0.4, 0.6, 0.8)		
		SE0.2	(0.6, 0.8, 1.0)		
		SE0.3	(0.6, 0.8, 1.0)		
	Social	SE0.4	(0.4, 0.6, 0.8)	(0.46, 0.73, 0.93)	
		SG.1	(0.6, 0.8, 1.0)		
		SG.2	(0.6, 0.8, 1.0)		
		SG.3	(0.0, 0.2, 0.4)		

Source: The Autor (2024)

Table 6 – Quantified Individual Value Perceived in Scenario 1.

Country	Dimension	Code	Value by Attribute	Value by Dimension	Value by Process
		QE1.1	(0.6, 0.8, 1.0)		
		QE1.2	(0.6, 0.8, 1.0)		
	Quality	QG.1	(0.6, 0.8, 1.0)	(0.6, 0.8, 1.0)	
		QG.2	(0.6, 0.8, 1.0)		
		QG.3	(0.6, 0.8, 1.0)		
		PE1.1	(0.8, 1.0, 1.0)		
	Price	PG.1	(0.4, 0.6, 0.8)	(0.50, 0.70, 0.85)	
		PG.2	(0.4, 0.6, 0.8)		
Spain		PG.3	(0.4, 0.6, 0.8)		(0.45, 0.65, 0.81)
		EE1.1	(0.8, 1.0, 1.0)		
		EE1.2	(0.8, 1.0, 1.0)		
	Emotional	EG.1	(0.6, 0.8, 1.0)	(0.48, 0.68, 0.80)	
		EG.2	(0.2, 0.4, 0.6)		
		EG.3	(0.0, 0.2, 0.4)		
		SG.1	(0.2, 0.4, 0.6)		
	Social	SG.2	(0.2, 0.4, 0.6)	(0.2, 0.4, 0.6)	
		SG.3	(0.2, 0.4, 0.6)		
Country	**Dimension**	**Code**	**Value by Attribute**	**Value by Dimension**	**Value by Process**
		QE1.1	(0.4, 0.6, 0.8)		
		QE1.2	(0.8, 1.0, 1.0)		
	Quality	QG.1	(0.8, 1.0, 1.0)	(0.68, 0.88, 0.96)	
		QG.2	(0.8, 1.0, 1.0)		
		QG.3	(0.6, 0.8, 1.0)		
		PE1.1	(0.8, 1.0, 1.0)		
	Price	PG.1	(0.6, 0.8, 1.0)	(0.55, 0.75, 0.90)	
		PG.2	(0.4, 0.6, 0.8)		
Brazil		PG.3	(0.4, 0.6, 0.8)		(0.46, 0.68, 0.88)
		EE1.1	(0.8, 1.0, 1.0)		
		EE1.2	(0.8, 1.0, 1.0)		
	Emotional	EG.1	(0.6, 0.8, 1.0)	(0.65, 0.88, 1.00)	
		EG.2	(0.6, 0.8, 1.0)		
		EG.3	(0.6, 0.8, 1.0)		
		SG.1	(0.8, 1.0, 1.0)		
	Social	SG.2	(0.6, 0.8, 1.0)	(0.67, 0.87, 1.00)	
		SG.3	(0.6, 0.8, 1.0)		

Source: The Autor (2024)

Table 7 – Quantified Individual Value Perceived in Scenario 2.

Country	Dimension	Code	Value by Attribute	Value by Dimension	Value by Process
Spain	Quality	QE2.1	(0.8, 1.0, 1.0)	(0.72, 0.92, 1.0)	(0.61, 0.81, 0.95)
		QE2.2	(0.8, 1.0, 1.0)		
		QG.1	(0.6, 0.8, 1.0)		
		QG.2	(0.6, 0.8, 1.0)		
		QG.3	(0.8, 1.0, 1.0)		
	Price	PG.1	(0.6, 0.8, 1.0)	(0.60, 0.80, 1.0)	
		PG.2	(0.6, 0.8, 1.0)		
		PG.3	(0.6, 0.8, 1.0)		
	Emotional	EE1.1	(0.8, 1.0, 1.0)	(0.65, 0.85, 0.95)	
		EG.1	(0.8, 1.0, 1.0)		
		EG.2	(0.6, 0.8, 1.0)		
		EG.3	(0.4, 0.6, 0.8)		
	Social	SG.1	(0.4, 0.6, 0.8)	(0.47, 0.67, 0.87)	
		SG.2	(0.6, 0.8, 1.0)		
		SG.3	(0.4, 0.6, 0.8)		
Country	**Dimension**	**Code**	**Value by Attribute**	**Value by Dimension**	**Value by Process**
Brazil	Quality	QE2.1	(0.8, 1.0, 1.0)	(0.76, 0.96, 1.00)	(0.66, 0.86, 0.97)
		QE2.2	(0.8, 1.0, 1.0)		
		QG.1	(0.8, 1.0, 1.0)		
		QG.2	(0.6, 0.8, 1.0)		
		QG.3	(0.8, 1.0, 1.0)		
	Price	PG.1	(0.6, 0.8, 1.0)	(0.60, 0.80, 1.00)	
		PG.2	(0.6, 0.8, 1.0)		
		PG.3	(0.6, 0.8, 1.0)		
	Emotional	EE1.1	(0.8, 1.0, 1.0)	(0.80, 1.00, 1.00)	
		EG.1	(0.8, 1.0, 1.0)		
		EG.2	(0.8, 1.0, 1.0)		
		EG.3	(0.8, 1.0, 1.0)		
	Social	SG.1	(0.4, 0.6, 0.8)	)	
		SG.2	(0.6, 0.8, 1.0)	(0.47, 0.67, 0.87	
		SG.3	(0.4, 0.6, 0.8)		

Source: The Autor (2024)

Table 8 – Quantified Individual Value Perceived in Scenario 3.

Country	Dimension	Code	Value by Attribute	Value by Dimension	Value by Process
Spain	Quality	QE3.1	(0.20, 0.40, 0.60)	(0.45, 0.65, 0.85)	(0.50, 0.70, 0.88)
		QG.1	(0.60, 0.80, 1.00)		
		QG.2	(0.60, 0.80, 1.00)		
		QG.3	(0.40, 0.60, 0.80)		
	Price	PG.1	(0.40, 0.60, 0.80)	(0.47, 0.67, 0.87)	
		PG.2	(0.60, 0.80, 1.00)		
		PG.3	(0.40, 0.60, 0.80)		
	Emotional	EE1.1	(0.60, 0.80, 1.00)	(0.70, 0.90, 1.00)	
		EG.1	(0.60, 0.80, 1.00)		
		EG.2	(0.80, 1.00, 1.00)		
		EG.3	(0.80, 1.00, 1.00)		
	Social	SG.1	(0.20, 0.40, 0.60)	(0.4, 0.6, 0.8)	
		SG.2	(0.60, 0.80, 1.00)		
		SG.3	(0.40, 0.60, 0.80)		
Country	**Dimension**	**Code**	**Value by Attribute**	**Value by Dimension**	**Value by Process**
Brazil	Quality	QE3.1	(0.60, 0.80, 1.00)	(0.55, 0.75, 0.95)	(0.45, 0.65, 0.85)
		QG.1	(0.60, 0.80, 1.00)		
		QG.2	(0.40, 0.60, 0.80)		
		QG.3	(0.60, 0.80, 1.00)		
	Price	PG.1	(0.20, 0.40, 0.60)	(0.33, 0.53, 0.73)	
		PG.2	(0.40, 0.60, 0.80)		
		PG.3	(0.40, 0.60, 0.80)		
	Emotional	EE1.1	(0.60, 0.80, 1.00)	(0.50, 0.70, 0.90)	
		EG.1	(0.60, 0.80, 1.00)		
		EG.2	(0.40, 0.60, 0.80)		
		EG.3	(0.40, 0.60, 0.80)		
	Social	SG.1	(0.40, 0.60, 0.80)	(0.40, 0.60, 0.80)	
		SG.2	(0.40, 0.60, 0.80)		
		SG.3	(0.40, 0.60, 0.80)		

Source: The Autor (2024)

Table 9 – Quantified Group Value Perceived in Scenario 0.

Country	Code		Value by Attribute	Value by Dimension	Mi	Value by Process	Mi
		QE0.1	(0.56, 0.76, 0.93)				
		QE0.2	(0.67, 0.87, 0.97)				
		QE0.3	(0.57, 0.77, 0.92)				
	Quality	QE0.4	(0.54, 0.74, 0.91)	(0.63, 0.83, 0.95)	0.80		
		QE0.5	(0.64, 0.84, 0.96)				
		QG.1	(0.69, 0.89, 0.97)				
		QG.2	(0.65, 0.85, 0.96)				
		QG.3	(0.68, 0.88, 0.98)				
		PE0.1	(0.60, 0.80, 0.94)				
	Price	PG.1	(0.43, 0.63, 0.81)	(0.48, 0.68, 0.85)	0.67		
Spain		PG.2	(0.46, 0.66, 0.85)			(0.55, 0.77, 0.91)	0.74
		PG.3	(0.43, 0.63, 0.82)				
		EE0.1	(0.62, 0.82, 0.95)				
	Emotional	EG.1	(0.68, 0.88, 0.97)	(0.59, 0.79, 0.92)	0.77		
		EG.2	(0.58, 0.78, 0.92)				
		EG.3	(0.47, 0.67, 0.85)				
		SE0.1	(0.56, 0.76, 0.92)				
		SE0.2	(0.68, 0.88, 0.97)				
		SE0.3	(0.72, 0.92, 1.00)				
	Social	SE0.4	(0.68, 0.88, 0.98)	(0.57, 0.77, 0.92)	0.75		
		SG.1	(0.46, 0.66, 0.85)				
		SG.2	(0.49, 0.69, 0.88)				
		SG.3	(0.43, 0.63, 0.82)				
Country	**Code**		**Value by Attribute**	**Value by Dimension**	Mi	**Value by Process**	Mi
		QE0.1	(0.60, 0.80, 0.95)				
		QE0.2	(0.66, 0.86, 0.98)				
		QE0.3	(0.57, 0.77, 0.93)				
	Quality	QE0.4	(0.58, 0.78, 0.92)	(0.67, 0.86, 0.97)	0.83		
		QE0.5	(0.65, 0.85, 0.97)				
		QG.1	(0.67, 0.87, 0.98)				
		QG.2	(0.69, 0.89, 0.98)				
		QG.3	(0.67, 0.86, 0.97)				
		PE0.1	(0.65, 0.85, 0.95)				
	Price	PG.1	(0.55, 0.75, 0.92)	(0.59, 0.78, 0.91)	0.76		
Brazil		PG.2	(0.55, 0.75, 0.90)			(0.62, 0.81, 0.94)	0.79
		PG.3	(0.55, 0.75, 0.92)				
		EE0.1	(0.64, 0.84, 0.96)				
	Emotional	EG.1	(0.65, 0.85, 0.97)	(0.61, 0.81, 0.94)	0.79		
		EG.2	(0.60, 0.80, 0.93)				
		EG.3	(0.54, 0.74, 0.89)				
		SE0.1	(0.59, 0.79, 0.94)				
		SE0.2	(0.66, 0.86, 0.97)				
		SE0.3	(0.69, 0.89, 0.98)				
	Social	SE0.4	(0.69, 0.89, 0.98)	(0.60, 0.80, 0.93)	0.78		
		SG.1	(0.53, 0.73, 0.88)				
		SG.2	(0.57, 0.77, 0.92)				
		SG.3	(0.49, 0.69, 0.85)				

Source: The Autor (2024)

Table 10 – Quantified Group Value Perceived in Scenario 1.

Country	Code		Value by Attribute	Value by Dimension	Mi	Value by Process	Mi
		QE1.1	(0.64, 0.84, 0.95)				
		QE1.2	(0.64, 0.84, 0.97)				
	Quality	QG.1	(0.68, 0.88, 1.0)	(0.65, 0.85, 0.98)	0.83		
		QG.2	(0.65, 0.85, 0.97)				
		QG.3	(0.65, 0.85, 0.99)				
		PE1.1	(0.72, 0.92, 1.00)				
	Price	PG.1	(0.63, 0.83, 0.97)	(0.63, 0.83, 0.97)	0.81		
Spain		PG.2	(0.56, 0.76, 0.93)			(0.59, 0.79, 0.93)	0.77
		PG.3	(0.60, 0.80, 0.96)				
		EE1.1	(0.65, 0.85, 0.97)				
		EE1.2	(0.72, 0.92, 1.00)				
	Emotional	EG.1	(0.63, 0.83, 0.95)	(0.62, 0.82, 0.94)	0.79		
		EG.2	(0.60, 0.80, 0.92)				
		EG.3	(0.49, 0.69, 0.85)				
		SG.1	(0.48, 0.68, 0.85)				
	Social	SG.2	(0.52, 0.72, 0.91)	(0.48, 0.68, 0.85)	0.67		
		SG.3	(0.43, 0.63, 0.81)				
Country	**Code**		**Value by Attribute**	**Value by Dimension**	Mi	**Value by Process**	Mi
		QE1.1	(0.61, 0.81, 0.92)				
		QE1.2	(0.66, 0.86, 0.96)				
	Quality	QG.1	(0.70, 0.91, 0.99)	(0.68, 0.88, 0.97)	0.84		
		QG.2	(0.71, 0.91, 0.99)				
		QG.3	(0.72, 0.92, 0.99)				
		PE1.1	(0.75, 0.95, 1.00)				
	Price	PG.1	(0.64, 0.84, 0.98)	(0.66, 0.86, 0.97)	0.83		
Brazil		PG.2	(0.60, 0.80, 0.93)			(0.65, 0.85, 0.96)	(0.82)
		PG.3	(0.63, 0.83, 0.96)				
		EE1.1	(0.74, 0.94, 0.99)				
		EE1.2	(0.66, 0.86, 0.95)				
	Emotional	EG.1	(0.68, 0.88, 1.00)	(0.67, 0.89, 0.97)	0.84		
		EG.2	(0.68, 0.88, 0.96)				
		EG.3	(0.67, 0.89, 0.97)				
		SG.1	(0.62, 0.82, 0.93)				
	Social	SG.2	(0.60, 0.80, 0.95)	(0.59, 0.79, 0.93)	0.77		
		SG.3	(0.55, 0.75, 0.89)				

Source: The Autor (2024)

Table 11 – Quantified Group Value Perceived in Scenario 2.

Country	Code		Value by Attribute	Value by Dimension	Mi	Value by Process	Mi
		QE2.1	(0.69, 0.88, 0.95)				
		QE2.2	(0.68, 0.88, 0.97)				
	Quality	QG.1	(0.64, 0.84, 0.96)	(0.68, 0.88, 0.95)	0.84		
		QG.2	(0.68, 0.88, 0.97)				
		QG.3	(0.71, 0.91, 0.97)				
		PG.1	(0.43, 0.63, 0.80)				
Spain	Price	PG.2	(0.44, 0.64, 0.83)	(0.42, 0.62, 0.80)	0.61	(0.59, 0.74, 0.88)	0.77
		PG.3	(0.40, 0.60, 0.79)				
		EE2.1	(0.69, 0.89, 0.97)				
	Emotional	EG.1	(0.64, 0.84, 0.95)	(0.59, 0.79, 0.93)	0.77		
		EG.2	(0.56, 0.76, 0.93)				
		EG.3	(0.47, 0.67, 0.85)				
		SG.1	(0.45, 0.65, 0.83)				
	Social	SG.2	(0.52, 0.72, 0.89)	(0.47, 0.67, 0.84)	0.66		
		SG.3	(0.43, 0.63, 0.80)				
Country	**Code**		**Value by Attribute**	**Value by Dimension**	Mi	**Value by Process**	Mi
		QE2.1	(0.69, 0.89, 1.00)				
		QE2.2	(0.68, 0.88, 0.99)				
	Quality	QG.1	(0.64, 0.84, 0.99)	(0.66, 0.86, 0.99)	0.84		
		QG.2	(0.64, 0.84, 0.99)				
		QG.3	(0.62, 0.82, 0.97)				
		PG.1	(0.59, 0.79, 0.96)				
Brazil	Price	PG.2	(0.56, 0.76, 0.92)	(0.56, 0.76, 0.93)	0.75	(0.59, 0.79, 0.94)	0.78
		PG.3	(0.54, 0.74, 0.91)				
		EE2.1	(0.68, 0.88, 1.00)				
	Emotional	EG.1	(0.64, 0.84, 0.99)	(0.61, 0.81, 0.96)	0.79		
		EG.2	(0.60, 0.80, 0.96)				
		EG.3	(0.57, 0.77, 0.93)				
		SG.1	(0.51, 0.71, 0.88)				
	Social	SG.2	(0.53, 0.73, 0.92)	(0.50, 0.70, 0.89)	0.70		
		SG.3	(0.45, 0.65, 0.84)				

Source: The Autor (2024)

Table 12 – Quantified Group Value Perceived in Scenario 3.

Country	Code		Value by Attribute	Value by Dimension	Mi	Value by Process	Mi
	Quality	QE3.1	(0.61, 0.81, 0.92)	(0.58, 0.78, 0.92)	0.76		
		QG.1	(0.57, 0.77, 0.93)				
		QG.2	(0.55, 0.75, 0.89)				
		QG.3	(0.59, 0.79, 0.92)				
Spain	Price	PG.1	(0.40, 0.60, 0.80)	(0.44, 0.64, 0.83)	0.64	(0.50, 0.70, 0.87)	0.69
		PG.2	(0.44, 0.64, 0.84)				
		PG.3	(0.48, 0.68, 0.85)				
	Emotional	EE3.1	(0.67, 0.87, 0.95)	(0.55, 0.75, 0.90)	0.73		
		EG.1	(0.56, 0.76, 0.93)				
		EG.2	(0.53, 0.73, 0.92)				
		EG.3	(0.43, 0.63, 0.81)				
	Social	SG.1	(0.40, 0.60, 0.80)	(0.42, 0.62, 0.82)	0.62		
		SG.2	(0.49, 0.69, 0.89)				
		SG.3	(0.36, 0.56, 0.76)				
Country	**Code**		**Value by Attribute**	**Value by Dimension**	Mi	**Value by Process**	Mi
	Quality	QE3.1	(0.69, 0.89, 0.96)	(0.67, 0.87, 0.97)	0.84		
		QG.1	(0.65, 0.85, 0.99)				
		QG.2	(0.67, 0.87, 0.96)				
		QG.3	(0.67, 0.87, 0.99)				
Brazil	Price	PG.1	(0.49, 0.69, 0.87)	(0.48, 0.68, 0.84)	0.67	(0.54, 0.74, 0.89)	0.72
		PG.2	(0.45, 0.65, 0.83)				
		PG.3	(0.41, 0.61, 0.79)				
	Emotional	EE3.1	(0.57, 0.77, 0.95)	(0.59, 0.79, 0.93)	0.77		
		EG.1	(0.64, 0.84, 0.97)				
		EG.2	(0.63, 0.83, 0.93)				
		EG.3	(0.47, 0.67, 0.85)				
	Social	SG.1	(0.44, 0.64, 0.81)	(0.45, 0.65, 0.81)	0.64		
		SG.2	(0.52, 0.72, 0.88)				
		SG.3	(0.44, 0.64, 0.81)				

Source: The Autor (2024)

5.3 STAGE 3: ALIGNMENT OF MODELED VALUE AND PERCEIVED VALUE

In this stage, the alignment between the modeled values and the perceived value for the "*Online Shopping*" process model is analyzed, broken down by dimension and specific *Value Statement*, as discussed in Section 4.3. The analysis aims to assess how effectively the values modeled by the organization translate into perceived customer value, providing insights into potential gaps and areas for optimization.

1. **Alignment Analysis by Dimension**

   a) **Scenario 0**:

   The comparative analysis of scenario 0 (Table 9) and the modeled values presented in Table 4 reveals that all dimensions of customer value perception were incorporated into initial modeling of scenario 0. However, individual analysis highlights areas requiring prescriptive interventions to address less satisfactory results, particularly in the *Price*, *Social*, and *Emotional* dimensions.

   As detailed in Table 9, the group's perceived value in the *Quality* dimension is rated as *very good*, with defuzzified scores of ($Mi = 0.80$) in Spain and ($Mi = 0.83$) in Brazil. These results underscore the company's effectiveness in delivering high-quality processes, as perceived by customers. The consistent strength in this dimension suggests that quality remains a core competency, reflecting successful alignment between business process design and customer perceptions within this value dimension.

   However, other dimensions — *Price* ($Mi = 0.67$ in Spain; $Mi = 0.76$ in Brazil, *Social* ($Mi = 0.77$ in Spain; $Mi = 0.79$ in Brazil), and *Emotional* ($Mi = 0.75$) in Spain; $Mi = 0.78$ in Brazil) — are evaluated as *good* rather than *very good*. While these scores remain positive, they indicate areas with potential for improvement to further enhance customer satisfaction.

   The *Price* dimension, in particular, exhibits relatively lower scores compared to the other. This discrepancy may be partially attributed to the methodological context of the study. The data were collected through a simulation of the "*Online Shopping*" process model, where the monetary aspect of *price* was hypothetical. Participants may not have experienced the tangible financial implications typically associated

with real transactions. Additionally, since participants volunteered for the study, costs related to effort and inconvenience were likely minimized, potentially leading to an underestimation of challenges in price-related evaluation.

b) **Scenario 1**:

Table 4 shows that all customer value dimensions were incorporated into the initial modeling of Scenario 1, except for the *Social* dimension.

As detailed in Table 10, the perceived value in Scenario 1 is rated as *very good* in both Spain and Brazil for two key dimensions: *Quality* ($Mi = 0.83$ for Spain, $Mi = 0.84$ for Brazil) and *Price* ($Mi = 0.81$ for Spain, $Mi = 0.83$ for Brazil). These high ratings suggest that customers are generally satisfied with the company's performance in delivering value in these areas.

The consistently high scores in the *Quality* dimension highlight customers' perception that the service or product reliably meets or exceeds their expectations. Similarly, the performance in the *Price* dimension suggests that customers perceive the process as offering a favorable cost-benefit ratio, reinforcing the notion of economic value as a key determinant in purchase decisions. These results emphasize the company's effectiveness in delivering on its value proposition in these dimensions across both countries.

The *Emotional* dimension, closely tied to customer satisfaction and overall experience, received mixed ratings: *very good* in Brazil ($Mi = 0.84$) and *good* in Spain ($Mi = 0.77$). These results suggest that while customers in Brazil experience strong positive emotional engagement with the process, there is room for improvement in Spain. *Emotional* value often stems from a product or service's ability to evoke feelings of joy, trust, and connection (factors essential for building long-term customer loyalty).

To strengthen this dimension in Spain, the company could consider the following strategies:

i. **Enhanced Customer Experience**: Design more emotionally engaging interactions, such as incorporating storytelling or memorable moments in to the customer journey.

ii. **Localized Initiatives**: Adapt emotional engagement strategies to better align with cultural preferences specific to the Spanish market, which may differ from

those in Brazil.

iii. **Continuous Feedback Mechanisms**: Collect and act on customer feedback to identify emotional pain points and address them effectively.

However, the *Social* dimension received lower ratings, with defuzzified scores of $Mi = 0.67$ for Spain and $Mi = 0.77$ for Brazil. Although these scores are categorized as *good*, they highlight a potential area for improvement. The absence of specific modeled values for the *Social* dimension (as shown in Table 4) likely contributed to this lower performance. This finding reinforces the idea that explicitly modeling values for specific dimensions positively impacts their perceived performance, consistent with theories of value modeling and alignment. Incorporating tailored values within underperforming dimensions could, therefore, serve as a strategic lever for enhancing customer perception.

Social value is often linked to perceptions of community, belonging, and alignment with shared values (critical elements for fostering customer trust and loyalty). The comparatively lower rating in this dimension may indicate a perception that the process lacks sufficient social interaction or engagement. Enhancing this dimension could involve the following strategies:

i. **Personalized Interactions**: Implement tailored communication and service approaches to create stronger connections with customers.

ii. **Community-Building Initiatives**: Facilitate opportunities for customers to interact with each other, fostering a sense of belonging.

iii. **Corporate Social Responsibility (CSR)**: Increase the visibility of CSR efforts to resonate with customers' values and societal expectations.

By addressing these areas of improvement, the company can further enhance its perceived value across all dimensions, strengthening its competitive position and deepening customer satisfaction and loyalty.

c) **Scenario 2**:

Table 4 shows that the *Quality* and *Emotional* dimensions were considered in the initial modeling of scenario 2, while the *Price* and *Social* dimensions were not.

The findings in Table 11 reveal that customers rated the perceived value in Scenario 2 as "*very good*" for both Spain and Brazil in the *Quality* dimension ($Mi = 0.84$

in both countries). This result indicates that the process effectively delivers the value proposition in terms of quality. The high score in this dimension reflects key attributes such as reliability, consistency, and the overall effectiveness in delivering value.

The scores for the *Emotional* dimension ($Mi = 0.77$ in Spain and $Mi = 0.79$ in Brazil) reflect positive customer experiences, albeit slightly lower than those for *Quality*. *Emotional* value, often associated with feelings of trust, satisfaction, and attachment, plays a critical role in fostering long-term loyalty. While the scores suggest that the process elicits favorable emotional responses, there is room for improvement to further enhance customer engagement. Possible strategies include:

- **Designing emotionally engaging touchpoints** within the customer journey, such as personalized interactions or surprise-and-delight moments.
- **Adopting storytelling techniques** in marketing and communication to evoke stronger emotional connections.
- **Enhancing the user experience (UX)** by improving ease of use, aesthetics, and responsiveness.

The scores for the *Price* dimension ($Mi = 0.61$ in Spain and $Mi = 0.75$ in Brazil) indicate that customers perceive the value received relative to cost as less favorable compared to other dimensions. This suggests potential concerns regarding affordability, perceived fairness, or the competitiveness of the pricing structure. *Price* is a crucial component of customer value perception, as it shapes satisfaction and purchase intentions based on perceived price fairness. To address this, companies could consider strategies such as:

- **Implementing promotional campaigns** or time-limited discounts to enhance the perceived cost-benefit ratio.
- **Offering tiered pricing structures** to cater to diverse customer segments and reduce price sensitivity.
- **Clearly communicating the value proposition** to emphasize benefits over costs.

The *Social* dimension received scores of $Mi = 0.66$ for Spain and $Mi = 0.70$ for Brazil, categorized as "*good*" but still lagging behind other dimensions. This

dimension relates to customers' perceptions of social interaction, community engagement, and alignment with shared values. The lower scores may indicate that customers perceive limited opportunities for interaction or insufficient emphasis on community-building and CSR. Research highlights the importance of *social* value in creating a sense of belonging and fostering trust among stakeholders. To enhance the *Social* dimension, the following approaches could be employed:

- **Increasing customer engagement** through interactive features, such as forums, user-generated content, or social media campaigns.
- **Strengthening CSR initiatives** and effectively communicating their impact to customers, enhancing the perception of shared values.
- **Hosting community-building events or programs** to promote collective involvement and foster a sense of identity with the brand.

In summary, the *Quality* dimension maintained its "*very good*" rating, whereas *Price*, *Emotional*, and *Social* were rated as "*good*". Notably, *Price* and *Social*, which lacked specific modeled values, received the lowest scores in perceived value. This indicates a gap between organizational intent and customer perception, suggesting that the absence of specific modeled values may weaken the ability of these dimensions to deliver value effectively. Interestingly, despite the *Emotional* dimension having an assigned modeled value, it was rated only as "*good*". However, its Mi score was higher than the other similarly rated dimensions, suggesting a partial positive impact from the explicit modeling of this value.

d) **Scenario 3**:

Table 4 shows that, as in Scenario 2, the *Quality* and *Emotional* dimensions were considered in the initial modeling of Scenario 3, while the *Price* and *Social* dimensions were not.

The results presented in Table 12 indicate that the perceived value in Scenario 3 is rated as "*good*" in both Spain and Brazil across three dimensions: *Price*, *Emotional*, and *Social*. While these ratings reflect an overall positive perception of the process, they also reveal areas for improvements to enhance the overall value delivered.

The relatively moderate scores in the *Price* dimension ($Mi = 0.64$ for Spain and $Mi = 0.67$ for Brazil) suggest that customers perceive the cost-to-benefit ratio as

less favorable. These ratings indicate potential concerns regarding affordability or value-for-money perception. Strategies to address this dimension could include:

- **Transparent Pricing Models**: Offering clear and comprehensible pricing structures that highlight the benefits relative to the costs.
- **Value-Added Services**: Incorporating additional benefits, such as extended warranties, premium support, or complementary features, to justify the pricing.
- **Revised Pricing Strategies**: Exploring tiered pricing or promotional discounts to cater to diverse customer segments.

Scores for the *Emotional* dimension ($Mi = 0.73$ for Spain and $Mi = 0.77$ for Brazil) highlight the process' ability to generate positive emotional responses, albeit with potential for further enhancement. *Emotional* value often stems from experiences that transcend the transactional, including feeling of trust, connection, and satisfaction. Improvements in this dimension could be achieved through:

- **Personalized Interactions**: Leveraging customer data to offer tailored recommendations, communications, and services.
- **Customer-Centric Experiences**: Designing touchpoints that evoke delight, surprise, and positive emotional engagement.
- **Trust-Building Mechanisms**: Ensuring transparency, reliability, and responsiveness to strengthen customer confidence.

The *Social* dimension ($Mi = 0.62$ for Spain and $Mi = 0.64$ for Brazil) shows the lowest scores among the evaluated dimensions, highlighting opportunities to improve *Social* value. This dimension relates customers' perceptions of community involvement, social interaction, and alignment with shared values. Lower scores may indicate a lack of focus on fostering social connections or demonstrating CSR. To address this, companies could:

- **Strengthen CSR Initiatives**: Actively promote and communicate the organization's commitment to social and environmental causes to resonate with customers seeking value alignment.
- **Foster Community Engagement**: Develop initiatives that encourage customer interaction, such as social media campaigns, community forums, or co-creation activities.

- **Enhance Shared Experiences**: Create opportunities for customers to connect with the brand and each other, cultivating a sense of belonging and shared purpose.

The *Quality* dimension scored significantly higher in Brazil ($Mi = 0.84$) compared to Spain ($Mi = 0.76$), indicating that the process achieved greater success in executing its value proposition in the former. *Quality* is widely regarded as a cornerstone of customer satisfaction and perceived value, encompassing attributes such as reliability, consistency, and superior performance.

While the scores reflect satisfactory outcomes, opportunities for optimization include:

- **Refining Operational Efficiency**: Reducing errors, streamlining processes, and enhancing service delivery to ensure consistent quality.
- **Continuous Feedback Mechanisms**: Implementing systems for capturing and acting on customer feedback to identify and resolve quality gaps.
- **Investment in Training and Resources**: Equipping teams with the skills and tools needed to maintain high standards of quality.

In Summary, the analysis reveals that the *Price* and *Social* dimensions consistently received the lowest ratings, aligning with their lack of specific modeled values. The gap in the Mi parameter between these dimensions 1.00 point in each country. This underscores the importance of explicitly modeling values to enhance perceived value, as suggested by prior studies on the relationship between structured modeling and customer perception.

The findings across scenarios reveal a consistent trend: dimensions with explicitly modeled values, such as *Quality*, consistently receive higher ratings, whereas dimensions without modeled values, such as *Social* (except in Scenario 0), tend to underperform. This underscores the importance of assigning modeled values to all dimensions to achieve a more balanced and enhanced perception of value. Addressing these gaps enables organizations to improve their processes, fostering promoting better value creation and greater customer satisfaction.

2. **Alignment Analysis by Value Statements:** This analysis evaluates the alignment between the specific modeled values and customer perceptions by analyzing the group

"*Value by Attribute*", using the defuzzified number "Mi" as a reference. The results for each of the four scenarios are presented below, with particular attention to the degree of alignment achieved and its implications for the perceived value across different attributes.

Table 13 – Scenario 0.

Code		**Value**	**Value by Attribute**	
			Spain	**Brazil**
Quality	QE0.1	Variety of Products	(0.75)	(0.78)
	QE0.2	Intuitive Selection Process	(0.84)	(0.84)
	QE0.3	Security and Privacy	(0.75)	(0.76)
	QE0.4	Security and Privacy	(0.73)	(0.76)
	QE0.5	Product	(0.81)	(0.82)
Price	PE0.1	Transparency - Price and Fee breakdown	(0.78)	(0.82)
Emotional	EE0.1	Convenience	(0.80)	(0.81)
Social	SE0.1	Extensive Delivery Coverage	(0.75)	(0.77)
	SE0.2	Delivery Flexibility	(0.84)	(0.83)
	SE0.3	Payment flexibility	(0.88)	(0.85)
	SE0.4	Accessibility	(0.85)	(0.82)

Source: The Autor (2024)

According to Table 13, all the specific values modeled in Scenario 0 were positively perceived by both Spanish and Brazilian respondents. Approximately 55% of the values were rated as "*very good*", while the remaining values were classified as "*good*". Among the evaluated attributes, the most positively perceived was "*payment flexibility*", which received a TFN of 0.88 in Spain and 0.85 in Brazil. This result underscores the significant impact of offering diverse and adaptive payment options ranging from traditional methods like cash on delivery to innovative digital solutions such as BIZUM in Spain and Pix in Brazil.

On the other hand, the attributes "*data security*" (QE0.3 and QE0.4), while still positively perceived, received the lowest TFN scores among the analyzed values: 0.75 and 0.73 for Spain and 0.76 for Brazil. This result suggests a potential gap in communication regarding the company's commitment to data protection and adherence to regulatory frameworks, such as the General Data Protection Regulation (GDPR) in Europe and Brazil's General Data Protection Law (LGPD).

The specific values modeled in Scenario 1, as presented in Table 14, were predominantly

Table 14 – Scenario 1.

Code		Value	Value by Attribute	
			Spain	Brazil
Quality	QE1.1	Commitment to customer satisfaction	(0.81)	(0.78)
	QE1.2	Proactivity in problem-solving	(0.82)	(0.81)
Price	PE1.1	Financial savings	(0.88)	(0.90)
Emotional	EE1.1	Compensation for inconvenience	(0.82)	(0.89)
	EE1.2	Personalization of customer attention	(0.88)	(0.82)
Social	-	-	-	-

Source: The Autor (2024)

perceived as "*very good*" by the Spanish and by almost all of the Brazilian respondents. The only exception was the value "*Commitment to customer satisfaction*", which was rated as "*good*" by the Brazilian respondents. Among the modeled value, "PE.1 *Financial Savings*" achieved the highest TFNs ($Mi = 0.88$ for Spain and $Mi = 0.90$ for Brazil), demonstrating a highly satisfactory performance.

This positive perception is largely attributable to the alternative solution implemented in Scenario 1, which involved the provision of a discount coupon. By directly addressing customers' cost concerns, this initiative had a significant impact on the Price dimension of perceived value. It highlights how price reductions or cost-saving strategies can enhance perceptions of fairness and value, especially in competitive markets.

Interestingly, while two values tied for the highest perceived value ($Mi = 0.88$ and $Mi = 0.90$), another two values tied for the lowest TFNs within the "*very good*" range: "*Commitment to customer satisfaction*" and "*Proactivity in problem-solving*". Although these scores remain positive, they highlight areas where customer perception can be further improved.

The effectiveness of the discount coupon highlights the value of providing tangible and direct benefits in improving perceptions of price and personalization. However, the relatively lower ratings for "*Commitment to Customer Satisfaction*" and "*Proactivity in Problem-Solving*" indicate an opportunity to enhance the relational and experiential dimensions of value. These dimensions are essential for building trust and fostering long-term customer loyalty, extending beyond the impact of immediate economic incentives.

To enhance the perception of values related to commitment and proactivity, the following

strategies are recommended:

- Commitment to Customer Satisfaction:
  - Create initiatives that visibly demonstrate a commitment to customer well-being, such as personalized follow-ups or satisfaction guarantees.
  - Incorporate real-time feedback mechanisms to identify and address customer concerns promptly, fostering a sense of inclusion and collaboration in problem resolution.
- Proactivity in Problem-Solving:
  - Share detailed explanations of the steps taken to address issues, including anticipated resolution timelines, to build trust and reduce uncertainty.
  - Highlight success stories or case studies where the company resolved similar issues, reinforcing confidence in its capabilities.

Table 15 – Scenario 2.

Code		**Value**	**Value by Attribute**	
			Spain	**Brazil**
Quality	QE2.1	Proactivity in problem-solving	(0.84)	(0.86)
	QE2.2	Flexibility and Adaptability	(0.84)	(0.85)
Price	-	-	-	-
Emotional	EE2.1	Attention to customer needs	(0.85)	(0.85)
Social	-	-	-	-

Source: The Autor (2024)

As shown in Table 15, all the specific values modeled in Scenario 2 were perceived as "*very good*", with scores ranging between 0.84 and 0.86. These consistent and high ratings indicate a strong alignment between the proposed solution and customer perceptions.

In this scenario, the solution provided by the company when home delivery was not feasible involved offering customers the option to pick up their orders at the most convenient store. Beyond merely offering this alternative the company went further by suggesting the nearest stores based on the customer's provided address. This additional layer of customization likely reinforcing the perception that the company was attentive to individual customer needs, thereby enhancing the value associated with "*Attention to customer needs*".

The positive reception of this approach highlights the significance of perceived effort and customer-centricity in service delivery. Customers often evaluate value not only based on the outcome but also on the effort and care perceived during the service process. By proactively offering "*Proactivity in problem-solving*" and "*Flexibility and Adaptability*", the company likely conveyed a commitment to responsiveness and personalization—key factors in enhancing customer satisfaction.

Table 16 – Scenario 3.

Code		**Value**	**Value by Attribute**	
			Spain	**Brazil**
Quality	QE3.1	Proactivity in problem-solving	(0.78)	(0.85)
Price	-	-	-	-
Emotional	EE3.1	Convenience	(0.83)	(0.76)
Social	-	-	-	-

Source: The Autor (2024)

As indicated in Table 16, all the specific values modeled for Scenario 3 were positively perceived by respondents, underscoring the organization's success in delivering customer value. This outcome is particularly significant as it reflects the recognition of the company's efforts in creating value for the customers.

In Spain, the highest Mi score was attributed to the value of "*Convenience*". This finding suggests that the organization's ability to overcome obstacles (such as the non-approval of a credit card at the time of purchase) by providing alternative payment methods had a significant positive impact. his action can directly impact the emotions of a customer who is eager to acquire a particular product. It underscores how swift and effective solutions can mitigate potential negative emotions and even enhance customers' perceptions of the organization. By addressing the emotional needs of customers eager to complete the transaction, the organization likely reinforced Convenience as a critical aspect of the overall service experience.

However, in Brazil, the perception of "*Convenience*" was comparatively less positive. This discrepancy could indicate that, despite offering alternative payment methods, the Brazilian customers' overall purchasing experience may have encountered additional friction. Potential contributing factors could include:

- A lack of clear communication about alternative payment options.
- Delays or complexities in completing transactions through these methods.

Conversely, "*Proactivity in Problem-Solving*" was more positively perceived in Brazil.

In Spain, however, the perception of "*Proactivity in Problem-Solving*" was less favorable. While the organization offered effective alternative payment methods, its failure to directly investigate or resolve the credit card issue may have been viewed as a shortcoming. This highlights that neglecting to address the root cause of a problem can undermine the perceived effectiveness of service recovery efforts.

The analysis of Scenario 3 underscores the need to provide alternative solutions while addressing root causes to improve perceptions of convenience and proactivity. Key insights include:

- Convenience and Emotional Impact: Perceptions of convenience are closely tied to the emotional relief offered by alternative solutions. To enhance this, the organization should:
  - Simplify and clarify alternative payment options.
  - Proactively explain credit card non-approval and suggest preventive measures.
- Proactivity and Personalized Attention: Addressing underlying issues, such as resolving credit card problems directly, demonstrates a proactive and customer-focused approach.
- Cultural Sensitivity in Service Delivery: Differences between Spain and Brazil highlight the need for culturally tailored strategies. In relationship-oriented markets, personalized communication and empathetic engagement can enhance customer perceptions across value dimensions.

To enhance the understanding and interpretation of the results obtained through the proposed method, the "*Online Shopping*" process model was redesigned. This redesign aimed to visually differentiate business values based on their effectiveness in delivering perceived value to users. Figure 12 presents the results of the customer value perception evaluation within this model, allowing for a clear identification of the performance of each analyzed value and the specific tasks to which they are associated.

An examination of Figure 12 reveals that all analyzed values received positive evaluations, with none falling into the categories of "*regular*", "*poor*", or "*very poor*". Values highlighted in green were perceived as "*very good*", while those in blue were perceived as "*good*". This differentiation facilitates an intuitive understanding of the process's performance in delivering value, emphasizing areas of strength and opportunities for improvement.

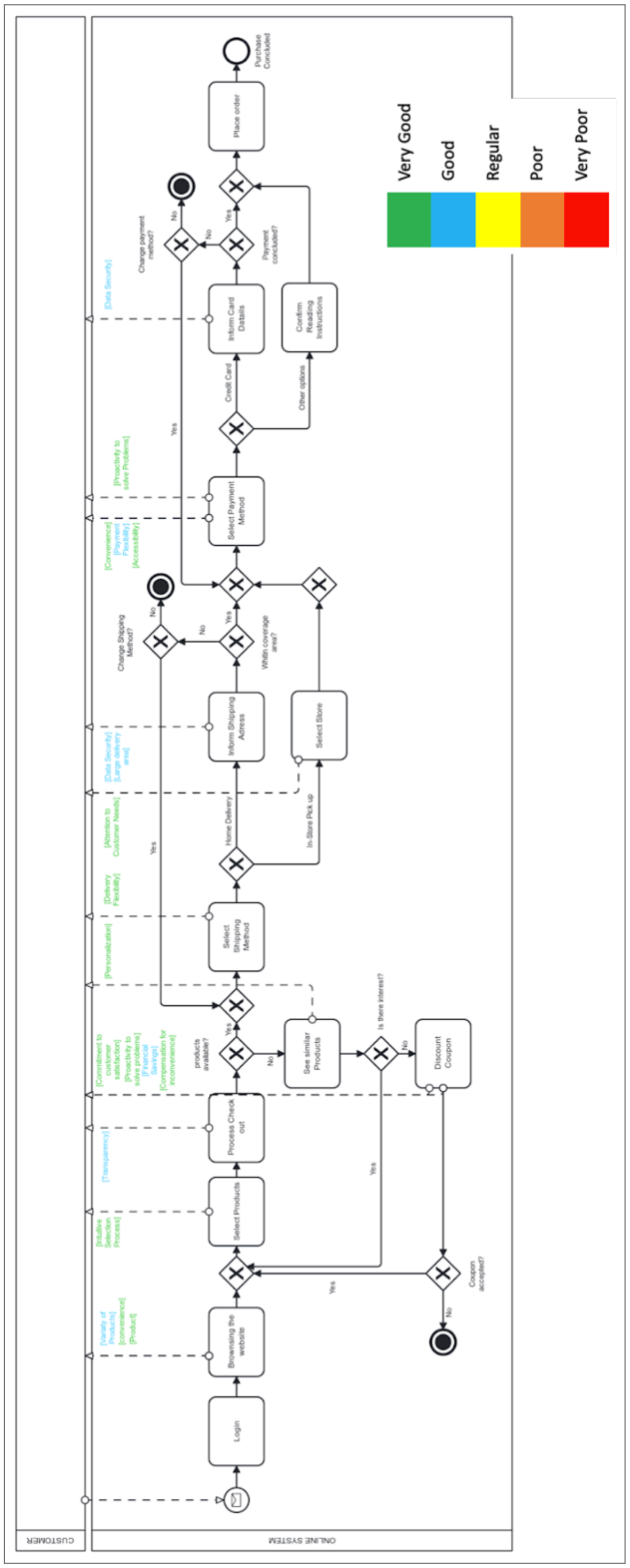
The proposed method significantly improves the clarity and precision of BPMN models, enabling a more nuanced interpretation of stakeholder value perceptions. By providing insights into how different process components contribute to customer satisfaction, the method offers substantial benefits for business managers. These include:

- **Identification of Improvement Areas**: Stakeholders' perceptions of value highlight tasks or activities that may require optimization to enhance overall process effectiveness.
- **Strategic Resource Allocation**: By identifying high-performing values, organizations can allocate resources to sustain or replicate successful practices across other processes.

While the results provide valuable insights into the creation and delivery of value within BPMN models, it is essential to recognize the limitations of their generalizability. Empirical studies in software engineering and business process management are often influenced by a wide range of contextual variables (BASILI; SHULL; LANUBILE, 1999). These variables include organizational culture, industry sector, stakeholder characteristics, and technological infrastructure, among others. Consequently, the results observed in the "Online Shopping" model are specific to the environment in which the study was conducted and may not be directly applicable to other contexts.

Even well-designed empirical studies face challenges in assessing their broader applicability. As highlighted in (BASILI; SHULL; LANUBILE, 1999), building a body of knowledge in software engineering or process management requires the accumulation of evidence across diverse settings. Therefore, while this study provides a meaningful contribution to understanding the interplay between business processes and value creation, its findings should be interpreted as context-specific insights rather than universal truths.

Figure 12 – Quantified Online Shopping - Spain.



Source: The Author (2024)

6 EMPIRICAL EVALUATION

To evaluate the proposed method, a series of experiments were conducted as part of an established research strategy, enabling the systematic exploration of key aspects such as theory testing, model accuracy evaluation, and measurement validation. Experiments are important in empirical research because they provide a structured approach to assess causal relationships and derive evidence-based conclusions. Notably, the replication of experiments enhances the reliability and external validity of findings by addressing limitations that extend beyond individual studies. Replications facilitate the generalization of results across different contexts and provide evidence to confirm or refute specific hypotheses (BASILI; SHULL; LANUBILE, 1999).

In the context of this research, as far as our investigation has reached, there is currently no standardized or widely accepted method currently exists in the industry for aligning business values with BPMN process models. This limitation made it impractical to conduct a fully controlled experiment, which typically requires the inclusion of a control group for systematic outcome comparisons. As a result, the empirical study was designed as a *quasi*-experiment, a method particularly suited for research scenarios where practical constraints limit experimental control. The *quasi*-experiment was structured based on the experimental framework widely employed in Software Engineering (WOHLIN et al., 2012).

The following subsections detail the main features of the conducted experiment and its replications, covering its objectives, context selection, variable identification, hypothesis formulation, experimental design, tasks specification, operational execution, and data analysis.

6.1 GOAL

This *quasi*-experiment is designed to systematically evaluate BPMN models specified using the proposed method. The research objectives are defined as follows:

- **Objective**: To analyze BPMN models specified with the proposed method.
- **Purpose:** To assess models.
- **Focus**: On perceived value, encompassing dimensions such as perceived quality, perceived price, perceived emotional value, and perceived social value.
- **Perspective:** From the viewpoint of BPMN analysts and modelers.

- **Context:** Involving students and members from both the Universitat Politècnica de València () and the Immaculate Conception Catholic College of Recife ().

The study aims to address the following research question:

- **RQ1:** *Does the adoption of alternative solutions improve customers' perceived value?*

6.2 CONTEXT OF THE STUDY

This study examines how customers analyze BPMN process models, focusing on their perceived value across distinct scenarios. The context is defined by three key components:(1) the proposed method for measuring perceived value in BPMN models, (2) the selection and characteristics of the BPMN process models under analysis, and (3) the criteria for participant selection and their profiles.

1. **Method for Aligning Business Values in BPMN Process Models**: The proposed method aims to bridge the gap between an organization's business values and their representation in BPMN process models. It is structured into three stages, of which two are incorporated into this *quasi*-experiment:

    a) **Analysis and Identification of Business Values in the BPMN Model**: This initial stage involves analyzing BPMN models to identify key scenarios and process paths that influence customer perceptions of value. Collaboration with managers is essential to ensure that the identified values align with organizational objectives. These values are then mapped to specific tasks in the process model and categorized according to the dimensions of the PERVAL scale: *quality*, *price*, *emotion*, and *social* value.

    b) **Quantification of Perceived Value**: In this stage, stakeholders execute the process, and their perceptions are measured using an adapted version of the PERVAL scale. *Fuzzy* logic is applied to convert linguistic responses (*e.g.*, "*high quality*" or "*low cost*") into quantitative metrics, allowing for a more nuanced analysis. Perceptions are quantified at three levels:

        - *Attributes*: Specific features or characteristics of the process.
        - *Dimensions*: Aggregated attributes categorized under the PERVAL dimensions.

- *Overall Process*: A comprehensive evaluation of the process.

Individual responses are then aggregated to derive group-level perceptions of value, offering insights into the collective stakeholder experience.

The third stage, *Alignment of Modeled Value and Perceived Value*, evaluates how closely the values modeled by the organization align with those perceived by stakeholders. While this stage is crucial for a holistic assessment, it was excluded from the *quasi*-experiment because it requires researcher-driven analysis, which falls outside the scope of the experimental framework.

2. **BPMN Process Models - Online Shopping**: The BPMN process model selected for analysis were based on a typical online shopping scenario, extended and refined to capture the nuances of customer value perception. The process represents key customer-company interactions, encompassing both successful transactions and potential failure points. Four distinct scenarios were designed, each depicting a unique process path:

   a) **Scenario 0 - Baseline (Error-Free)**: This scenario represents the ideal process flow, where every task is executed successfully without errors or disruptions. It serves as a baseline for comparison with other scenarios.

   b) **Scenario 1 - Stock Shortage**: This scenario addresses situations where the requested product is unavailable. To mitigate customer dissatisfaction, the company offers a discount coupon for similar items. This approach demonstrates a commitment to customer satisfaction by adding financial value and enhancing overall perceptions of service quality.

   c) **Scenario 2 - Delivery Coverage Issue**: In this scenario, the challenge arises when home delivery is not available for the customer's location. Offering in-store pickup as an alternative highlights the company's flexibility and attentiveness, ensuring a positive customer experience despite logistical limitations.

   d) **Scenario 3 - Payment Failure**: This scenario focuses on problems with credit card payments. By providing alternative payment methods (*e.g.*, PayPal, bank transfer), the company enphasizes adaptability and ensures transaction completion, reinforcing perceptions of convenience and reliability.

To ensure a fair comparison, all four BPMN models were designed to have similar size and complexity. This uniformity minimizes potential biases in the results thar could arise from variations in model scale or intricacy, allowing the analysis to focus exclusively on the perceived value of each process paths.

3. **Participant Selection**: The study involved 96 participants, 45 from Spain (🇪🇸) and 51 from Brazil (🇧🇷), selected through convenience sampling to represent average customers with no prior experience in process model analysis. This sampling method was chosen to capture the perspectives of non-expert stakeholders, reflecting real-world scenarios where customers interact with business processes without technical expertise.

   Participants' profiles were validated through a pre-experiment questionnaire, which gathered demographic information and assessed their familiarity with BPMN and process modeling. Only individuals with no prior knowledge of BPMN analysis were included in the study to ensure a consistent baseline understanding among participants.

   Participation was entirely voluntary, and all participants were informed about the study's practical and educational objectives. To avoid biasing their responses, the research question and hypotheses were not disclosed. Furthermore, no financial or material compensation was offered, reinforcing the academic focus of the research.

6.3 EXPERIMENT PLANNING

The experiment follows the methodological framework proposed in (WOHLIN et al., 2012), aiming to ensure internal, external, construct, and conclusion validity. Differences between the base experiment and its replications are also addressed.

1. **First Experiment (🇪🇸 - Spain 1)**: The objective of this experiment was to evaluate whether the adoption of alternative solutions in error scenarios positively affects customers' perceived value. To this end, BPMN models representing Scenario 0 (*error-free process*) and Scenario 1 (*process with stock problem*) were analyzed.

   a) **Hypotheses**:

      Hypothesis testing forms the foundation of the experiment's statistical analysis. To ensure a structured and meaningful evaluation, hypotheses were formulated during

the planning phase, enabling their systematic testing using the collected data. In this experiment, The null hypotheses for this experiment are as follows:

- $H1_0$: The adoption of alternative solutions does not significantly change the **perceived *quality*** in the BPMN process model, $H1_0 = \neg H1_1$.
- $H2_0$: The adoption of alternative solutions does not significantly change the **perceived *price*** in the BPMN process model, $H2_0 = \neg H2_1$.
- $H3_0$: The adoption of alternative solutions does not significantly change the **perceived *emotional*** in the BPMN process model, $H3_0 = \neg H3_1$.
- $H4_0$: The adoption of alternative solutions does not significantly change the **perceived *social*** in the BPMN process model, $H4_0 = \neg H4_1$.

The null hypotheses ($H1_0, H2_0, H3_0$, and $H4_0$) propose that there are no significant differences in the dependent variables of the experiment when one BPMN model is replaced by another. Conversely, the alternative hypotheses ($H1_1, H2_1, H3_1$ and $H4_1$) assert that significant differences do exist under these conditions. For instance, $H1_0 = \neg H1_1$, and similarly for the other hypotheses.

b) **Variables**

In experimental research, two types of variables are defined: **independent** and **dependent**.

- **Independent variables** are those that can be controlled and manipulated during the experiment. These variables are expected to influence the dependent variables and must be clearly defined and carefully managed. Examples include the modeling language or the layout of a process model.
- **Dependent variables** measure the effect of changes in the independent variables. To ensure accurate data collection and analysis, it is essential to establish their measurement scales and ranges for these variables.

In this study, the **independent variable** is the *BPMN Online Shopping process model*, which includes four distinct scenarios designed to reflect varying conditions:

i. **Scenario 0**: Error-free process.

ii. **Scenario 1**: Process with a stock problem.

iii. **Scenario 2**: Process with a delivery problem.

iv. **Scenario 3**: Process with a payment failure.

The **dependent variable** is *perceived value*, further divided into four dimensions to capture a comprehensive evaluation of stakeholders' perceptions:

i. **quality perceived value**: Represents the performance and expected quality of the process.

ii. **price perceived value**: Reflects cost-effectiveness, considering both short- and long-term perspectives.

iii. **emotional perceived value**: Relates to the affective states and emotions elicited by the process.

iv. **social perceived value**: Measures how the process enhances the individual's social self-concept.

Each dimension was assessed using an adapted version of the PERVAL (Perceived Value) scale (SWEENEY; SOUTAR, 2001), applied through a structured questionnaire. Participants evaluated the process using a 5-point Likert scale ranging from "*Totally Disagree*" to "*Totally Agree*".

To address the continuous nature of human perception, responses were processed using *fuzzy* logic. The fuzzification step converted discrete responses into TFN, which were subsequently defuzzified to generate real values for statistical analysis. This approach enhances the accuracy of subjective judgments and reduces potential bias in data interpretation.

c) **Scale**

To interpret the defuzzified scores obtained from participants' evaluations, this study adopts a standardized scale, providing a clear framework for classifying the perceived value associated with each scenario. This scale, adapted from (AQUINO et al., 2019), ensures consistent and meaningful comparisons across the dimensions of perceived value:

(a.) ***Very Poor***: 0 to 0.2;

(b.) ***Poor***: 0.2 to 0.4;

(c.) ***Regular/Neutral***: 0.4 to 0.6;

(d.) ***Good***: 0.6 to 0.8;

(e.) ***Very Good***: 0.8 to 1.

For the purposes of this study, only scores above 0.6 were considered indicative of positive perceived value.

d) **Design**

Experiments can adopt either a within-subject or between-subject design (WOHLIN et al., 2012). In a within-subject design, all participants are exposed to both BPMN models, and the results are compared within the same group. Conversely, in a between-subject design, each participant interacts with only one model, and the results are compared across different groups.

In this study were employed a within-subject design, where all participants interacted with both models. This approach enabled direct pairwise comparisons between Scenario 0 (error-free process) and Scenario 1 (stock problem). By having participants serve as their own control, the design minimized the influence of individual differences, enhancing the reliability of the results.

e) **Experimental Tasks**

The experimental tasks were structured to evaluate the BPMN models and assess perceived value through a controlled sequence of steps:

- **Task 1**: Interact with the error-free BPMN process model (Scenario 0) using a visual interface.
- **Task 2**: Complete the PERVAL questionnaire for Scenario 0.
- **Task 3**: Interact with the BPMN process model featuring an alternative solution using the interface.
- **Task 4**: Complete the PERVAL questionnaire for Alternative Solution BPMN process model.

2. **Second Experiment (** - Spain 2): This experiment was an internal replication of the First Experiment (Spain 1), following the same experimental protocol, context, experimenters, design, variables, and instrumentation. The only modification was the introduction of a different type of error in the BPMN process model, paired with a corresponding alternative solution scenario. The objective of this replication was twofold:

   - To determine whether the adopting of an alternative solution for a different type of error influences customer-perceived value.

- To evaluate the consistency of the findings when applied to other types of process errors.

The experiment was conducted in June 2024 with 15 participants from Spain, selected through convenience sampling.

3. **Third Experiment (** Spain 3): The third experiment was an additional internal replication of the *First Experiment*, closely following the design of Spain 2. The only difference was the type of error and its corresponding alternative solution in the BPMN process model. All other factors, including the context, experimenters, design, variables, and instruments remained consistent.

   The objective was to further investigate the impact of alternative solutions on customer-perceived value, ensuring the consistency and generalizability of the results across different types of erros. This replication also involved 15 participants from Spain, selected through convenience sampling, and was conducted in June 2024.

4. **Fourth Experiment (** - Brazil 1): The fourth experiment marked the first external replication of the original experiment, applying the established protocol to a different population. To ensure comparability, the same BPMN process models and experimental materials used in Spain 1 were employed.

   The primary aim of this replication was to evaluate the validity of the initial findings in a different cultural and demographic context. A total of 17 participants from Brazil, selected through convenience sampling, participated in the study, which was conducted in October 2024.

5. **Fifth Experiment (- Brazil 2)**: This fifth experiment was an external replication of Spain 2, applying the same protocol and BPMN process models to a Brazilian population. To ensure consistency, the context, design, variables, and instruments remained unchanged to maintain consistency.

   The goal was to evaluate the generalizability of the results obtained in Spain when applied to a different population. This experiment involved 17 participants from Brazil, selected through convenience sampling, and was conducted in October 2024.

6. **Sixth Experiment (** - Brazil 3): The sixth experiment was an external replication of Spain 3, following the same protocols, BPMN process models, context, design, variables, and instruments to ensure consistency.

   The primary objective was to evaluate to applicability of the findings to a different population and verify the consistency of results across varied process error scenarios. Similar to Brazil 2, this experiment involved 17 Brazilian participants selected via convenience sampling and was conducted in October 2024.

6.4 OPERATION

Before conducting the main experiment, a pilot test was carried out with three IT professionals to evaluate the experimental setup and identify potential issues in the design and materials. The pilot test provided valuable insights, leading to several refinements that enhanced task clarity and comprehension. For instance, adjustments were made to the Spanish language used in the materials, incorporating expressions more commonly used by native speakers, as all experimental materials were in Spanish to ensure better participant understanding. These improvements enabled participants to engage effectively with the experimental scenarios, ensuring a smoother transition to the full-scale study.

Participants received detailed instructions regarding the experimental procedure to ensure a clear understanding of their tasks. This included step-by-step explanations of the scenarios and the expected interactions with the BPMN process models.

To account for prior knowledge, participants completed a pre-questionnaire assessing their familiarity with process models.

The experiments were conducted at two distinct institutions to test the robustness and generalizability of the findings:

- The Spain 1, 2, and 3 experiments were conducted in a laboratory at the Polytechnic University of Valencia (UPV).
- The Brazil 1, 2, and 3 experiments took place in a laboratory at the Immaculate Conception Catholic College of Recife (FICR).

Each participant engaged with two experimental scenarios based on the type of error simulated in the BPMN process models:

- **Spain 1** / **Brazil 1**: Scenario 0 (*Error-Free*) and Scenario 1 (*Stock Problem*).
- **Spain 2** / **Brazil 2**: Scenario 0 (*Error-Free*) and Scenario 2 (*Delivery Problem*).
- **Spain 3** / **Brazil 3**: Scenario 0 (*Error-Free*) and Scenario 3 (*Payment Problem*).

This systematic design ensured consistency while allowing for a focused investigation of different error scenarios and their impact on perceived value.

Participants interacted with the BPMN process models corresponding to their assigned scenarios. Importantly, there were no time constraints, enabling participants to complete the tasks at their own pace. This approach aimed to reduce cognitive pressure and gather more accurate data regarding their perceptions and decision-making processes.

After interacting with the process models, participants completed a structured questionnaire designed to measure perceived value across four dimensions: *quality*, *price*, *emotional*, and *social* value. The questionnaire responses were analyzed using *fuzzy* logic to account for the subjective and continuous nature of human perception.

6.5 DATA ANALYSIS

The data analysis aimed to evaluate the proposed hypotheses and assess the variables of interest using a combination of descriptive and inferential statistical methods. To ensure robust and accurate results, the analysis adhered to established best practices in statistical evaluation.

The first step involved a descriptive analysis of the dependent variables to provide an overview of their distribution, central tendencies, and dispersion. Violin plots, combined with embedded boxplots, were employed to visually assess data distribution. This graphical representation offered insights into central tendency, variability, and symmetry, aiding in the preliminary exploration of the dataset.

To rigorously test the hypotheses, a significance level (*p-value*) of 0.05 was adopted, corresponding to a 5% probability of committing a Type I error, as recommended in the statistical literature (HEDGES; OLKIN, 2014). The analysis proceeded as follows:

1. **Normality and Homogeneity Testing**:
    - Given the relatively small sample size (fewer than 50 observations per experimental group), the *Shapiro-Wilk* test was applied to assess normality, and the *Brown-*

Forsythe Levene test was used to evaluate the homogeneity of variances. The outcomes of these tests guided the choice of subsequent statistical methods.

2. **Test Selection Based on Data Characteristics**:

   - For data that met normally assumptions, Student's *t*-test was chosen to compare group means.
   - However, because the dependent variables in this experiment were measured on an ordinal scale, the *Wilcoxon-Mann-Whitney* test was selected for hypothesis testing. This non-parametric test is particularly suitable for ordinal data and yields reliable results when normality assumptions are violated.

Beyond statistical significance, the analysis also considered the magnitude of the observed effects to emphasize the practical relevance of the findings. Cliff's δ was used to estimate effect sizes, along with a 95% confidence interval (CLIFF, 1993). This measure is particularly advantageous for ordinal data as it is non-parametric and less sensitive to outliers, dispersion differences in dispersion, and non-normal distributions.

- **Effect Size Thresholds**: The interpretation of Cliff's δ followed the thresholds proposed in (KRAEMER; KUPFER, 2006):
  - $|d| < 0.112$: Negligible effect.
  - $0.112 \leq |d| < 0.276$: Small effect.
  - $0.276 \leq |d| < 0.428$: Medium effect.
  - $|d| \geq 0.428$: Large effect.

These thresholds provided a clear and practical framework for understanding the impact of experimental conditions on the perceived value dimensions.

6.5.1 Descriptive Analysis of Dependent Variables

This section provides a detailed analysis of the dependent variables evaluated in the experiments, focusing on their descriptive characteristics and trends across different scenarios. Each subsection explores one dimension of perceived value (*quality*, *price*, *emotional*, and *social*) providing insights into how alternative solutions influenced participants' perceptions. The final

subsection synthesizes these findings into a broader discussion, highlighting key patterns identified in this study and their implications for understanding customer value in BPMN process models.

Figures 13, 14, 15 and 16, along with Tables 17 and 18, present the median and mean values for *quality*, *price*, *emotional*, and *social* dimensions of perceived value, respectively.

6.5.1.1 Perceived Quality Value

Tables 17 and 18 show that *Perceived Quality Value* was consistently higher in most scenarios when executing the alternative solutions:

- **Spain 1**: Scenario 0 = 0.81; Scenario 1 = 0.83
- **Spain 2**: Scenario 0 = 0.82; Scenario 2 = 0.84
- **Brazil 1**: Scenario 0 = 0.82; Scenario 1 = 0.84
- **Brazil 2**: Scenario 0 = 0.81; Scenario 2 = 0.83
- **Brazil 3**: Scenario 0 = 0.81; Scenario 3 = 0.84

These findings indicate a positive perceived *quality* value when the alternative solutions were applied.

An exception occurred in **Spain 3**, where the base BPMN model exhibited slightly higher *quality* values (Scenario 0 = 0.78; Scenario 3 = 0.76). Nonetheless, the perceived *quality* of the alternative solution remained positive, highlighting the robustness of the alternative approaches in delivering *quality* value.

6.5.1.2 Perceived Price Value

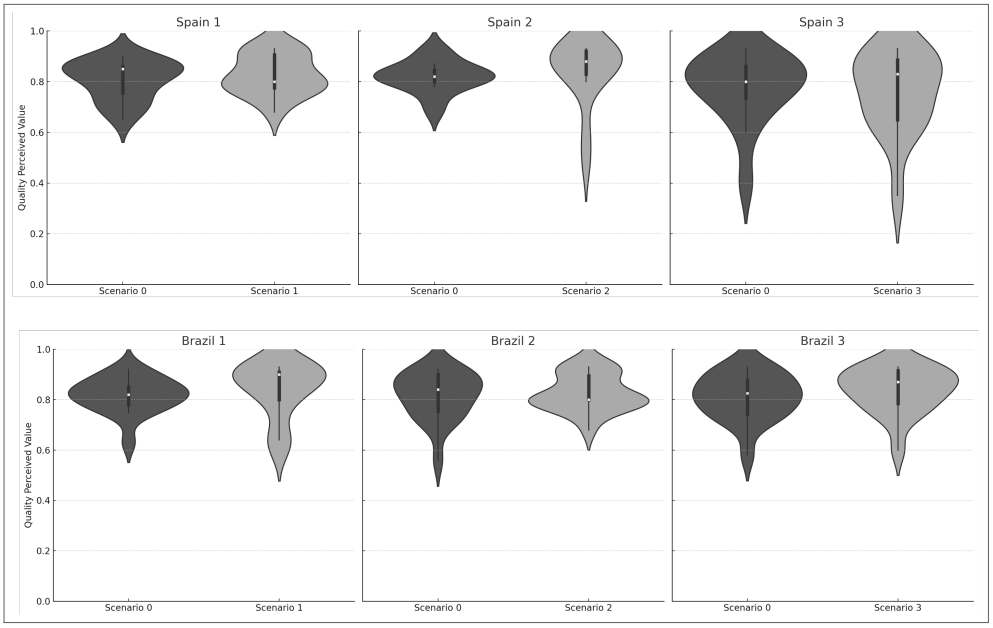
The *Price Perceived Value* (see Tables 17 and 18) exhibited variability across scenarios.

The alternative solutions outperformed the base model in:

- **Spain 1**: Scenario 0 = 0.68; Scenario 1 = 0.80
- **Brazil 1** Scenario 0 = 0.82; Scenario 1 = 0.84

In contrast, the BPMN base model yielded higher *price* values in:

Figure 13 – Violin Plots of Quality Perceived Value.



Source: The Author (2024)

- **Spain 2**: Scenario 0 = 0.65; Scenario 2 = 0.61
- **Spain 3**: Scenario 0 = 0.68; Scenario 3 = 0.64
- **Brazil 2**: Scenario 0 = 0.77; Scenario 2 = 0.75)
- **Brazil 3**: Scenario 0 = 0.73; Scenario 3 = 0.67)

Despite these variations, all *price* values for the alternative solutions remained above 0.6, reflecting a consistently positive perception of *price* value. These findings suggest that while the base BPMN model may perform better in specific contexts, the alternative solutions still offer acceptable and favorable *price* perceptions overall.

6.5.1.3 Emotional Perceived Value

The *Emotional Perceived Value* (see Tables 17 and 18) showed higher scores for the alternative solutions in the following cases:

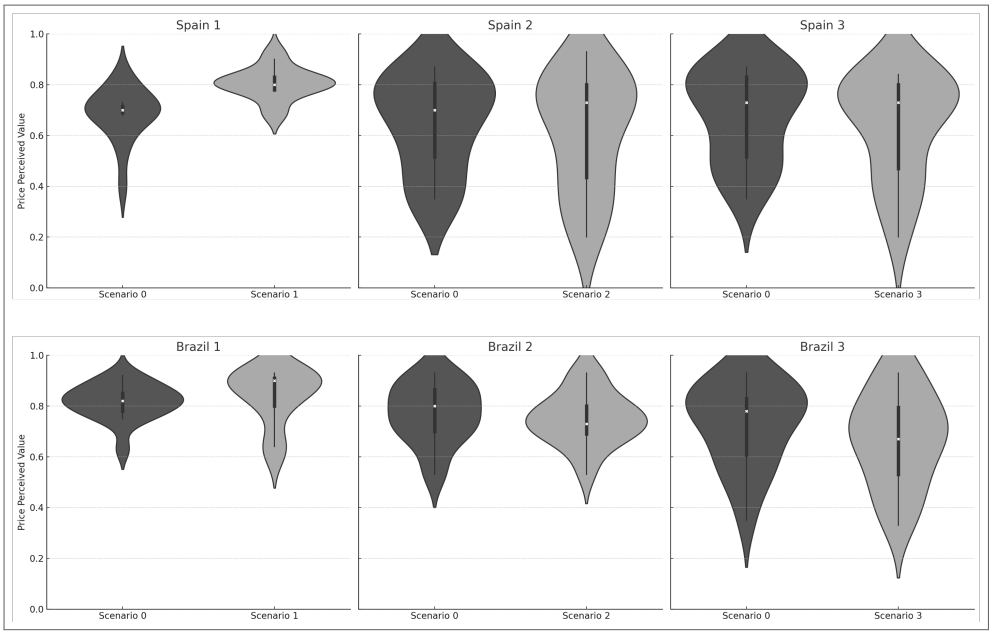
- **Spain 1**: Scenario 0 = 0.78; Scenario 1 = 0.79
- **Spain 3**: Scenario 0 = 0.72; Scenario 3 = 0.73
- **Brazil 1**: Scenario 0 = 0.79; Scenario 1 = 0.84

Table 17 – Descriptive analysis of Spain

Exp	Variable	BPMN	Min	Max	Mean	SD
Spain 1	Quality PV	Scenario 0	0,65	0,90	0,8066667	0,0766874
		Scenario 1	0,68	0,93	0,8273333	0,0786009
	Price PV	Scenario 0	0,40	0,83	0,6846667	0,1047355
		Scenario 1	0,68	0,93	0,8053333	0,0630042
	Emotional PV	Scenario 0	0,55	0,93	0,7793333	0,1215652
		Scenario 1	0,56	0,93	0,7920000	0,1110470
	Social PV	Scenario 0	0,54	0,90	0,7680000	0,1034546
		Scenario 1	0,40	0,89	0,6693333	0,1407869
Spain 2	Quality PV	Scenario 0	0,68	0,92	0,8200000	0,0625643
		Scenario 2	0,48	0,93	0,8400000	0,1307670
	Price PV	Scenario 0	0,35	0,87	0,6466667	0,1882501
		Scenario 2	0,20	0,93	0,6153333	0,2302442
	Emotional PV	Scenario 0	0,55	0,93	0,7880000	0,1087067
		Scenario 2	0,40	0,93	0,7693333	0,1383302
	Social PV	Scenario 0	0,62	0,91	0,7626667	0,0848079
		Scenario 2	0,40	0,93	0,6573333	0,1544792
Spain 3	Quality PV	Scenario 0	0,40	0,93	0,7780000	0,1367061
		Scenario 3	0,35	0,93	0,7580000	0,1597856
	Price PV	Scenario 0	0,35	0,87	0,6806667	0,1800979
		Scenario 3	0,20	0,84	0,6360000	0,2061484
	Emotional PV	Scenario 0	0,20	0,87	0,7253333	0,1702044
		Scenario 3	0,55	0,87	0,7313333	0,0999190
	Social PV	Scenario 0	0,60	0,85	0,7346667	0,0790901
		Scenario 3	0,33	0,80	0,6186667	0,1120502

Source: The Autor (2024)

Figure 14 – Violin Plots of Price Perceived Value.



Source: The Author (2024)

In **Brazil 2**, the *emotional* value was equal between the base BPMN model and the alternative solution (Scenario 0 = 0.81; Scenario 2 = 0.81). Conversely, the base model

Table 18 – Descriptive analysis of Brazil

Exp	Variable	BPMN	Min	Max	Mean	SD
Brazil 1	Quality PV	Scenario 0	0,63	0,92	0,8170588	0,0698001
		Scenario 1	0,60	0,93	0,8417647	0,1083533
	Price PV	Scenario 0	0,58	0,90	0,7570588	0,1046282
		Scenario 1	0,67	0,93	0,8258824	0,0802386
	Emotional PV	Scenario 0	0,55	0,93	0,7870588	0,1302289
		Scenario 1	0,54	0,93	0,8405882	0,1066226
	Social PV	Scenario 0	0,51	0,93	0,7688235	0,1231301
		Scenario 1	0,33	0,93	0,7682353	0,1702291
Brazil 2	Quality PV	Scenario 0	0,56	0,92	0,8142105	0,0932330
		Scenario 2	0,68	0,93	0,8273684	0,0721759
	Price PV	Scenario 0	0,53	0,93	0,7705263	0,1164986
		Scenario 2	0,53	0,93	0,7500000	0,1029023
	Emotional PV	Scenario 0	0,55	0,93	0,8078947	0,1238089
		Scenario 2	0,65	0,93	0,8078947	0,0870168
	Social PV	Scenario 0	0,63	0,91	0,7768421	0,0700835
		Scenario 2	0,47	0,89	0,6978947	0,1073716
Brazil 3	Quality PV	Scenario 0	0,58	0,93	0,8111111	0,0908709
		Scenario 3	0,60	0,93	0,8377778	0,0892159
	Price PV	Scenario 0	0,35	0,93	0,7272222	0,1647031
		Scenario 3	0,33	0,93	0,6683333	0,1840796
	Emotional PV	Scenario 0	0,45	0,93	0,7911111	0,1283785
		Scenario 3	0,55	0,93	0,7672222	0,1000474
	Social PV	Scenario 0	0,60	0,93	0,7727778	0,0972447
		Scenario 3	0,20	0,93	0,6383333	0,2013265

Source: The Autor (2024)

outperformed the alternative solution in:

- **Spain 2**: Scenario 0 = 0.79; Scenario 2 = 0.77
- **Brazil 3**: Scenario 0 = 0.79; Scenario 3 = 0.77

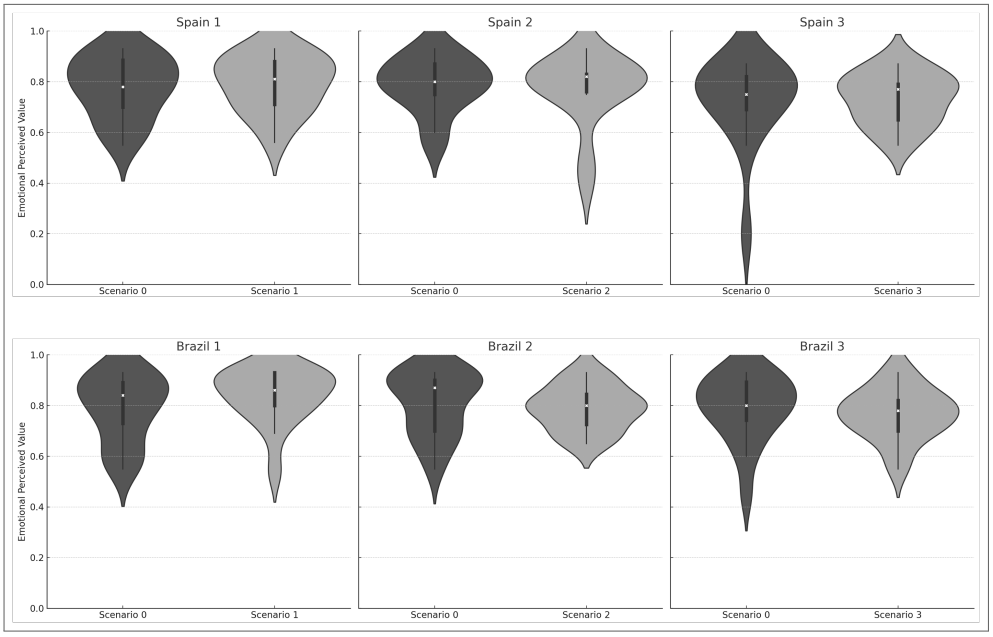
Despite these variations, the *emotional* value for all scenarios involving alternative solutions consistently exceeded 0.7, indicating a generally positive perception.

6.5.1.4 Social Perceived Value

The *Social Perceived Value* results (see Tables 17 and 18) favored the base BPMN model in most scenarios:

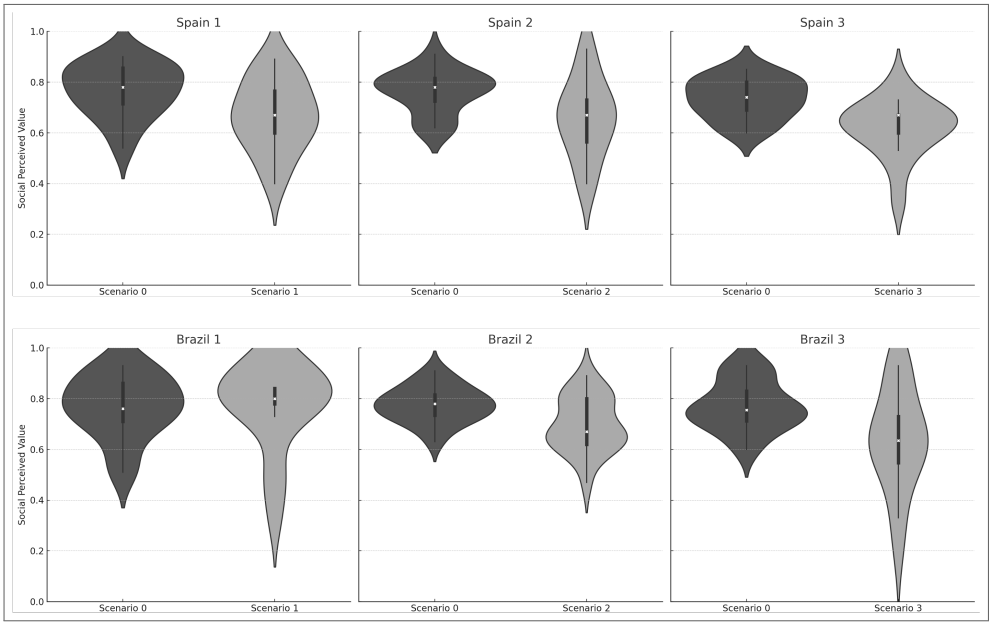
- **Spain 1** Scenario 0 = 0.77; Scenario 1 = 0.67
- **Spain 2** Scenario 0 = 0.76; Scenario 2 = 0.66
- **Spain 3** Scenario 0 = 0.73; Scenario 3 = 0.62

Figure 15 – Violin Plots of Emotional Perceived Value.



Source: The Author (2024)

Figure 16 – Violin Plots of Social Perceived Value.



Source: The Author (2024)

- **Brazil 2** Scenario 0 = 0.78; Scenario 2 = 0.70
- **Brazil 3** Scenario 0 = 0.77; Scenario 3 = 0.64

The only exception was **Brazil 1**, where the alternative solution matched the performance of the base BPMN model (Scenario 0 = 0.77; Scenario 1 = 0.77).

Although the base BPMN model consistently showed higher perceived *social* value in most cases, the alternative solutions still achieved scores above 0.6 across all cases. This indicates that, even in less favorable conditions, the alternative solutions maintained a positive perception of *social* value.

6.5.1.5 Discussion of Results

Across all scenarios, the adoption of alternative solutions consistently resulted in positive perceived values across the *quality*, *price*, *emotional*, and *social* dimensions. This highlights the adaptability and effectiveness of the alternative solutions in maintaining or enhancing customer value perceptions.

However, the base BPMN model outperformed the alternative solutions in specific contexts, particularly in perceived *social* value and occasionally for *price* and *emotional* value dimensions. These results suggests that while the alternative solutions are broadly effective, specific adjustments may be required to better align with stakeholder expectations in these areas.

The findings reinforce customer value theories that highlight the multidimensional nature of perceptions—encompassing *quality*, *price*, *emotional*, and *social* aspects. Practically, the results emphasize the importance of iterative refinements in process design to address *social* and *emotional* value dimensions more effectively. This would allow organizations to optimize configurations and align better with stakeholder expectations.

A combined analysis of violin plots (Figures 13, 14, 15 and 16) and Standard Deviation (SD) values (Tables 17 and 18) from Spain 1, 2, and 3, and Brazil 1, 2, and 3, revealed that Brazilian groups exhibited more homogeneous responses. Their violin plots were horizontally denser near the median, and standers deviations were lower indicating greater consistency in perceptions across scenarios. Conversely, the Spanish group displayed higher variability, with wider violin plots and higher standard deviations, reflecting more divergent perceptions among participants from Spain.

To better explore these results, an analysis of participant profiles (based on age, educational level, professional background, and nationality) was conducted using data from a demographic form.

Despite greater diversity in age and educational levels among Brazilian groups, their responses were more consistent compared to the Spanish groups:

- **Brazil 1 *vs.* Spain 1**:
  - **Age**: A 28-year age range in Brazil 1, compared to an 8-year range in Spain 1.
  - **Educational level**: 47% of Brazil 1 participants had higher or technical education, compared to 100% in Spain 1.
- **Brazil 2 *vs.* Spain 2**:
  - **Age**: A 26-year age range in Brazil 2, compared to a 16-year range in Spain 2.
  - **Educational level**: 35% of Brazil 2 participants had higher or technical education, compared to 80% in Spain 2.
- **Brazil 3 *vs.* Spain 3**:
  - **Age**: A 16-year age range in Brazil 3, compared to a 20-year range in Spain 3.
  - **Educational level**: 29% of Brazil 3 participants had higher or technical education, compared to 53% in Spain 3.

Despite these differences, the Brazilian groups demonstrates greater alignment in their perceptions, as indicated by violin plots and SD values.

A significant factor contributing to this consistency was nationality: the Brazilian groups were composed exclusively of Brazilians, while the Spanish groups included participants from 10 different nationalities (Cuban, Mexican, Ecuadorian, Brazilian, Bolivian, Peruvian, Colombian, Portuguese, Venezuelan, and Spanish). This diversity in nationalities likely introduced cultural variability, which may explain the greater response variability observed in the Spanish groups.

These findings suggest that, in the context of online shopping, customer nationality and culture may play a more critical role in shaping value perceptions than demographic factors like age or education.

Cultural influences can directly affect:

1. **Interpretation of stimuli**: Definitions of "*quality*" or "*fair price*" can vary significantly across cultures.
2. **Expression of emotional and social values**: Cultural norms shape how factors like trust, emotional experience, and social status are prioritized.

3. **Previous experience with online shopping**: Participants from mature markets, like Spain, may have different references points for price and quality compared to those from emerging economies, such as Latin American countries.

For example:

- A product considered expensive in Bolivia might be perceived as affordable in Spain.
- Perceived quality could differ between customers accustomed to European products and those from emerging markets.

These cultural differences further highlight the subjectivity of perceived value. For instance, trust in online shopping varies across cultures (*e.g.*, mature *vs.* emerging markets), as does the perception of *emotional* or *social* value, which are influenced by local norms.

The greater variability observed in the Spanish group supports the cultural factors plays a significant role in shaping customer value perceptions in online shopping contexts.

The results suggest that customer culture (nationality) has a greater impact on value perceptions (across *quality*, *price*, *emotional*, and *social* dimensions) than age or educational level.

This insight underscores the importance of adapting market strategies to account for cultural diversity. Companies should consider these cultural diversity when designing marketing campaigns or configuring online shopping platforms, recognizing that each culture interprets "perceived value" uniquely.

6.5.2 Tests of Normality and Homogeneity

The *Shapiro-Wilk* test was used to assess data normality, yielded mixed results across the experimental scenarios. In both **Spain 1** and **Brazil 1**, only *price* perceived value followed a normal distribution. In **Spain 2**, normality was observed solely for *social* perceived value, while in **Brazil 2**, both *price* and *social* perceived value adhered to normality, with other variables (*quality* perceived value and *emotional* perceived value) deviating from it. In **Spain 3**, only *social* perceived value showed a normal distribution, whereas in **Brazil 3**, this was true exclusively for *price* perceived value. These results underscore the variability in data distributions across different perceived value dimensions and experimental scenarios.

Homogeneity of variance was assessed using the *Brown-Forsythe Levene* test. The result confirmed that all variables maintained homogeneity of variance across all cases (**Spain 1**, **Spain 2**, **Spain 3**, **Brazil 1**, **Brazil 2**, and **Brazil 3**). This consistency in variance ensures the reliability and robustness of subsequent non-parametric analyses.

6.5.3 Hypotheses Testing

The *Wilcoxon signed-rank* test was used to evaluate the proposed hypotheses due to the ordinal nature of the data.

- In **Spain 1**: The test identified a statistically significant difference in the *price* perceived value dimension when the alternative solution was applied, leading to the rejection of the null hypothesis $H2_0$ (p-value $= 0.00113$. This indicates that the alternative solution had a positive and measurable impact on the perceived *price* value.
- **Spain 2** and **Spain 3**: Significant changes were observed in the *social* perceived value dimension, resulting in the rejection of the null hypothesis $H4_0$ (p-value $= 0.0277$ for **Spain 2**; p-value $= 0.002$ for **Spain 3**). These result emphasize the role of the alternative solutions in enhancing the perceived *social* value in these scenarios.
- **Brazil 1**: None of the hypotheses were rejected, suggesting that the alternative solution did not cause significant changes in any of the perceived value dimensions.
- **Brazil 2** and **Brazil 3**: The null hypothesis $H4_0$ was rejected for the *social* perceived value dimension (p-value $= 0.02354$ for **Brazil** 2;p-value $= 0.01583$ for **Brazil 3**). These findings are consistent with the results from Spain, demonstrating the consistent effect of alternative solutions on the *social* dimension of perceived value.

6.5.4 Practical Significance Using Cliff's Estimation

To complement the statistical hypothesis testing, Cliff's δ was calculated to assess the effect size of the observed differences. This method adds an important layer of interpretation by evaluating the practical significance of the results, which is crucial for understanding their real-world applicability.

The analysis revealed a large effect size for *price* perceived value in **Spain 1** (Table 19) and for *social* perceived value in both **Spain 2** (Table 20) and **Spain 3** (Table 21). These findings highlight the substantial practical impact of the alternative solution in these specific dimensions and scenarios.

A medium effect size was observed for *social* perceived value in **Brazil 2** (Table 23) and **Brazil 3** (Table 24), suggesting that the alternative solution had a moderate but meaningful influence on the perceived *social* value in these cases.

Interestingly, in **Spain 2** (Table 20) and **Brazil 1** (Table 22), the hypothesis tests did not identify statistically significant differences for the *quality* perceived value variable. However, Cliff's δ indicated that the alternative solution performed moderately better than the baseline BPMN model (Scenario 0). This trend was also noted for **Brazil 1** for the *price* perceived value and *social* perceived value variables. These results emphasize the potential value of the alternative solution, even when statistical tests fail to confirm significance, underscoring the importance of considering effect sizes alongside *p*-values in practical contexts.

The discrepancies between statistical significance and practical significance in these cases may be partly result from variations in standard deviation. Such variations can diminish the sensitivity of hypothesis tests, particularly in studies with small sample sizes. Replicating the experiment with a larger sample size would help validate these findings and enhance the reliability of the conclusions.

Table 19 – Hypotheses testing (Spain 1).

Variable	**Test**	**p-value**	**Cliff's δ estimate**	**Effect size**
Quality PV	Wilcoxon	0,47212	-0,1066667	Negligible
Price PV	Wilcoxon	0,00113	-0,6933333	**Large**
Emotional PV	Wilcoxon	0,76794	-0,0711111	Negligible
Social PV	Wilcoxon	0,03724	0,4133333	Medium

Source: The Autor (2024)

6.5.5 Discussion

RQ: Does the adoption of alternative solutions improve customers' perceived value?

The findings provide a nuanced answer to this research question, revealing variations in how different dimensions of perceived value are impacted by the adoption of alternative solutions

Table 20 – Hypotheses testing (Spain 2).

Variable	Test	p-value	Cliff's δ estimate	Effect size
Quality PV	Wilcoxon	0,06101	-0,4044444	Medium
Price PV	Wilcoxon	0,78695	0,0622222	Negligible
Emotional PV	Wilcoxon	1	0,0044444	Negligible
Social PV	Wilcoxon	0,0277	0,4755556	**Large**

Source: The Autor (2024)

Table 21 – Hypotheses testing (Spain 3).

Variable	Test	p-value	Cliff's δ estimate	Effect size
Quality PV	Wilcoxon	0,83511	0,0488889	Negligible
Price PV	Wilcoxon	0,45354	0,1644444	Small
Emotional PV	Wilcoxon	0,61706	0,1111111	Negligible
Social PV	Wilcoxon	0,002	0,6622222	**Large**

Source: The Autor (2024)

Table 22 – Hypotheses testing (Brazil 1).

Variable	Test	p-value	Cliff's δ estimate	Effect size
Quality PV	Wilcoxon	0,08718	-0,3460208	Medium
Price PV	Wilcoxon	0,06145	-0,3771626	Medium
Emotional PV	Wilcoxon	0,2099	-0,2525952	Negligible
Social PV	Wilcoxon	0,51106	-0,1349481	Medium

Source: The Autor (2024)

across scenarios and contexts.

6.5.5.1 Spain

Spain 1: The analysis showed no statistically significant changes in the *quality* perceived value and *emotional* perceived value variables between Scenario 0 (error-free) and Scenario 1 (stock issue). This stability suggests that these dimensions are resilient to operational disruptions in this context. However, the *price* perceived value demonstrated a statistically significant improvement, indicating that the alternative solution not only mitigated potential negative effects but also enhanced customers' *price* perceptions. This finding highlight the potential for operational adjustments to transform negative experiences into opportunities to improve customer satisfaction in specific dimensions.

Table 23 – Hypotheses testing (Brazil 2).

Variable	Test	p-value	Cliff's δ estimate	Effect size
Quality PV	Wilcoxon	0,76796	-0,0581717	Negligible
Price PV	Wilcoxon	0,48073	0,1357341	Negligible
Emotional PV	Wilcoxon	0,41035	0,1578947	Small
Social PV	Wilcoxon	0,02354	0,4293629	Medium

Source: The Autor (2024)

Table 24 – Hypotheses testing (Brazil 3).

Variable	Test	p-value	Cliff's δ estimate	Effect size
Quality PV	Wilcoxon	0,31525	-0,1975309	Small
Price PV	Wilcoxon	0,34089	0,1882716	Small
Emotional PV	Wilcoxon	0,34812	0,1851852	Small
Social PV	Wilcoxon	0,01583	0,4722222	Medium

Source: The Autor (2024)

Spain 2: Similar to Spain 1, the *price* perceived value and *emotional* perceived value variables remained statistically unchanged between Scenario 0 and Scenario 2, reflecting the alternative solution's effectiveness in maintaining perceived value during operational issues. While *quality* perceived value did not show statistical significance, effect size analysis indicated a moderate improvement, hinting at a subtle enhancement in customers' *quality* perceptions.

Spain 3: The results for **Spain 3** were consistent with the previous scenarios. Neither *quality* perceived value nor *emotional* perceived value exhibited statistically significant changes between Scenario 0 and Scenario 3, indicating a consistent ability to maintain customer perceptions despite operational challenges.

6.5.5.2 Brazil

Brazil 1: None of the hypotheses yielded statistically significant results between Scenarios 0 and Scenario 1. However, the *emotional* perceived value variable remained stable, and effect size analysis suggested moderate improvements in *quality*, *price*, and *social* perceived value dimensions under the alternative solution. This indicates potential benefits that were not detected through statistical significance alone.

Brazil 2: Both *quality* perceived value and *price* perceived value remained stable across scenarios, with no statistically significant differences observed.

Brazil 3: A slight improvement was noted in *quality* perceived value under the alternative solution compared to the baseline BPMN model (Scenario 0), suggesting incremental gains in customer perception.

The results demonstrate that the adopting alternative solutions is generally effective in maintaining customers' perceived value, especially in terms of *quality* and *emotional* perceived value. These dimensions remained stable in most scenarios, reflecting the robustness of the solutions in preserving customer perceptions during operational disruptions. Specific improvements in *price* perceived value were also observed in **Spain 1** and **Brazil 1**, suggesting that strategic adjustments can enhance customer perceptions in this dimension.

However, a contrasting trend emerged for the *social* perceived value variable. In **Spain 2**, **Spain 3**, **Brazil 2**, and **Brazil 3**, the *social* dimension exhibited a decline under alternative solutions, with the base BPMN model generally outperforming in this area. Although the *social* value remained positive, the consistent decline suggests a potential misalignment between alternative solutions and *social* expectations. This gap warrants further investigation to understand the factors limiting the effectiveness of these solutions in enhancing perceptions of *social* value.

The adopting of alternative solutions proves effective in preserving and, in some cases, enhancing customers' perceived value, particularly in terms of *price* and *quality*. These solutions demonstrate their ability to mitigate the negative impacts of operational issues and, in some cases, turn challenges into opportunities to boost customer satisfaction.

However, the persistent decline in *social* perceived value across scenarios highlights a critical area for improvement. Future research should focus on uncovering the reasons behind this trend and exploring strategies to better incorporate *social* dimensions into alternative solutions. Such efforts would ensure a more comprehensive alignment with customer expectations across all dimensions of perceived value.

6.6 THREATS TO VALIDITY

This section outlines the potential limitations of the study to ensure transparency and uphold methodological rigor. To establish the credibility of the results, it is necessary to assess how various types of threats may have influenced the experiment and describe the strategies employed to mitigate them. The following subsections address these considerations.

6.6.1 Internal validity

Internal validity pertains to factors that could introduce bias or confounding variables into the experimental results. The primary threats identified include the learning effect, participants' experience, information exchange between participants, comprehensibility of materials, and instrumentation validity (WOHLIN et al., 2012).

- **Learning Effect**: This risk was mitigated by designing the experiment so that each participant was exposed to only one error scenario. By avoiding repeated exposures, the likelihood of participants improving their performance through familiarity with the task was minimized.
- **Participants' Experience**: All participants lacked prior experience in process analysis or modeling, ensuring a uniform baseline of knowledge. This reduced variability in the results due to differences in expertise.
- **Information Exchange**: To prevent cross-contamination of responses, participants were closely monitored during the experiment, ensuring no communication occurred between them.
- **Comprehensibility of Materials**: A pilot study was conducted to assess and refine the experimental materials. This preliminary study identified potential issues, which were addressed to ensure the clarity and relevance of the materials.
- **Instrumentation Validity**: To mitigate potential biases in the experimental setup, the materials were reviewed by an experienced researcher in empirical software engineering, ensuring they adhered to best practices.

6.6.2 External Validity

External validity relates to the generalizability of the study's findings beyond the specific experimental context.

One limitation stems from small number of BPMN models analyzed. Although the selected models provided a foundation for understanding the relationship between process characteristics and perceived customer value, they do not comprehensively represent all business processes or domains. To improve generalizability, future replications of the study should include a broader

and more diverse set of BPMN models. Such replications would enable a more comprehensive evaluation of how different business process-related variables influence perceived value.

6.6.3 Construct Validity

Construct validity evaluates whether the study accurately measures the intended constructs.

- Questionnaire Reliability: The reliability of the questionnaire used in the experiment posed a potential risk. To address this, a pre-tested and validated questionnaire was employed, ensuring the questions were both relevant and effective in capturing the constructs of interest.
- Participants' Apprehension: There was a concern that participants might feel anxious about being evaluated, potentially influencing their responses. This threat was mitigated by explicitly assuring participants that their performance would not be judged based on the experiment's results. This reassurance fostered a relaxed environment, reducing the likelihood of bias caused by evaluation apprehension.

7 RELATED WORK

This chapter presents the results obtained through a systematic mapping, aimed at understanding how process models represent and validate business values. To achieve this objective, a research protocol was defined according to the guidelines established by (BRERETON et al., 2007), (PETERSEN et al., 2008);(PETERSEN; VAKKALANKA; KUZNIARZ, 2015), and (KEELE et al., 2007), as presented in Appendix A. The application of the protocol identified a total of 755 primary studies. However, after applying the exclusion criteria detailed in Sections A5, A6, and A7, 741 studies were excluded, leaving only 14 primary studies selected. The next section provides an analysis of these 14 studies, which are related to this research.

In 2003, (GORDIJN; WIERINGA, 2003) argued the weak or non-existent integration between business processes and the commercial perspective present in business models. These authors promised to provide guidelines for the transition from a business model to a process model. However, in their 2003 work, they only presented a conceptual framework to map the idea of e-commerce to a business process, maintaining a value orientation (expenses and benefits). Although they mention the validation of the approach in several consulting projects across different sectors, this validation was not detailed in the study (GORDIJN; WIERINGA, 2003).

By 2005, these same authors (WIERINGA; GORDIJN, 2005) proposed an approach to designing coordination processes from a value model. This approach starts by identifying the essential services in the business model and designing the process to execute the necessary business transactions according to the business model's logic. However, to build the coordination model, they assume certain trust assumptions, highlighting that all actors fulfilled their responsibilities in terms of delivering money or goods. In the study, they presented five methodological guidelines for constructing the coordination model:

1. Define a value model as the source model, considering the necessary trust assumptions;
2. Ensure that the process model follows the same trust assumptions for consistent applicability in the same value model;
3. Decide which activities implement each business transaction in the value model;
4. Prove correctness in relation to the value model, demonstrating that all execution paths contain the activities that implement the business transactions, according to the Boolean

logic of the dependency path triggered by the consumer's needs; and Remove trust assumptions as necessary, adding actors and activities when needed.

However, the authors only illustrate this method with a relatively simple business model, where a shipper sends goods through a carrier to a recipient. Unlike the two previous studies, (ZLATEV; WOMBACHER, 2005) did not propose a methodology to derive a process model from a value model. Instead, their methods assume that both models, value and process, are independent of each other. Their approach focuses on verifying consistency between these models using an equivalence check of a common semantic model. In this sense, a reduction model is built from the value and process models, and these reduced models are compared to identify potential inconsistencies between the original models. If there is a lack of consistency, they suggest modifying the process model or the value model to ensure harmony between them. To illustrate the method, the authors present a business case involving a buyer, a seller, and a shipping company as participants.

(WEIGAND et al., 2007) present a method aimed at deriving a process model from a value model, specifically, a BPMN model from an e^{3}value model. The goal is to overcome the ontological gap between the value model (which represents the business's objectives and purposes) and process models (which represent how these objectives are achieved through activities and resources). The proposed method is based on the analysis of the "value object", which is a combination of value resources and the transformations of value subjects. In other words, the value object represents what is valuable to the business and how that value is created and transformed into tangible results. The transformation process from the value model to the process model considers three main aspects of a business:

1. Resource Management Aspect, which relates to the physical flow of resources and the planning of activities over time. Ensuring efficient management of the resources needed to deliver value is essential during the process;

2. Communication Aspect, which involves coordination between customers and suppliers to initiate and complete value transfers. Effective communication is crucial for aligning all involved parties and ensuring understanding of process objectives; and

3. Risk Aspect, which is related to identifying and mitigating risks throughout the process. Considering potential risks and strategies to address them is important for reliably achieving business objectives.

During the transformation from the value model to a process model, the authors recommend using a pattern library. Patterns are general solutions to specific analysis and design problems and can help select the best transformation steps based on the client's non-functional objectives. In this study, no formal validation process is presented, only an illustration of the method using an example.

In 2008, in another study, (WIERINGA et al., 2008) proposed an intermediate model called the "physical delivery model" to bridge the conceptual gap between the value and process models. The need to create this intermediate model stems from the differences between these two types of models. The physical delivery model acts as a bridge to facilitate coordination modeling, as the authors consider both the business model and the coordination model as visualizations of a network of physical deliveries. Therefore, both models describe aspects of the physical world, with the business model being from the real world. To validate the proposed method, the authors applied it in three case studies: electricity delivery, health insurance, international trade with bills of lading, and handling landing at an international airport. These practical applications helped demonstrate the effectiveness of the physical delivery model in harmonizing and coordinating between value and process models in different business contexts.

In 2010, (FATEMI; SINDEREN; WIERINGA, 2010) proposed an approach that combines deriving a coordination model from a business model with formal consistency verification between the models using a model checker. The approach presented by these authors is divided into five steps:

1. Ensure that the actors represented in the value model are the same as those in the coordination model;

2. Identify related groups of value transfers and select the most suitable coordination pattern for each group;

3. Organize the message transfers in the coordination model in the same logical sequence in which value transactions occur;

4. Verify the time constraints of the messages in the coordination model; and

5. Add the necessary administrative activities for each partner and link the included interaction messages.

Except for the second step, which depends on human interpretation, all other steps can be automated using a CASE tool, provided that the answers to each step are supplied to the tool. If implemented, this approach could make the process more efficient and consistent, enabling the verification and validation of the coordination model derived from the business model.

However, it is interesting to highlight that in 2009, in an initial study, (FATEMI; SINDEREN; WIERINGA, 2009) had already presented the initial guidelines for deriving a coordination process model (BPMN) from the value model (e^3value). Later, in 2010, in the subsequent study (FATEMI; SINDEREN; WIERINGA, 2010), this approach was refined with the inclusion of a step to determine exactly the sender, the recipient of the request message, and the involved value object. This addition was considered crucial by the authors to ensure effective coordination between the actors involved in the process.

In both the 2009 (FATEMI; SINDEREN; WIERINGA, 2009) and the 2010 studies (FATEMI; SINDEREN; WIERINGA, 2010)), a manual consistency check is carried out between the models, considering the following informal parameters:

1. If the sets of actors in both models are the same;
2. If the contract period in both models is the same;
3. If for each transaction path in the value model, there is an execution sequence in the coordination model that performs the value transfers of that path; and
4. If for each possible execution sequence in the coordination model, there is a corresponding transaction path where the message exchanges in the sequence represent all the value transfers in the transaction path.

Then, both studies (FATEMI; SINDEREN; WIERINGA, 2009); (FATEMI; SINDEREN; WIERINGA, 2010) tested the scalability of their method in a real-world case, using an example addressing the problem of Intellectual Property Rights release.

(SCHUSTER et al., 2010) provide a mapping of the Resource-Event-Agents (REA) value model to the UN/CEFACT's Modeling Methodology (UMM) global interorganizational business process choreography model through the use of the Atlas Transformation Language (ATL) model-to-model transformation language. The goal is to ensure that the generated business processes do not violate domain rules, meaning they adhere to the basic economic principle of economic reciprocity (give and receive). The authors demonstrate their conceptual mapping method by applying it to a simplified real-world case example.

(BROCKE; MENDLING; RECKER, 2008a); (BROCKE; MENDLING; RECKER, 2008b); (BROCKE; RECKER; MENDLING, 2010)) present and discuss an approach to extending typical process modeling approaches with value-related information. The basic idea of the approach is based on the observation that in every process, every function generates payments (accounts payable) and receipts (accounts receivable). Thus, what is proposed is to estimate and aggregate them based on the overall process structure. To demonstrate and validate the method, two case studies are presented.

In (HOTIE; GORDIJN, 2019), a step-by-step method is proposed to develop a BPMN process model from a previously provided value model. Then, it is verified whether the proposed method produces a process model close to the known reality through a field study. The proposed method is useful for similar value modeling techniques, such as the e^{3}value model and the REA model. The authors argue that due to the semantic gap between the two mentioned models, a simple mapping between them is not possible. Instead, a transition process between the two models is proposed through a human design process. To enable the derivation of the process model, two intermediate models are created:

1. The trust model, based on the value model, which shows the temporal order of value transfers (e.g.: whether a seller gives money before receiving the good or vice versa); and

2. The possession flow model, developed based on the trust model, which represents the physical flow of objects (e.g., if an actor transfers a value object without owning it).

(KHARMOUM et al., 2019) present an approach for automatic model derivation using ATL. In this study, the authors used the e^{3}value value model as a basis for generating three BPMN models: a conversation model, a choreography model, and a collaboration model. The derivation is performed by mapping elements from the e^{3}value and BPMN metamodels, with these transformation rules detailed separately for each target element.

In a subsequent study, (KHARMOUM et al., 2023) also proposed the automatic derivation of a value model into a process model based on ATL. However, in this case, the e^{3}value model serves as the source for deriving a DFD. The authors implement five transformation rules:

1. Convert the 'actors' in the e^{3}value model into 'external entities' in the DFD model;

2. Convert 'value activities' into 'processes' and generate 'data flows' related to the 'external entities' created in rule 1;

3. Generate DFD 'data flows' from e^{3}value 'value objects';
4. Group all the generated DFD objects into one model;
5. Finally, the two attributes 'name' and 'title' from the e^{3}value model are extracted and applied to all the generated DFD objects.

In both studies (KHARMOUM et al., 2019)(KHARMOUM et al., 2023), the authors demonstrate the approach using case studies.

This systematic mapping has revealed important insights into the representation of business values in process models, providing key areas for further exploration in this research.

In summary, we identified that several research efforts have delved into the alignment of business values with organizational processes, offering methods to enable this integration (FATEMI; SINDEREN; WIERINGA, 2010)(GORDIJN; WIERINGA, 2003)(HOTIE; GORDIJN, 2019)(KHARMOUM et al., 2023)(KHARMOUM et al., 2019; SCHUSTER et al., 2010) (BROCKE; RECKER; MENDLING, 2010; WEIGAND et al., 2007; WIERINGA et al., 2008; WIERINGA; GORDIJN, 2005; ZLATEV; WOMBACHER, 2005). However, despite these efforts, there continue to be gaps in understanding the representation of business values in process models.

One of these gaps is that all mentioned articles focus solely on tangible values in process models like money and goods, ignoring the importance of intangible values, such as social, ethics and emotional values. However, these values are also created, captured, and exchanged, and therefore should be represented and validated in process models. Papers like (BROCKE; RECKER; MENDLING, 2010) even highlight the exclusion of intangible values as a limitation of their work. Thus, there is a clear research opportunity in this study, which aims to address the specification of tangible and intangibles values in BPMN process models.

Furthermore, the methods proposed in the papers (SCHUSTER et al., 2010),(WEIGAND et al., 2007),(ZLATEV; WOMBACHER, 2005),(WIERINGA; GORDIJN, 2005) are merely illustrated in simplified examples simulating real cases. However, it is noteworthy that the method proposed in (BROCKE; RECKER; MENDLING, 2010) is demonstrated through case studies. On the hand, papers (FATEMI; SINDEREN; WIERINGA, 2010),(KHARMOUM et al., 2019),(KHARMOUM et al., 2023) perform a model-to-model consistency check. However, none of them provide validation of value representation in BPMN models considering stakeholders' value perception, as proposed in this study.

This research seeks to address these limitations by proposing an instance-based approach that focuses on validating value specifications in BPMN process models. The proposed approach facilitates a comparative evaluation of specified and perceived values by stakeholders, offering prescriptive insights to guide business managers in identifying and addressing potential gaps. By addressing these limitations, this study provides a practical framework for improving the alignment of process models with organizational values, ultimately enhancing business performance.

Although this chapter has presented the main research related to the present work, Table25 summarizes some of the main characteristics extracted from these studies for direct comparison with the objectives of this research.

Table 25 – Summary of Related Works.

Study	Modeling Notation	Type of Value	Validation Method	Analysis Perspective
Kharmoum et al. (2023)	DFD	Monetary	Informal evidence presented in case studies and method-based consistency check	Modeler's view
Hotie and Gordijn (2019)	BPMN	Monetary	Informal evidence presented in case studies	Modeler's view
Kharmoum et al. (2019)	BPMN	Monetary	Informal evidence presented in case studies and method-based consistency check	Modeler's view
Brocke et al. (2010)	EPC e VOFI	Monetary	Informal evidence presented in case studies	Modeler's view
Schuster et al. (2010)	UMM	Monetary	Informal evidence presented in case studies	Modeler's view
Fatemi et al. (2010)	BPMN	Monetary	Informal evidence presented in case studies and manual consistency check	Modeler's view
Fatemi et al. (2009)	BPMN	Monetary	Informal evidence presented in case studies and manual consistency check	Modeler's view
Wieringa et al. (2008)	UML	Monetary	Informal evidence presented in case studies	Modeler's view
Brocke et al. (2008)	EPC e VOFI	Monetary	Informal evidence presented in case studies	Modeler's view
Brocke et al. (2008)b	EPC e VOFI	Monetary	Informal evidence presented in case studies	Modeler's view
Weigand et al. (2007)	BPMN	Monetary	Informal evidence presented in case studies	Modeler's view
Zlatev e Wombacher (2005)	Not specified	Monetary	Informal evidence presented in case studies	Modeler's view
Gordijn e Wieringa (2003)	Not specified	Monetary	Informal evidence presented in case studies	Modeler's view
Wieringa e Gordijn (2005)	UML	Monetary	Informal evidence presented in case studies	Modeler's view
This Study	**BPMN**	**Value of all natures**	**Formalized method based on decision support methods, empirically validated**	**Stakeholder's view**

Fonte: The Author (2024)

8 CONCLUSIONS

Ensuring the alignment between the specified values in a business model and those perceived by stakeholders is a critical imperative for organizations striving to sustain competitiveness and enhance customer satisfaction. This alignment serves as the fundamental part for delivering consistent value propositions, strengthening stakeholder relationships, and achieving strategic objectives. By enabling organizations to identify discrepancies between intended and perceived values, this comparative analysis provides actionable insights, empowering organizations to implement targeted corrective actions that improve the congruence between their strategic goals and the operational outcomes derived from business processes modeled in BPMN, as discussed throughout this thesis.

A key contribution of the proposed method is its innovative use of *fuzzy* logic to assess and interpret value perceptions within BPMN models. By recognizing the multidimensional and subjective nature of value, *fuzzy* logic addresses the inherent imprecision and ambiguity that often characterizes human reasoning. This approach provides a more nuanced and flexible framework for interpreting stakeholders' value perceptions, moving beyond binary classifications and capturing subtle variations in feedback. This nuanced analysis allows for a deeper understanding of whether perceived values align with those specified in BPMN models, facilitating closer alignment with organizational objectives and enhancing process design and execution.

The method's capacity to offer rapid, actionable feedback to process designers and business analysts is another significant advantage. By focusing on usage scenarios directly experienced by stakeholders, the method provides a more practical and efficient alternative to exhaustive validation approaches, which often require extensive time and resources. This makes the proposed method both accessible and scalable, allowing organizations to validate and refine their process models in dynamic, complex environments without sacrificing analytical rigor.

While significant progress has been made in the literature regarding the modeling of values in business processes (GORDIJN; WIERINGA, 2003; WIERINGA; GORDIJN, 2005; WEIGAND et al., 2007; HOTIE; GORDIJN, 2019; KHARMOUM et al., 2019; FATEMI; SINDEREN; WIERINGA, 2010), this research underscores the importance of validating specified values against those perceived by stakeholders—an approach that has been relatively underexplored. This validation is especially pertinent for the widespread adoption of BPMN models among Information

Systems designers, who can leverage this approach not only to assess the accuracy of process specifications but also to develop use cases that are more closely aligned with business requirements.

Nevertheless, the method is not without limitations. While it enhances confidence in the consistency of values, it does not guarantee perfect alignment, which is often the case with exhaustive validation methods. Achieving higher levels of consistency requires testing scenarios with a diverse range of stakeholders to better represent real-world conditions and expectations. The challenge of recruiting such a varied group of stakeholders remains an open problem and presents a promising avenue for future research. Future work could explore innovative mechanisms for automating stakeholder engagement, thus expanding scenario coverage without compromising analytical precision.

Thus, the primary contribution of this research lies in the definition and automation of a systematic, non-exhaustive method for aligning an organization's business values with its BPMN process models. This method is expected to increase efficiency and reduce errors in process design and execution. Additionally, the automation of the tool supporting this method is another significant contribution. By simplifying the application of the proposed method, even for users with limited experience in BPMN or *fuzzy* logic, the tool ensures greater accessibility for organizations that may struggle to find experts in both domains. This capability enhances the practical value of the research and encourages broader adoption of the method across industries.

8.1 FUTURE WORK

Several promising directions for future research emerge from this study. One potential avenue is to apply the proposed method prior to the BPMN modeling stage. This proactive approach would aim to identify which solution alternatives offer the greatest value to the customer before implementation. By doing so, organizations could enhance the accuracy of their decision-making processes and allocate resources more effectively, ensuring that the selected process models align better with customer expectations and business goals from the outset.

Another compelling area for future research involves incorporating the proposed method into usability studies. These studies could focus on assessing stakeholders' value perceptions across different interfaces on the same device or evaluating the same interface across multiple devices, such as computers, tablets, and smartphones. This would provide valuable insights

into how interface design and device-specific factors influence the way stakeholders perceive and engage with business processes, helping organizations optimize their digital touchpoints.

In addition, we plan to explore the inclusion of additional dimensions for quantifying perceived value, such as *ethics*. To integrate these new dimensions into our method, we would first need to identify appropriate attributes that capture ethical considerations in business processes. Subsequently, we would expand our questionnaire to incorporate relevant questions that address these dimensions. Previous research, such as that by (GALLARZA et al., 2017), offers useful insights into consumer value perceptions, particularly in relation to ethical constructs, and could serve as a basis for these new additions.

Furthermore, we envision incorporating an AI-based recommendation system within the proposed method. This system would analyze stakeholders' perceptions of value and suggest potential process improvements based on these insights. By leveraging AI, organizations could dynamically adapt their processes to better meet stakeholder expectations, ultimately enhancing the overall value perception and fostering stronger relationships with their customers and partners.

REFERENCES

AGARWAL, S.; TEAS, R. K. Cross-national applicability of a perceived quality model. *Journal of product & brand management*, MCB UP Ltd, v. 11, n. 4, p. 213–236, 2002.

ALMEIDA, A. T.; MORAIS, D. C. *Decisão em grupo e negociação: métodos e aplicações*. [S.l.]: Interciencia, 2021.

APPADOO, S. S. Pricing financial derivatives with fuzzy algebraic models: A theoretical and computational approach. 2006.

AQUINO, J. T. de; MELO, F. J. C. de; JERONIMO, T. d. B.; MEDEIROS, D. D. de. Evaluation of quality in public transport services: the use of quality dimensions as an input for fuzzy topsis. *International Journal of Fuzzy Systems*, Springer, v. 21, p. 176–193, 2019.

BABIN, B. J.; DARDEN, W. R.; GRIFFIN, M. Work and/or fun: measuring hedonic and utilitarian shopping value. *Journal of consumer research*, The University of Chicago Press, v. 20, n. 4, p. 644–656, 1994.

BAI, Y.; LI, C.; NIU, J. et al. Study on customer-perceived value of online clothing brands. *American Journal of Industrial and Business Management*, Scientific Research Publishing, v. 6, n. 08, p. 914, 2016.

BASILI, V. R.; SHULL, F.; LANUBILE, F. Building knowledge through families of experiments. *IEEE Transactions on Software Engineering*, IEEE, v. 25, n. 4, p. 456–473, 1999.

BAYARAA, S.-O. Some characteristics of fuzzy numbers of curve type. In: IEEE. *2016 11th International Forum on Strategic Technology (IFOST)*. [S.l.], 2016. p. 307–310.

BOEHM, B. W. Value-based software engineering: Overview and agenda. In: _____. *Value-Based Software Engineering*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2006. p. 3–14. ISBN 978-3-540-29263-0.

BOTELHO, T. G. Uma nova proposta para a implementação computacional do princìpio de extensão de zadeh. 2012.

BRADY, M. K.; ROBERTSON, C. J. An exploratory study of service value in the usa and ecuador. *International journal of service industry management*, MCB UP Ltd, v. 10, n. 5, p. 469–486, 1999.

BRERETON, P.; KITCHENHAM, B. A.; BUDGEN, D.; TURNER, M.; KHALIL, M. Lessons from applying the systematic literature review process within the software engineering domain. *Journal of systems and software*, Elsevier, v. 80, n. 4, p. 571–583, 2007.

BROCKE, J. V.; RECKER, J.; MENDLING, J. Value-oriented process modeling: integrating financial perspectives into business process re-design. *Business Process Management Journal*, Emerald Group Publishing Limited, v. 16, n. 2, p. 333–356, 2010.

BROCKE, J. V.; ROSEMANN, M. *Handbook on business process management 1: Introduction, methods, and information systems*. [S.l.]: Springer, 2014.

BROCKE, J. vom; MENDLING, J.; RECKER, J. Towards a value-oriented approach to business process modelling. In: INSTICC-INSTITUTE FOR SYSTEMS AND TECHNOLOGIES OF INFORMATION, CONTROL. *Proc. of the Tenth International Conference on Enterprise Information Systems*. [S.l.], 2008. p. 380–395.

BROCKE, J. vom; MENDLING, J.; RECKER, J. Value-oriented process modeling-towards a financial perspective on business process redesign. In: ASSOCIATION FOR INFORMATION SYSTEMS (AISEL). *Proc. of the Fourteenth Americas Conference on Information Systems*. [S.l.], 2008. p. 1–10.

CARVALHO, P. V. R. de; GRECCO, C. H. dos S.; SOUZA, A. M. de; HUBER, G. J.; GOMES, J. O. A fuzzy model to assess disaster risk reduction maturity level based on the hyogo framework for action. *Natural Hazards*, Springer, v. 83, p. 309–326, 2016.

CHANG, T.-Z.; WILDT, A. R. Price, product information, and purchase intention: An empirical study. *Journal of the Academy of Marketing science*, Springer, v. 22, p. 16–27, 1994.

CHEN, Z.; DUBINSKY, A. J. A conceptual model of perceived customer value in e-commerce: A preliminary investigation. *Psychology & marketing*, Wiley Online Library, v. 20, n. 4, p. 323–347, 2003.

CLIFF, N. Dominance statistics: Ordinal analyses to answer ordinal questions. *Psychological bulletin*, American Psychological Association, v. 114, n. 3, p. 494, 1993.

CRESWELL, J. W. Mapping the developing landscape of mixed methods research. *SAGE handbook of mixed methods in social & behavioral research*, v. 2, n. 0, p. 45–68, 2010.

CRESWELL, J. W.; CLARK, V. L. P. *Pesquisa de Métodos Mistos-: Série Métodos de Pesquisa*. [S.l.]: Penso Editora, 2015.

CRESWELL, J. W.; CRESWELL, J. D. *Research design: Qualitative, quantitative, and mixed methods approaches*. [S.l.]: Sage publications, 2017.

DASTANE, O.; GOI, C. L.; RABBANEE, F. K. The development and validation of a scale to measure perceived value of mobile commerce (mval-scale). *Journal of Retailing and Consumer Services*, Elsevier, v. 71, p. 103222, 2023.

DODDS, W. B. In search of value: How price and store name information influence buyers product perceptions. *Journal of Consumer Marketing*, MCB UP Ltd, v. 8, n. 2, p. 15–24, 1991.

DROGE, C. Know your customer: new approaches to understanding customer value and satisfaction. *Journal of the Academy of Marketing Science*, Springer Nature BV, v. 26, n. 4, p. 351, 1998.

DUBOIS, D.; PRADE, H. Systems of linear fuzzy constraints. *Fuzzy sets and systems*, Elsevier, v. 3, n. 1, p. 37–48, 1980.

DUMAS, M.; ROSA, L. M.; MENDLING, J.; REIJERS, A. H. *Fundamentals of business process management*. [S.l.]: Springer, 2018.

EID-SABBAGH, R.-H.; DIJKMAN, R.; WESKE, M. Business process architecture: use and correctness. In: SPRINGER. *International Conference on Business Process Management*. [S.l.], 2012. p. 65–81.

ELZINGA, D. J.; HORAK, T.; LEE, C.-Y.; BRUNER, C. Business process management: survey and methodology. *IEEE transactions on engineering management*, IEEE, v. 42, n. 2, p. 119–128, 1995.

ENTRINGER, T. C.; FERREIRA, A. d. S.; NASCIMENTO, D. C. d. O. Comparative analysis of the main business process modeling methods: a bibliometric study. *Gestão & Produção*, SciELO Brasil, v. 28, p. e5211, 2021.

ERIKSSON, H.-E.; PENKER, M. Business modeling with uml. *New York*, v. 12, 2000.

FATEMI, H.; SINDEREN, M. van; WIERINGA, R. From business value model to coordination process model. In: SPRINGER. *Enterprise Interoperability: Second IFIP WG 5.8 International Workshop, IWEI 2009, Valencia, Spain, October 13-14, 2009. Proceedings 2*. [S.l.], 2009. p. 94–106.

FATEMI, H.; SINDEREN, M. van; WIERINGA, R. Value-oriented coordination process modeling. In: SPRINGER. *International Conference on Business Process Management*. [S.l.], 2010. p. 162–177.

FLICK, U. An introduction to qualitative research. Sage publications, 2022.

GALLARZA, M. G.; ARTEAGA, F.; CHIAPPA, G. D.; GIL-SAURA, I.; HOLBROOK, M. B. A multidimensional service-value scale based on holbrook's typology of customer value: Bridging the gap between the concept and its measurement. *JOSM*, Emerald Publishing Limited, v. 28, n. 4, p. 724–762, 2017.

GORDIJN, J.; AKKERMANS, H.; VLIET, H. V. Business modelling is not process modelling. In: SPRINGER. *Conceptual Modeling for E-Business and the Web: ER 2000 Workshops on Conceptual Modeling Approaches for E-Business and The World Wide Web and Conceptual Modeling Salt Lake City, Utah, USA, October 9–12, 2000 Proceedings 19*. [S.l.], 2000. p. 40–51.

GORDIJN, J.; WIERINGA, R. J. A value-oriented approach to e-business process design. In: SPRINGER. *Advanced Information Systems Engineering*. [S.l.], 2003. p. 390–403.

GORSCHEK, T.; GARRE, P.; LARSSON, S.; WOHLIN, C. A model for technology transfer in practice. *IEEE software*, IEEE, v. 23, n. 6, p. 88–95, 2006.

GRACE, D.; WEAVEN, S. An empirical analysis of franchisee value-in-use, investment risk and relational satisfaction. *Journal of Retailing*, Elsevier, v. 87, n. 3, p. 366–380, 2011.

HARMON, P.; WOLF, C. Business process modeling survey. *Business process trends*, v. 36, n. 1, p. 1–36, 2011.

HARTLINE, M. D.; JONES, K. C. Employee performance cues in a hotel service environment: Influence on perceived service quality, value, and word-of-mouth intentions. *Journal of business research*, Elsevier, v. 35, n. 3, p. 207–215, 1996.

HEDGES, L. V.; OLKIN, I. *Statistical methods for meta-analysis*. [S.l.]: Academic press, 2014.

HELFAT, C. E.; PETERAF, M. A. The dynamic resource-based view: Capability lifecycles. *Strategic management journal*, Wiley Online Library, v. 24, n. 10, p. 997–1010, 2003.

HELKKULA, A.; KELLEHER, C.; PIHLSTRÖM, M. Characterizing value as an experience: implications for service researchers and managers. *Journal of service research*, Sage publications Sage CA: Los Angeles, CA, v. 15, n. 1, p. 59–75, 2012.

HILL, J. B.; SINUR, J.; FLINT, D.; MELENOVSKY, M. J. Gartner's position on business process management. *Gartner Research G*, v. 136533, 2006.

HOLBROOK, M. B. The nature of customer value: An axiology of services in the consumption experience. *Service Quality: New Directions in Theory and Practice/Sage*, 1994.

HOLBROOK, M. B. Introduction to consumer value. *Consumer Value: A Framework for Analysis and Research*, London: Routledge, p. 1–28, 1999.

HOTIE, F.; GORDIJN, J. Value-based process model design. *Business & Information Systems Engineering*, Springer, v. 61, n. 2, p. 163–180, 2019.

INDULSKA, M.; RECKER, J.; ROSEMANN, M.; GREEN, P. Business process modeling: Current issues and future challenges. In: SPRINGER. *Advanced Information Systems Engineering: 21st International Conference, CAiSE 2009, Amsterdam, The Netherlands, June 8-12, 2009. Proceedings 21*. [S.l.], 2009. p. 501–514.

KEELE, S. et al. *Guidelines for performing systematic literature reviews in software engineering*. [S.l.], 2007.

KERIN, R. A.; JAIN, A.; HOWARD, D. J. Store shopping experience and consumer price-quality-value perceptions. *Journal of retailing*, Elsevier Limited, v. 68, n. 4, p. 376, 1992.

KHALIFA, A. S. Customer value: a review of recent literature and an integrative configuration. *Management decision*, Emerald Group Publishing Limited, v. 42, n. 5, p. 645–666, 2004.

KHARMOUM, N.; RETAL, S.; BOUCHTI, K. E.; RHALEM, W.; ZITI, S. An automatic alignment of the business process and business value models: a novel mda method. *IJEECS*, v. 30, n. 1, p. 501–509, 2023.

KHARMOUM, N.; ZITI, S.; RHAZALI, Y.; FOUZIA, O. A method of model transformation in mda approach from e3value model to bpmn2 diagrams in cim level. *IAENG International Journal of Computer Science*, v. 46, n. 4, 2019.

KO, R. K. A computer scientist's introductory guide to business process management (bpm). *XRDS: Crossroads, The ACM Magazine for Students*, ACM New York, NY, USA, v. 15, n. 4, p. 11–18, 2009.

KOCBEK, M.; JOŠT, G.; HERIČKO, M.; POLANČIČ, G. Business process model and notation: The current state of affairs. *Computer Science and Information Systems*, v. 12, n. 2, p. 509–539, 2015.

KRAEMER, H. C.; KUPFER, D. J. Size of Treatment Effects and Their Importance to Clinical Research and Practice. *Biological Psychiatry*, Elsevier, v. 59, n. 11, p. 990–996, Jun 2006. ISSN 0006-3223.

LAMRHARI, S.; ELGHAZI, H.; FAKER, A. E. Business intelligence using the fuzzy-kano model. *Journal of Intelligence Studies in Business*, v. 9, n. 2, 2019.

LAPIERRE, J. Customer-perceived value in industrial contexts. *Journal of business & industrial marketing*, MCB UP Ltd, v. 15, n. 2/3, p. 122–145, 2000.

LEOPOLD, H.; MENDLING, J.; GUENTHER, O. Learning from quality issues of bpmn models from industry. *IEEE Software*, IEEE Computer Society, v. 33, n. 4, p. 26–33, 2016.

LU, R.; SADIQ, S. A survey of comparative business process modeling approaches. In: SPRINGER. *Business Information Systems: 10th International Conference, BIS 2007, Poznan, Poland, April 25-27, 2007. Proceedings 10*. [S.l.], 2007. p. 82–94.

MA, M.; KANDEL, A.; FRIEDMAN, M. Representing and comparing two kinds of fuzzy numbers. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, IEEE, v. 28, n. 4, p. 573–576, 1998.

MACKAY, H. *Turning point: Australians choosing their future*. [S.l.]: Pan Macmillan, 1999.

MAGALHÃES, W. d. F. Um modelo para a autoavaliação das mpes construtoras de edifícios aos requisitos do pbqp-h/siac. 2012.

MATTSSON, J. Better business by the abc of values. 1991.

MEIRELLES, D. S. e. Business model and strategy: in search of dialog through value perspective. *Revista de Administração Contemporânea*, SciELO Brasil, v. 23, n. 6, p. 786–806, 2019.

MELO, F. J. C. de; XAVIER, L. d. A.; ALBUQUERQUE, A. P. G. de; MEDEIROS, D. D. de. Evaluation of quality of online shopping services in times of covid-19 based on es-qual model and fuzzy topsis method. *Soft computing*, Springer, v. 27, n. 11, p. 7497–7511, 2023.

MENDLING, J.; STREMBECK, M. Influence factors of understanding business process models. In: SPRINGER. *International conference on business information systems*. [S.l.], 2008. p. 142–153.

MINAYO, M. C. d. S.; SANCHES, O. Quantitativo-qualitativo: oposição ou complementaridade? *Cadernos de saúde pública*, SciELO Public Health, v. 9, p. 237–248, 1993.

MIZIK, N.; JACOBSON, R. Trading off between value creation and value appropriation: The financial implications of shifts in strategic emphasis. *Journal of marketing*, SAGE Publications Sage CA: Los Angeles, CA, v. 67, n. 1, p. 63–76, 2003.

MOORE, R. *Formal Theories of the Common Sense World, chapter A Formal Theory of Knowledge and Action*. [S.l.]: Ablex Publishing Company, 1984.

MOORE, R. C. *The role of logic in knowledge representation and commonsense reasoning*. [S.l.]: SRI International. Artificial Intelligence Center, 1982.

NEUMAN, W. L. *Social research methods: Qualitative and quantitative approaches*. [S.l.]: Pearson, 2014.

NGUYEN, H. T.; WALKER, C.; WALKER, E. A. *A first course in fuzzy logic*. [S.l.]: Chapman and Hall/CRC, 2018.

Object Management Group. *Business Process Model and Notation (2.0.2)*. 2014. <https://www.omg.org/spec/BPMN>.

OSTERWALDER, A.; PIGNEUR, Y.; TUCCI, C. L. Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems*, v. 16, n. 1, p. 1, 2005.

OVERBY, J. W.; LEE, E.-J. The effects of utilitarian and hedonic online shopping value on consumer preference and intentions. *Journal of Business research*, Elsevier, v. 59, n. 10-11, p. 1160–1166, 2006.

PARASURAMAN, A.; GREWAL, D. The impact of technology on the quality-value-loyalty chain: a research agenda. *Journal of the academy of marketing science*, Sage Publications Sage CA: Thousand Oaks, CA, v. 28, n. 1, p. 168–174, 2000.

PATHINATHAN, T.; SANTHOSHKUMAR, S. Quadrilateral fuzzy number. *International Journal of Engineering and Technology*, v. 7, n. 4-10, p. 1018–1021, 2018.

PEDRYCZ, W. Why triangular membership functions? *Fuzzy sets and Systems*, Elsevier, v. 64, n. 1, p. 21–30, 1994.

PEDRYCZ, W.; EKEL, P.; PARREIRAS, R. *Fuzzy multicriteria decision-making: models, methods and applications*. [S.l.]: John Wiley & Sons, 2011.

PETERSEN, K.; FELDT, R.; MUJTABA, S.; MATTSSON, M. Systematic mapping studies in software engineering. In: BCS LEARNING & DEVELOPMENT. *12th international conference on evaluation and assessment in software engineering (EASE)*. [S.l.], 2008.

PETERSEN, K.; VAKKALANKA, S.; KUZNIARZ, L. Guidelines for conducting systematic mapping studies in software engineering: An update. *Information and software technology*, Elsevier, v. 64, p. 1–18, 2015.

PETRICK, J. F. Development of a multi-dimensional scale for measuring the perceived value of a service. *Journal of leisure research*, Taylor & Francis, v. 34, n. 2, p. 119–134, 2002.

PRASAD, S.; SINHA, A. Ranking fuzzy numbers with unified integral value and comparative reviews. *Journal of Scientific Research*, v. 14, n. 1, p. 131–151, 2022.

PRESTES, M. L. d. M. A pesquisa e a construção do conhecimento científico: do planejamento aos textos, da escola à academia. são paulo: Rêspel, 2003. richardson, roberto jarry. *Pesquisa social: métodos e técnicas*, v. 3, 2012.

RECKER, J.; ROSEMANN, M.; INDULSKA, M.; GREEN, P. Business process modeling-a comparative analysis. *Journal of the association for information systems*, v. 10, n. 4, p. 1, 2009.

RICHARDSON, R. J. métodos e técnicas. *São Paulo: Atlas*, 1999.

RICHARDSON, R. J.; PERES, J. A.; WANDERLEY, J. C. V. et al. *Pesquisa social: métodos e técnicas*. [S.l.]: Atlas São Paulo, 1985.

RINTAMÄKI, T.; KUUSELA, H.; MITRONEN, L. Identifying competitive customer value propositions in retailing. *Managing Service Quality: An International Journal*, Emerald Group Publishing Limited, v. 17, n. 6, p. 621–634, 2007.

ROIG, J. C. F.; GARCIA, J. S.; TENA, M. A. M.; MONZONIS, J. L. Customer perceived value in banking services. *International Journal of Bank Marketing*, Emerald Group Publishing Limited, v. 24, n. 5, p. 266–283, 2006.

ROSS, T. J. *Fuzzy logic with engineering applications*. [S.l.]: John Wiley & Sons, 2005.

SÁNCHEZ-FERNÁNDEZ, R.; INIESTA-BONILLO, M. Á. The concept of perceived value: a systematic review of the research. *Marketing theory*, Sage Publications Sage UK: London, England, v. 7, n. 4, p. 427–451, 2007.

SANTOS-NETO, J. B. S. dos; COSTA, A. P. C. S. A multi-criteria decision-making model for selecting a maturity model. *International Journal of Decision Support System Technology (IJDSST)*, IGI Global, v. 15, n. 1, p. 1–15, 2023.

SCHUETTE, R.; ROTTHOWE, T. The guidelines of modeling–an approach to enhance the quality in information models. In: SPRINGER. *International Conference on Conceptual Modeling*. [S.l.], 1998. p. 240–254.

SCHUSTER, R.; MOTAL, T.; HUEMER, C.; WERTHNER, H. From economic drivers to b2b process models: A mapping from rea to umm. In: SPRINGER. *Business Information Systems*. [S.l.], 2010. p. 119–131.

SETH, J.; NEWMAN, B. I.; GROSS, B. L. Consumption values and market choices. *Theory and Applications, South Western Publising, Fort Knox, TX*, 1991.

SILVA, L. C. E.; COSTA, A. P. C. S. It project investments: an analysis based on a sort and rank problem. *International Journal of Information Technology & Decision Making*, World Scientific, v. 13, n. 04, p. 699–719, 2014.

SIMÕES, M. G.; SHAW, I. S. *Controle e modelagem fuzzy*. [S.l.]: Editora Blucher, 2007.

SOLINGEN, R. V.; BASILI, V.; CALDIERA, G.; ROMBACH, H. D. Goal question metric (gqm) approach. *Encyclopedia of software engineering*, Wiley Online Library, 2002.

SOUZA, E.; MOREIRA, A.; ARAÚJO, J.; ABRAHÃO, S.; INSFRAN, E.; SILVEIRA, D. S. D. Comparing business value modeling methods: A family of experiments. *Information and Software Technology*, Elsevier, v. 104, p. 179–193, 2018.

SOUZA, L. M. de; SILVEIRA, D. S. da; DUARTE, R. B.; BEZERRA, A. T. Diretrizes de layout na compreensão de modelos bpmn: Uma análise cognitiva. *Revista Ibérica de Sistemas e Tecnologias de Informação*, Associação Ibérica de Sistemas e Tecnologias de Informacao, n. E65, p. 529–542, 2024.

SPITERI, J. M.; DION, P. A. Customer value, overall satisfaction, end-user loyalty, and market performance in detail intensive industries. *Industrial marketing management*, Elsevier, v. 33, n. 8, p. 675–687, 2004.

SWEENEY, J. C.; SOUTAR, G. N. Consumer perceived value: The development of a multiple item scale. *Journal of retailing*, Elsevier, v. 77, n. 2, p. 203–220, 2001.

SWEENEY, J. C.; SOUTAR, G. N.; JOHNSON, L. W. The role of perceived risk in the quality-value relationship: A study in a retail environment. *Journal of retailing*, Elsevier, v. 75, n. 1, p. 77–105, 1999.

TEIXEIRA, J.; SANTOS, M. Y.; MACHADO, R. J. Business process modeling languages and their data representation capabilities. In: IEEE. *2018 International Conference on Intelligent Systems (IS)*. [S.l.], 2018. p. 685–691.

TUREL, O.; SERENKO, A.; BONTIS, N. User acceptance of wireless short messaging services: Deconstructing perceived value. *Information & Management*, Elsevier, v. 44, n. 1, p. 63–73, 2007.

VARSHNEYA, G.; DAS, G. Experiential value: Multi-item scale development and validation. *Journal of Retailing and Consumer Services*, Elsevier, v. 34, p. 48–57, 2017.

VERGIDIS, K.; TURNER, C. J.; TIWARI, A. Business process perspectives: Theoretical developments vs. real-world practice. *International journal of production economics*, Elsevier, v. 114, n. 1, p. 91–104, 2008.

VIRIYASITAVAT, W.; XU, L. D.; MARTIN, A. Swspec: The requirements specification language in service workflow environments. *IEEE Transactions on Industrial Informatics*, IEEE, v. 8, n. 3, p. 631–638, 2012.

WALSH, G.; MITCHELL, V.-W.; KILIAN, T.; MILLER, L. Measuring consumer vulnerability to perceived product-similarity problems and its consequences. *Journal of Marketing Management*, Taylor & Francis, v. 26, n. 1-2, p. 146–162, 2010.

WALSH, G.; SHIU, E.; HASSAN, L. M. Replicating, validating, and reducing the length of the consumer perceived value scale. *Journal of Business Research*, Elsevier, v. 67, n. 3, p. 260–267, 2014.

WANG, Y.; LO, H. P.; CHI, R.; YANG, Y. An integrated framework for customer value and customer-relationship-management performance: a customer-based perspective from china. *Managing service quality: An international journal*, Emerald Group Publishing Limited, v. 14, n. 2/3, p. 169–182, 2004.

WEIGAND, H.; JOHANNESSON, P.; ANDERSSON, B.; BERGHOLTZ, M.; EDIRISURIYA, A.; ILAYPERUMA, T. On the notion of value object. In: SPRINGER. *Advanced Information Systems Engineering: 18th International Conference, CAiSE 2006, Luxembourg, Luxembourg, June 5-9, 2006. Proceedings 18*. [S.l.], 2006. p. 321–335.

WEIGAND, H.; JOHANNESSON, P.; ANDERSSON, B.; BERGHOLTZ, M.; EDIRISURIYA, A.; ILAYPERUMA, T. Value object analysis and the transformation from value model to process model. In: SPRINGER. *Enterprise Interoperability: new challenges and approaches*. [S.l.], 2007. p. 55–65.

WESKE, M. *Business Process Management*. [S.l.]: Springer, 2019.

WIERINGA, R.; PIJPERS, V.; BODENSTAFF, L.; GORDIJN, J. Value-driven coordination process design using physical delivery models. In: SPRINGER. *International Conference on Conceptual Modeling*. [S.l.], 2008. p. 216–231.

WIERINGA, R. J.; GORDIJN, J. Value-oriented design of service coordination processes: correctness and trust. In: *Proc. of the 2005 ACM symposium on Applied computing*. [S.l.: s.n.], 2005. p. 1320–1327.

WILLIAMS, J.; GAZLEY, A.; ASHILL, N. Children's perceived value: conceptualization, scale development, and validation. *Journal of Retailing*, Elsevier, v. 97, n. 2, p. 301–315, 2021.

WILLIAMS, P.; SOUTAR, G. N. Dimensions of customer value and the tourism experience: An exploratory study. In: PROMACO CONVENTIONS PTY. LTD. QUEENSLAND, AUSTRALIA. *Australian and New Zealand Marketing Academy Conference*. [S.l.], 2000. v. 28, n. 5, p. 1415–1421.

WILLIAMS, P.; SOUTAR, G. N. Value, satisfaction and behavioral intentions in an adventure tourism context. *Annals of tourism research*, Elsevier, v. 36, n. 3, p. 413–438, 2009.

WOHLIN, C.; RUNESON, P.; HÖST, M.; OHLSSON, M. C.; REGNELL, B.; WESSLÉN, A. et al. *Experimentation in software engineering*. [S.l.]: Springer, 2012.

WOODRUFF, R. B. Customer value: the next source for competitive advantage. *Journal of the academy of marketing science*, Springer, v. 25, p. 139–153, 1997.

WU, T.; LIU, X.; QIN, J.; HERRERA, F. An interval type-2 fuzzy kano-prospect-topsis based qfd model: Application to chinese e-commerce service design. *Applied Soft Computing*, Elsevier, v. 111, p. 107665, 2021.

XU, L. D. Enterprise systems: state-of-the-art and future trends. *IEEE transactions on industrial informatics*, IEEE, v. 7, n. 4, p. 630–640, 2011.

ZADEH, L. The concept of a linguistic variable and its application to approximate reasoning i. fuzzy sets and applications: Selected papers by la zadeh. rr yager, s. ovchinnikiv, r. tong and ht nguyen. *New York, John Wiley & Sons. Reprinted from: Information Sciences*, v. 8, n. 1975, p. 219–269, 1987.

ZADEH, L. A. Fuzzy sets. *Information and control*, Elsevier, v. 8, n. 3, p. 338–353, 1965.

ZADEH, L. A. Knowledge representation in fuzzy logic. In: *An introduction to fuzzy logic applications in intelligent systems*. [S.l.]: Springer, 1992. p. 1–25.

ZEITHAML, V. A. Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence. *Journal of marketing*, SAGE Publications Sage CA: Los Angeles, CA, v. 52, n. 3, p. 2–22, 1988.

ZHAO, X.; HWANG, B.-G.; LOW, S. P. Developing fuzzy enterprise risk management maturity model for construction firms. *Journal of construction engineering and management*, American Society of Civil Engineers, v. 139, n. 9, p. 1179–1189, 2013.

ZIMMERMANN, H.-J.; ZIMMERMANN, H.-J. Future perspectives. *Fuzzy Set Theory—and Its Applications*, Springer, p. 403–405, 1996.

ZLATEV, Z.; WOMBACHER, A. Consistency between e 3-value models and activity diagrams in a multi-perspective development method. In: SPRINGER. *On the Move to Meaningful Internet Systems 2005: CoopIS, DOA, and ODBASE*. [S.l.], 2005. p. 520–538.

APPENDIX A – SYSTEMATIC MAPPING PROTOCOL

1

Este mapeamento teve seu início a partir da elaboração de um protocolo de pesquisa, onde as questões de pesquisa e a *string* de busca utilizada nas bibliotecas digitais foram formuladas. Em seguida, as estratégias de busca, as fontes de pesquisa e os critérios para inclusão e exclusão dos estudos foram definidos. Posteriormente, os critérios de qualidade pelos quais os estudos selecionados seriam avaliados foram estabelecidos. Por fim, a validação e sugestões adicionais para aprimoramento do protocolo definido foram buscadas através de revisão realizada por especialistas em engenharia de software baseada em evidências (do inglês, *Evidence-Based Software Engineering* ou EBSE).

A.1 Formulação das Questões de Pesquisa

A definição do objetivo deste mapeamento segue a estrutura PICOC (PETTICREW; ROBERTS, 2005) (ver Tabela 7), que é um acrônimo dos seguintes termos em inglês: *Population*, *Intervention*, *Comparison*, *Outcome* e *Context* (população, intervenção, comparação, resultado e contexto). Essa estrutura foi utilizada para direcionar o foco do estudo para aspectos relevantes, orientando também a fase de seleção dos estudos incluídos. Dessa forma, essa abordagem levou à formulação da seguinte questão de pesquisa (QP):

Como a criação, captura e entrega de valor estão sendo representadas nos modelos de processos de negócio?

Tabela 1 - *Análise PICOC.*

População:	Artigos que se concentram na modelagem da criação, captura e entrega de valor nos modelos de processos de negócio.
Intervenção:	Formas de representar a criação, entrega e captura de valor em modelos de processos de negócio.
Comparação:	Não aplicável, pois a intenção aqui é apenas identificar as formas de representação gráfica de valor nos modelos de processos.
Resultado:	Visão geral da representação de valor nos modelos de processos.
Contexto:	Artigos de pesquisa, pois estamos trabalhando em um contexto de pesquisa com especialistas em modelagem de processos, bem como outros profissionais e acadêmicos da área de sistemas de informação.

Com o propósito de alcançar esse objetivo, foram investigadas questões secundárias (QS) para estruturar a obtenção de informações relevantes para responder à questão de pesquisa principal. Dessa forma, as questões definidas neste mapeamento foram os seguintes:

- QS_1: qual é a notação utilizada para especificar a criação, captura e entrega de valor nos modelos de processos de negócio?
- QS_2: Existem técnica de validação ou verificação da acurácia da especificação de valor nos modelos de processo de negócio?
- QS_3: Existem experimentos que comprovem a eficácia dessa validação ou verificação no estudo?

A.2 Formulação da *String* de Busca

Os termos-chave na questão de pesquisa resultaram na definição das *strings* de busca. Na Tabela 8, a questão de pesquisa repetida destaca os termos-chave com negrito, repetindo-os na primeira coluna, e as respectivas expressões conectadas com operadores *AND* seguem respectivamente na mesma linha, formando assim a *string* de busca final.

Tabela 2 - *Construção da String de Busca.*

QP: Como a criação, captura e entrega de **valor** estão sendo **representadas** nos **modelos de processos de negócio**?	
Valor	(“*value-based*” *OR* “*value based*” *OR* “*value-driven*” *OR* “*value driven*” *OR* “*value-oriented*” *OR* “*value oriented*” *OR* “*business value*” *OR* “*value model*”)
Representadas	(“*representation*” *OR* “*construction*” *OR* “*design*” OR “*transformation*”)
Modelos de processos	(“*process model*” *OR* “*business process*”)

A.3 Definição das Estratégias de Busca

Nesta revisão, a estratégia de busca adotou dois métodos complementares (ZHANG et al., 2011): automático e manual. A busca automática utilizou os termos de busca descritos na Tabela 8 para localizar os estudos primários em fontes de dados eletrônicos. Por outro lado, na busca manual, foi empregada uma abordagem de bola de neve (do inglês, *snowball*) para identificar estudos primários adicionais com foco na questão de pesquisa mencionada previamente.

A.4. Seleção das Fontes de Pesquisa

A pesquisa utilizou uma *string* de busca que foi executada em seis bibliotecas digitais, sem qualquer tipo restrição: IEEE *Explore*, ACM, *Science Direct*, *Springer*, *Scopus* e Web *of*

Science. Essa escolha foi feita porque essas bibliotecas abrangem os fóruns mais importantes tanto para estudos organizacionais como para a ciência da computação, publicando trabalhos sobre processos de negócios.

Porém, em um estágio posterior da pesquisa, tanto o DBLP quanto o *Google Scholar* também foram utilizados para apoiar as buscas com informações adicionais sobre cada estudo, como o número de citações e informações sobre os autores.

A.5 Definição dos Critérios de Inclusão e Exclusão

Os critérios de inclusão e exclusão foram estabelecidos para auxiliar na seleção dos estudos primários relevantes para análise e extração de dados. Como resultado, foram incluídos estudos revisados por pares de revistas, conferências e *workshops* que abrangem a especificação de valor na modelagem de processos (I1). Adicionalmente, foram incluídos estudos relevantes mencionados pelos autores que foram revisados durante a condução da pesquisa, obtidos meio do método de bola de neve (I2).

Por outro lado, foram excluídos estudos que não estavam disponíveis para *download* das bases de origem e cujos autores não responderam à nossa solicitação (E1), também foram excluídos estudos que contavam apenas os resumos ou resumos estendidos com menos de seis páginas (E2). Outras exclusões foram aplicadas a estudos duplicados ou com o mesmo conteúdo (E3), estudos que não responderam à questão de pesquisa principal (E4), estudos escritos não escritos em idioma diferente do inglês (E5) e estudos que não atendiam aos critérios de qualidade (E6). Mais detalhes sobre os critérios de qualidade podem ser encontrados na seção A.7.

Aqui é importante destacar que os critérios de exclusão foram aplicados em quatro etapas distintas. Na primeira etapa, todos os estudos candidatos foram analisados através da leitura dos títulos e resumos. Posteriormente, com os estudos candidatos remanescentes, foi realizada a segunda etapa, com leitura completa dos textos, excluindo alguns estudos e incluindo outros de acordo com o critério I2. Na terceira etapa, foram analisados os estudos candidatos incluídos pelo critério I2 através da leitura completa dos textos. Por fim, os critérios de exclusão, conforme mencionado, foram aplicados.

A.6 Definição da Estratégia de Extração de Dados

4

O objetivo desta etapa foi definir a estratégia para a extração de dados dos estudos primários selecionados. Para isso, foi elaborado um formulário de extração de dados que inclui seções obrigatórias e, pelo menos, uma das seções opcionais. Essa abordagem foi necessária porque nem todos os estudos selecionados abordam todas as questões secundárias de pesquisa. As seções do formulário são as seguintes:

1o Seção (obrigatório): registra informações básicas sobre o identificador do artigo, título, conferência ou periódico, ano, número de citações e biblioteca digital;

2o Seção (obrigatória e associada a QP): registra o método de especificação de valor utilizado;

3o Seção (opcional e associada ao QS_1): registra a notação utilizada para especificar a criação, captura e entrega de valor nos modelos de processos de negócio;

4o Seção (opcional e associada ao QS_2): registra se há alguma técnica de validação ou verificação da acurácia da especificação de valor nos modelos de processo de negócio;

5o Seção (opcional e associada ao QS_3): registra se há algum tipo de experimento que comprove a eficácia dessa validação ou verificação no estudo.

A.7 Definição dos Critérios de Avaliação de Qualidade

Nesta seção é importante destacar que o objetivo deste mapeamento não é inferir sobre a qualidade dos estudos em si. Em vez disso, o foco é avaliar a adequação dos estudos em relação aos objetivos do mapeamento. Conforme destacado por Kitchenham e Charters (2007), a qualidade dos estudos primários selecionados é fundamental para garantir resultados mais confiáveis em um mapeamento. Com esse propósito, foram definidos quatro critérios de avaliação da adequação à qualidade (AQ1-AQ4) que foram aplicados no critério de exclusão E6, seguindo uma abordagem similar àquela apresentada por Souza *et al*. (2019) e replicada com sucesso por Duarte *et al*. (2021), utilizando informações bibliométricas de impacto.

Em relação aos critérios de adequação de qualidade, o critério AQ1 utiliza quatro questões gerais e quatro específicas (Tabela 9). O critério AQ2 baseia-se na classificação dos fóruns de publicações, o critério AQ3 utiliza o número de citações dos estudos e, por fim, o

critério AQ4 que apresenta uma abordagem mais flexível em relação aos estudos mais recentes. A seguir, cada um desses critérios está apresentado com mais detalhes.

Sobre o critério AQ1, ele é calculado utilizando o índice de qualidade dado por Equação (5), na qual os fatores de avaliação geral (*G*) e específico (*E*) estão resumidos na Tabela 9. Esse cálculo resulta em uma quantificação numérica para classificar os estudos selecionados. A lista de verificação de avaliação da adequação possui os fatores *G* e *E*, compostos por quatro itens cada, sendo cada item recebe uma pontuação máxima de 1. Neste sentido, é possível calcular uma média ponderada, na qual o fator *E* tem um peso três vezes mais do que o fator *G*. Isso ocorre porque as contribuições específicas (*E*) de um estudo são consideradas mais importantes do que as contribuições gerais (*G*).

Com base nessa avaliação, os estudos com pontuação geral ≥ 2,5 foram classificados como "*alto*" em termos de qualidade. Já os estudos com pontuação ≥ 1,5 e < 2,5 foram considerados de "*médio*" nível de qualidade. Por outro lado, os estudos com pontuação < 1,5 foram classificados como "*inferior*" e, portanto, serão excluídos da análise.

Tabela 3 - *Critérios AQ1.*

Itens Gerais (G) = 25%	**Itens Específicos (E) = 75%**
G1: Definição do problema e motivação do estudo	E1: se o estudo apresenta alguma validação para o resultado apresentado
a) definição explícita (1,0)	a) validação formalizada (1,0)
b) definição geral (0,5)	b) algumas evidências informais de validação são fornecidas (0,5)
c) sem definição (0,0)	c) validação não justificada ou *ad-hoc* (0,0)
G2: Metodologia e organização de pesquisa	E2: se o estudo apresenta algum método de especificação de valor nos modelos
a) uma metodologia empírica (1,0)	a) método de especificação formalizado (1,0)
b) uma análise generalizada (0,5)	b) algumas evidências informais de método são fornecidas (0,5)
c) não tem métodos adequados (0,0)	c) método de especificação não justificado ou *ad-hoc* (0,0)
G3: As contribuições do estudo referem-se aos resultados do estudo	E3: se há insights ou lições relatadas sobre o uso dos modelos (reflexão)
a) correlaciona explicitamente contribuições aos resultados (1,0)	a) insights e lições bem estruturadas e fundamentadas (1,0)

b) não há correlação entre contribuições e resultados (0,5)	b) indícios de insights e lições vagas e pouco estruturadas são relatados (0,5)
c) não há descrição de contribuições ou resultados (0,0)	c) sem relato de insights ou lições sobre o uso dos modelos (0,0)
G4: Limitações e implicações futuras do estudo	E4: se o estudo apresenta exemplos/modelos reais
a) avaliações empíricas formalizadas (1,0)	a) exemplo de caso real formalizado (1,0)
b) algumas evidências informais são fornecidas (0,5)	b) algumas evidências informais de aplicação em caso real são fornecidas (0,5)
c) validação não justificada ou ad hoc (0,0)	c) caso real não apresentado (0,0)

Fonte: Adaptado de Souza *et al*. (2019) e Duarte *et al*. (2021).

$$\text{Índice de Qualidade} = \left[\left(\frac{1}{4} \times \sum_{i=1}^{4} G_i\right) + \left(\frac{3}{4} \times \sum_{i=1}^{4} E_i\right)\right] \quad \text{Eq. (5)}$$

Sobre o AQ2, ele classificou os estudos de acordo com os fóruns em que foram publicados. Para essa avaliação, foi utilizado o CORE para determinar as classificações das conferências taxas para conferências e o *SCImago* para determinar as taxas das revistas. Assim, foi considerado como "*alto*" os estudos publicados em conferências com classificação como "*A*" ou em revistas classificadas como "*Q*1". Já os estudos publicados em conferências classificadas como "*B*" ou revistas classificadas como "*Q*2" foram consideradas como de adequação "*média*". Por fim, os estudos publicados em conferências classificadas como "*C*" ou em revistas classificadas como "*Q*3" foram considerados de adequação "*inferior*".

O critério AQ3 classificou os estudos de acordo com o número de citações que receberam. Os estudos com mais de cinco citações foram considerados com "*alta*" adequação, os estudos com menos de cinco citações foram classificados com a adequação "*média*" e os estudos sem citações como de adequação "*inferior*". Para verificar o número de citações, utilizou-se o *Google Scholar*. No entanto, o critério AQ3 pode ser injusto com trabalhos mais recentes, que podem ter menos citações. Para lidar com essa situação, o critério AQ4 analisou os estudos publicados nos últimos cinco anos. Dessa forma, esses estudos foram considerados com "*alta*" adequação se possuíam pelo menos uma citação. Já os estudos sem citações foram considerados com adequação "*média*".

Portanto, para que um estudo fosse devidamente incluído neste mapeamento, ele deveria ter a avaliação indicada em todos os critérios como "*alta*".

7

A.8 Revisão de Protocolo

Após a conclusão do protocolo, o mesmo foi submetido à revisão por dois revisores externos ao estudo. A avaliação foi baseada em uma apresentação com *slides* explicando o estudo e o próprio protocolo. As opiniões dos revisores, em geral, foram positivas.

Entretanto, o processo de revisão proporcionou melhorias no protocolo, especialmente em relação aos critérios de adequação, permitindo inclusão também de estudos classificados como "*médio*", visando uma maior abrangência de periódicos e conferências escolhidos, bem como mitigar possíveis subjetividades na avaliação dos fatores gerais e específicos.

Além da avaliação pelos revisores, um teste piloto foi realizado para identificar possíveis problemas na aplicação do protocolo. Neste teste, nenhum problema foi identificado, mas ficou evidente a necessidade de utilizar uma ferramenta bibliográfica para facilitar o gerenciamento de todos os estudos. Assim, os estudos selecionados foram catalogados em uma ferramenta de gerenciamento de bibliografia, enquanto os dados extraídos foram mantidos em uma planilha de trabalho no *excel*.

APPENDIX B – CONSENT FORM IN SPANISH

U P V - D S I C
Universitat Politécnica de València
Departamento de Sistemas
Informáticos y Computación

CONSENTIMIENTO A PARTICIPAR EN UN ESTUDIO EXPERIMENTAL

Título del Estudio:	Evaluación de la Percepción de Valor en Modelos de Proceso
Investigador:	Tatiane da Costa Torres de Andrade
Conductores del experimento:	
Correo de contacto:	tatiane.torres@ufpe.br

Gracias por considerar participar en esta investigación. La persona encargada del experimento debe explicarle el proyecto antes de que acepte colaborar. Si tiene cualquier pregunta relativa a la hoja informativa o a la explicación proporcionada, pregunte a la persona que está llevando a cabo el experimento antes de decidir si desea participar. Si lo necesita, se le proporcionará una copia de este formulario de consentimiento para que la guarde y pueda utilizarla en cualquier momento.

Usted entiende que, si decide en cualquier momento a lo largo del experimento que ya no desea seguir participando en él, puede avisar a los investigadores involucrados y abandonarlo inmediatamente.

Consiente en el procesamiento de su información personal para las necesidades de este estudio de investigación. Esta información será considerada como estrictamente confidencial y tratada de acuerdo con lo recogido en las políticas de protección de datos de la España y General Data Protection Regulation (GDPR).

□ Por favor, marque esta casilla si acepta que los investigadores se pongan en contacto con usted en lo relativo a participar en experimentos futuros.
Si así lo desea, por favor, indique su dirección de e-mail: ……..

Declaración del participante:
Yo, ……., acepto que el proyecto de investigación nombrado anteriormente me ha sido explicado satisfactoriamente y acepto formar parte del estudio. He leído tanto los datos escritos anteriormente como la hoja informativa del proyecto, y entiendo lo que conlleva el estudio en el que acepto participar.

Firmado: Fecha:

Declaración del conductor del experimento:
Yo, Tatiane da Costa Torres de Andrade, confirmo que he explicado cuidadosamente la naturaleza, requerimientos y cualquier posible riesgos (cuando sea aplicable) de la investigación propuesta a la persona voluntaria.

Firmado: Fecha:

VALENCIA | Valencia | Comunidad Valenciana | España
Camí de Vera, s/n, 46022 València, Valencia
tatiane.torres@ufpe.br

APPENDIX C – DEMOGRAPHIC FORM IN SPANISH

U P V - D S I C
Universitat Politécnica de València
Departamento de Sistemas
Informáticos y Computación

CUESTIONARIO PARA PARTICIPAR EN UN ESTUDIO EXPERIMENTAL

Título del Estudio: Evaluación de la Percepción de Valor en Modelos de Proceso
Investigador: Tatiane da Costa Torres de Andrade
Experimentadores:
Correo de contacto: tatiane.torres@ufpe.br

Datos personales
Código anónimo: ……(rellenado por el experimentador)
Nombre: …… (será anonimizado posteriormente)
Nacionalidad ……..
Género: ……..
Edad: …… (años)
Ocupación: [ ] Estudiante [ ] Ejecutivo [ ] Empleado
[ ] Autónomo [ ] Jubilado [ ] Desempleado
[ ] Otro: …… (especifique por favor)
Sector de ocupación: …….. (e.g., administración, dirección, finanza, técnico)
Antecedentes: …… (sector de tu último diploma, e.g., Master, Grado, …)

Sé lo que es un Modelo de Proceso:	En desacuerdo	1	2	3	4	5	6	7	De acuerdo
Sé cómo modelar un Proceso Negocio:	En desacuerdo	1	2	3	4	5	6	7	De acuerdo
Uso Modelo de Proceso frecuentemente:	En desacuerdo	1	2	3	4	5	6	7	De acuerdo

---

APPENDIX D – QUESTIONNAIRE (SCENARIO 0) IN SPANISH

CUESTIONARIO PARA EVALUAR LA PERCEPCIÓN DE VALOR EN MODELOS DE PROCESO

Esta investigación de naturaleza académica está siendo conducida por investigadores de la Universidad Federal de Pernambuco (UFPE) en colaboración con la Universidad Politécnica de Valencia (UPV). El objetivo principal de esta investigación es validar procedimientos capaces de estimar la percepción de valor en los procesos de negocios. Las respuestas recolectadas por medio de este cuestionario adaptado de (SEENEY; SOUTAR 2001) contribuirán significativamente al avance de las investigaciones en el área de procesos de negocios.

Un PROCESO DE NEGOCIO es un conjunto de tareas interconectadas que llevan a la creación de un servicio o producto específico con el objetivo de agregar valor para un actor o grupo de actores, maximizando al mismo tiempo la eficiencia de los recursos.

Información importante:

El proceso de negocio a ser analizado aquí es el proceso "Comprar Productos *Online*", así que para los términos "Proceso de Negocio", "Proceso", "Proceso General" léase "Comprar Productos *Online*".

El cuestionario está compuesto por 20 preguntas.

Importante: SOLO RESPONDER al cuestionario DESPUÉS de haber usado/experimentado el proceso de negocio en análisis por medio del experimento con interfaces.

Para cada una de las afirmaciones marque con una X **sólo una de las alternativas de respuesta.**

Ejemplo:

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
Afirmación 1				X	
Afirmación 2		X			

De acuerdo, ahora que ya entendemos todo, comencemos :)

CALIDAD

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
CE.1) Al navegar por el sitio *web* se percibe la oferta de una buena variedad de productos					
CE.2) La selección de productos es percibida como un proceso intuitivo					
CE.3) Al proporcionar mi dirección, percibí seguridad de datos					
CE.4) Al proporcionar los datos de mi tarjeta de crédito durante la actividad "pago", percibí seguridad de los datos					
CE.5) Al navegar por el sitio *web* se percibe que los productos ofrecidos son de buena calidad					
CG.1) El proceso general es percibido como consistente					
CG.2) Las etapas del proceso son percibidas como bien diseñadas					

CG.3) El nivel de calidad del proceso es percibido como satisfactorio					

PRECIO

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
PE.1) Al realizar el "pago", es percibida transparencia al proporcionar informaciones detalladas sobre los precios de los productos y gastos de envío					
PG.1) Los precios de los productos/servicios de este proceso son percibidos como razonables para su categoría					
PG.2) Los beneficios generales (conveniencia, facilidad de compra, etc.) generados por este proceso justifican su coste					
PG.3) Los precios ofrecidos son percibidos como competitivos					

EMOCIONAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
EE.1) Al navegar por el sitio *web*, se percibe "conveniencia"					
EG.1) El proceso es percibido como agradable					
EG.2) El proceso me atrae / me da ganas de usarlo					
EG.3) Usar/experimentar este proceso hace sentirme realizado					

SOCIAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
SE.1) Al proporcionar la dirección, se percibe que hay cobertura de una amplia área de entrega					
SE.2) Al realizar el checkout se percibe una flexibilidad en la elección del método de entrega					

SE.3) La realización del pago es percibida como flexible por permitir su realización por medio de métodos distintos					
SE.4) La realización del pago es percibida como accesible por permitir su realización por medio de métodos distintos					
SG.1) Usar/experimentar este proceso es percibido como algo que contribuirá a que me sienta aceptado					
SG.2) Usar/experimentar este proceso es percibido como una experiencia que me agregará algo					
SG.3) Usar/experimentar este proceso es percibido como algo que generará buena impresión en los demás sobre mí					

APPENDIX E – QUESTIONNAIRE (SCENARIO 1) IN SPANISH

CUESTIONARIO PARA EVALUAR LA PERCEPCIÓN DE VALOR EN MODELOS DE PROCESO

Esta investigación de naturaleza académica está siendo conducida por investigadores de la Universidad Federal de Pernambuco (UFPE) en colaboración con la Universidad Politécnica de Valencia (UPV). El objetivo principal de esta investigación es validar procedimientos capaces de estimar la percepción de valor en los procesos de negocios. Las respuestas recolectadas por medio de este cuestionario adaptado de (SEENEY; SOUTAR 2001) contribuirán significativamente al avance de las investigaciones en el área de procesos de negocios.

Un PROCESO DE NEGOCIO es un conjunto de tareas interconectadas que llevan a la creación de un servicio o producto específico con el objetivo de agregar valor para un actor o grupo de actores, maximizando al mismo tiempo la eficiencia de los recursos.

Información importante:

El proceso de negocio a ser analizado aquí es el proceso "Comprar Productos *Online*", así que para los términos "Proceso de Negocio", "Proceso", "Proceso General" léase "Comprar Productos *Online*".

El cuestionario está compuesto por 20 preguntas.

Importante: SOLO RESPONDER al cuestionario DESPUÉS de haber usado/experimentado el proceso de negocio en análisis por medio del experimento con interfaces.

Para cada una de las afirmaciones marque con una X **sólo una de las alternativas de respuesta.**

Ejemplo:

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
Afirmación 1				X	
Afirmación 2		X			

De acuerdo, ahora que ya entendemos todo, comencemos :)

CALIDAD

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
CE1.1) La oferta de un cupón de descuento en caso de falta del artículo deseado se percibe como un compromiso con la satisfacción del cliente					
CE1.2) La oferta de un cupón de descuento en caso de falta del artículo deseado se percibe como proactividad para resolver problemas.					
CG.1) El proceso general es percibido como consistente					
CG.2) Las etapas del proceso son percibidas como bien diseñadas					
CG.3) El nivel de calidad del proceso es percibido como satisfactorio					

PRECIO

	Totalmente en	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo

	desacuerdo				
PE1.1) La compra de un producto con descuento se percibe como la posibilidad de hacer un buen negocio, ya que genera ahorro financiero					
PG.1) Los precios de los productos/servicios de este proceso son percibidos como razonables para su categoría					
PG.2) Los beneficios generales (conveniencia, facilidad de compra, etc.) generados por este proceso justifican su coste					
PG.3) Los precios ofrecidos son percibidos como competitivos					

EMOCIONAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
EE1.1) La oferta de un cupón de descuento en caso de indisponibilidad del artículo deseado se percibe como una					

compensación por la inconveniencia					
EE1.2) Indicar productos similares al artículo deseado en caso de falta de *stock* se percibe como una personalización de la atención al cliente					
EG.1) El proceso es percibido como agradable					
EG.2) El proceso me atrae / me da ganas de usarlo					
EG.3) Usar/experimentar este proceso hace sentirme realizado					

SOCIAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
SG.1) Usar/experimentar este proceso es percibido como algo que contribuirá a que me sienta aceptado					
SG.2) Usar/experimentar este proceso es percibido como una experiencia que me agregará algo					

SG.3) Usar/experimentar este proceso es percibido como algo que generará buena impresión en los demás sobre mí					

APPENDIX F – QUESTIONNAIRE (SCENARIO 2) IN SPANISH

CUESTIONARIO PARA EVALUAR LA PERCEPCIÓN DE VALOR EN MODELOS DE PROCESO

Esta investigación de naturaleza académica está siendo conducida por investigadores de la Universidad Federal de Pernambuco (UFPE) en colaboración con la Universidad Politécnica de Valencia (UPV). El objetivo principal de esta investigación es validar procedimientos capaces de estimar la percepción de valor en los procesos de negocios. Las respuestas recolectadas por medio de este cuestionario adaptado de (SEENEY; SOUTAR 2001) contribuirán significativamente al avance de las investigaciones en el área de procesos de negocios.

Un PROCESO DE NEGOCIO es un conjunto de tareas interconectadas que llevan a la creación de un servicio o producto específico con el objetivo de agregar valor para un actor o grupo de actores, maximizando al mismo tiempo la eficiencia de los recursos.

Información importante:

El proceso de negocio a ser analizado aquí es el proceso "Comprar Productos *Online*", así que para los términos "Proceso de Negocio", "Proceso", "Proceso General" léase "Comprar Productos *Online*".

El cuestionario está compuesto por 23 preguntas.

Importante: SOLO RESPONDER al cuestionario DESPUÉS de haber usado/experimentado el proceso de negocio en análisis por medio del experimento con interfaces.

Para cada una de las afirmaciones marque con una X **sólo una de las alternativas de respuesta.**

Ejemplo:

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
Afirmación 1				X	
Afirmación 2		X			

De acuerdo, ahora que ya entendemos todo, comencemos :)

CALIDAD

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
CE2.1) Ofrecer la posibilidad de recoger en tienda en caso de imposibilidad de entrega a domicilio se percibe como proactividad en la resolución de problemas					
CE2.2) Ofrecer la posibilidad de recoger en tienda en caso de imposibilidad de entrega a domicilio se percibe como capacidad de flexibilidad y adaptabilidad por parte de la empresa					
CG.1) El proceso general es percibido como consistente					
CG.2) Las etapas del proceso son percibidas como bien diseñadas					
CG.3) El nivel de calidad del proceso es percibido como satisfactorio					

PRECIO

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
PG.1) Los precios de los productos/servicios de este proceso son percibidos como razonables para su categoría					
PG.2) Los beneficios generales (conveniencia, facilidad de compra, etc.) generados por este proceso justifican su coste					
PG.3) Los precios ofrecidos son percibidos como competitivos					

EMOCIONAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
EE2.1) Indicar tiendas cercanas para recoger el producto en caso de imposibilidad de entrega a domicilio se percibe como atención a la necesidad del cliente					

EG.1) El proceso es percibido como agradable					
EG.2) El proceso me atrae / me da ganas de usarlo					
EG.3) Usar/experimentar este proceso me da una sensación de realización					

SOCIAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
SG.1) Usar/experimentar este proceso es percibido como algo que contribuirá a que me sienta aceptado					
SG.2) Usar/experimentar este proceso es percibido como una experiencia que me agregará algo					
SG.3) Usar/experimentar este proceso es percibido como algo que generará buena impresión en los demás sobre mí					

APPENDIX G – QUESTIONNAIRE (SCENARIO 3) IN SPANISH

CUESTIONARIO PARA EVALUAR LA PERCEPCIÓN DE VALOR EN MODELOS DE PROCESO

Esta investigación de naturaleza académica está siendo conducida por investigadores de la Universidad Federal de Pernambuco (UFPE) en colaboración con la Universidad Politécnica de Valencia (UPV). El objetivo principal de esta investigación es validar procedimientos capaces de estimar la percepción de valor en los procesos de negocios. Las respuestas recolectadas por medio de este cuestionario adaptado de (SEENEY; SOUTAR 2001) contribuirán significativamente al avance de las investigaciones en el área de procesos de negocios.

Un PROCESO DE NEGOCIO es un conjunto de tareas interconectadas que llevan a la creación de un servicio o producto específico con el objetivo de agregar valor para un actor o grupo de actores, maximizando al mismo tiempo la eficiencia de los recursos.

Información importante:

El proceso de negocio a ser analizado aquí es el proceso "Comprar Productos *Online*", así que para los términos "Proceso de Negocio", "Proceso", "Proceso General" léase "Comprar Productos *Online*".

El cuestionario está compuesto por 22 preguntas.

Importante: SOLO RESPONDER al cuestionario DESPUÉS de haber usado/experimentado el proceso de negocio en análisis por medio del experimento con interfaces.

Para cada una de las afirmaciones marque con una X **sólo una de las alternativas de respuesta.**

Ejemplo:

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
Afirmación 1				X	
Afirmación 2		X			

De acuerdo, ahora que ya entendemos todo, comencemos :)

CALIDAD

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
CE3.1) La posibilidad de cambiar el método de pago cuando hay un problema con la tarjeta de crédito es percibida como proactividad para resolución de problemas					
CG.1) El proceso general es percibido como consistente					
CG.2) Las etapas del proceso son percibidas como bien diseñadas					
CG.3) El nivel de calidad del proceso es percibido como satisfactorio					

PRECIO

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
PG.1) Los precios de los productos/servicios de este proceso son percibidos como					

razonables para su categoría					
PG.2) Los beneficios generales (conveniencia, facilidad de compra, etc.) generados por este proceso justifican su coste					
PG.3) Los precios ofrecidos son percibidos como competitivos					

EMOCIONAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
EE3.1) La posibilidad de cambiar el método de pago cuando hay un problema con la tarjeta de crédito es percibida como conveniente					
EG.1) El proceso es percibido como agradable					
EG.2) El proceso me atrae / me da ganas de usarlo					
EG.3) Usar/experimentar este proceso hace sentirme realizado					

SOCIAL

	Totalmente en desacuerdo	En desacuerdo	Indiferente	De acuerdo	Totalmente de acuerdo
SG.1) Usar/experimentar este proceso es percibido como algo que contribuirá a que me sienta aceptado					
SG.2) Usar/experimentar este proceso es percibido como una experiencia que me agregará algo					
SG.3) Usar/experimentar este proceso es percibido como algo que generará buena impresión en los demás sobre mí					