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Department of Marketing, Operations and Management

Project Evaluation Methodology for Digital Transformation

José Pedro Gonçalves dos Santos

PhD in Management, specialization of Strategy and Entrepreneurship

Supervisor:

Doctor Leandro Luís Ferreira Pereira, Full Professor, Iscte-IUL

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BUSINESS
SCHOOL

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Jury:

Doctor Diana Aldea Mendes, Associated Professor, Iscte-IUL (President)
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Que nunca por vencidos se conheçam (*Lus. VII-71*)

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"*Sempre faça tudo com muito amor e com muita fé em Deus, que um dia você chega lá. De alguma maneira você chega lá*"

Ayrton Senna

Resumo

A pandemia de COVID-19 acelerou da transformação digital nas organizações devido à necessidade de aplicar os avanços digitais para manter a sustentabilidade das organizações, aumentar o desempenho dos projetos e contribuir para a criação de valor. O aumento da transformação digital levou à formulação de projetos digitais. Os projetos digitais são empreendimentos que realizam ações planeadas para estratégias e operações digitais nas organizações. Assim, a Gestão de Projetos confronta-se com o aumento da complexidade intensiva e problemas inesperados decorrentes do volume crescente de projetos digitais e da falta de conhecimento científico em termos de processos metodológicos para as práticas iniciais e adequadas à avaliação deste tipo de projetos. Para responder a esta necessidade, foi desenvolvido um modelo teórico designado por Digital Business Case baseado na integração de cinco passos (Requisição de Projeto, Estimativa de Benefícios e Custos, Avaliação Económica e Decisão). Para entender a adaptação e capacidade do Digital Business Case, foram efetuadas várias entrevistas a gestores de projeto com capacitação em modelo de negócios e *stakeholders*. Este modelo é considerado como uma ferramenta científica, que incorpora a filosofia de gestão científica, para resolver os problemas de decisão quanto à aceitação ou rejeição de uma decisão de investimento. Para validar o modelo teórico, foi convidado um painel de especialistas e utilizado o método *Delphi* em várias rondas de iteração para chegar a uma conclusão. O painel de especialistas foi unânime que o Digital Business Case utilizando cinco etapas aumenta o nível de capacidade para avaliar um projeto digital, o que pode contribuir para uma identificação mais precisa do problema, estimativa precisa de benefícios e custos e avaliação económica adequada usando vários cenários. Dessa forma, as informações fornecidas aos decisores aumentarão o nível de aceitação do projeto bem como reduzirão as probabilidades de insucesso do projeto nas etapas subsequentes de desenvolvimento do projeto.

Palavras-chave
Avaliação de Projetos, Transformação Digital, Gestão Científica, Gestão de Projetos, Caso de Negócio

Classificação JEL
M10, M20

Abstract

The COVID-19 pandemic has accelerated digital transformation within organizations due to the need to leverage digital advancements to ensure organizational sustainability, enhance project performance, and contribute to value creation. The intensification of digital transformation has led to the formulation of digital projects. Digital projects are initiatives that execute planned actions aligned with digital strategies and operations within organizations.

Consequently, Project Management is confronted with increasing complexity and unforeseen challenges arising from the growing volume of digital projects and the lack of scientific knowledge regarding methodological processes for the initial and appropriate evaluation practices of such projects. To address this need, a theoretical model termed the Digital Business Case was developed, based on the integration of five stages (Project Request, Benefits and Costs Estimation, Economic Evaluation, and Decision-Making). To understand the applicability and capability of the Digital Business Case, several interviews were conducted with project managers experienced in business models and stakeholders. This model is considered a scientific tool that incorporates the philosophy of scientific management to address decision-making problems regarding the acceptance or rejection of investment decisions. To validate the theoretical model, a panel of experts was convened, and the Delphi method was employed through several iterative rounds to reach a conclusion. The panel unanimously agreed that the Digital Business Case, through its five-stage structure, enhances the capability to evaluate digital projects. This, in turn, contributes to a more accurate problem identification, precise estimation of benefits and costs, and appropriate economic evaluation using multiple scenarios. Thus, the information provided to decision-makers increases the likelihood of project acceptance while reducing the probability of project failure in subsequent development stages.

Keywords

Project Evaluation, Digital Transformation, Scientific Management, Project Management, Business Case

Classification JEL

M10, M20

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Glossary

BCR – Benefit Cost Ratio

COVID-19 – Coronavirus SARS-CoV2

DT – Digital Transformation

IRR – Internal Rate of Return

KPI – Key Performance Indicator

NPV – Net Present Value

NLP – Natural Language Processing

ROI – Return on Investment

SMART – Specific, Measurable, Attainable, Relevant and Time-bound

CHAPTER I

Introduction

1.1. Context

The coronavirus SARS-Cov-2 (COVID-19) pandemic had changed and influenced, significantly, the global economy and environment (Bai *et al*., 2021). The COVID-19 determined new lifestyles and underpinning business redesign (Gigauri, 2021). The current enterprise and organizational world that we knew had to change and adapt to the new reality since COVID-19 increased the fragility of the whole system and changed the way in which companies and institutions create, share and capture value (Acciarini *et al*., 2021). Unexpectedly, organisations had to set up digital infrastructures, reconfigure global supply chains, and launch new services in days, not years (Rodriguez-Nieto, 2026). Constant technological changes, intensified competition, market globalization, and the search for more efficient internal processes are some of the key challenges organisations face (Basadur *et al*., 2014) moreover, due to COVID-19, companies, mainly micro and small enterprises (MSEs), were more severely affected when compared to larger and global firms (Shafi et al., 2020)

A considerable effect of COVID-19 was the acceleration of the digital transformation (DT) trend (Kudyba, 2020; Soto-Acosta, 2020; Kodama, 2020; Holl *et al*., 2024; Yao *et al*., 2024).

During the pandemic, new strategies and creative ideas had to be generated faster than usual as well as deliberations of project implementations conducted, all in an expedited manner (Kudyba, 2020). According to the authors Elrefaey *et al*., (2022), the contribution of digital transformation and emerging digital technology helped to improve several dimensions such as communication, collaboration, better project comprehension, improved information retrieval, and increased productivity rates as well as time and cost savings in projects. According to Kraus *et al*., (2022), there were some considerable benefits of DT, namely that it increased sales and productivity, enhanced innovation in value creation, and provided novel forms of interaction with customers.

The digital transformation contributed to business performance through the formulation of digital projects, strategies, and value creation (Vial, 2019).

The digital transformation is understood, according to Hinings *et al*., (2018), as a digital innovation process and digital innovations can hatched novel value creation and value appropriation pathways (Nambisan *et al*., 2017; Marnewick & Marnewick, 2022). Apart from DT, there are other concepts associated with DT, namely digitation, digitalisation and the digital transformation itself. From these concepts, the digitalisation is the main concept associated with this thesis since it is focus on processes,

business models, value creation and a spectrum of improvements for distinct opportunities such as centralized management (Saarikko *et al*., 2020; Marnewick & Marnewick, 2022).

According to Papadonikolaki *et al*., (2025), the digitalisation of project management contributed to digital transformation (DT) by enabling faster decision-making, cross-team collaboration, and adaptive planning. Within DT, there were so-called "digital projects." These digital projects provided the means through which specific transformation objectives were delivered, operationalised, and implemented, as organisations often treated digital transformation initiatives as structured projects that translated strategic goals into actionable deliverables (Cavalcante *et al*., 2025). Moreover, these projects systematically affected core business functions by embedding digital practices that enacted strategic change (Tian *et al*., 2023).

Digital projects during the COVID-19 pandemic acted as triggers that accelerated digital transformation. During this period, process transformation projects played a critical role in ensuring operational continuity, as firms rapidly digitalised workflows, automated processes, and adopted remote service delivery to cope with lockdowns, workforce disruptions, and supply-chain instability. Such crisis-driven process reconfiguration aligned with the process-centric view of digital transformation proposed by Saeed *et al*., (2025).

At the same time, the pandemic intensified the importance of business model transformation projects, as organisations were compelled to develop new digital channels, platform-based offerings, and subscription models to maintain customer engagement and revenue streams under conditions of restricted physical interaction—a phenomenon that was consistent with the business model innovation perspective discussed by Verhoef *et al*., (2021). Domain transformation projects also gained momentum during COVID-19, as firms leveraged digital capabilities to enter adjacent markets or industries, such as manufacturers offering digital services or retailers expanding into logistics and financial solutions, thereby reflecting strategic boundary shifts enabled by digital technologies.

Furthermore, organisational transformation projects proved essential in enabling rapid adaptation, with organisations adopting agile governance structures, decentralising decision-making, and establishing cross-functional digital teams to respond to unprecedented uncertainty. As highlighted by Saeedikiya *et al*., (2025), such organisational changes underpinned the successful execution of digital initiatives and were crucial within the pandemic context.

Therefore, based on the conjunction of the COVID-19 pandemic and the acceleration of digital transformation, organisations were required to increase their level of adoption of digital innovation and digital technologies. These levels of adoption aimed to create competitive advantage and expand organisational capabilities (Raguseo, 2018; Chen *et al*., 2021; Mostaghel *et al*., 2022), to transform the content of value propositions and enhance value creation (Kannan & Li, 2017; Piepponen *et al*., 2022), and to maintain organisational agility and flexibility (AlNuaimi *et al*., 2022). In other words,

organisations were compelled to turn challenges into opportunities for improvement by creating value and developing sustainable competitive advantages.

Consequently, management was confronted with increasing complexity and unexpected challenges, and such uncertainty could have led to organisational failure or the erosion of organisational benefits (Ellert *et al*., 2015). To create initial added value, organisations had to select an initial plan that justified undertaking a project, programme, or portfolio (Murray-Webster & Dalcher, 2019) and to identify target benefits within the Business Case in order to meet project objectives (PMI's Pulse of the Profession, 2016). Among the various methods for evaluating projects in terms of benefits, the business case was regarded as a fundamental tool, as it provided an overview of the project scope, costs, timeframe, and risks (Marnewick & Einhorn, 2019). This facilitated the decision-making process and served as a critical mechanism for communicating project value, expected costs, and anticipated benefits to management (Azmi, 2007).

Thus, the business case became a fundamental tool for addressing contemporary concerns and needs related to project evaluation. As a result, companies were required to readapt project decisions and improve operational efficiency (Horal *et al*., 2020), anticipate market opportunities (Fernandez-Vidal *et al*., 2022), and develop case studies exploring business resilience during natural biological disasters, such as the COVID-19 pandemic, through a risk management perspective and based on outcomes derived from Business Cases (Martinelli *et al*., 2021). Additionally, organisations adopted risk-mitigation strategies and implemented supplementary measures, drawing on multiple examples of organisational responses grounded in Business Case analyses (Swain & Brahimi, 2022).

Although, the implementation of a Business Case strategy, as the initial step of a project endeavour, nowadays, must guide the digital transformation (Tabrizi *et al*., 2019). The current Business Case structure is composed of specific elements that characterise an investment, such as objectives, costs and benefits (Hsiao, 2008). Nevertheless, to be in line with the current digital transformation, the Business Case strategy must be updated to face the current needs and the ability to manage projects with high performance as well as to deliver an evaluation metrics for digitalisation projects (Jafari-Sadeghi *et al*., 2023).

Despite its widespread use, the traditional Business Case framework had significant limitations when applied to digital transformation projects. Conventional Business Case frameworks tended to rely on static assumptions, linear value creation models, and financial metrics that inadequately captured the dynamic, uncertain, and iterative nature of digital initiatives (Abdallah *et al*., 2020). Furthermore, companies did not rely on a strategic alignment vision, which could have enabled them to respond more effectively to changes in the market (Niguse *et al*., 2025), thus it was not systematically incorporated into Business Case frameworks (Gkrimpizi *et al*., 2023) as a changing factor, which increased the organisational resistance. While recent studies have applied Business Case

methodologies to specific digital transformation contexts, such as talent management systems (Martínez-Morán *et al*., 2021), higher education institutions (Zulfikar *et al*., 2018), and organisational transformation initiatives (Boffa & Maffei, 2024; Tiwari, 2024) these contributions remain fragmented and lack a unified theoretical foundation. Notably, a clear and academically grounded definition of a "Digital Business Case" is largely absent from the scientific literature, namely in the main publishers such as Elsevier, Springer Nature, Taylor & Francis, Wiley or MDPI, with existing interpretations primarily originating from consultancy practice rather than peer-reviewed research.

In order to address the research problem identified in Section 1.2, which states that there is a lack of suitable methodologies and evaluation practices, particularly digital Business Case frameworks, to effectively assess and guide digital transformation projects within organisations exacerbated by the COVID-19 as well as the identified gaps (Table 3 in section 2.4) from the literature review and research questions presented, a novel theoretical framework designed to support value creation assessment, benefit realisation, and strategic alignment under conditions of uncertainty was proposed.

This theoretical model draws on the principles of Scientific Management originally articulated by Frederick Taylor (1911). The definition of Scientific Management is a theory of management that analyses and synthesizes workflows, and its main objective is improving economic efficiency, especially labour productivity (Taylor, 1911). Currently, the Principle of scientific management concept developed initially by Taylor has been undergoing some changes over the last century with a considerable relevance from the contribution of the authors McNaughton, 1959; Ritzer, 2002. More recently, the philosophy behind the concept of scientific management is an integration approach that incorporates behavioural, technological and human factors alongside classical efficiency goals. For example, Uddin and Hossain, (2015) describe how scientific management has been adjusted to encompass behavioural science and globalization contexts, where modern organisations value employee contribution and feedback rather than purely mechanistic task optimisation. Such work shows that advances in technology, project management, and organizational psychology have reshaped Taylor's original principles into a more holistic model that blends systematic work analysis with human-centric practices to address limitations inherent in the original theory.

Furthermore, also recent research conceptualizes practices such as *growth hacking* as extensions of scientific management, where iterative experimentation and data analytics are used to shape organisational strategy and operational decisions in digital contexts, combining the scientific method with managerial principles for competitive advantage (Cristofaro *et al*., 2025).

Thus, the objective of using the major concept of Scientific Management principles in this thesis led to the main research question (sub-divided into more 5-research questions) "*How do scientific management theories inform the design and implementation of effective processes for Digital Business Case development?*". According to the authors Fleischmann *et al*., (2013), the scientific management

component is useful for evaluating work methods and project efficiency and applying mathematical models and computing technology (Taylor, 2013) to support the evaluation process but is it effective and can contribute to a Digital Business Case tailored to digital projects evaluation? To address this question, the research adopted a multi-method approach combining a systematic literature review, qualitative interviews with senior decision-makers, and expert validation through the Delphi method. This methodological design enabled the integration of theoretical insights and practitioner perspectives, thereby enhancing the robustness and practical relevance of the proposed model (Zwikael *et al*., 2018).

The theoretical model also contributed to the concept of Strategic Agility, defined as the ability of an organization to regularly adapt to uncertain and changing environments (Doz & Kosonen, 2008), which aligned closely with the pandemic scenario, characterized by high uncertainty (Zhao *et al*., 2024). The importance of this contribution was primarily reflected in its ability to enable faster, data-driven decision-making that responded effectively to environmental changes.

In order to evaluate the efficiency of the proposed theoretical model, a validation group was established using the Delphi method, involving several experts from both academic and industry fields. The thesis results and the presentation of the theoretical model were expected to reduce assumptions arising from gaps in the literature, as well as the lack of adaptation and technical rigor in project evaluation for digital projects when using the traditional Business Case approach. The theoretical model also contributed to increased certainty in project evaluation in terms of value creation and benefits realization. All these steps were described in the subsequent chapters.

1.2. Research Problem

Nowadays, there is a consensus on how DT projects should be carried out, involving the following steps: initiation, ideation, assessment, commitment, implementation and sustainability (Veldhoven & Vanthienen, 2022). However, there is a lack of scientific knowledge regarding the methodological processes and suitable practices for evaluating digital projects (Temple, 2024). For example, current project evaluation metrics and control practices are not optimal for managing projects involving digital transformation, as they lack the capabilities, framework, and methodologies required to account for the characteristics of these projects (Berghaus & Back, 2017; Wiener *et al*., 2019). Thus, the evaluation of digital projects remains largely elusive (Barthel *et al*., 2021), with a considerable lack of suitable practices for proper digital evaluation (Barthel *et al*., 2020; Gimpel *et al*., 2018).

The case of the Business Case was though for this research as a project evaluation metric since, usually, the Business Case is positioned in a common framework towards projects evaluation and feasibility based in frameworks and methodologies, considered not easy to be fully implemented

during the implementation period, by focusing on process theory in developing Business Cases (Einhorn *et al*., 2019). The authors Herman and Siegelaub, (2009) affirms, if a project is custom-made without the consideration for the value it can brings to an organisation there are several issues that can appear such as: Waste of valuable resources; No clear basis to prioritize projects; Final deliveries may not provide the expected results; No target is established for why the project deliveries are needed; No project improvement opportunity.

According to Terlizzi *et al*., (2017), the Business Case represents a significant value-added tool for benefits management estimation; however, its direct application by non-specialist professionals may be challenging. Another author, Badewi, (2016), mentions that the development of a Business Case in terms of combining the benefits with project management principles is fundamental to improve the performance or success of a project significantly since only benefits do not increase the project evaluation metrics, which will support the decision-makers. According to Pederson *et al*., (2017), the practical use of the business case tool is sometimes associated with an element of elasticity linked to the complexity of the project to be evaluated and the difficulties in making precise Business Case estimates. In some cases, the Business Case can be biases. For instance, Flyvbjerg, (2021) indicates several behaviour biases in project planning and management and one of them is linked with the Business Case, namely the *Planning fallacy (Writ Large)*. This type of bias underestimate costs, schedule, and risk and overestimates benefits and opportunities in projects.

Before the COVID-19 outbreak, to implement a certain strategy or product into the market, the typical Business Case was applied. The typical Business Case provided a proper project evaluation, since the previous adopted frameworks didn´t reply to past needs, in terms of using the right processes due to the fact it could hinder the approval process (Farbey *et al*., 1999) based on its complexity and risk, selection of stakeholder's implications and responsibilities (Maes *et al*., 2014), and difficulties to assemble a considerable comprehensive Business Case (Einhorn *et al*., 2020).

During the COVID-19 pandemic, several management and business problems were identified (Margherita & Heikkilä, 2021) which, by consequence, required further attention and consideration, namely frameworks to assess the readiness of organisation uncertainty (Zackery *et al*., 2022), business performance (Harel, 2021), data-driven decision-making (Elrefaey *et al*., 2022) and value creation. For instance, it is necessary to redesign several corporate processes and stimulate the redefinition of strategies and actions in order to create a new business value as well business continuity and business model innovation for value creation (Margherita & Heikkilä, 2021). In addition, the impact of the COVID-19 in management-related fields, focused on the long-term effects and mitigation of such future events, has also not been thoroughly studied, according to the authors Hashemi *et al*., (2022).

During the pandemic, small and medium-sized businesses have been the hardest hit by the COVID-19, thus, these companies must continuously reinvent themselves quickly if they want to survive during

the current unforeseen scenario and business uncertainty (Carracedo *et al.*, 2021; Harel, 2021). Organisations should identify, optimize, and re-access existing technologies and business models (Donthu & Gustafsson, 2020). To achieve this compromise, organisation should rely in proper evaluation metrics in order to sustain their business continuity because the COVID-19 pandemic, according to the authors Khlystova *et al.*, (2022), is very different from other forms of crisis since it impacted all business models and organisations (OECD, 2020).

Moreover, during COVID-19, and according to the Project Management Institute and the Project Business Foundation, (2020), there were several major factors that have been impacted organisations with a considerable level of negativity. In Figure 1, adapted from the Project Management Institute and the Project Business Foundation, (2020), it is described the major impacts of the COVID-19 in organisations. In most of the identified factors, the negative impact of COVID-19 had an average of 80%.

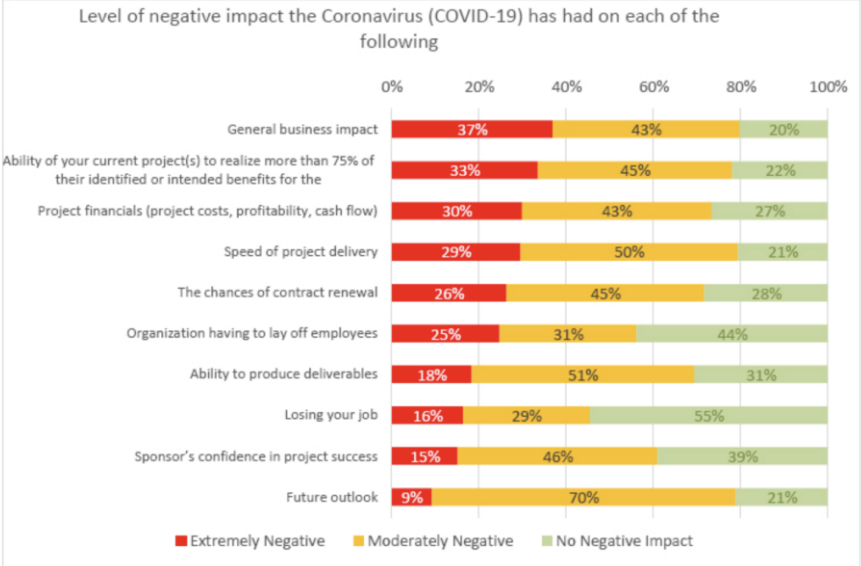


Figure 1 - Level of Negative Impact due to COVID-19 (Source: Adapted from Project Management Institute 2020)

In Figure 1, the most relevant factor to this research is the "General Business Impact" and "Ability of your current project(s) to realize more than 75% of their identified of intended benefits". Both factors contain 80% and 78% of impact respectively.

Consequently, with the current pandemic, where is also necessary for a successful project digitally meet the demands of the business landscape, it is fundamental a digital Business Case aligned with the current digital transformation process where companies must leverage their capabilities to overcome a fundamental issue of translating explorative innovation efforts into exploitative value that is a key challenge when dealing with innovation and one of the main barriers for the digital transformation (Colli *et al.*, 2021).

To create more sustainable Business Cases, it is essential to implement a strategic methodology that can address these digital challenges and highlight that disruptive transformation should be viewed as a strategic investment to support an organisation's business strategy. Furthermore, the real value of a digital transformation investment project should be related to long-term revenue growth, which should align with the incentive to develop a Business Case that focuses solely on long-term profits (Carrol & Shabana, 2010), rather than short-term return on investment (ROI). Therefore, an updated methodology is essential to evaluate and support the realisation of intended qualitative and quantitative benefits (Murray-Webster & Dalcher, 2019) and to inform the decision-making process for long-term investment projects, as well as minimising the assumptions created by the current pandemic.

1.3. Research Questions

The importance of a research question is recognised as an essential initial step that provides direction and guidelines for an investigation (Bryman, 2007). According to Saunders *et al*., (2019), research questions can play a vital role in generating theoretical explanations, regardless of how limited these explanations may be.

The research questions were developed based on gaps in the literature review previously identified and the assumptions created. Furthermore, all research questions were developed using the SMART approach (Specific, Measurable, Attainable, Relevant, Time-bound), which adds considerable value to the research. Table 1 presents the applicability of SMART to the main research question.

This provides considerable added value in terms of academic overview and can also be applied by managers when evaluating projects in their organisations. Initially, this research aimed to answer the main question.

How do scientific management theories inform the design and implementation of effective processes for Digital Business Case development?

The main research question is divided into sub-questions that cover the full range of information required to substantiate the main question and validate the created assumptions. The sub-questions are as follows:

1. What is the state of the art in academic research regarding Business Case formulation and evaluation for digital transformation projects in the context of the COVID-19 pandemic?

The aim of this question is to identify the current status of the Business Case literature review and overview its relation, potential adaptation and potential modification to the current changes created by the digital transformation conjugated with COVID-19.

2. What is the contemporary relevance and contribution of commonly employed Business Case methods in facilitating organisational decision-making?

This question aims to understand the relevance of several common methods applied to a Business Case in order to support the decision-making process and evaluate if the proposed methods are a considerable added value to a project evaluation. To achieve this understanding, it was made a comprehensive literature review as well several interviews to decision-makers about the understanding of the potential applicability of the several different methods in order to create a new theoretical model.

3. How effectively can a dynamic digital Business Case respond to the changing requirements of ongoing digital projects within organisations compared to traditional static Business Case methodologies?

Based in the assumptions that the current Business Case metrics cannot reply to the current digital project needs due to the several gaps, this question aims to analyse the current structure of a Business Case and compare it with the proposed model in order to validate the dynamic output that can be created in a Business Case monitoring

4. How can principles derive from Scientific Management be operationalised within the different steps of a Business Case to create an effective Digital Business Case framework for the evaluation of digital transformation projects?

The objective of this question is to validate the added value provided by a scientific management approach in terms of contribution for the evaluation of digital projects using a Business Case methodology tailored to digital evaluation.

5. Which are the current methods and techniques most relevant in a Business Case for project evaluation that contribute for testing assumptions about operating costs and expected benefits?

In this question, the aim is to validate the most suitable methods and techniques to test assumptions created regarding the operating costs and expected benefits (tangible and intangible). In Table, 1 it is described the SMART approach for the main research question.

Table 1 - SMART Objectives for the Research Question

Key Component	**Objective**
Specific - What is the specific objective?	Propose a Theoretical process to assist the digital projects evaluation using the Business Case
Measurable - What are the concrete criteria for measuring change?	- Conducted interviews to understand the most applied techniques in digital evaluation projects and understand the problems and difficulties to evaluate a digital evaluation project mainly the lack of adaptability and technicality
Attainable - Is the objective feasible?	Yes, when the proposed theoretical process mode will be defined it will support the evaluation of digital projects
Relevant and/or Realistic - Does the objective relate directly to the goal?	- Yes, it should support digital project evaluation - However, does this theoretical process model will be adapted to every project? - Should the processes increase the level of confidence of the decision-makers?
Time-specific – When will objective be measured/met?	- The interviews took place in reasonable period due to availability of the interviewed - The Delphi method was conducted afterwards during three rounds

1.4. Theoretical Framework

The research process will be structured around a methodology and research strategy involving qualitative data collection and analysis procedures (described in more detail in Chapter III). To complete the context, the interviews will be analysed and the content validated through the Delphi method with experts in the field. The conceptual framework is described in Figure 2.

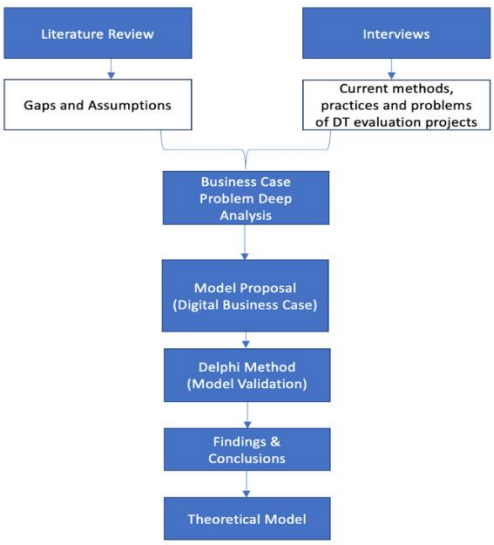


Figure 2 - Conceptual Framework (Source: Author)

Combining both approaches (literature review and interviews) provides a more comprehensive overview of the current state of implementation of a Business Case in terms of project evaluation, since the literature review identified the relationship between the concept of Business Case applied to digital evaluation projects, their relevance in the current state of affairs, and the questions to be asked in the interviews. In practical terms, combining the literature review and interviews has helped to clarify on the gaps, practices and problems associated with the lack of a strategy for implementing a proper project evaluation methodology for digital projects.

1.5. Thesis Structure

This research is structured in VIII chapters. The first chapter (I) compromises the introduction consisted by research context, research problem, research questions, research objectives and the theoretical framework. The chapter II is focused on the literature review. In this chapter II all the keywords are described with a major focus in Business Case. The chapter III compromises the methodology, which includes the research project (research objectives, strategy, design), data collection (bibliometric data and interviews) and validation. The chapter IV presents the bibliometric analysis based in the research focused on relevant keywords such as “Business Case” and “Business Case-Digital Transformation”. Chapter V presents the data analysis from obtained results regarding the interviews and the evaluation of the proposed model based in the interviews output. In chapter VI the research questions will be answered based in the previous data analysis and all finds will be presented in addition to the benefits and value creation of the applicability of the theoretical model. In chapter VII, it will be proceeded with discussions and finding from the obtained results. The final chapter, VIII, presents the final remarks and conclusions together with the study limitations and proposals for next challenges and potential future research. The structure of the thesis is described in Figure 3.

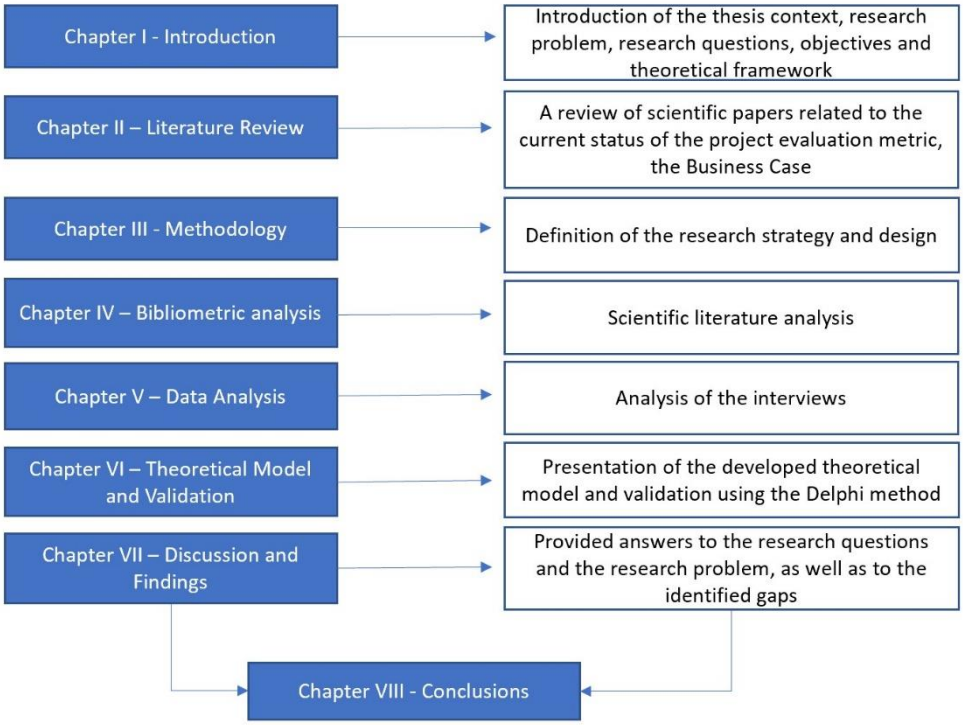


Figure 3 - Thesis Structure (Source: Author)

In terms of the research objectives proposed in Section 3.1.1, each one will correspond to a research sub-question and be addressed in Chapter VII. However, the objectives will also be described alongside the thesis and not only within the research questions. For example, objective 1 will be described in chapter II. Objective 2 will be addressed in chapters I and II. Objective 3 will be addressed in Chapter III, while objectives 4 and 5 will be addressed in Chapters V and VI.

CHAPTER II

Literature Review

This chapter provides an overview of the literature review of the Business Case, focusing on the overall concept. The chapter is divided into four sections. The first two sections (2.1 and 2.2) cover the current state of research on the Business Case. The third section covers the main dimensions of the Business Case and is subdivided into several subsections. The final section summarises the research gaps identified in the literature review.

2.1. Business Case Concept

The first appearance of the word “Business Case” was in a paper published by the authors Keys and Bell (1977). In this paper, it was described several different Business Cases where it was included in each one a created environment in which students can assimilate the proper organisation of reality. Although, and according to Maes *et al*., (2014), it was only in 1995 that Sarkis and Liles developed a high-level process that includes five interrelated steps, which is now closely related to the Business Cases that are implemented nowadays. Besides being used as an initial project evaluation methodology, the Business Case can be used to measure the project performance success (Meredith & Zwikael, 2019).

The importance of a Business Case is to verify the economic and financial viability of an investment initiative in a company/organization (Murray-Webster & Dalcher, 2019). In other words, the Business Case is an independent and rigorous evaluation process of an initiative that aims value creation in the organisation through the application of its financial, human and time means. A Business Case consists of a decision-making tool to determine whether an investment will create value or not by a GO/NO GO decision. It summarizes anticipated benefits while considering alternative options and recommending a preferred solution (Einhorn *et al*., 2019). One of the goals of a comprehensive Business Case for a certain project is to increase value, provide a competitive advantage, and generate business benefits in the areas of business the company is engaged in (Johanes & Arviansyah, 2021).

Currently, the Business Case concept is applied to different areas of knowledge. It’s not an effort of a specific thematic. Moreover, a Business Case is a project management document that explains how the benefits of a project outweigh its costs and why it should be executed and once it is planned and managed effectively, it dramatically increases the likelihood of the project's success (Herman & Siegelaub 2009). Business cases are prepared before the project initiation phase, and their purpose is to include all the project’s objectives, costs and benefits to convince stakeholders of its value. The need

for a Business Case is that it collects several different types of information from different steps in certain frameworks in order to provide concise added value for project evaluation.

Nowadays, the Business Case is more than a document, it's a comprehensive framework where it´s provided the description of Cost, Benefits and Risk. For instance, Teixeira, (2015) proposes an 8 major steps for the elaboration of a Business Case Model (Project Request; Strategic Alignment; Benefits Estimation; Cost Estimation; Economic Evaluation; Context Readiness; Decision-Making; Benefits tracking). The authors Sarkis and Lies (1995) propose a 5 steps framework (identify system impact, identify transition impact, estimate costs and benefits, perform decision analysis, and audit decision). Ward *et al*., (2008) described a framework with 6 steps (Business Drivers and Investment Objectives; Benefits Measurements; Benefits Categorisation; Organisational Changes; Value creation for each benefit; Cost Estimation and Risk Assessment) and Schaltegger *et al*., (2012), developed an integrated framework by combining sustainability strategies, degrees of business model innovation and Business Case drivers. Thus, the current structure of a Business Case summarizes the expected benefits for all stakeholders in the light of alternative options and proposes the preferred choice for all stakeholders (Krell & Matook, 2009).

The elaboration of a Business Case plays a helpful role on facilitating stakeholders deciding where to or not to invest their resources in a project endeavour, in order to add continuously value by providing the ability on making the right investment decision within the frame time-to-market.

The Business Case is considered as the "Pre-initiation phase" of a project, namely is created before the projects are chartered and the project manager is assigned (Mossalam & Arafa, 2016). Moreover, it must be updated including new variables and new methods, which can bring a considerable added value and cope with the dynamic environment of projects. Thus, according to Mossalam and Arafa, (2016), the Business Case also request a periodical review and validation when new information is loaded. This review it is suggested to be done at the end of each phase.

2.2. Business Case Structure

Nowadays, a Business Case is fundamental for a project endeavour, and it can be applied to several different categories (IT, retail, construction, banking, etc.). It is not fixed to a certain topic or area not even to a single content. For instance, Maes *et al*., (2014) in his paper describes that the literature findings, concerning the Business Case, show a wide variety of areas in which a Business Case can be employed and its dimensionality. The importance of such analysis is crucial to sustain project implementation and Business case development. The Business Case not only supports project governance from the beginning through IT delivery and eventually to benefits realisation, but it also supports the governance of a portfolio of projects, where project selection and prioritisation are

needed (Müller *et al*., 2014). A Business Case can have different methodology (conceptual application such as benefits management, cost effectiveness) or framework (software or platform integrating the Business Case methodology that can be applied to several cross fields. For instance, the BCTool (Pereira *et al*., 2021, 2023) is a framework that can be applied to every domain, and it is based in the Teixeira (2015) methodology.

The structure of a Business Case requires not only to realise the scope, the anticipated benefits and costs but as well the associated risks (Ward *et al*., 2008). It is evident that a well structure and implemented Business Case is an important instrument in value creation (Maes *et al*., 2013) besides is an indispensable tool to help increase the success. Johanes and Arviansyah, (2021) describe this success in an IT project or investment. Pereira *et al*., (2021) demonstrate the dimensionality of the Business Case by applying a Business Case framework to measure the impact of salt consumption on a Portuguese foundation for the elderly, contributing to an intervention plan to reduce hypertension. Also, Pereira *et al*., (2023) applied the same Business Case methodology to other thematic, namely in social communities in order to measure the benefits and social impact of the community intervention of proximity. Other authors such as Quigley *et al*., (2021) have examined the Business Case for investing in patient experiences. Manfredi and Clayton-Hathway (2021) applied the Business Case methodology to a top-down initiative, driven by women in senior roles. Such initiatives can set change in motion to benefit women across an entire sector. In this 'Business Case' paradigm, women's equal involvement and representation was justified because it fosters competitive advantage, increased performance and productivity. Finally, Damnjanović *et al*., (2020), created a case study to explain the digital marketing strategy for different target segments of Accor Hotels, the most diversified hotel player, using a Business Case methodological approach.

Based on these references, it can be empirically assumed that applying a Business Case framework or methodology to several thematic fields adds value and provides a corresponding framework for value creation.

2.3. Business Case State of the Art

The state of the art of Business Cases is a topic that has been explored in various fields, including management, sustainability, technology, and entrepreneurship. Several studies from different authors (Table 2), which will be presented next, have examined different aspects of Business Cases and their impact on organizational performance, innovation, leadership, and value creation.

Table 2 – Business Case Studies

Authors	Publication Year	Paper Description
Luo *et al*.,	2012	Focuses on the relationship between guanxi (a social network tie drawing on connections in business relations) and organizational performance. The study

		uses a meta-analytic framework to review and quantify the guanxi-performance link. The findings suggest that guanxi does enhance organizational performance, with both business and government ties contributing to economic and operational performance
Boons & Lüdeke-Freund	2013	Discuss business models for sustainable innovation. They argue that empirical research, such as case studies, is needed to understand the state of the art of corporate sustainability management, sustainable organizational development, and sustainable innovation in daily business
Kodama	2020	Explores the concept of conceptual/industrial transformation in the automobile industry. The study suggests that a breakthrough in the business model can inaugurate a new cycle of transformation and innovation in the industry
Tuarob *et al.*,	2018	Discuss the use of big financial transaction data in business transactions. The study highlights the importance of historical financial data for prediction models and the challenges posed by discontinuity in financial transaction streams
Joubert *et al.*,	2018	Propose a technique to integrate business analysis with information systems development. The study emphasizes the use of case studies to generate or test hypotheses during theory-building.
Thomas *et al.*,	2016	Present a Business Case for nuclear plant control room modernization. The study uses a generic business case to demonstrate the benefits of advanced communication, networking, and analytical technologies in improving control room operations and overall efficiency in nuclear power plants
Paolone *et al.*,	2010	Discuss a methodology for business use case driven development. The methodology promotes iterative and incremental development of complex software systems using a model-driven engineering approach
Konrad *et al.*,	2015	Examine the antecedents and outcomes of diversity and equality management systems. The study argues that the business case for diversity goes beyond employment equity and can include marketing and decision-making processes in the firm
D'Amato & Roome	2009	Propose an integrated model of leadership for corporate responsibility and sustainable development. The model connects leadership in organizational change with management innovation and emphasizes the role of leadership in supporting organizational and social innovation
Scuotto et *al.*,	2022	Explores the role of social bricolage in business model innovation for social entrepreneurship organizations. The study analyses how social bricolage can adapt business models and develop social innovation
Ren & Zhu	2017	Apply the complexity leadership paradigm to fringe arts businesses in China. The study examines the role of arts and

		cultural leadership in the context of societal transformation and explores the interactive dynamism between leaders, leadership, and multiple contexts

These studies provide insights into various aspects of Business Cases, including their impact on organizational performance, sustainability, innovation, leadership, and value creation. They highlight the importance of empirical research, case studies, and theoretical frameworks in understanding the state of the art of business cases and their implications for business and society.

2.3.1. Business Case Main Dimensions

The key variables that define a Business Case can vary depending on the specific context and purpose of the case. However, several common variables can be identified based on the references provided. Several authors have provided evidence of the multi-dimensionality and adaptability of the Business case to different markets. For example, ownership, management, successors, governance, age of the business, complexity of the business, financial performance and imminence of succession are identified as variables that define succession concerns in a family business Chua *et al*., (1999). These variables are important in understanding the dynamics and challenges associated with succession planning and management in family businesses. The Business Case for becoming a high reliability organisation in the healthcare sector involves defining problems and opportunities for each target variable, identifying root causes, and estimating costs and savings (Karalis & Barbery, 2018). This suggests that variables related to adverse outcomes, near misses, risky situations and baseline measurements of outcome variables are important in developing a comprehensive Business Case for improving reliability in healthcare organisations. Relevant information is a key variable in driving the Business Case process before, during and after the production of IT deliverables (Marnewick & Einhorn, 2019). The availability of relevant information influences the effectiveness of the Business Case in justifying investments and decisions in IT or IT-related projects. Business performance is a multidimensional variable that includes financial and non-financial components (Ranasinghe, 2021). Measuring and evaluating business performance requires consideration of various aspects and dimensions, including financial indicators, operational metrics, customer satisfaction and market share. All these dimensions can be found or developed within a Business Case. Overall, and based on the previous references, there are several variables that can define a Business Case, including ownership, management, succession, governance, financial performance, process lifecycle, cost, variability, relevant information, business performance, market expansion and adoption factors. The specific variables that define a Business Case will depend on the industry, context and objectives of the case.

2.3.2. Main Key Success in a Business Case

In a Business Case there are several key success factors that can be summarised as follows:

1. Reputation for honesty and friendliness: The entrepreneur's reputation for honesty and friendliness is identified as one of the most important success factors in a Business Case (Benzing *et al*., 2009). This factor contributes to building trust and positive relationships with customers and stakeholders.

2. Soft skills and good customer service: Social skills and good customer service are cited as critical success factors in several Business Cases (Benzing *et al*., 2009). These factors contribute to customer satisfaction, loyalty and positive word-of-mouth.

3. Entrepreneurial conditions: Entrepreneurial conditions, such as goal orientation and entrepreneurial competence, are identified as important success factors in the context of design start-ups (Kim *et al*., 2018). These factors contribute to the successful development and commercialisation of innovative ideas.

4. Commitment and positive outlook: Commitment and positive outlook are identified as key success factors in the development of women entrepreneurs in the IT industry (Cho *et al*., 2020). These factors help entrepreneurs overcome challenges and maintain motivation and resilience.

5. Technical expertise: Technical expertise has been identified as a key success factor in the senior healthcare business (Kortana, 2017). This factor contributes to the delivery of high-quality services and the ability to meet the specific needs of the target market.

6. Networking: Networking has been identified as a key success factor in various Business Cases (Cho *et al*., 2020). Building and maintaining a strong network of contacts and relationships can provide access to resources, opportunities and support.

7. Organisation: The attributes of the organisation such as existence, development, family unity and sustainability are identified as critical success factors in business succession (Tirdasari & Dhewanto, 2020). These factors contribute to the smooth transition and continuity of the business.

8. Competitive advantage: The identification and development of competitive advantages are important success factors in business succession (Kuronen & Takala, 2013). These advantages can differentiate the business from competitors and provide value to customers.

9. Innovation and adaptability: Innovation, commercialisation of ideas and adaptability are identified as critical success factors in design start-ups Kim *et al*., (2018) and in the context of the cosmetics industry (Farisha & Safari, 2021). These factors enable businesses to remain competitive, meet changing market demands, and seize new opportunities.

10. Customer satisfaction: Customer satisfaction has been identified as a critical success factor in various Business Cases (Kuronen & Takala, 2013; Wu *et al*., 2009). Satisfying customers' needs and expectations is crucial for building a loyal customer base and achieving long-term success.

These key success factors highlight the importance of factors such as reputation, customer service, business conditions, commitment, technical expertise, networking, organisation, competitive advantage, innovation, adaptability and customer satisfaction in the analysis and evaluation of Business Cases. Considering and addressing these factors can contribute to the overall success and sustainability of a business.

2.3.3. Business Case Challenges for a Digital Era

Nowadays, in the digital age and digital transformation era, there are several different challenges for a Business Case. These challenges can be summarised as follows:

1. Understanding and adapting to digital technologies: The rapid advancement of digital technologies poses a challenge for businesses to understand and effectively use these technologies in their operations and strategies Parida *et al*., (2019). This includes challenges related to digital literacy, technology infrastructure and keeping up with the pace of technological change.

2. Developing digital business models: The transition to the digital era requires firms to develop and implement digital business models that leverage digital technologies to create value and generate revenue (Bican & Brem, 2020). This involves challenges such as identifying new revenue streams, redefining value propositions, and adapting existing business models to the digital context.

3. Managing organisational change: Digital transformation often requires significant changes to organisational structures, processes and culture (Ackermann *et al*., 2021). Managing these changes can be challenging, as it involves overcoming resistance to change, aligning employees with new digital strategies, and developing new skills and capabilities.

4. Data management and privacy: The digital age generates vast amounts of data, and organisations need to effectively manage and use this data for decision-making and innovation (Schneider & Kokshagina, 2021). However, challenges related to data privacy, security and ethical considerations need to be addressed to ensure the responsible and effective use of data.

5. Leadership and talent management: Digital transformation requires strong leadership and the ability to attract, develop and retain digital talent (Wrede *et al*., 2020). Leaders need to have a deep understanding of digital technologies and their impact on the business, as well as the ability to drive and manage change in a digital context.

6. Customer experience and engagement: The digital era has changed customer expectations and behaviour, requiring companies to deliver seamless and personalised digital experiences (Gao *et al*., 2019). This involves challenges such as understanding customer needs and preferences, effectively leveraging digital channels, and integrating digital and physical touchpoints.

7. Integration and interoperability: Digital transformation often involves the integration of different digital systems, platforms and technologies within the organisation (Härting *et al*., 2020).

Ensuring interoperability and seamless integration between different systems can be a complex challenge, requiring careful planning and coordination.

8. Strategic alignment: Digital transformation should be aligned with the overall strategic goals and objectives of the organisation (Philippart, 2022). Ensuring that digital initiatives are aligned with the broader business strategy and contribute to the long-term success of the organisation can be a challenge.

9. Risk management: The digital era introduces new risks and vulnerabilities, such as cybersecurity threats and data breaches (Kutnjak, 2021). Organisations need to develop robust risk management strategies and processes to mitigate these risks and protect their digital assets.

10. Stakeholder engagement and collaboration: Digital transformation often involves collaboration with various stakeholders such as customers, suppliers and partners (González-Serrano *et al*., 2023). Establishing and maintaining effective relationships and collaboration with stakeholders can be challenging, requiring clear communication, trust, and shared goals.

These challenges highlight the complexity and multifaceted nature of digital transformation in a business context. Successfully addressing these challenges requires a strategic and holistic approach that includes leadership commitment, organisational agility, and a deep understanding of the digital landscape and its impact on the business.

2.4. Research Gaps

Table 3 describes the gaps found in the literature review, as well as the assumptions created by each gap, as described by the author.

Table 3 - Research GAP´s and assumptions

ID	GAP	Authors	Assumption
1	Evaluation of digital transformation projects contributions remains largely elusive	Barthel *et al*., 2021	Lack of project evaluation metrics directed for digital transformation projects
2	- Management and Business Problems related with project and business objectives - Need to create a new business value as well business continuity and business model innovation for value creation	Margherita and Heikkilä, 2021	- Lack of productivity, absence of Project Goals and alignment with Business Objectives - Lack of innovation and information for the elaboration of a Business Case, resulting in its ineffective use
3	Frameworks to assess the readiness of organization uncertainty	Zackery *et al*., 2022	Creation of uncertainty in organisations due to the current specific project needs

4	Lack of Business Performance	Harel, 2021	Affect the Business Performance of an organisation and consequent project development and implementation
5	Data-driven decision-making	Elrefaey *et al*., 2022	Lack of project evidence and benefits measurement to support the decision-making process
6	Long term effects in management-related fields	Hashemi *et al*., (2022)	Lack of effectiveness in considering the long term added value and business return
7	Unforeseen scenario and business uncertainty	Carracedo *et al*., 2021 Harel, 2021	Not considering the current scenarios for create a new business strategy and project evaluation metrics
8	The need to identify, optimize, and re-access existing technologies and business models	Donthu and Gustafsson, 2020	Applicability of digitalization in business performance to increase the value creation of a project endeavour
9	Creation of new and proper evaluation metrics in order to sustain their business continuity	Khlystova *et al*., (2022)	The need to assume a project evaluation methodology and benefits definition for project implementation
10	General Business Impact	PMI (2020)	Overall impact in an organisation performance and management
11	Ability of your current project(s) to realize more than 75% of their identified of intended benefits	PMI (2020)	Uncapable to cope the dynamic environment of projects

CHAPTER III

Methodology

This chapter will describe the research project, including the research questions and objectives of this thesis. The main research question will be presented alongside the research objectives. The research strategy and design aim to align the thesis with its philosophy. Finally, the concluding sections will address the data collection methods and the various stages of the written interview.

3.1. Research Project

The research project encompasses the core of this thesis, as well as the research problem described in Chapter I, and the research questions and objectives that will be described in the following sections.

3.1.1. Research Objectives

The objective of this research is to propose a new theoretical model for evaluating digital projects during the digital transformation era, based on the principles of scientific management and using a Business Case. To accomplish the desired results, this thesis will focus on two main actions. First, it will minimise the assumptions created by the gaps identified in the literature review (Table 3) regarding the lack of scientific knowledge about digital evaluation projects. The second action is divided into three parts. The first part is to collect information from interviews with several decision-makers in order to gain a deep understanding of the current problem of evaluating digital projects using several different methods. The second part is to extract knowledge about different methods and procedures that can be applied to digital evaluation projects. The third part is to validate the perceptions of the interviewees regarding the problems and difficulties of evaluating digital projects. The written interview was developed based on the literature review, and the author needed to fulfil the second and third parts of the second objective.

In this thesis, the theoretical model will be aligned with the main general objectives proposed by several authors (Herman & Siegelaub, 2009; Zwikael *et al*., 2018; Murray-Webster & Dalcher, 2019; Ward *et al*., 2008; Einhorn *et al*., 2020; Einhorn *et al*., 2021) regarding the contribution to the process of decision-making, to a project success and to mitigate the risks and project failure based in the following expectation (Table 4).

Table 4 - General objectives

Objective	Contribution
1	Through continuously monitorisation of the project´s lifetime, a Digital Business Case should provide to stakeholders the understand of the digital project's ongoing, mainly covering benefits, costs and risks, thereby allowing them to take well-informed decisions

2	Applying a scale to measure effective target benefits as well a proactive management throughout the entire life cycle in order to contribute but a better information in a digital project investment decision-making and the subsequent benefit management process
3	Assessment and understanding of major risks are critical to the digital evaluation of project viability
4	Enables the prioritization of the different digital investment projects and identify how the combination of IT and business changes will deliver the output of each benefit

Thus, based in the principal general objectives of a Business Case, and having in mind the concept of digital transformation in project evaluation, the author defined several research objectives, which are described in Table 5.

Table 5 - Research Objectives

Objective	Contribution
1	Characterisation and analysis of the Business Case applications through a literature review;
2	Collection of the impact of COVID-19 and Digital Transformation in project evaluation by identify the gaps and assumptions created
3	Organising interviews with decision-makers in order to discuss the lack of adaptability and technicality of project evaluation for digital Business Cases
4	Elaboration of new processes applied to the Business Case based in the principles of scientific management towards digital project evaluation
5	Validation of the proposed processes for project evaluation based in the Delphi method with experts in the field

In addition to its main purpose, this research is expected to make a significant contribution to scientific literature and address existing assumptions at theoretical and methodological levels. From an academic point of view, this research intends to address gaps in the literature that have led to various assumptions, particularly regarding the long-term effects of the pandemic on project evaluation and how to adapt the evaluation methodology in the digital transformation era. Secondly, this research addresses the ability to implement organisational strategy by developing a theoretical model for project evaluation supported by a Business Case. This model will inform decision-making processes and generate benefits, enabling the intended value to be accrued. The first expected empirical contribution is to maintain alignment between projects and strategic objectives by proposing a theoretical model that enables the realisation of benefits underpinning the value proposition and securing long-term profits. The second expected empirical contribution is to detail the Digital Business Case methodology in order to assist with the initial digital project assessment/evaluation and contribute to value creation within an organisation.

3.2. Research Strategy

The research strategy is considered a plan of action to achieve a goal, namely about answering the research questions (Saunders *et al*., 2019). This section pretends to describe the boundaries of this

thesis by presenting the research philosophies, approaches and strategies, which have been applied. In the Figure 4, it is highlighted all applied research methodology.

Before defining the research philosophies, the philosophical assumptions of each one were taken into account (epistemology, ontology and axiology). For this research, the selected philosophical assumption was epistemology, as the aim is to gain knowledge from the variations of the different assumptions. This philosophy considers several factors, such as competing views on morality, nature, definition, standards, sources and functions of knowledge. Moreover, it is based on what constitutes acceptable knowledge (Saunders *et al*., 2019). Thus, based on this selection, this thesis is oriented towards a positivist paradigm. This paradigm asserts that phenomena can be understood through models that constitute true, independent explanations that can be measured (Sanchez *et al*., 2022; Geels, 2022).

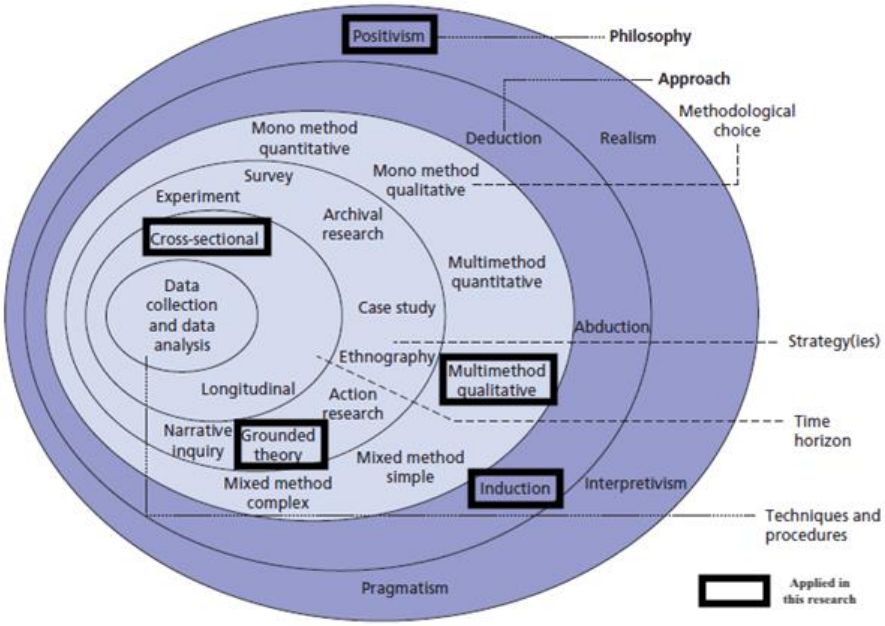


Figure 4 - Research Onion (Source: Saunders *et al*., 2019)

In terms of research approach, this thesis used an inductive method. The inductive approach was directed when there was a need to explore a topic and develop a theoretical explanation as the data were collected and analysed following a data-driven method (Saunders *et al*., 2019). This approach was directed to a topic where there was a vast literature review in one context (Project evaluation) but far less in the context of digital project evaluation, which led to constructing a theoretical model. The adoption of an inductive method reflected this thesis data collection method, namely the interview and the application of the Delphi method, since this inductive approach was the most common to work with qualitative data (Saunders *et al*., 2019) and provided an easily used and systematic set of methods for qualitative data that could produce reliable and valid findings (Thomas, 2006).

This research adopted a single research strategy: Grounded Theory. This theory was developed by Glaser and Strauss (1967) based on the idea that theory could be discovered from systematically obtained and analysed data in social research. This theoretical approach was a systematic method of conducting research, shaping the collection of data and providing explicit strategies for analysing it (Charmaz & Thornberg, 2021). Based on these facts, data collection from interviews began without an initial theoretical framework, although some initial assumptions were made based on a literature review. This framework was only developed once the interviews were finished.

The interviews took the form of a structured questionnaire (Saunders *et al*., 2019), in which the same set of questions was asked and recorded by the interviewer. This was an important feature that allowed for comparison across all respondents (Fox, 2009). Using a structured interview as a research strategy could provide a high level of valid prediction (Macan, 2009) when pre-coded questions were used.

The questionnaires used during the interviews allowed standardised data to be collected from many respondents in an economical way, enabling easy comparison (Saunders *et al*., 2019). The applicability of questionnaires was analysed in more depth in the next sections.

Finally, this research was cross-sectional, as it involved studying a specific phenomenon (the Business Case for Project Evaluation), which had been accelerated due to special circumstances (the enhancement of digital transformation) at a particular time (the epidemic of the Coronavirus disease (Covid-19))

3.3. Research Design

The research design is considered the plan how the research questions will be replied (Saunders *et al*., 2019). The present research follows an exploratory study (with the goal of getting to know a new topic better and to formulate more precise research questions). It is important to highlight that the exploratory research may start with a broad focus although it will become narrower as the research progresses (Saunders *et al*., 2019). This Exploratory Study has been conducted based on literature reviews, interviewing experts and Delphi outputs. In Table 6, it is described the research framework for this thesis.

Table 6 - Research Framework

Literature Review	**Data Collection**	**Methodology**	**Data Analysis**	**Theoretical Framework**	**Output**
Main topic: Business Case (**Bibliometric networks; Research Gaps)**	- Interviews - Delphi Method	- Research Questions - Research Strategy - Research Design	- Multi-method Qualitative	- Described in section 1.4	- Digital Evaluation Business Case - Findings

		- Validation Methodology			

This thesis relay in a qualitative research design using a multi-method qualitative study based in the structured interviews and Delphi method with experts for fine-tuning the theoretical model developed after the interviews. Based in an exploratory study where qualitative interviews are taking place and the research design adopts an inductive approach, such as the grounded theory, it is considerable beneficial for a research topic (Saunders *et al*., 2019).

The selection of a multi-method qualitative study allows to overcome weaknesses associated with only a single or mono technique and it also provides a richer approach to data collection, analysis and data interpretation besides the advantages identified in several schemes of the results of merging these two types of research (Saunders *et al*., 2019; Bryman, 2006).

The steps of discovering and generating factual and objective decision-making derived from a Business Case have steps that are extremely important to the credibility and reliability of the research data. In fact, based on the suggestion from Yin (2018), this research was planned and over time evaluated in order the same study produce the same findings and conclusions if the same processes proposed by Teixeira (2015) are applied.

In terms of reliability/dependability, there is the potential scenario to create an interviewer bias. Thus, in order to contain or reduce this potential bias the option for structured interviews will ensure a level of consistency between interviewees having multiple questions to avoid confusing the interviewee and ensure a clear answer from each interviewer. Using the structured interviews can enhance the reliability and validity of interviewer evaluations (Macan, 2009).

This research cycle starts with the historical knowledge and present knowledge that analysed together will help the formulation of the research questions during the research process. These research questions then needed to be tested and validated against reality, what can be done through exploration, using a proposed model formulated after the interviews. Throughout the entire cycle, these methods will reply to the research questions, which will lead to the creation of knowledge (Zikmund *et al*., 2010).

3.4. Data Collection

The data collected for this thesis and the literature review analysis were obtained using a bibliometric method involving a literature search (evaluating sources, identifying keywords and major concepts, and outlining the structure). Structured asynchronous electronic interviews were used for model creation due to the temporal and spatial flexibility they offer (Hosain *et al*., 2025). These were applied

to the Delphi group to validate model development after interviews held between 15/07/2022 and 15/10/2022. The following sections will describe each data collection method in more detail.

3.4.1. Bibliometric Data

The bibliometric analysis-based data collection process aimed to provide a scientific literature review to lay a strong groundwork (Passas, 2024) for the keyword 'Business Case' and variations such as 'Business Case-Digital Transformation'. Using this approach, it will be analysed a considerable large number of scientific papers in order to have a broader understanding of the current research gaps as well the relation between the Business Case and the keywords presented in this research. The main data-source for the bibliometric analysis was the database Scopus. The selection of only one database (Scopus) and not include Web of Science was related with the fact that 99.11% and 96.61% of the journals indexed in Web of Science are also indexed in Scopus (Singh *et al*., 2021). The process of papers data collection was by searching the keyword 'Business Case' on the website www.scopus.com through a query presented in Figure 5.

"TITLE-ABS-KEY ("business case") AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (SUBJAREA, "BUSI"))"

Figure 5 - Business Case research query (Source: Author)

This query resulted in 1,359 records. Since not all the records matched the defined criteria, it was filtered according to the following criteria:

1 - The paper was written in English, as the language most used in the academia.

2 - The paper must be published.

3 – The paper should be published in journals where the subject area is related with "Business, Management and Accounting".

On this dataset it was not filtered the year in order to provide a more comprehensive data analysis with more data as well the initial references to the keyword Business Case. Thus, after the dataset being filtered, according to the established criteria, the total records were 1,293.

In order to evaluate the data collection, it has been selected five random papers from the dataset to validate if their abstract, methodology and results are relevant for this study. The random function

was applied to the dataset by using the Excel formula (=RAND()). The first paper from the selected five was from the author Kingston (2003) where he describes how to carry out a feasibility study for a potential knowledge-based system application using three major aspects and one of them is the Business Case. The second paper written by Mease and Collins, (2018) where the paper draws the analysis on interviews with 19 self-identified US diversity consultants and 94 diversity statements posted on corporate websites applying the Business Case for diversity as a discursive strategy that connects human differences to an organisation's bottom line. Su *et al*., (2009) describes how firm common functions merged performed by multiple units into a single service delivery organisation, provides an innovative approach to make business more efficient and effective. The authors applied to this methodology a real Business Case to justify a global firm's strategic decision between moving a financial function to several regional shared services centres and to a global shared services centre. Erzurumlu and Rollag, (2013) proposed a role-play-based consulting exercise as an enhancement to the traditional case teaching method in order to get undergraduate students more interested and engaged with Business Cases. Lahue *et al*., (2012) tried to quantify the economic burden of preventable ADEs related to inpatient injectable medications in the USA by using a Business Case of investing in efforts to prevent errors related to injectable medications.

Thus, having this evidence it is clear the contribution of this dataset for a comprehensive literature review and providing increased confidence on the validity of the study (Guedes & Pereira, 2020).

To evaluate the literature references retrieved from this query it was used the software VOSviewer. This software is particularly useful for displaying large bibliometric maps in an easily interpretable format (Van Eck & Waltman, 2010). Furthermore, it has possible to create maps based on network data and for visualizing and exploring these maps and is a considerable added value for bibliometric analysis since it intends, primarily, analyse bibliometric networks (Van Eck and Waltman, 2013). The advantage of using this technique is that it adds value by transforming massive datasets into actionable academic insights, a fact that has been identified by several authors (Ying-Yin *et al*., 2026; Liu *et al*., 2025). In this software, there are several types of analysis and counting method available, which can be combined and are available depending on the type of analysis selected. These types of data analysis are presented in Table 7.

Table 7 - Type of Bibliometric Analysis

Type of Analysis	Unit of Analysis	Counting Method
Co-authorship	Authors	Full Counting Fractional counting
	Organizations	
	Countries	
Co-occurrence	All Keywords	
	Author Keywords	
	Index Keywords	
Citation	Documents	
	Sources	

	Authors	
	Organizations	
	Countries	
Bibliographic coupling	Documents	
	Sources	
	Authors	
	Organizations	
	Countries	
Co-citation	Cited References	
	Cited Sources	
	Cited Authors	

Based in the several different types of potential analysis and counting methods, for this thesis 3 options have been selected from the type of analysis, 5 options from the unit of analysis and 1 counting method. The selected information will provide a comprehensive overview of the dataset and the status of the current literature review associated with the Business Case. The selected analysis and the subsequent combinations are described in Table 8.

Table 8 - Types of analysis selected

Type of Analysis	Unit of Analysis	Counting Method
Co-authorship	Authors	Full counting
	Organizations	
	Countries	
Co-occurrence	All Keywords	
Citation	Sources	

In the "Type of Analysis", the selected options have different meaning and information to be analysed. For instance, the "Co-authorship" is the relatedness of items that are determined based on their number of co-authored documents. The "Co-occurrence" is related with the relatedness of items that are determined based on the number of documents in which they occur together. The "Citation" is the relatedness of items that are determined based on the number of times they cite each other. The "Co-citation" means the relatedness of items that are determined based on the number of times they are cited together.

Other searches were conducted by combining the concepts of "Business Case" and "Digital Transformation", applying the same criteria as those defined in the research query presented in Figure 5. As the number of retrieved papers was deemed insufficient for bibliometric analysis, only the validation metrics were applied. The query is as follows (Figure 6):

```
( TITLE-ABS-KEY ( "business case" ) AND TITLE-ABS-KEY ( "scientific management" ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( DOCTYPE , "cp" ) OR LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SUBJAREA , "BUSI" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )
```

Figure 6 - Business Case & Digital Transformation research query (Source: Author)

In terms of the results, the research query shown in Figure 6 retrieved nine papers. To validate the data obtained from the query in Figure 6, the same validation approach used for the output in Figure 5 was followed.

Regarding the outputs provided from the query in figure 6, the random selected papers were, initially, from Colli *et al*., (2021). These authors describe the development of a framework as an extended view concerning the potential value of digital transformation projects. They have used a case study and refer the framework reversed initially negative perceptions around a narrowly scoped Business Case towards an opportunity-oriented attitude exploring further potentials of the technology. The second paper was from the authors Rambow-Hoeschele *et al*., (2019). These authors described a tool, which was built to support businesses facing the consequences of digital transformation. This tool can be applied to several dimensions and see the effect on the outcome of the Business Case.

3.4.2. Primary data source collection

In qualitative research, structured interviews of representative participants are the most common method of data collection (Sandelowski, 2000). The primary source of data collection was obtained by interviews, namely structure asynchronous electronic interviews sent by email and private text messages to 62 selected relevant people.

For the purpose to get the data from the interviews, it was structuring a written interview where the questions were developed based in the literature review (explained in the next sections). When creating the questions for the written interview a crucial factor to have in mind is using open-ended or closed-ended response questions (Dalati & Gómez, 2018). Thus, this written interview followed that analogy and was based in closed questions with limited options of open questions. Although, the open questions were related with previously chosen option “other”, from a closed question, where the replier would state which other method/option it could be described. The option of closed questions relies in the fact this is a very precise topic where the new methods can be evaluated and these types of questions, according to Saunders *et al*., (2019) and Vinten, (1995), are easy to compare, less-time consuming, possess a higher enforcement and no extending writing among other benefits.

The collected information was done using standardised written interviews based in closed questions (only small exceptions where the respondent is requested to mention another method in case, if they use it) using a type of list (where the respondent is offered a list of items, any of which may be selected (Saunders *et al*., 2019)) and ranking questions (in order to measure the importance of the chosen methods). The chosen type will guarantee that all questions will be interpreted the same way by all respondents. For the exploratory type of research used in this thesis, the structured questions in the written interview are well performed and more suitable applicable.

Regarding the option of using asynchronous electronic interview by email and text (private LinkedIn messages), it has its own advantages. For instance, data are recorded, thereby removing problems associated with other forms of recording and transcription such as cost, accuracy and participants (Saunders *et al*., 2019) and it can be conducted with participants all over the world without additional expenses (Hawkins, 2018) as well the participants will have more control of their level of participation and consequently will have an ethical advantage (Mason & Ide, 2014).

3.4.2.1. Interview

To reach out to the relevant people for the interviews the professional network LinkedIn and relevant known contacts from the enterprise world were chosen. Thus, in order to have relevant contacts key players were selected (top management, management intermediate and operational-technical) to work in the field of Project Management and with experience in Business Case (described in their LinkedIn profile). It was queried my personal LinkedIn network in order to reach the desired people. The contacts were selected from the total 635 connections where the profiles were filtered in two steps. The first step by selecting the industry "Management Consulting". The result were 61 contacts that match the initial requirement. The second step consisted in evaluating each profile in order to identify the key words "Project Management" or "Project Evaluation" and "Business Case" and "Digital". The adoption of the Boolean operator from "Project Management" and "Project Evaluation" is related with the fact that "Project Evaluation" is not a common key word detected in LinkedIn profiles. Consequently, the result was 30 connections that match the defined requirements.

Regarding the contact by emails, it was sent 25 emails to top management contacts. From the 25 emails sent only 2 agreed to reply. The conjunction of emails and LinkedIn search aimed to reach a higher number of relevant profiles. Although, the contact by email it wasn´t relevant neither expressive. Nowadays, there is a considerable difficulty to contact top managers directly by email and request them an interview or other type of contribution. By the contrary, LinkedIn proved to be a relevant tool to search and request participation of relevant people.

In short, the request for interview had a sample size of reached a total number of 55 direct invitations (LinkedIn private messages and email). From the 55 request 32 reply positively (all 30 replies from LinkedIn accepted to participate as well as 2 contacts from the emails sent). Once the participant accepted, an email was sent with the different questions. After the initial explanation (first part), the participant accessed to the second and third part of the questions.

Though, from the 30 accepted participants from LinkedIn, 3 mentioned, after starting the interview, they do not have enough skills to reply to the interview content due to lack of knowledge about the metrics applied or because the Business Case they usually apply for projects evaluation are only cost-benefit analysis, which are clearly a very simplistic version regarding the proposed questions,

which aim to get a complete overview of the several different steps of a Business Case instead of only a cost and benefit analysis.

In terms of sample, it was used a common method in Grounded Theory, the theoretical sampling, which continues until the theoretical saturation is reached (Saunders *et al*., 2019). Thus, since the most selected and prominent contacts from LinkedIn have a considerable experience in Business Case and replied "yes" to the interview (not considering here the 3 participants that declare they were not capable to reply), it wasn´t needed to request more participants due to the level of theoretical saturation (data collection ceases to reveal any new properties that are relevant to a category). This brought the final total of participants to 29.

Considering the total response rate, based in Neuman, (2014) formula, the written interview had 52% of response rate.

In terms of fulfilment, not all questions have been replied. Although, in the overall, the proportion of applicable questions, that have been answered, was considered as a complete response (more than 80% of all questions answered).

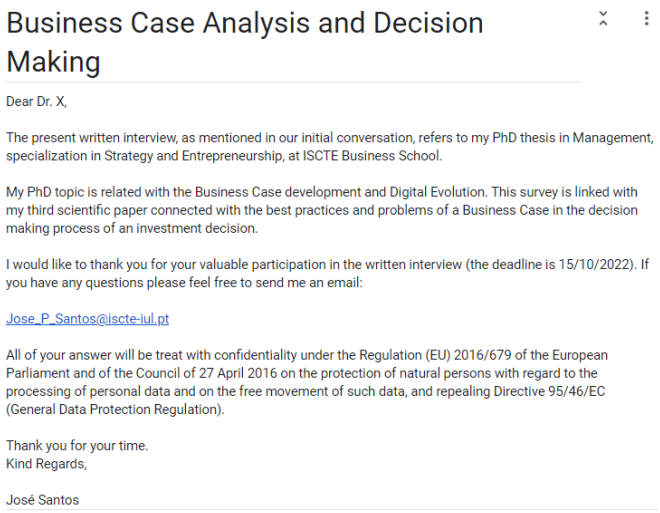
3.4.2.1.1. Interview Script

The interview was based in a structure way and divided in 3 parts. The first part was an introductory explanation of the interview objective, the second section was related with the general information about the participants and the level of experience, and the third section was related with the problems and difficulties of the several presented methods. The second and third section's visualisation structure are described in the appendices. The methods used will be explained in the next sections. The elaboration of each question, as described in section 1.3, was based in the literature review. The conjunction of both approaches allowed to understand deeply the research problem. Thus, it will follow a precise and methodological structure of questions, in order to support the validation and applicability of several methods in a digital project evaluation, as well to validate the problems and difficulties of the presented methods in the evaluation of a digital project. Each interview section and corresponding methods will be explained during the next sections.

The questionnaire was constructed in English, and it was developed in Google forms and shared with 29 participants after the confirmation for the interview. The request for the interview started in July 2022, with the first sending emails and private text messages, until the last acceptance of replies in October 2022. Since the request for the interview crosses a period of vacations, the respondents had 3 months to reply to the questions. One advantage of interview email means the participants can answer any time of day or night that suits their needs (Burns, 2010) given a considerable advantage of having a reply based on participant's availability.

3.4.2.1.2. First Part

The first part of the written interview consisted of a brief explanation of the objectives of the interview, as well as an explanation of the European regulation that guarantees the confidentiality of the responses. Figure 7 presents the initial statement.



Business Case Analysis and Decision Making

Dear Dr. X,

The present written interview, as mentioned in our initial conversation, refers to my PhD thesis in Management, specialization in Strategy and Entrepreneurship, at ISCTE Business School.

My PhD topic is related with the Business Case development and Digital Evolution. This survey is linked with my third scientific paper connected with the best practices and problems of a Business Case in the decision making process of an investment decision.

I would like to thank you for your valuable participation in the written interview (the deadline is 15/10/2022). If you have any questions please feel free to send me an email:

Jose_P_Santos@iscte-iul.pt

All of your answer will be treat with confidentiality under the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

Thank you for your time.
Kind Regards,

José Santos

Figure 7 - Interview first section (Source: Author)

3.4.2.2.2. Second Part

The second part comprises the introduction, which starts with a binary question: has the respondent already participated in the development of a digital evaluation project? If the answer is no, the respondent should not proceed with the questionnaire. If the answer is positive, the respondent will continue to complete the questionnaire. The information requested covers general information and consists of four questions presented in Appendix A. The first question provides options aimed at identifying the respondent's position within an organisation. The second question provides 19 options for Portuguese industries, as classified in CAE Rev. 3. CAE Rev. 3 is a harmonised and integrated classification system for economic activities within the European Union (NACE Rev. 2) and the United Nations (CITA Rev. 4) (INE, 2007).

The fourth question aims to gather information on the number of years spent evaluating digital projects, and the fifth question aims to establish how many years of experience the respondent has participating in the development of a digital project.

3.4.2.3.2. Third Part

The final part of the interview consists of two questions, which are described in Appendix B. From sections 2 to 7, there are two common questions related to the specific method of each section. One question is related to the types of techniques that can be applied to evaluate digital projects using a specific method. The other question is related to the main problems or difficulties of using a specific

method to evaluate a digital project. Since it is possible for participants to mention several problems and difficulties, but in some cases only one, it was decided to use a threshold of 9 problems. Otherwise, the theoretical model output would include several individual problems, creating significant bias and redundant information.

The methods and the corresponding selected techniques (identified by the author) are described in the following sections.

3.4.2.3.2.1. Problem-Solving

The Problem-Solving approach in a Business Case is considered the first step, as it provides an initial assessment. According to Aarikka-Stenroos and Jaakkola, (2012), this process begins with identifying the content of the exchange, the goals, the needs, and the solutions to meet those needs.

In this step the aim is to evaluate the type of techniques from the Problem-Solving method the interviewed applied to a digital project and to know the type of problems or difficulties they have using this method. The most common techniques are presented in Table 9.

Table 9 - Problem Solving Methods

Methods			
Creative Problem Solving	Fishbone Diagram	Root Cause Analysis	Five Why´s
Layout generation problem	Pereira Problem Solving	Problem Definition Process	Six Thinking Hats
Lightning Decision Jam	World Cafe	Discovery & Action Dialogue	Design Sprint 2.0
Open Space Technology			

In order to justify the selection of these 13 options, it has been used the citations count metrics provided by Google Scholar. The option for Google Scholar is related with the fact that is indexing more journals and more publication types than other databases such as Scopus or Web of Science, providing a broader number of citations.

Also, some of these methods are described in other papers. For instance, Pereira and Santos (2020), describe several different techniques such as Fishbone diagram, Root Cause Analysis, Five Why´s, and Layout Generation Problem besides proposing a new modern Problem-Solving methodology called Pereira Problem Solving, which is also included in this thesis mainly aggregated to the Digital Business Case. In Table 10, it is described the techniques and the total count number of citations as well the reference name and authors. It is important to mention that some methods it wasn´t possible to identify the reference paper. Other methods it doesn´t have a reference paper but rather a methodology developed by a company based on their needs. Thus, for papers N/D it is provided a reference name and authors, which are considerable relevant in terms of citations.

Table 10 - Problem Solving Methods

Method	Total Number of Citations from the initial reference	Reference Publication	Authors
Creative Problem Solving	455	Create Problem Solving	Lumsdaine, E., & Lumsdaine, M.
Fishbone Diagram	1231	Introduction to Quality Control	Ishikawa, K.
Root Cause Analysis	2084	The last planner system of production control	Ballard (Technique created by Toyoda)
Five Why´s	11055	Toyota production system: beyond large-scale production	Ohno, T.
Layout Generation Problem	13	An algorithmic design grammar for problem solving	Hou & Stouffs
Pereira Problem Solving	18	Pereira Problem Solving	Pereira, L, & Santos, J.
Problem Definition Process	N/D	N/D	Creator Dwayne Spradlin
Six Thinking Hats	3781	Six Thinking Hats: The multi-million bestselling guide to running better meetings and making faster decisions	Bono, E.
Lightning Decision Jam	N/D	N/D	Jonathan Courtney of AJ&Smart Berlin
World Cafe	128	The world café: part one	Schieffer, A, Isaacs, D, & Gyllenpalm, B. (although it was originated in the USA by Academy Fellow by Juanita Brown and David Isaacs)
Discovery & Action Dialogue	N/D	The Surprising Power of Liberating Structures: Simple Rules to Unleash a Culture of Innovation	Lipmanowicz, J, & McCandless, K
Design Sprint 1.0/2.0	725	Sprint: How to solve big problems and test new ideas in just five days	Knapp, J., Zeratsky, J., & Kowitz, B
Open Space Technology	198	Expanding our now: The story of open space technology	Owen

The Root Cause Analysis according to the website SCISPACE[1] (a website implementing Artificial Intelligence to decode any research paper) has more than 1770 publications and more than 23050 citations. The referenced paper from Ballard, (2000) is a dissertation and contains the highest number of citations.

[1] https://typeset.io/

The Lightning Decision Jam (LDJ) is an exercise created by AJ&Smart, thus it wasn´t possible to find any citations regarding the initial development of this method since it is mostly adopted in companies like the technique Problem Definition Process.

In the case of Design Sprint, the number of citations related to the version 1.0, which was developed by Knapp *et al*., (2016). The Design Sprint 2.0 version was developed in 2018 by Jake Knapp and a private company AJ&Smart.

An important fact is that several of these methods can be complemented. For instance, the Problem Definition Process can be complemented with the Five Why´s method (Kohfeldt & Langhout, 2012) or the Root Cause Analysis may include the technique Five Why´s as well.

The Layout Generation Problem is both an ancient and modern issue in architectural design with many studies have attempted to solve it with advanced computational methods (Hou & Stouffs, 2018). In table 10, it´s referred the citations from the paper Hou and Stouffs (2018).

3.4.2.3.3.1. Strategic Alignment

The second step of the questionnaire is the Strategic Alignment. To accomplish strategic alignment, it should begin at the start of the evaluation and selection process (Hamdan & Jaafar, 2014) since project strategic alignment is considered a mean for the strategic implementation. Thus, several options are provided, namely if a project proposal should be evaluated according to the request source; top management perception, voting process, scoring model, analytic hierarchy process or if isn't rated at all. The proposal of these several different options and merge between quantitative and qualitative options aims to close the gap of separation between quantitative financials from qualitative strategic issues (Hamdan & Jaafar, 2014).

3.4.2.3.3.2. Benefits Estimation

Benefits Management is a common step during a project evaluation and, in terms of organisational tools, is currently applied in a Business Case as an effective benefits target estimation (Zwikael & Meredith, 2019).

During the interview several options to analyse the quantitative benefits were proposed (Table 11) based in Cooper and Schindler (2013), which described the methods (Historical, Questioning and Experimental) and techniques. Some of the techniques were not described or provided in the interview, in order to avoid creating an exhaustive list of questions. These techniques were selected for their applicability to the process of measuring benefits and for their ability to cover the whole spectrum of benefits (both tangible and intangible). These techniques derive from the capabilities of qualitative and quantitative measurements (see Table 11).

Table 11 - Benefits Evaluation Techniques (Adapted from Cooper & Schindler, 2013)

Methods and Techniques		
Historical	Questioning	Experimental
Trend Analysis	Market Research	Observation
Regression Analysis	Focus Group	Monte Carlo Simulation
Interviews	Interview	Gap Analysis
Observation	Expert Judgement	#
Expert Judgement	Survey	#
Benchmarking	#	#

The aim of this question in this section is to evaluate the participants' understanding of which metrics they use and whether they consider other types of metrics relevant for evaluating benefits. For each type of benefit (tangible and intangible), the most relevant method is presented. This information is provided in Table 12.

Table 12 - Type of Benefits and Applied Methods

Type of Benefit	Techniques
Tangible	Regression Analysis
	Trend Analysis
	Monte Carlo Simulation
	Expert Judgement
	Focus Group
	Gap Analysis
Intangible	Focus Group
	Market Research
	Interviews
	Benchmarking
	Observation
	Surveys
	Expert Judgement

3.4.2.3.3.3. Cost Estimation

Project investment is related with the need for business to growth in certain following strategies that will define the business sustainability. There are several different methods to evaluate if an investment will be assertive or not. This section proposes nine different techniques that can be applied to a Business Case or other framework for project evaluation. These techniques are presented in Table 13.

Table 13 - Investment techniques of evaluation

Techniques		
Expert judgement	Estimation by analogy	Bottom – up approach
Independent estimation	Parametric estimation	Performing independent estimates
By creating scenarios	Via Monte Carlo Simulation	Asking other party to review it

Several metrics were provided in response to this question, following the same structure as the other identified methods and corresponding questions. All of the presented techniques can either perform a quantitative evaluation or provide qualitative indicators to support decision-makers. In the case of forecasting, this is a significant factor in project evaluation, since if the forecast does not meet expectations, the project will be cancelled (Homer, 2007). These techniques support the three core concepts of the project system (Homer, 2007):

- Ongoing Control of the estimate reliability
- Codifying the estimates into a means of measuring project performance
- A watch system that monitors the project and extrapolates this information to project outcomes.

3.4.2.3.3.4. Economic Evaluation

In this step the economic evaluation aims to provide information regarding the types of indexes. The Economic evaluation of a project implies to measure of the benefits in monetary terms (Boadway, 2020).

The proposed indexes are commonly used in an economic evaluation of a project endeavour (Schmidt, 2009). The proposal indexes are presented in Table 14.

Table 14 - Economic evaluation indexes

Index		
Payback	NPV	BCR
ROI	IRR	Breakeven

In terms of the nomenclature, Dalcher, (2016) define net present value (NPV) as the difference between the present value of cash inflows and the present value of cash outflows over a given period. According to Dalcher (2016), Internal Rate of Return (IRR) represents the expected profitability of a potential investment. The Payback according to Brown, (2007) is defined as the measure of time until the total cash or benefits received for the project equal or exceed the total costs. The ROI (Return on Investment), also according to Brown, (2007), is a calculation of the rate of return for a given investment for a given period. The last option to select is the BCR (Benefit Cost Ratio), the BCR is derived from the mathematics of NPV and is subject to the assumptions of the discounting model (Smith & Barker, 1999).

3.4.2.3.3.5. Organisation Readiness Analysis

The Organisation Readiness Analysis aims to evaluate if a market is ready for a project implementation. This is a critical section in the interview since there is a lack of effective models to leverage the lessons

learned from previous projects to evaluate an organisation's readiness for, as example, a big data project (Barham & Daim, 2020). The organisation readiness is considered the capacity to strategically change is only partly the result of management capabilities (Guenduez & Mergel, 2022).

The proposed methods will allow an organisation to capture the internal and external environment as well the followers and antagonists of the project initiative before the final decision from the decision-makers. The proposed techniques (Table 15) cover all range of possibilities and evaluation metrics to support a final decision.

Table 15 - Evaluation Techniques

Techniques		
Empiricism	Force Field Analysis	Stakeholder Analysis
Cost/Benefit Matrix	Scenario Analysis	#

These techniques can be used to assess readiness for operational deployment, for instance in terms of technological project market entry (Uren & Edwards, 2023). Additionally, they can be combined or supplemented to provide a more comprehensive project analysis.

3.4.2.3.3.6. Sensitivity Analysis

The Sensitivity analysis enables the identification of the 'critical' variables of the project (Sartori *et al*., 2014) and helps to determine which individual project risks or other sources of uncertainty have the most potential impact on project outcomes (Project Management Institute, 2017).

This analysis can integrate the several indexes, provided by the economic evaluation, in order to measure the economic performance of the identified variables (positive or negative variance) provided by the current techniques describe in this section and presented in Table 16.

Table 16 - Sensitivity analysis techniques

Techniques	
Delta Logs	Betas Sector
Beta Triangular Distributions	Monte Carlo Simulation

The Beta triangular distributions, according to the Project Management Institute (2017), are common applied when a project duration, cost or resource requirement for a planned activity is uncertain, thus, it´s applied a model as a probability distribution. Also, according to the Project Management Institute (2017), the Monte Carlo simulation focus on risks and other sources of uncertainty to calculate possible schedule outcomes for the total project. The Betas sector and the Delta Logs are measures to support the quantitative risk analysis integrated in the Sensitivity Analysis.

3.4.2.3.3.7. Written Interview Validity

According to Saunders *et al*., (2019), a valid questionnaire will produce accurate data, which can be used to successfully measure the topic under discussion, meaning that the data was collected consistently. To ensure external validity, the data collected aimed to address participants from different industries, which was achieved through the interview results. Therefore, the findings from this sample can be applied to other samples that share the same characteristics. Because the written interviews were submitted by email and private text message containing a link to the form, and the time allotted for completion was considerable, all interviews and transcribed interview data were recorded (no personal data was recorded or collected). This ensured the reliability of the information.

In terms of content validity, three experts with a considerable experience in Business Case (One academic and working in the private sector and two purely academic) provided guidelines and support to the construction of the questionnaire. Their opinions are presented in Table 17.

Table 17 - Experts Output

Expert Profile	Comment	Author Actions
1 - Academic & Entrepreneur	1 - Provided useful suggestions of techniques for the presented methods in all technical questions 2 - Proposed the segmentation of the industries applying CAE Rev3 3 - Proposed the last questions related with the Project Measurements in order to have a clear picture of the measurement strategy and difficulties and problems in measure digital projects	1 – Updated the available techniques for each method based in the analysis of the most common used techniques and suggestions by the experts 2 – Adopt the CAE Rev3 from the Portuguese National Institute of Statistics 3 – Added 2 last questions regarding project measurements
2 - Academic	1 - The question made for the first version of the questionnaire in the third part seemed towards a market study and the objective initially was not clear 2 – In the third part, proposed the option “other” in the question related with the techniques from each method	1 – Redefined the context of the questions for the questionnaire 2 – Questions updated with new techniques
3 - Academic	1 – Proposed to provide more options in the techniques for each method 2 – Proposed to add a question in the second part of the questionnaire related with the number of years of experience in elaborating digital projects	1 – Updated the number of techniques for each method based in an exhaustive literature review 2 – Added a new question (1.4) in order to evaluate the number of years elaborating a digital project

3.5. Validation Methodology

To evaluate the model after the interviews, the Delphi method was used as the final step to validate the model. To this end, a group of relevant experts from the business consulting and academic fields

was created to evaluate the proposed theoretical model in different phases using a balanced scorecard key performance indicator (KPI) questionnaire.

3.5.1 Delphi Method

The Delphi method aims to achieve consensus about a specific topic by using several rounds of questionnaires in different phases to collect data from a panel of selected experts on the topic of interest (Barrios *et al.*, 2021). Due to its ampleness, the Delphi method is applied in several cross areas, as an example, energy sector (Kattirtzi & Winskel, 2020), financial markets (Kauko & Palmroos, 2014), tourism products (Konu, 2015) and global societal trends (Van de Linde & Van der Duin, 2011) among several other areas.

The Delphi method has, as primary goal, the objective of generate consensus among the different experts by sharing their ideas and feedback about a specific topic in a structured way (Linstone & Turoff, 1975; Kaartemo & Nyström, 2021). The selection of this method is related in the fact that Delphi studies are mostly based on literature reviews, which is the bases of this thesis in terms of research gaps (Nyström & Kaartemo, 2022). The elaboration of the different steps of the workflow applied in this validation process is described in Figure 8.

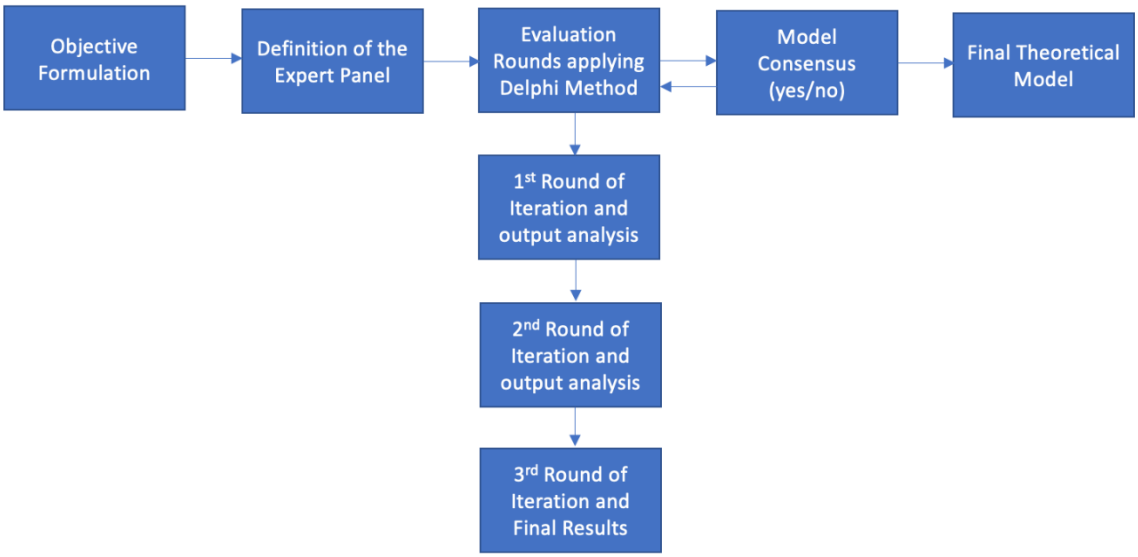


Figure 8 - Delphi method validity workflow (Source: Author)

3.5.1.1. Evaluation Phases

The model evaluation was conducted in four different phases using the Delphi method. According to Linstone and Turoff (1975), the first phase involves exploring the subject under discussion. During this phase, each participant contributes additional pertinent information. The second phase involved reaching an understanding of how the participants viewed and analysed the proposed theoretical

model in terms of three variables: importance, desirability, and feasibility. If participants disagree with the content of the variables described in the second phase, these disagreements are explored in the third phase. The final evaluation phase occurs once all the information has been collected and analysed, and the final evaluations have been provided for consideration.

This analysis was performed online using the form *real-lucre Delphi*. This form, contrary to the form *Conventional Delphi*, has the advantage of eliminating the delay caused in summarizing each round of Delphi, thereby turning the process into a real-time communications system (Linstone & Turoff, 1975).

3.5.2. Objective Formulation

The objective of this process is to validate a theoretical model that aims to create a Business Case for evaluating digital projects. This main objective, as well as the several sub-research objectives, was clearly communicated to the expert panel.

3.5.3. Expert Group

Since the complexity of the topic and based in the several gaps and assumptions created in turn of digital projects, it was invited 9 experts. According to Saunders *et al*., (2019), when the complexity of subject is considerable, it should be selected a smaller number of experts. These experts, from several different industries, fulfil the defined criteria, which will contribute to eliminate bias and increase the internal validity of the present evaluation process (Linstone & Turoff, 1975). The defined criteria were the following ones: 1 - Have experience in the elaboration of a theoretical Business Case or have conducted more than 1 digital project evaluation using a Business Case framework; 2 – Have experience with digital transformation projects; 3 – Are aware of the transversality of the Business Case applicability in terms of proposed frameworks and methodologies; 4 – Are from different industries although, if from the same, it must have a different position in the organisation.

In Table 18, it is described the expert's profile and background.

Table 18 - List of Experts

Expert ID	Position	Industry
1	University Professor and Project Manager	Digital Services Business Models and General Management
2	University Professor and Project Manager	Financial Services General Management
3	University Professor and Project Manager	Consumer and Industrial Products Dynamic Capabilities
4	University Professor and Project Manager	Telecommunications General Management

5	University Professor	Tourism and Business Management
6	University Professor	Organisational Strategy and Business Management
7	Project Manager	Health
8	Project Manager	Research and Development in several cross industries
9	Consulting Manager	Health

Although several of the expert participants hold similar positions and roles, they have professional and academic experience in a variety of different industries. This diversity considerably enhances the validity of the model. Since the Business Case is applicable to all industries, the greater the diversity of industry segments involved, the better the overall validation will be. Another positive factor was the selection of the experts and their connection with academia. This connection provides considerable added value in terms of theoretical and practical knowledge of the field, as well as real-world applicability.

Once the interview questions had been finalised and the outputs collected, all these experts were invited to participate in the study. As the balanced scorecard with Key Performance Indicators (KPI) was the main source of information in the Delphi process, the experts were familiar with its output and used this knowledge to inform their evaluations in each iteration. The KPI scorecard enabled the experts to develop a thorough understanding of how to boost productivity and efficiency.

The Delphi study was therefore conducted in November 2022. All sessions were held online in three rounds.

3.5.4. Evaluation Rounds

The theoretical model was discussed with the expert group in two rounds of iterations, followed by a final presentation in a third round. The aim of the iteration process in each round was to determine which proposals should be included in a Business Case for evaluating digital projects.

3.5.4.1. First Round

In the first-round of iteration, it was applied an initial variation of the Balanced Scorecard KPI based in four main domains (Economic Evaluation, Project Request Cost Estimation and Benefit Estimation) although, after the presentation of the initial theoretical model, it was proposed a fifth domain, the Decision-Making. In the first round, the objective, based in the initial question (Which proposal should include a Business Case in order to evaluate digital projects?), is to define the most relevant 4 proposals for each domain (Table 19).

Table 19 - Balanced Scorecard-First Round of Iteration

First Round of Iteration			
Economic Evaluation	Proposal 1	**Project Request**	Proposal 1
	Proposal 2		Proposal 2
	Proposal 3		Proposal 3
	Proposal 4		Proposal 4
Decision-Making	Proposal 1	**Cost-Benefit Estimation**	Proposal 1
	Proposal 2		Proposal 2
	Proposal 3		Proposal 3
	Proposal 4		Proposal 4

3.5.4.2. Second Round

In the second iteration, the final proposals were clustered based on the collection and merging of inputs from the ten experts and matched with the current theoretical model. In this second iteration, each expert evaluated the proposals using a Likert scale (Vagias, 2006) with responses ranging from "Strongly Disagree" to "Strongly Agree", as well as a simple qualitative metric of "Relevance" based on a scale of "High", "Moderate" and "Low (Table 20).

Table 20 - Balanced Scorecard KPI-Second Round of Iteration

Second Round of Iteration							
Domain	**Proposal**	**Likert**	**Relevance**	**Domain**	**Proposal**	**Likert**	**Relevance**
Economic Evaluation	Proposal 1	0-5	High; Moderate; Low	**Project Request**	Proposal 1	0-5	High; Moderate; Low
	Proposal 2	0-5	High; Moderate; Low		Proposal 2	0-5	High; Moderate; Low
	Proposal 3	0-5	High; Moderate; Low		Proposal 3	0-5	High; Moderate; Low
	Proposal 4	0-5	High; Moderate; Low		Proposal 4	0-5	High; Moderate; Low
Decision-Making	Proposal 1	0-5	High; Moderate; Low	**Cost-Benefit Estimation**	Proposal 1	0-5	High; Moderate; Low
	Proposal 2	0-5	High; Moderate; Low		Proposal 2	0-5	High; Moderate; Low
	Proposal 3	0-5	High; Moderate; Low		Proposal 3	0-5	High; Moderate; Low

	Proposal 4	0-5	High; Moderate; Low		Proposal 4	0-5	High; Moderate; Low

3.5.4.3. Third Round

In the third round, the final theoretical model is presented, incorporating all the inputs provided during the last two rounds of iterations. During this final iteration process, the experts responded to three open questions, one of which addressed the main research question of this thesis (although the focus shifted from 'how' to 'can'):

1 – Can scientific management contribute to create a Digital Business Case to support the evaluation process of digital projects?

2 - Does this Digital Business Case reply to the current digital evaluation project needs?

3 – The current methods and techniques available match the current needs for evaluating digital projects?

It was also requested to the experts to evaluate the contribution of the theoretical model for the accomplishment of the research problems. It was asked to the experts to evaluate using the Likert scale (Level of Probability: 1 – Not probable; 2 – Somewhat improbable; 3 – Neutral; 4 – Somewhat probable; 5 – Very probable).

CHAPTER IV

Bibliometric Networks

This chapter will present the outputs obtained from the bibliometric network analysis. According to Passas (2024), this concept is defined as a systematic study carried out on scientific literature to identify patterns, trends and impact within a certain field. The different methods and results are presented in the next sections.

4.1. Clustering techniques

Clustering techniques play a prominent role in bibliometric research (Van Eck & Waltman, 2017). The development of these clusters and how it works is described by the authors Van Eck and Waltman, (2013). The cluster analysis aims to create several clusters of items from the dataset with the objective of group items with similar indicators, relation, or link (Van Eck & Waltman, 2010). According to the authors Van Eck and Waltman, (2010), clusters that are located close to each other in the map indicate closely related fields. An item may belong to only one cluster, and clusters do not need to exhaustively cover all items in the network. Hence, there may be items that do not belong to any cluster. If items have been assigned to clusters, cluster numbers become an example of an attribute. The two most important factors to analyse the clusters are the weight and score attributes. These attributes are represented by numerical values and provided for each item. The weight attribute then determines how prominently items are shown in the visualization of the currently active map as well the importance of the item. The higher the weight of an item, the larger the label of the item in the visualization. The score attribute determines the variable which will be represented on the map as well it determines the colouring of items in the visualization of the currently active map. By default, the higher (lower) the score of an item, the closer the colour of the item is to yellow (blue).

4.1.1. Clusters co-authorship-countries

Using the dataset and the query “Co-authorship – Countries” it has been created 7 different clusters with 40 items (countries). The clusters are presented in Table 21.

Table 21 - Cluster Items

Cluster	Country
Cluster 1	Brazil
	Czech Republic
	Denmark
	France
	Italy
	Netherlands
	Norway
	Portugal
	Romania
	Russian Federation

Cluster 2	Austria
	Finland
	Germany
	Greece
	India
	Poland
	Spain
	Sweden
	Switzerland
Cluster 3	Belgium
	Israel
	Singapore
	South Africa
	South Korea
	USA
Cluster 4	Canada
	Chile
	Ireland
	United Arab Emirates
	United Kingdom
Cluster 5	Australia
	Malaysia
	Pakistan
	Thailand
Cluster 6	China
	Hong Kong
	Japan
	New Zealand
Cluster 7	Indonesia
	Taiwan

It's important to mention that not all countries mentioned in the dataset are represented either in the Figure 9 or 10 since the selected threshold from the databased (minimum number of documents of a country) has a minimum of 5 documents to be eligible. Thus, having this threshold only 40 of 127 countries identified in the dataset are eligible and presented in the map network. For each of the 40 selected countries, the total strength of the co-authorships links with other countries will be calculated. The countries with the greatest total link strength will be selected and described. From the selected countries in Table 21 the top 5, in terms of total link strength, are United States of America (USA), United Kingdom (UK), Australia, Germany and Netherlands. The characterization of the top 5 is available in Table 22. Regarding the outputs provided by the dataset, Canada has more documents and citations than the Netherlands, although it has a lower total link strength. Since the evaluation of the outputs is based on this last variable, the Netherlands assumes the fifth position. This is due to the link strength between items in the Netherlands and items in other countries, which can increase based on the average publication year or average citations.

Table 22 - Top 5 countries based in Total Link Strength

Country	Documents	Citations	Total Link Strength
United States of America	323	13382	97
United Kingdom	237	11417	87
Australia	101	2642	48
Germany	94	2547	41
Netherlands	64	1901	37

The selected query “Co-authorship – Countries” produced two outputs which will be described in the following two figures (9 and 10). Figure 9 shows the average publication year in which the keyword occurs, from 1977 until 2022. Items with a higher weight are more prominent, while items with a lower weight are less prominent. Figure 9 clearly shows that the countries with a considerably higher weight in terms of average publication year are the United States of America, the United Kingdom, Australia, Germany and Canada, due to the total number of publications using the keyword or relating to the Business Case. This output was determined using the "documents" as weight and the "average publication year" as score. The details of each are presented in Table 23.

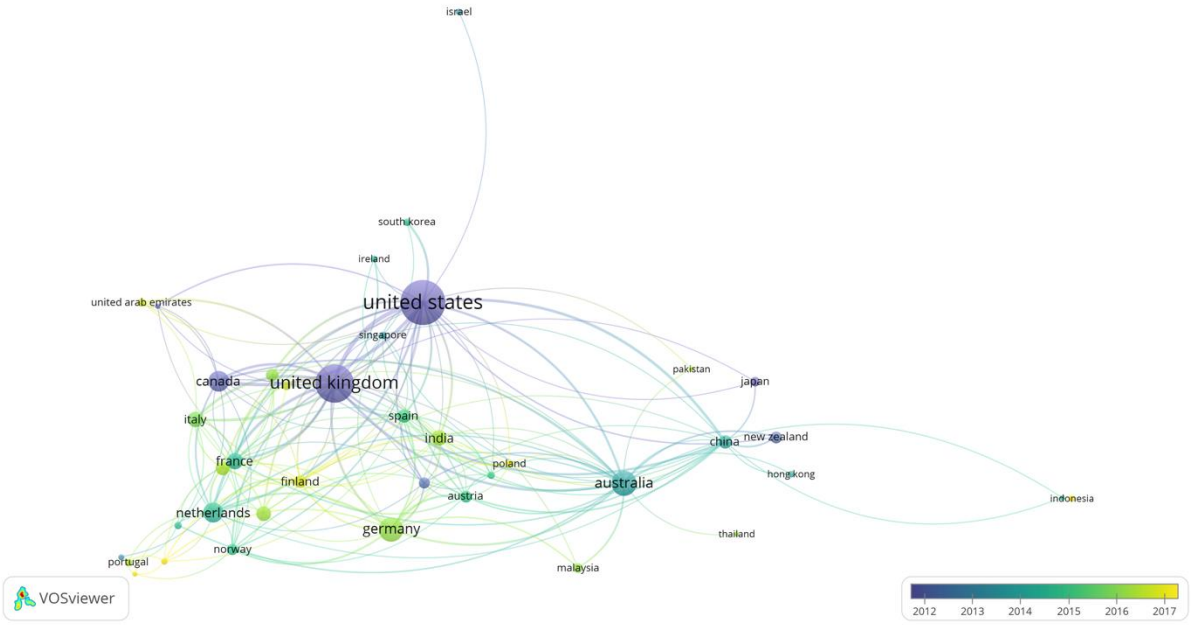


Figure 9 - Average Publications (Source: VosViewer)

Table 23 was ranked based on the total number of documents, which was selected as the weight. In this table, a link represents a connection or relation between two items. Each link has a strength, represented by a positive numerical value. The stronger the link, the thicker the line used to display it in the currently active map visualisation. For example, the total number of links associated with the USA indicates that it has 29 connections with other third countries. In terms of average publication year, bearing in mind the date differences, the US, UK and Canada have almost the same average, whereas Germany has a considerably more recent average, meaning its publications are more recent than those of the other countries.

Table 23 - Top 5 countries with higher Average Publications

Country	Cluster	Link	Total Link Strength	Documents	Avg. Publications year
United States of America	3	29	97	323	2011
United Kingdom	4	21	87	237	2011

Australia	5	24	48	101	2014
Germany	2	17	41	94	2016
Canada	4	13	32	69	2012

In terms of Average citations, the same weight has been used "documents" although with a different score, namely the average citations. The results are presented in Figure 10. It is possible to analyse from this figure that the top five countries with the highest citation rate are the United Kingdom, the United States of America, Canada, the Netherlands and Germany. These countries are described in Table 24.

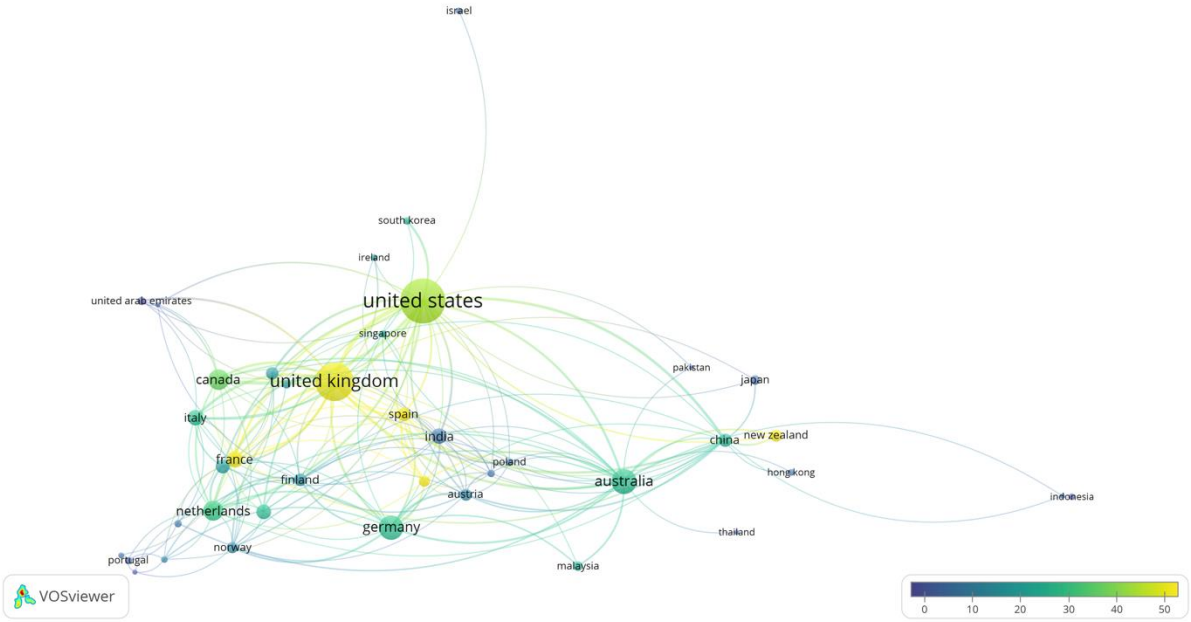


Figure 10 - Average Citations (Source: VosViewer)

Table 24 shows the countries ranked by average citation. For example, the United Kingdom surpassed the United States of America by a considerable margin. Canada is also close to the United States, and the Netherlands and Germany have a very similar average citation.

Table 24 - Top 5 countries with higher Average Citations

Country	Cluster	Link	Total Link Strength	Documents	Avg. Citations
United Kingdom	4	21	87	237	48,17
United States of America	3	29	97	323	41,43
Canada	5	24	48	101	36
Netherlands	2	17	41	94	30
Germany	4	13	32	69	27.10

4.1.2. Clusters co-authorship-Organisations

In order to extract information from the dataset regarding the organizations, it was applied the query "Co-authorship – Organizations" where the minimum number of documents of an organization was 2. The result of such query delivers an output of 62 organizations that match the corresponding criteria.

These 62 items were clustered in 54 new clusters. The first 6 clusters have more than one item although the remaining ones have only 1 cluster. The output is available in Figure 11.

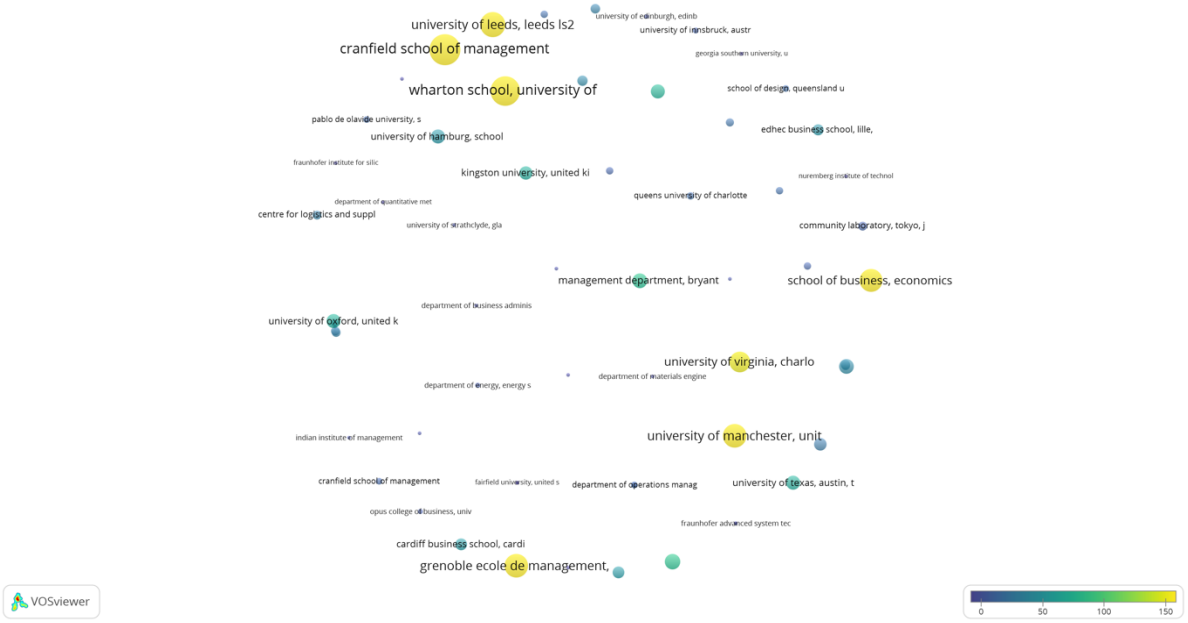


Figure 11 - Organisations Citations Overlay (Source: VosViewer)

In Figure 11, the selected visualization method was the overlay where the scores of the items range from blue (lowest score) to yellow (highest score). The larger the number of items about a point and the higher the weights of the neighbouring items, the closer the colour of the point is too yellow. In this Figure 11 is represented the organizations with the highest average citation rate. It is interesting to observe that the organizations with the highest average number of citations are, most of them, in different positions and not even clustered. The distance between two clusters approximately indicates the relatedness of the clusters in terms of citations which means that organizations located close to each other tend to be strongly related in terms of citations (Van Eck & Waltman, 2017). On the other hand, clusters that are located further away from each other tend to be less strongly related with a low or inexistent relation.

The organizations with the highest citations rates are presented in Table 25. In this table were selected the organisations with more than 300 citations from among of the 62 organizations selected with this query.

Table 25 - Organizations with highest rate citations

Organization	Documents	Citations
Cranfield School of Management	2	651
Wharton School	2	591
University of Leeds	2	430
University of Manchester	2	385
Grenoble Ecole	2	373
School of Business, University of Hamburg	2	369

Table 25 shows that, of the organisations with more than 300 citations, the Cranfield School of Management (Cranfield, United Kingdom) and the Wharton School (University of Pennsylvania, United States) have a considerably higher number of citations than the other organisations presented in Figure 11. Although the two documents provided in the dataset and linked with the Cranfield School of Management have a total of 30 citations from the publications of Moir *et al*., (2007) and Maklan *et al*., (2005), the value of 651 citations indicates the relationship between the organisations presented in Figure 11, bearing in mind that the weight used for data visualisation was the number of citations.

4.1.3. Cluster Co-authorship-Authors

Clusters were created based on the query co-authorship, identifying 2,913 authors in the dataset. However, a threshold was applied for cluster development based on the minimum number of an author's documents. This clustering technique determines the relatedness of publications based on direct citation relations (Van Eck & Waltman, 2017).

The selected threshold was a minimum of two documents for each author. Thus, of the 2,913 identified authors, only 218 met the defined criteria. The total strength of the co-authorship links with other authors was then calculated for each of the 218 authors. Consequently, the authors with the greatest total link strength were selected. The results are presented in Figure 12. To generate this figure, the weight applied was citations and the score was the average publication year, as presented in the visualisation. It is important to note that some of the authors presented in Figure 12 are not connected to each other, and the largest set of connected items consists of six items. However, it was decided to include all items.

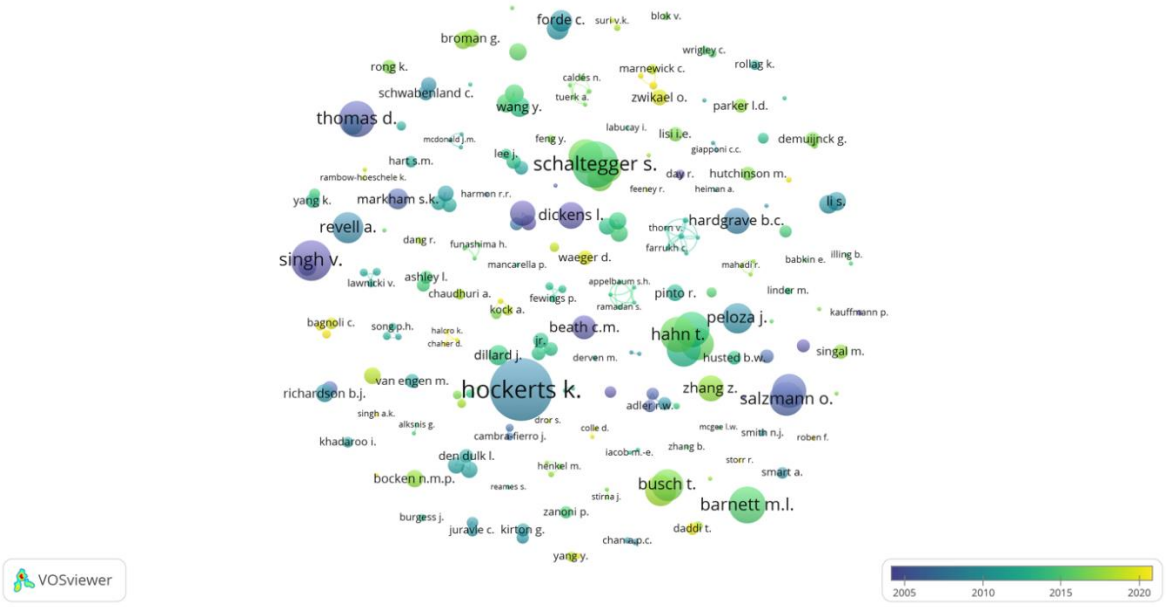


Figure 12 -Author's Citations Overlay (Source: VosViewer)

During this process it has been a total number of 127 clusters. The biggest size in terms of visualization means the higher number of citations and the proximity between some authors represents the level of connection among those authors in terms of citations and publications connectivity. Thus, in the figure 12 the most prominent authors related with the keyword “Business Case” are described in Table 26.

Table 26 - Authors with more citations

Author	Documents	Citations	Total Link Strength
Hockerts	2	1789	0
Schaltegger	6	962	5
Singh	2	751	1

The author, Hockerts, has two papers in the dataset related to the Business Case and corporate responsibility: one from 2015 and one from 2002 (the latter as second author). According to the dataset, Hockerts (2015) has received 92 citations. In this paper, Hockerts (2015) proposes that adopting a cognitive perspective on corporate sustainability and competitiveness could provide new insights into the question of the Business Case. In the second paper (Dyllick & Hockerts, 2002), Hockerts is a co-author and has been cited 1,697 times. This paper is intended as a contribution to the ongoing conceptual development of corporate sustainability. Schaltegger has six published papers and 962 citations. The most cited paper by this author is Schaltegger et al., (2012), with 489 citations. In this paper, the author describes a substantial body of literature that deals with creating economic value while improving corporate environmental and social performance. The last author presented in table 26, Singh, has more than 700 citations with 2 published papers. In one of his papers, Terjesen *et al*., (2009), Singh, as co-author, has 643 citations. This paper examines how gender diversity on corporate boards influences corporate governance outcomes that in turn impact performance and the practical findings implications generally draw on the Business Case.

4.1.4. Cluster Co-ocurrence-All Keywords

The query Co-occurrence-all keywords resulted in 10 clusters with 377 items. In the overall dataset 5935 keywords were identified on several different extracted papers. To have a more concise and relevant number of keywords, a threshold (>= 4) has been applied based on the minimum number of occurrences on the dataset. The result has 377 keywords that match the threshold requirements. The next step consisted in clustering the keywords based on their characterization and data link. In Figure 13, the connection between the several keywords is observed the level of proximity and relation as well. The cluster designation based on the keywords is described on Table 27.

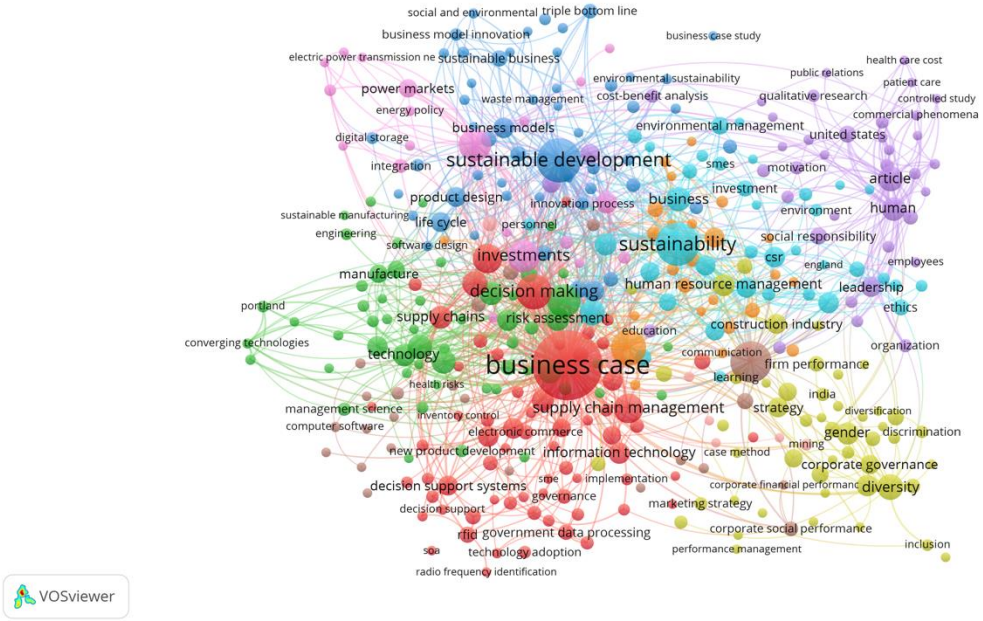


Figure 13 - Keywords Occurrences (Source: VosViewer)

Table 27 provides information on each cluster, namely the cluster designation, name and clustered keywords. As mentioned previously, these clusters were based on the keywords selected and shown in Figure 13. It is important to note that not all keywords are clustered in Table 27, but only those with multiple occurrences and data links between them. The cluster names were defined by the authors based on the assumption that each keyword was grouped.

Table 27 - Clusters Designation

Cluster 1 (Scientific Business Decision)	Cluster 2 (Technology Centricity)	Cluster 3 (Business Management)	Cluster 4 (Cultural Knowledge)
Business Case; Supply Chain Management; Decision Making; Governance; Business Strategy; Artificial Intelligence	Data Mining; Product Development; Converging Technologies; Technology; Knowledge Management	Business Model; Case Study; Life Cycle; Product Design; Sustainable Development; Sustainability	Performance; Risk Management; Productivity; Equality; Diversity; Adoption; Inclusion

Figure 14 presents the top three keywords with the highest number of occurrences. As expected, the keyword with the most occurrences is clearly “Business case” with 212, followed by “sustainable development” with 85 and “sustainability” with 82. These keywords were obtained from a total of 5,935 keywords in 1,293 papers published between 1977 and 2022.

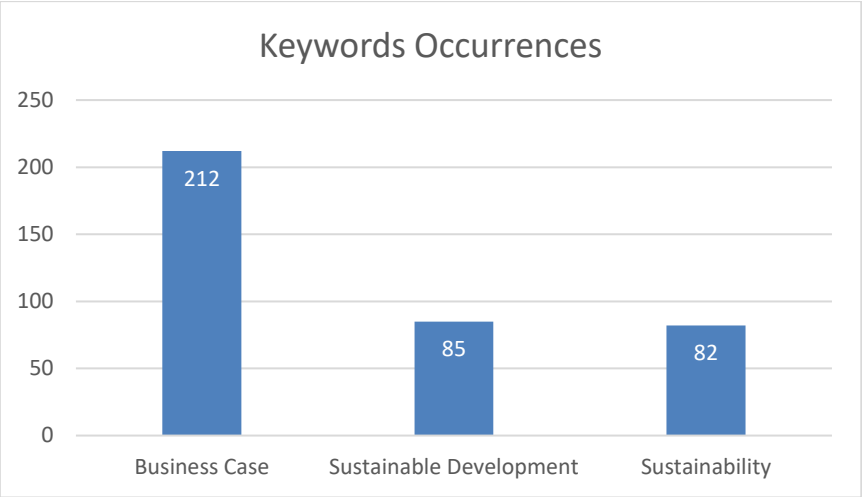


Figure 14 - Top 3 Keywords Occurrences (Source: Author)

4.1.5. Citation-Sources

The last dataset analysis complements the query citation-sources. In this section the applied threshold was, at least, 3 documents published by the source, in this case the journals. From the 569 sources identified in the dataset, 124 meet the designated threshold. Although, some of the 124 items in the network are not connected to each other. The largest set of connected items consists of 58 items. For the visualization purpose all 124 items were displayed which led to the creation of 75 clusters. The journals are visible in Figure 15.

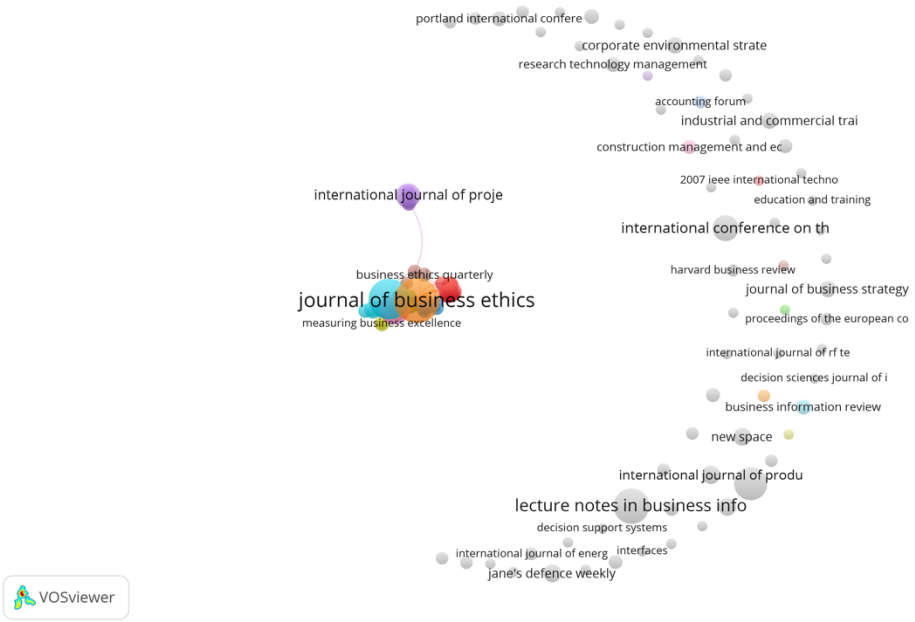


Figure 15 - Top journals with published papers (Source: VosViewer)

In Figure 15 is possible to visualize the considerable weight of the Journal of Business Ethics and journal of Clear Production besides the connectivity between those journals (in terms of citations and

documents link) as well as the rest of the other journals described. The data is presented in Table 28. In this table, journals are ranked based on the documents they have published.

Table 28 - Top 5 journals with more documents

Source	Documents	Citations
Journal of Business Ethics	52	3700
Journal of Clear Production	43	1518
Lecture Notes in Business Information Processing (LNBIP)	32	145
Emerald Emerging Markets Case Studies	28	21
Business Strategy and the Environment	24	3309

In Table 29, the top 5 journals with more published documents were described. It´s clear the importance of the Journal of Business Ethics and Journal of Clear Production in promotion of the Business Case as concept in the literature review with several publications and considerable number of citations. Thus, the reference journal for publications topics related with the Business Case is, definitively, the Journal of Business Ethics due to the number of published papers and citations.

Another important indicator from Table 29 is the total number of documents that were published as an article or conference paper.

Table 29 - Total number of document type

Source	Article	Conference Paper
Journal of Business Ethics	50	2
Journal of Clear Production	43	0
Lecture Notes in Business Information Processing	0	32
Emerald Emerging Markets Case Studies	28	0
Business Strategy and the Environment	24	0

As can be seen from Table 29, most of the publications were articles. The only difference is the source: 'Lecture Notes in Business Information Processing', which only publishes conference papers. This is actually a book series reporting on the latest results in areas related to business information systems and industrial application software development. According to the dataset, publications in LNBIP related to the Business Case have been appearing since 2008, with the most recent one published in 2020.

CHAPTER V

Data Analysis

To respond to the research questions and accomplish the objectives of the thesis, this chapter presents replies collected from the interviews with decision-makers in the second and third parts of the interview process. As previously explained, the first part of the questionnaire consisted of the introduction and regulatory requirements.

5.1. Organisation Role

The initial question (1.1 - Please indicate your role in your current Organization) was related with the role from the participants. Since the selection process aimed to extract people only with the experience in the elaboration of a Business Case and some roles are not explicit in the LinkedIn or are quite vague, this question aimed to have a clear picture of the designated role (Figure 16).

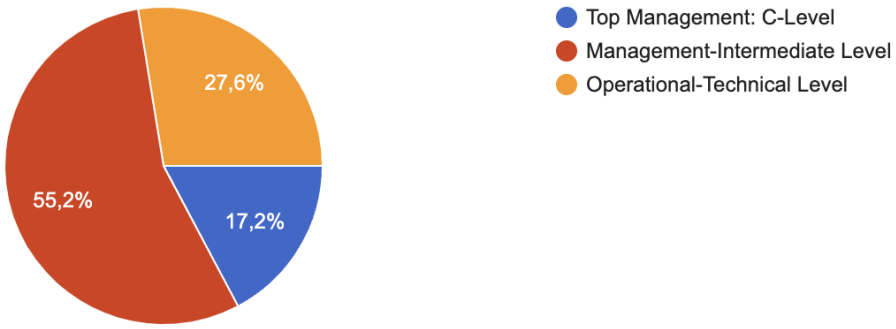


Figure 16 - Organisation Role (Source: Google Forms)

From the main observe roles the most preeminent was the Management-Intermediate Level with 55,2% of the respondents. In fact, this was a considerable good achievement since the management level is considered, in organisations, the level where the manager has an explicit role of internal validation of the Business Case and has a long experience in the field. The Top Management is generally, in organisations, the person responsible for approving the Business Case.

5.2. Type of Industry

The second question (1.2 - Please select below the industry according to the CAE-Rev.3 where you perform your role) related with the industry, from the several different 19 options provided, 8 industries were selected. Although some industries most probably weren´t relevant, it was an option

to include them. Due to the plurality of the Business Case neglecting an option could end up in creation bias. The output industries are presented in Figure 17.

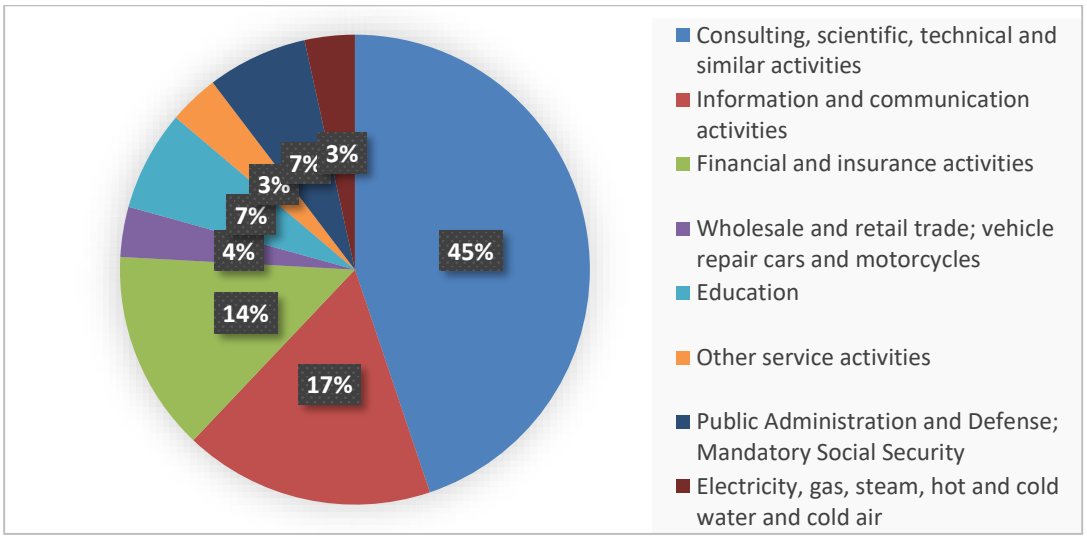


Figure 17 - Industry (Source: Author)

According to Figure 17, the highest number of replies are from industry is the consulting, scientific, technical and similar activities. This is considered relevant for the topic in discussion in this thesis, with a total of 13 participants (45% of the total number of replies). It is interesting to note the heterogeneity of the Business Case, from the 29 replies there are 8 different industries participants.

5.3. Digital Evaluation Project

In terms of digital evaluation project (1.3 - Please Indicate for how many years you have been involved in digital evaluation project) the replies are presented in Figure 18.

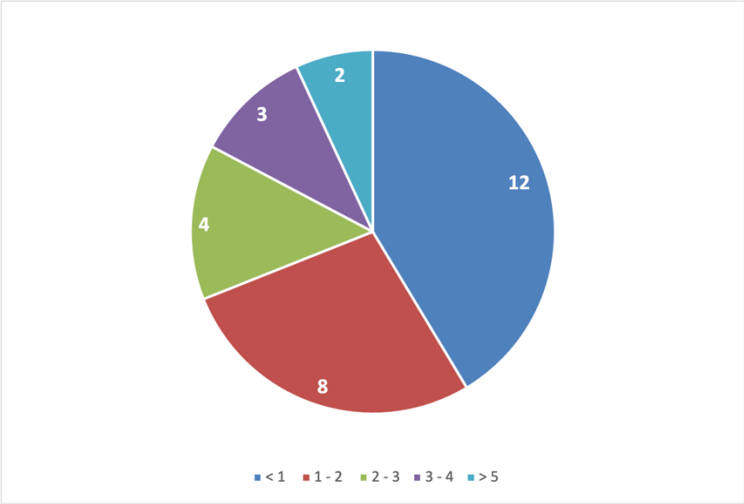


Figure 18 - Digital Projects Evaluation experience (Source: Author)

The number of years of experience vary from <1; 1-2; 2-3; 3-4; >5. Most of the replies show that the participants have mainly from <1 to 1-2 years. The fact the digital transformation is a field that begun to prosper recently (Kraus *et al.*, 2022) maybe justify the level of experience from the participants. Although, 9 participants have a relevant experience in evaluation digital projects, which means around 31% of the total number of participants.

5.4. Digital Elaboration Project

The last question from the second part of the interview (1.4 - Please Indicate for how many years you have been involved in the elaboration of a digital project?) was related with number of years of experience dealing with the elaboration of digital projects (Figure 19).

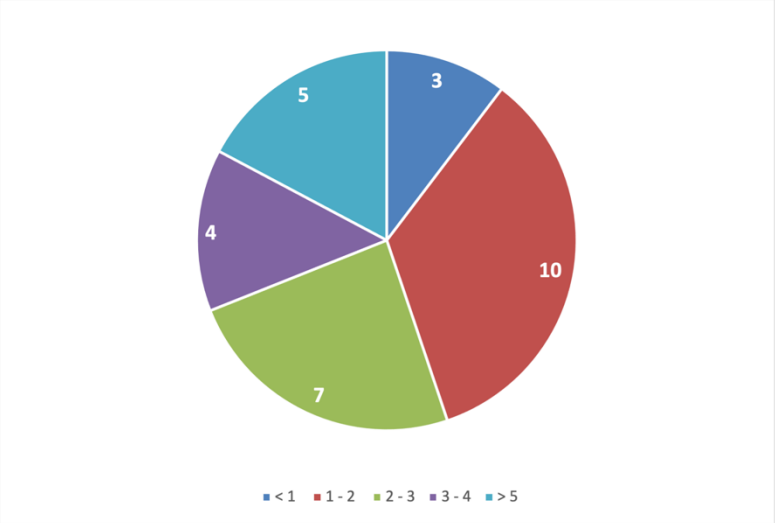


Figure 19 - Digital Elaboration Project Experience (Source: Author)

In Figure 19, it is relevant to point out that 16 participants have more than 2 years of experience in the elaboration of digital projects, which means a total of 55% and only 3 have less than 1 year. This 55% is considered a relevant participation for the future steps, namely the third part of the interview.

5.5. Problem Solving

The third and last part of the interview started with a question related with the method Problem-Solving (2.1 – Which are the main techniques from Problem-Solving that you apply for digital evaluation project?). The aim is to know the main applied techniques from a pre-defined list (Table 30).

Table 30 - Most Applied techniques of Problem Solving

Participant	Technique
1	Fishbone Diagram; Root Cause Analysis; Five Why's

2	Fishbone Diagram; Five Why's; Pereira Problem Solving
3	Creative Problem Solving; Fishbone Diagram; Root Cause Analysis; Five Why's; Six Thinking Hats
4	Fishbone Diagram; Root Cause Analysis; Five Why's
5	Root Cause Analysis; Five Why's
6	Root Cause Analysis
7	Fishbone Diagram; Root Cause Analysis
8	Fishbone Diagram; Root Cause Analysis; Five Why's; Pereira Problem Solving; Other
9	Root Cause Analysis; Five Why's; Design Sprint 2.0
10	Fishbone Diagram; Root Cause Analysis; Five Why's; Pereira Problem Solving; Problem Definition Process
11	Creative Problem Solving; Fishbone Diagram; Root Cause Analysis; Five Why's
12	Creative Problem Solving; Fishbone Diagram; Root Cause Analysis; Five Why's; Pereira Problem Solving; Problem Definition Process
13	Fishbone Diagram; Root Cause Analysis; Five Why's
14	Creative Problem Solving; Fishbone Diagram; Root Cause Analysis; Five Why's; Pereira Problem Solving
15	Root Cause Analysis; Pereira Problem Solving
16	Creative Problem Solving
17	Creative Problem Solving; World Cafe
18	Creative Problem Solving
19	Five Why's; Pereira Problem Solving
20	Creative Problem Solving; Fishbone Diagram; Root Cause Analysis; Problem Definition Process
21	Pereira Problem Solving
22	Fishbone Diagram; Other
23	Fishbone Diagram; Root Cause Analysis; Five Why's
24	Creative Problem Solving; Root Cause Analysis; Five Why's
25	Creative Problem Solving; Root Cause Analysis; Five Why's; Six Thinking Hats
26	Fishbone Diagram; Root Cause Analysis; Five Why's; Pereira Problem Solving
27	Problem Definition Process
28	Fishbone Diagram; Root Cause Analysis; Five Why's
29	Fishbone Diagram; Five Why's; Pereira Problem Solving

The results indicated that Fishbone Diagram, Root Cause Analysis and the Five Why´s are the most common used frameworks in Problem Solving when applied to digital evaluation projects. In the option "other", the participants refer to "Delphi technique", "Decision Trees", "Porter Five Forces" and "Design Thinking".

The most relevant words are presented in a word frequency, where the most weight value was the Fishbone Diagram (Figure 20), although the word that was referenced the most was 'Problem', from the Pereira Problem Solving and Creative Problem-Solving method.



Figure 20 - Problem Solving word frequency (Source: Author)

In question 2.2 (Which are the main problems or difficulties of Problem-Solving in the evaluation process of a digital project?) the author clustered the 4 more frequent problems identified by the participants (Table 31).

Table 31 - Main Problems and Difficulties in Problem-Solving

Participant	Problem & Difficulties
1,5,6,7,10,14,16,17,23,28,29	Lack of capabilities to identify the main project benefits
1,3,5,6,7,12,13,18,20,21,25,27,28,29	Measure the project impact in the benefits
2,4,6,8,11,12,15,17,19,24,27,28,29	Uncapable to Identify critical project factors
2,3,4,9,10,11,13,15,17,19,22,26,27,28,29	Difficulties to identify the main project problem

From Table 31 it is possible to conclude the 4 most relevant problems and difficulties that affect Problem Solving in evaluation digital projects. The lack of capabilities and difficulties identifying the main initial project problem using the current methods of Problem-Solving was selected as the most relevant problem using this method. Other major problems are related to a proper benefits estimation. In fact, two of the main problems are related to benefits. The identification and the project impact in benefits.

5.6. Strategic Alignment

In the section related to the concept of Strategic Alignment, it was asked to the participants several fundamental questions. The initial question was "3.1 - Which are the main criteria of Strategic alignment that you apply for digital evaluation project?". The replies are presented in Table 32.

Table 32 - Most Applied criteria in Strategic Alignment

Participant	Criteria
1	Other
2	It evaluated according to the request source
3	It is evaluated top management perception
4	It is evaluated top management perception
5	It is evaluated by a scoring model
6	It is evaluated top management perception
7	It is evaluated by an analytic hierarchy
8	It is evaluated by a scoring model
9	It is evaluated by a scoring model
10	It is evaluated by a scoring model
11	It is evaluated by a scoring model
12	It is evaluated by a scoring model
13	It is evaluated by a voting process
14	It evaluated according to the request source
15	It is evaluated by an analytic hierarchy
16	It is evaluated by a voting process
17	It is evaluated by an analytic hierarchy
18	It is evaluated top management perception
19	It is evaluated top management perception
20	It is evaluated by a voting process
21	It is evaluated by a voting process
22	It is evaluated by a scoring model
23	It is evaluated by a scoring model
24	It evaluated according to the request source
25	It is evaluated by an analytic hierarchy
26	It is evaluated by a scoring model
27	It evaluated according to the request source
28	It evaluated according to the request source
29	It is evaluated by a scoring model

The most selected criteria were the "it is evaluated by a scoring model", which is referred 10 times by the participant. This table is considered heterogeneous due to several criteria applied by the different participants. Regarding the option "other", the selected method was "All elements of a business: market strategy (the way the company itself is organised) that best supports the fulfilment of its long-term purpose."

The second question 3.2 (Which are the main problems or difficulties of Strategic Alignment in the evaluation process of a digital project?) the replies were the following (Table 33).

Table 33 - Main Problems and Difficulties in Strategic Alignment

Participant	Problem & Difficulties
2,5,8,11,13,19,20,23,26,27,29	Project alignments are not guaranteed
1,3,4,5,6,7,9,10,14,15,18,21,22,24,26	Absence of metrics to manage the alignment between digital processes
2,6,10,12,16,18,19,25,28,29	Identify critical project factors
2,3,4,9,10,11,13,15,17,19,20,22,26,27,28,29	Poor communication when evaluating a project between different decision-makers

The main problem with implementing proper strategic alignment for a current digital project is the poor communication between the various decision-makers during the evaluation process. Additionally, the absence of metrics to manage alignment between digital processes poses a significant challenge when employing this method to evaluate digital issues.

5.7. Benefits Estimation

In the method Benefit Estimation, the initial question follows the same structure of the other methods "4.1 – Which are the main techniques from Benefits Estimation that you apply for digital evaluation project?". The main replies are presented in Table 34. For this question more than one option can be selected.

Table 34 - Main techniques for Benefits Estimation

Participant	Technique
1	Expert judgment; Focus group; Market Research; The Gap Analysis; Interviews; Benchmarking
2	Do not apply
3	Expert judgment; Focus group; Market Research; Trend Analysis; The Gap Analysis; Interviews; Benchmarking; Observation; Surveys
4	Interviews; Benchmarking; Surveys; Monte Carlo Simulation
5	Focus group; Market Research; Trend Analysis; Interviews; Benchmarking; Surveys; Monte Carlo Simulation
6	Expert judgment; Focus group; Market Research; Regression Analysis; Interviews; Benchmarking; Surveys
7	Market Research; Benchmarking; Surveys
8	Other
9	Expert judgment; Focus group; Market Research; Trend Analysis; Regression Analysis; The Gap Analysis; Interviews; Benchmarking
10	Focus group; Trend Analysis; Regression Analysis; The Gap Analysis; Interviews; Benchmarking; Observation; Surveys; Monte Carlo Simulation

11	Expert judgment; Regression Analysis
12	Expert judgment; Focus group; Market Research; Trend Analysis
13	Focus group; Market Research; Benchmarking; Surveys
14	Market Research; Interviews; Benchmarking; Observation
15	Expert judgment; Focus group; Market Research; Interviews; Benchmarking; Surveys
16	Trend Analysis
17	Market Research; Benchmarking
18	Focus group; Market Research; Trend Analysis; Interviews; Benchmarking; Observation; Surveys
19	Focus group; Market Research; The Gap Analysis; Interviews; Benchmarking; Observation; Surveys
20	Expert judgment; Trend Analysis; Benchmarking; Monte Carlo Simulation
21	Focus group; Market Research; Regression Analysis; The Gap Analysis; Interviews; Benchmarking; Observation; Surveys
22	Expert judgment; Focus group; Market Research; Trend Analysis; Regression Analysis; Interviews; Benchmarking; Observation; Surveys
23	Expert judgment; Trend Analysis; Monte Carlo Simulation
24	Expert judgment; Trend Analysis; Interviews; Benchmarking; Observation
25	Focus group; Market Research; The Gap Analysis; Interviews; Benchmarking; Observation; Surveys
26	Market Research; Trend Analysis; Regression Analysis; Benchmarking
27	Expert judgment; The Gap Analysis
28	Expert judgment; Focus group; Market Research; The Gap Analysis; Interviews; Benchmarking
29	Expert judgment; Regression Analysis; Market Research

According to the results, the Benchmarking, Market Research and Expert judgment are the most well-known techniques. It is important to remember that participants can reply to more than one option. Regarding the selected options, the fact that the most voted techniques are qualitative doesn't mean that participants can´t apply quantitative methods. For instance, the author Zhu (2009), describe several quantitative methods applied to Benchmarking outputs. Regarding the option "Other" one participant describes the NPV/IRR as an option. Other users describe "he does not apply any method". No other response was provided even when asked the option "other".

From the selected techniques in question 4.1, it was created a word frequency (Figure 21). From the output of Figure 21, it is clear the most frequent words are "Benchmarking", "research" and "market" from the techniques Benchmarking and Market Research. This output can by useful since it provides a quick visual overview about the most relevant words by frequency.



Figure 21 - Benefits Estimation word frequency (Source: Author)

Regarding the second question "4.2 - Which are the main problems or difficulties of Benefits Estimation in the evaluation process of a digital project?" the main identified problem was the "Lack of benefit estimation for the worst and better scenario as well for a scenario with 95% of level of confidence". The results are presented in Table 35.

Table 35 - Main Problems and Difficulties in Benefits Estimation

Participant	Problem & Difficulties
4,5,6,8,10,11,12,14,18,19,20,21,22,23,25,27	Empiricism perspective
2,7,9,10,15,17,19,22,24,26,28,29	Absence of critical success factors to benefits measurement
1,2,4,9,11,12,13,20,21,23,24,28	Inexistence of benefits measurements for project final evaluation using confidence levels
2,3,4,7,10,11,12,13,14,16,17,19,20,21,22,23,27,28	Lack of benefit estimation for the worst and better scenario as well a scenario with 95% of level of confidence

5.8. Cost Estimation

The section for the Cost Estimation is somehow linked with the Benefits Estimation due to their relation about benefits measurement. The initial question (5.1 - Which are the main techniques from Cost Estimation that you apply for digital evaluation project?) are presented in Table 36.

Table 36 - Main techniques for Cost Estimation

Participant	Technique
1	Expert Judgment; Performing independent estimates; By creating scenarios
2	Expert Judgment
3	Expert Judgment; Bottom - Up Approach (sum of micro estimates); Independent estimation; By creating scenarios
4	Expert Judgment; Bottom - Up Approach (sum of micro estimates); By creating scenarios; Via Monte Carlo Simulation
5	Asking other party to review it

6	Expert Judgment; Bottom - Up Approach (sum of micro estimates); By creating scenarios
7	Estimation by Analogy; Bottom - Up Approach (sum of micro estimates)
8	Expert Judgment; Estimation by Analogy; Bottom - Up Approach (sum of micro estimates); Independent estimation; Performing independent estimates; Via Monte Carlo Simulation
9	Expert Judgment; By creating scenarios
10	Estimation by Analogy; Bottom - Up Approach (sum of micro estimates); Independent estimation; Parametric Estimation; By creating scenarios
11	By creating scenarios
12	Expert Judgment; Estimation by Analogy; Bottom - Up Approach (sum of micro estimates); Independent estimation; Parametric Estimation
13	Bottom - Up Approach (sum of micro estimates); Asking other party to review it
14	Bottom - Up Approach (sum of micro estimates); Parametric Estimation; By creating scenarios
15	Expert Judgment; Estimation by Analogy; Bottom - Up Approach (sum of micro estimates); Parametric Estimation; By creating scenarios
16	Performing independent estimates
17	Parametric Estimation; By creating scenarios
18	Independent estimation; Performing independent estimates; By creating scenarios; Other
19	By creating scenarios
20	Expert Judgment; Parametric Estimation; Via Monte Carlo Simulation
21	Estimation by Analogy; Parametric Estimation; By creating scenarios
22	Expert Judgment; Bottom - Up Approach (sum of micro estimates); Performing independent estimates; By creating scenarios
23	Expert Judgment; Independent estimation; Parametric Estimation; By creating scenarios; Via Monte Carlo Simulation
24	Expert Judgment; Bottom - Up Approach (sum of micro estimates); Independent estimation; By creating scenarios
25	Bottom - Up Approach (sum of micro estimates)
26	Expert Judgment; Estimation by Analogy; Bottom - Up Approach (sum of micro estimates)
27	Expert Judgment; Estimation by Analogy; Bottom - Up Approach (sum of micro estimates); By creating scenarios
28	Expert Judgment; Performing independent estimates; By creating scenarios
29	Expert Judgment

The main replies from the participants were “by creating scenarios” (multi criteria scenario), the expert judgement and the Bottom - Up Approach (sum of micro estimates). The participants selected the previous described methods 48 times. In the option “other”, one participant mentions the NPV/IRR.

Regarding the word frequency, the results are available in Figure 22 and based in the same structure question made for Problem Solving and Benefits Estimation.



Figure 22 - Cost Estimation word frequency (Source: Author)

The results indicate that the words with the highest frequency are “estimation” and “scenarios”. The estimation is applied in several techniques, so its relevance is considerable. The keyword “scenarios” is related to the “bottom-up approach” and “creating scenarios”.

Regarding the second question “5.2 - Which are the main problems or difficulties of Cost Estimation in the evaluation process of a digital project?” the main identified problem was the “Creation of cost assumptions formulated by empiricism”. This is a considerable issue in terms of cost analysis applied to digital projects since the structure of the project is considerable different as described before. The results are presented in Table 37.

Table 37 - Main Problems and Difficulties in Cost Estimation

Participant	Problem & Difficulties
1,2,3,4,7,8,13,15,16,18,19,20,22,23,26,27,28,29	Creation of cost assumptions formulated by empiricism
1,4,8,10,11,12,19,23,26,27,28	Unable to define the cost benefits if the project pass to the initiation phase
2,4,5,8,9,10,11,12,15,16,17,19,22,23,25,26	Unable to create cost projections
1,3,4,5,6,7,10,12,14,16,17,18,20,22,23,28,29	Unclear cost method to produce the estimation, which do not allow a validation scenario

5.9. Economic Evaluation

The section number 6 from the last part of the interview started with the question "6.1 - Which are the main techniques from Economic Evaluation that you apply for digital evaluation project?". The results are presented in Table 38.

Table 38 - Main techniques for Economic Evaluation

Participant	Technique
1	NPV; ROI; IRR
2	Payback; ROI
3	Payback; NPV; ROI
4	Payback; ROI; IRR
5	NPV; ROI; Breakeven
6	Payback; NPV; ROI; IRR; Breakeven
7	NPV; ROI; Breakeven
8	Payback; NPV; BCR; ROI; Breakeven
9	NPV; ROI; IRR; Breakeven
10	Payback; NPV; ROI
11	ROI
12	Payback; NPV; ROI
13	ROI; Breakeven
14	Payback; ROI; Breakeven
15	Payback; ROI
16	NPV; Breakeven
17	ROI
18	Payback; NPV; BCR; ROI; IRR; Breakeven
19	ROI
20	Payback; ROI; Breakeven
21	Payback; ROI; Breakeven
22	Payback; NPV; ROI; IRR; Breakeven
23	Payback; ROI; IRR; Breakeven
24	ROI; Breakeven
25	No index is used
26	Payback; NPV; ROI
27	ROI
28	NPV; ROI; IRR
29	Payback; ROI

The most used techniques are the well-known ROI, breakeven and payback. These techniques are commonly used in current economic evaluations. Of these, ROI has a clear advantage over the others. It is important to note that some of these techniques are complementary. For example, it is common to apply Payback alongside NPV.

In terms of word frequency, the most noticeable ones were ROI and Payback (Figure 23).

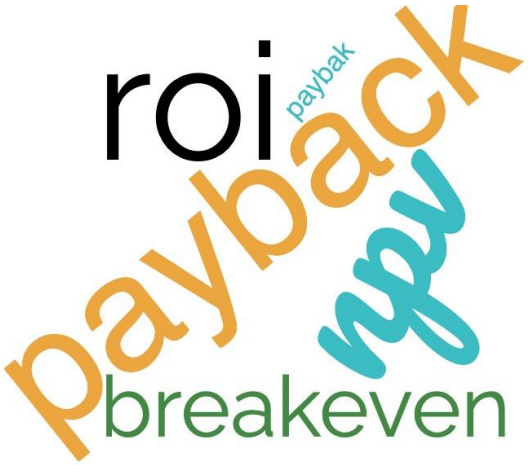


Figure 23 - Economic Evaluation applied techniques (Source: Author)

Regarding the relevance of ROI, a quick search was made to the Scopus database and searching for the keyword “Return on Investment”. The output retrieved, after an initial query using only the subject areas “Business, Management and Accounting” and “Economics, Econometrics and Finance” a total of 13,403 results (from 1999 until 2023). Doing the same process for Payback the results were 3,598 referenced papers.

The second question “6.2 - Which are the main problems or difficulties of Economic Evaluation in the evaluation process of a digital project?” the main identified problem was the “Inexistence of criteria to define the economic impacts of not advance the project” with 20 participants affirming this. Other problems and difficulties were also pointed out by most participants, which were of considerable relevance. The results are presented in Table 39.

Table 39 - Main Problems and Difficulties in Economic Evaluation

Participant	Problem & Difficulties
1,2,3,4,6,7,8,9,10,11,15,17,18,19,24,25,26	Inexistence of process to calculate the project estimations
2,5,8,10,13,14,17,18,19,20,21,23,24,26,28	Uncapable to validate assumptions using
1,2,3,4,6,7,8,9,11,12,13,17,18,19,21,22,23,24,26,28	Inexistence of criteria to define the economic impacts of not advance the project
2,6,7,8,12,15,16,18,19,20,21,29	Uncapable to measure forecasted project investments

5.10 Organisation Readiness Analysis

The penultimate question regarding the organisation readiness analysis started with the initial and defined question “7.1 - Which are the main techniques from Organisation Readiness Analysis that you apply for digital evaluation project?”. The results are presented in Table 40.

Table 40 - Main techniques for Organisation Readiness Analysis

Participant	Technique
1	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
2	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix
3	Didn’t Reply

4	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
5	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix
6	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
7	Stakeholder Analysis; Cost/Benefit Matrix
8	Force Field Analysis; Stakeholder Analysis
9	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
10	Empiricism; Force Field Analysis; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
11	Empiricism; Force Field Analysis; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
12	Empiricism; Force Field Analysis; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
13	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix
14	Stakeholder Analysis; Cost/Benefit Matrix
15	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
16	Cost/Benefit Matrix
17	Cost/Benefit Matrix
18	Cost/Benefit Matrix; Scenario Analysis
19	Empiricism; Cost/Benefit Matrix; Scenario Analysis
20	Empiricism; Cost/Benefit Matrix; Scenario Analysis
21	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
22	Force Field Analysis; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
23	Stakeholder Analysis; Cost/Benefit Matrix
24	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
25	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
26	Empiricism; Force Field Analysis; Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
27	Stakeholder Analysis; Cost/Benefit Matrix
28	Stakeholder Analysis; Cost/Benefit Matrix; Scenario Analysis
29	Empiricism; Stakeholder Analysis; Cost/Benefit Matrix

The results from Table 40 indicate that most participants are aware of all provided options with special incidence in the “Cost/Benefit Matrix”. In this question one of the participants didn´t reply and neither provided an explanation.

The second question “7.2 - Which are the main problems or difficulties of Organisation Readiness Analysis in the evaluation process of a digital project?” the main identified problem was the “Unable to define the main project priorities” with 20 participants stating the same problem. The results are presented in Table 41.

Table 41 - Main Problems and Difficulties in Organisation Readiness Analysis

Participant	Problem & Difficulties
1,3,6,7,8,10,12,13,24,25,28,29	It is not established the added value from the benefits to the project
1,2,3,4,5,6,10,11,14,15,16,17,20,23,24,25,27,28	Cannot understand the project priority in an organisational context
1,4,7,8,9,10,11,13,14,15,16,17,18,19,21,22,24,25,26,27	Unable to define the main project priorities
3,10,11,16,18,19,22,23,24,25,27	Unable to have a validation method for quality control during the project evaluation

5.11. Sensitivity Analysis

The last presented method, Sensitivity Analysis, started with the question "8.1 - Which are the main techniques from Sensitivity analysis that you apply for digital evaluation project?". The results are presented in Table 42.

Table 42 - Main techniques for Organisation Readiness Analysis

Participant	Technique
1	Betas Sector; Beta Triangular Distributions
2	Deltas Logs; Monte Carlo Simulation
3	I do not know any method of sensitivity analysis
4	Monte Carlo Simulation
5	I do not know any method of sensitivity analysis
6	Betas Sector
7	Monte Carlo Simulation
8	Deltas Logs; Beta Triangular Distributions
9	Deltas Logs; Monte Carlo Simulation
10	Beta Triangular Distributions; Monte Carlo Simulation
11	Monte Carlo Simulation
12	Monte Carlo Simulation
13	Monte Carlo Simulation
14	I do not know any method of sensitivity analysis
15	Monte Carlo Simulation
16	No reply
17	Other
18	I do not know any method of sensitivity analysis
19	I do not know any method of sensitivity analysis
20	Monte Carlo Simulation
21	Betas Sector; Beta Triangular Distributions
22	Betas Sector; Monte Carlo Simulation
23	Monte Carlo Simulation
24	I do not know any method of sensitivity analysis
25	Monte Carlo Simulation
26	Beta Triangular Distributions
27	I do not know any method of sensitivity analysis
28	Betas Sector; Beta Triangular Distributions

29	Deltas Logs; Monte Carlo Simulation

Table 42 shows that the 'Monte Carlo simulation' was the most popular method (14 replies). The option 'other' was not a valid reply. Therefore, it was not included in the table. One participant did not reply and did not provide any justification. Several participants requested a better explanation of the techniques presented for this method.

The second question “8.2 - Which are the main problems or difficulties of Sensitivity Analysis in the evaluation process of a digital project?”. The main identified problem was the “Lack of measurement capabilities to evaluate the critical variables” followed by the “Lack of knowledge extracted from the assumptions obtained with the indexes”. The results are presented in Table 43.

Table 43 - Main Problems and Difficulties in Sensitivity Analysis

Participant	**Problem & Difficulties**
1,5,7,9,10,18,19,21,25,26,28,29	Inexistence of process to calculate the project estimations
1,2,4,5,10,12,13,17,18,20,21,23,24,25,26,27,29	Lack of knowledge extracted from the assumptions obtained with the indexes
1,2,3,5,11,13,14,15,16,17,18,19,21,22,23,24,25,26,28,29	Lack of measurement capabilities to evaluate the critical variables
2,3,4,6,7,9,10,12,15,19,20,23,27,29	Unable to define the current processes to obtain estimations from project variables

CHAPTER VI

Theoretical Model and Validation

Chapter VI comprises the proposal of the theoretical model and its validation through the Delphi method using an expert panel. This begins with the development of the model following the output of the interviews. The proposed theoretical model is then validated by a panel of experts using the Delphi method over three rounds of iterations.

6.1. Model Development

Following validation using the Delphi method, a new theoretical model was proposed based on the current RG3 model (Teixeira, 2015), which is directed towards a traditional Business Case and does not consider the digital component. In fact, the purpose of using the Delphi method for validation allowed the theoretical model to be validated based on an expert panel. Thus, from the proposed steps of Teixeira, (2015) regarding the RG3 model (Project Request, Strategic Alignment, Benefits Estimation, Cost Estimation, Economic Evaluation, Context Readiness, Decision-Making and Benefits Tracking) the proposed theoretical model reformulated the model for a digital component and proposed 4 steps (Project Request, Benefits Estimation, Cost Estimation, Economic Evaluation) with different techniques directed to a digital evaluation. During the evaluation by the expert panel, a new step was added to the theoretical model: decision-making. This update aims to provide more comprehensive project evaluation and decision-making outputs based on information collected by other methods and merged into a multi-scenario. This will enable the integration of scientific knowledge with the social sciences and contribute to the development of a theoretical model for evaluating digital Business Cases.

In order to reach the five steps, the output of the interviews was fundamental, as it contributed to identifying and analysing the problem. The structure of the interviews aimed to ask questions related to the gaps in the literature, in order to identify the main problems and difficulties of implementing the various methods used in the project evaluation process. The interviews also aimed to identify the most common techniques used in the proposed methods during an evaluation of a Digital Business Case. Based on the proposed methods and their problem definition and current benefits for evaluating a digital project, a model was initially proposed that was based on four methods with different techniques that aimed to overcome the problems identified during the interview process. Hence, the remove methods were Strategic Alignment (this can be achieved by the project request and a proper project formulation and measurements), Organisation Readiness Analysis (the capabilities of this method can be applied in the final process of decision-making and the creation of the multiple scenarios) and Sensitivity Analysis (the new techniques in the Benefits and Cost Estimation

and Economic Evaluation will provide an estimation regarding the probability of a Benefit to change contrary to the Sensitivity methods that identify how the Benefit can be changed but and not the probability). Thus, by reducing the number of methods applied in a digital evaluation project will increase the effectiveness of the project evaluation and minimise assumptions and projects subjectivity during the project analysis. Therefore, the present theoretical model as the following structure:

- The project request is the first step of the Business Case proposal (Teixeira, 2015). One of the applied techniques according to Teixeira, (2015) is Problem Solving. This technique, nowadays, has been benefiting from the current developments in the field of the Natural Language Processing (NLP). Thus, the incorporation of such technique increases the capability of the decision-making process which will be described into more detail in section 6.1.1.1

- The Benefits Estimation, Cost Estimation and Economic Evaluation are quantitative methods that can be measured. Several statistical models can be applied to increase their efficiency and the added value they provide to project evaluation within the context of digital transformation.

- These 5 steps contribute to a go/no go decision and are fundamental for a successful project evaluation.

6.1.1. Project Request

The project request process aims to formalise the initiative request in a standard way. This is the very initial step and assumes several inputs, tools & techniques and outputs. Among the techniques applied Problem Solving is one of the most used and welcome techniques. In the Business Case Tool, this technique is the initial step and was adapted from the proposed Problem-Solving framework from Pereira and Santos (2020) and has upgraded in order to correspond to the current scientific developments and market demand.

In a project request, the Problem Solving is one of the most common applied techniques. Currently, complex problem solving is one of the main competences needed to maintain and address the complexity of the current business world (Pereira *et al*., 2023). Thus, it´s inclusion as a fundamental technique is considerable added value.

6.1.1.1. Problem Solving

Contrary to the project lifecycle where the Business case is incorporated in project feasibility phase the strategy adopted by the problem-solving approach is to relate how Business case establishes a strategy to solve corporate requirements.

In order to face a growing and complex market, the application of problem-solving mechanisms to overcome the lack of solutions and time consuming led to the implementation and use of text

miming algorithms with the aim of obtaining supporting knowledge discovery (Sinoara *et al*., 2017), which can be translated in a more efficient method of decision support in problem solving frameworks.

Problem solving means a conflict or a difficulty, which must be overcome during the solution process (Dostál, 2015). Often, the complexity of the processes and the constant change make it difficult to identify the solutions that effectively solve organizational problems. Therefore, it's crucial to understand the contribution of a problem-solving approach for organizations in order to solve, in a more concise way, several types of problems containing different needs of skills, knowledge and tactics.

The implementation of this development was based on the Problem-Solving Model (Pereira *&* Santos, 2020) available in Figure 24. The Pereira Problem-Solving model is a qualitative approach to solve a given problem. This technique states that the first step after a problem is identified, is to define and analyse the main business/process impacts using Pareto principle (up to three impacts should account for 80% of the effects of a particular problem) and their trend analysis over a certain period. This first phase is very important because the trend analysis done for each impact identified allows problems to be prioritized (Pereira *&* Santos, 2020). When the impacts justify moving forward with the problem-solving process, the next step consists of collecting the causes that originate the problem, based on the different root-cause techniques that exist. This step allows the analysis of the current situation (AS IS) to be finished. Afterwards, according to Pereira Problem-Solving Model, all the conditions needed to propose a solution are met, therefore, the last step is to define the solutions and benefits that mitigate the causes already identified (Pereira *&* Santos, 2020).

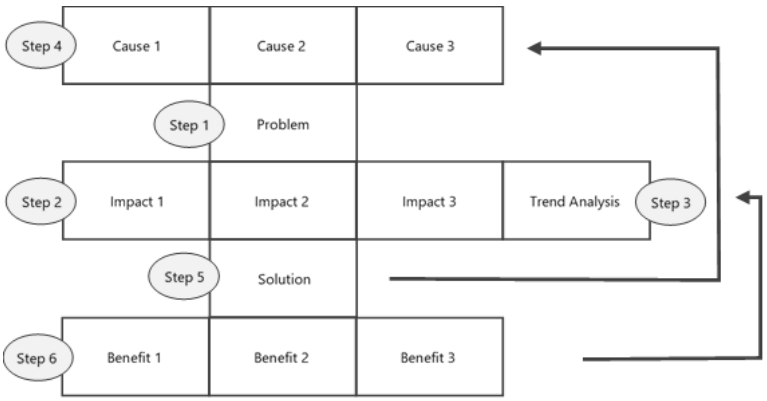


Figure 24 - Pereira Problem Solving (Source: Pereira & Santos, 2020)

Although, the implementation of this framework has been accomplished in the Business Case Tool (Pereira *et al*., 2023; Pereira *et al*., 2021). The application of this framework to two different use cases was without any previous knowledge or even connection among the Causes, Impact or Benefits. Thus, this new module developed using the baseline of this methodology approach added one important contribution, the NLP algorithm. The NLP is gaining momentum in management research for its ability

to automatically analyse and comprehend human language (Kang *et al*., 2020). With this new development, it is possible to extract the semantics of words and sentences from the benefits and Impacts in order to compare them in terms of words relation. In this way, it will be possible to measure the relation between these two steps and to validate if the level of connection and similarity are equal. Thus, if the desired benefit corresponds to the current impact of the problem. Using this scientific approach, it will be possible to increase the efficiency of the benefits since it attributes a probability estimation (from 0 to 1) of each word / sentence related with the impact with a semantic textual similarity (Figure 25).

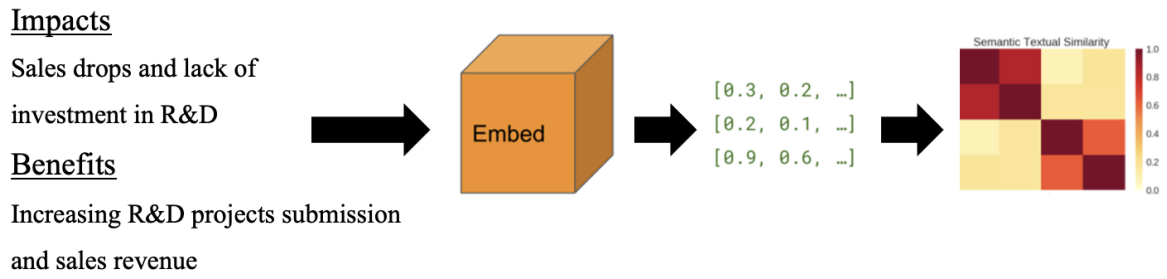


Figure 25 - Semantic Textual Similarity (Source: Author)

The combination of these identified techniques requires a very high complexity which, however, will allow considerable advance from a scientific point of view and which will translate into advantages far superior to the current Problem-Solving model. The automation of this process will allow a considerable reduction in the empirical time spent by a team as well as the subsequent analysis of all fields of information provided. The major development of this module will allow for considerable scientific analytical and predictive advancement for the subsequent modules.

6.1.2. Benefits Estimation

The Benefits Estimation is a fundamental step in any Business Case since it aims to assess the impact of project benefits quantitatively on the project and in the company. This step is intended that the benefits are calculated through a robust process, so they are presented in a rigorous, accurate and conservative manner. In Benefits Estimation the process of Benefit Modelling aims to assess the impact of project benefits quantitatively in the business and in the company. It is intended that the benefits are calculated through a robust process, so they are presented in a rigorous, accurate and conservative manner.

Among the several available techniques applied in Benefits Estimation parametric analysis is one of them. Although and due to the project's nature, data availability and needs the non-parametric approach seems a logical technique which can provide an added value in terms of benefits evaluation. In the next section the statistical models will be described in detail.

6.1.2.1. Parametric and Non-Parametric Analysis

The parametric model is one of the most accurate and reliable methods based on historical data and parameters from previous projects of the same type. It implements a mathematical model with statistic and capabilities analysis of any existing cause-effect relationship between variables, turning it on a valuable contribution to the initiative under analysis.

Parametric analysis has been commonly used in estimating the benefits of a project that can derive from very complex and opposite themes. However, these parametric methods (Asmare & Begashaw, 2018) assume that distributions are normal and, although, these models can have a more accurate estimate, they are considered methods less robust besides the fact that conducting the parametric approach is how to appropriately distinguish random noise from true in efficiency, as neither of them is observable (Huang & Wang, 2002). In this paper, an alternative was provided to the current use of parametric analysis for benefits estimation. In this paper, it presents a non-parametric approach.

The non-parametric methods are applied in highly complex themes in which the data does not have a normal distribution and are resistant to transformation. The scientific added value of this new methodology as well as the application of a scientific method will allow an increment in its technical development. This alternative will extend the estimation capacity of the models/data used in a way that will allow better analytical and assertive results regardless of whether the distribution is normal or not. Among the panoply of existing non-parametric methods, the Friedman test will be incorporated in this step. The Friedman test is a non-parametric statistical test developed by Friedman (1937). It is used to detect if an ordinal factor (dependent variable) has any statistical difference between several groups (Irigaray *et al*., 2019).

In the implementation of the Friedman test to the benefits estimation (which can vary from n to n+1) it is described, initially, the ordinal variables which are the ranked benefits value estimation. In the Digital Business Case framework, it is implemented to determine if there are statistically significant differences for comparisons of multiple groups, with different factors for each benefit. For instance, regarding the configured statistical significance (95%), the hypothesis that all benefits contribute similarly in terms of value to the Business Case is valid.

This non-parametric analysis uses the Friedman test to evaluate how each benefit contributes to the success of the Business Case, and act as a guidance tool for the benefits evaluation. Depending on the significance level, if the result is “Reject null hypothesis and accept the alternative”, then it means that one of the benefits has a much larger impact on the Business Case. Several steps have been undertaken to validate or reject:

1 – Null and alternative hypothesis,

H0: All benefits contribute similarly in terms of value to the business case

H1: At least one benefit brings greater impact to the business case

2 – State Alpha

α = 0.05

3 – Degrees of freedom

df = k-1, where k = number of groups

df = 3-1 = 2

4 – State the decision rule

This step is applied to look up to the critical value in the Chi-Square table and find a critical value of plus/minus 5.99. That means, a statistical value => than 5.99 means that the null hypothesis is accepted in the opposite =< than 5.99 means that the null hypothesis is rejected and accepted the alternative.

5 – Calculate Test Statistics

The benefits estimation values for each benefit are then ranked and inserted in the Friedman equation. These values are used as input. The Friedman test equation is computed as (1):

$$\chi_r^2 = \frac{12}{nk(k+1)} \sum R^2 - 3n(k+1) \qquad (1)$$

Where K is the number of benefits and N the number of rank variables for each benefit and R the final rank.

6.1.3. Cost Estimation

The module Cost Estimation process aims to get a cost estimate for the project. This estimate should include not only the cost of the project but also the new operational costs. In terms of applicability, the Cost estimation is one of the most significant steps in construction planning, which must be undertaken in the preliminary stages of any Project (Al-Tawal *et al.*, 2020) as well as the main criteria for decision-making at the early stages (Ambrule & Bhirud, 2017).

In Cost Estimation there is included the topic product definition, product breakdown structure and the cost breakdown structure. The Product Definition process aims to define what costs may be involved in the project. The Product Breakdown Structure process aims to qualitatively assess whether a particular initiative has costs that are not aligned with the benefits defined and the Cost Breakdown Structure process aims to get a cost estimate for the project. This Cost Breakdown estimate should include not only the cost of the project, as well as the new operational costs.

Several new algorithms have been applied in this segment to provide added value. The different methods developed and implemented will be described in the next sections: forecasting, Pearson correlation and Bayesian probability.

6.1.3.1. Forecasting

In a Business Case it is added value to forecast the products price estimation. In the Digital Business Case the Simple Moving Average (SMA) was implemented in order to perform the product cost estimation and analysis for the following years. Based on this information the decision-makers can make the decision to change products, validate costs or find an alternative to be in line with the project needs and requirements. The SMA moving average is a simple weighted sum calculated over a selected historical price range (Raudys & Pabarškaitė, 2018). It is widely used to estimate the current level of a time series, with this value being projected as a forecast for future observations (Johnston *et al*., 1999).

The SMA equation in computed as (2):

$$SMA = \frac{A_1 + A_2 + ... + A_n}{n} \quad (2)$$

Where the A1, A2, A*n* are the product cost for each year and n stands for the number of data prices used in the calculation. It varies in function of the cost number introduced each year.

6.1.3.2. Correlation Coefficient

Another important statistical method applied in the module Cost Estimation was the introduction of a correlation coefficient in order to measure the level of association between the different products forecasted defined for the current project. From the panoply of existing methods, the selected coefficient was Person Correlation. This correlation method measures the linear dependency between two random variables (Ly *et al*., 2018).

In terms of significance the results obtained from the Pearson Correlation according to the authors Schober *et al*., (2018) are the following:

- A correlation coefficient of 1 means that for every positive increase in one variable, there is a positive increase of a fixed proportion in the other.
- A correlation coefficient of -1 means that for every positive increase in one variable, there is a negative decrease in the other.
- Zero means that for every increase, there isn't a positive or negative increase.

The applied equation is computed as (3):

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}} \quad (3)$$

Where the $\bar{x}$ is the Mean of *x* variable and the $\bar{y}$ is the Mean of *y* variable.

In terms of interpretation in a Digital Business Case, the Pearson Coefficient aims to provide the level of association of the product cost forecasting with all products combinations. If the level of association is high, among the overall products, it means they could reflect in the variation of the price meaning that one product cost depends on the variation of the other project. In alternative, if there isn't any association, it means the products are totally different and the product cost is redundant among their price variation.

6.1.3.3. Bayes Theorem

The Bayesian statistics can be understood as the conditional measure of uncertainty associated with the occurrence of a particular event, given the available information and the accepted assumptions (Bernardo, 2004). Bayesian methods provide a complete paradigm for both statistical inference and decision making under uncertainty (Bernardo *et al.*, 2011). One important assumption in the development of a Bayesian approach is the selection of the prior distribution. This prior distribution reflects expert's knowledge about project trends, future threats and opportunities (Caron *et al.*, 2013). The application of a Bayesian approach has several advantages, for instance dealing with information provided by scarce and small samples (Dalla Valle *et al.*, 2008), where statistical power issues make it nearly impossible to support frequentist hypotheses with p values (Howson & Urbach, 2006). The application of a cost estimation approach using a Bayesian combination was already tried according to Jørgensen and Shepperd (2006).

The implementation of this model in the cost estimation aimed to calculate the posterior probability of an event, considering the prior probability of an event, activity or other type of numeric

subject that can be quantified, namely by defining the probability in three different states: “increase cost probability”; “stable cost probability” and “decrease cost probability”.

The applied equation, for calculating the conditional probability with 3 factors, is computed as (4):

$$P(R \mid H, S) = \frac{P(H \mid R, S)\ P(R \mid S)}{P(H \mid S)} \tag{4}$$

Where (R) is the probability of the price being stable given the increase cost probability (H) or decrease cost probability (S).

6.1.4. Economic Evaluation

The economic evaluation of a Business Case aims to validate if the project is viable or not depending on the defined threshold by the decision-makers. The project should ensure rapid return of the investment and good profitability over the expected lifetime, comparable with other industrial or financial projects (Dimian *et al*., 2014). The decision about a project moving forward or not should always consider a minimum trust level from 80% to 95% in the combined cost and benefit cash flows. Economic evaluation is commonly used in several different projects without being specific in terms of project nature.

Based in the economic indicators provided in the Business Case Tool (Pereira *et al*., 2023; Pereira *et al*., 2021) such as the ROI among several other (Net present value, benefit cost ratio, internal rate of return, external rate of return / MIRR, net external rate return and payback with interest) the implemented algorithm aims to provide advanced risk analysis for long term risk evaluation and to be complementary, that means, this algorithm doesn´t pretend to replace the current economic indicators but rather to provide a complementary risk information.

In this module, economic evaluation, it was implemented the Markov Chain in order to simulate all the economic evaluation indicators and its respective evolution, using a Markov chain and attributes a probability to each of the three states (Low, Moderate and High) that represent the risk of the Business Case model based in years, investments and benefits.

6.1.4.1. Marko Chain

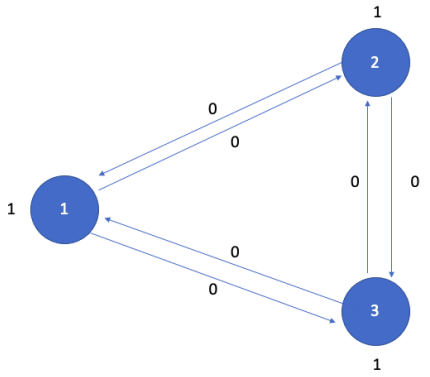
Markov chains are a class of stochastic processes very commonly used to model random dynamical systems (Douc *et al*., 2018). It is a probabilistic model describing a system that changes from state to state, and in which the probability of the system being in a certain state at a certain time depends only on the state of the preceding time step (Gagniuc, 2017). It´s important to mention that the two most fundamental probabilistic models for sequential data are independent and identically distributed

processes and Markov chains. In this step, the main objective is to analyse all the economic evaluation variables and its respective evolution, using a Markov Chain and attributes a probability to each of the three states (Low, Moderate and High) that represent the risk of the Business Case model to fail and represent, as well the long-term risk evaluation (based in the different steps of transition). The simulation of a homogenous Markov Chain is divided into three steps: Transition probabilities, state function and Markov graph. The transition probabilities aim to determine how the Markov chain to be simulated looks at each time (t) when the transition probabilities change from one state of a given finite Markov chain to another one with finite number x of states. These transition probabilities are given by the following matrix (5):

$$t = \begin{array}{c} \\ Low \\ Moderate \\ High \end{array} \begin{array}{c} \begin{array}{ccc} Low & Moderate & High \end{array} \\ \begin{vmatrix} (xi1)n & .. & (xi3)n \\ (xi2)n & .. & (xi2)n \\ (xi3)n & .. & (xi3)n \end{vmatrix} \end{array} \tag{5}$$

Where each element (xi_{n-1}) represents the probability (one step transition probability) for this finite Markov chain to go from the state *xn = x1(i)* to the next state x_{n+1} *= x(2-3)*.

The Markov graph is computed as (6):



(6)

Where the numbers on the edges give the transition probability; the numbers at the nodes are the chances to remain in the node. The current state in the current simulation step is highlighted, as well as the last-used edge.

6.1.5. Decision-Making in Digital Evaluation Projects

The decision-making process was based on the expert panel's recommendation. Based on this recommendation, a method was proposed that would address the current needs in terms of the final

evaluation of a project centred on scientific management principles. The decision-making process aims to gather all possible relevant information to support stakeholders in making a final project decision.

6.1.5.1. Multi-Criteria Scenarios

The multi-criteria scenario technique emphasises the importance of identifying several possible scenarios based on a set of appropriate evaluation criteria. Multi-criteria are often used in strategic planning (Stewart *et al.*, 2013). When information gathering is complex and involves multiple questions or parameters, a multi-scenario approach is necessary. For example, the current volume of information generated by several modules requires support to handle the decision-making process and deal with large amounts of data (Pérez *et al.*, 2022).

The contribution of multi-criteria scenarios to the digital evaluation project lies in their ability to manage different scenarios, which are grouped according to the information collected from previous modules. This technique is particularly well-suited to complex decision-making problems involving multiple and conflicting objectives and criteria. It enables a single preferred alternative to be identified, or possible alternatives to be ranked or shortlisted. The ability to manage several outputs (Figure 26) and provide a potentially better scenario adds considerable value to the evaluation of digital projects.

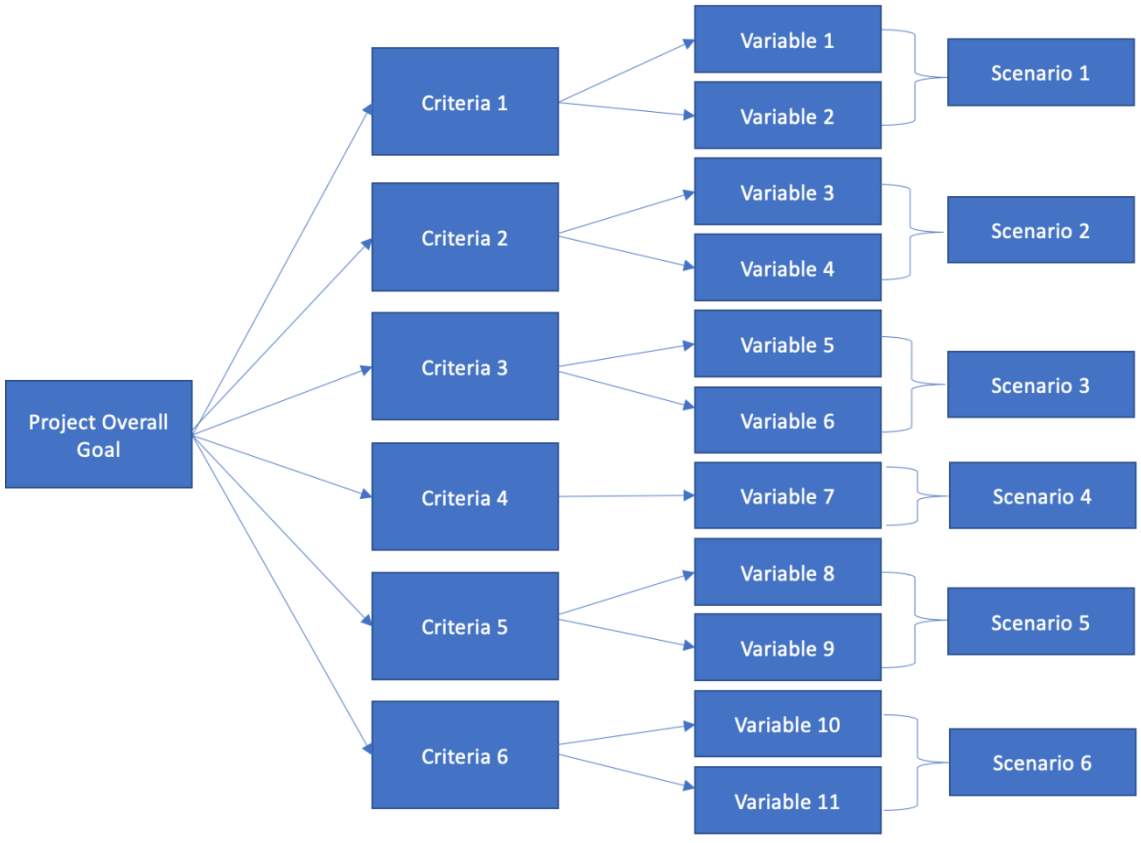


Figure 26 - Multi-Criteria scenarios (Source: Author)

6.2. Validation Delphi Method

The output from the Delphi method resulted in profitable engagement throughout the entire research process. Throughout the process, the experts collected various findings that aligned with the consensus. Thus, the applicability of the Delphi method proved to be a very effective way of validating the proposed theoretical model. In fact, the Delphi method has three significant advantages: 1) providing levels of agreement in areas where there is often an absence of empirical evidence, 2) being a quick and efficient method, and 3) pinpointing areas of agreement and disagreement in an existing knowledge area (Brown, 2018). The outputs collected from the Delphi method for the different rounds of evaluation will be explained in more detail in the following sections.

6.2.1. First Round Outputs

In the first-round iteration, the proposed theoretical model was presented and explained (Figure 27). Based in the presentation of the theoretical model and for the first iteration, it was made a single question: "*Which methods should be included in a Business Case in order to evaluate digital projects?*". It was requested to the expert panel to provide several proposals in each domain (Project Request, Economic Evaluation, Cost-Benefit Estimation) that could increase the theoretical model added value as well to validate its current workflow.

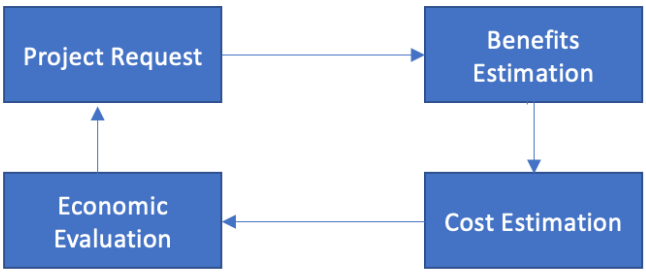


Figure 27 - Theoretical Model initial Proposal (Source: Author)

The expert panel unanimously agreed that a critical step was missing, namely the step that could provide the final decision based on the outputs from the previous domains. This new domain was named 'Decision-Making' and incorporated into the first iteration. It is important to note that several experts shared similar inputs, which were combined and categorised under the same proposal. The outputs are presented in Table 44.

Table 44 - Balanced Scorecard-First Round of Iteration Output

First Round of Iteration

Economic Evaluation	Capability to measure different types of economic evaluation transition phases	**Project Request**	Understand the project frame in terms of potential added value
	Possibility to quantify the risk, using several different indexes that can be applied to digital projects		Capability to understand a potential problem and deliver a solution for an initial project endeavour
	Construction of a method to integrate the output from Benefits, Cost and other relevant variables		Possibility to indicate an initial assumptions and predictions of potential benefits, impacts and causes of an initial project proposal
	Introduce the SROI measurement as an indicator for digital projects		Creation of Project Matrix and initial quantification of risk
Decision-Making	Capability to assists decision makers in order to understand digital business proposals	**Cost-Benefit Estimation**	Increase Profitability of each benefit in terms of digital adaptation
	Demonstrate the viability of the project in the frame of the digital transformation		Reduce Operating Costs by determine the different probabilities level
	Increase speed and flexibility in the digital project's evaluation		Monitor Benefits Estimation using correlation metrics in order to measure the association between the different benefits
	Clearly defined criteria and objectives metrics in line with the digital transformation requirements		Forecasting Cost Benefits to support the business decision

In order to create a clear understanding of each proposal, it was described the exploratory context. Starting from the Economic Evaluation, the following proposals can be described as follow:

- Capability to Measure different types of economic evaluation transition phases: The possibility to measure the economic risk by congregating several different variables in a scenario that can be quantified from low, moderate and high for several different years.
- Possibility to quantify the risk, using several different indexes that can be applied to digital projects: In this proposal the aim is to integrate several different indexes in order to evaluate the context of economic evaluation of a business proposal. The conjunction of indicators such as ROI, Payback, ERR and NPV among several other index, should create a possibility to measure efficiently if the project is economically interesting or efficient for the organisation using several indicators.
- Construction of a method to integrate the output from Benefits, Cost and other relevant variables: The aim is to have a method that can integrate the variables output "Benefits", "Cost" and other third-party variables that are relevant to measure the economic evaluation.
- Introduce the SROI measurement as an indicator for digital projects: The integration of a dedicated and single metric as Social Return on Investment in economic evaluation aimed to the contribute for the digital inclusion in a project as well the conjunction of social, environmental and economic value.

Regarding the Decision-Making, the proposals were the following:

- Capability to assists decision makers in order to understand digital business proposals: The capability to have supporting decision methods in order to understand the digital projects objectives.
- Demonstrate the viability of the project in the frame of the digital transformation: Being capable to demonstrate that the outcome of a project will fulfil the requirements of a digital project and it will be sustainable.
- Increase speed and flexibility in the digital project's evaluation: The aim is to allow a considerable faster decision in terms of project acceptance or rejection based in the outcome of a Business Case as well as flexibility to adapt to new requirements and needs from digital projects.
- Clearly defined criteria and objectives metrics in line with the digital transformation requirements: Understand the common digital transformation project requirements in order to have a clear project criteria definition and metrics to evaluate digital projects.

The context for each proposal in the Project Request is the following:

- Understand the project frame in terms of potential added value: Capability to understand into deep the project structure by providing initial insights about the project structure such as problem, causes, impact, benefits and solutions for potential problems.
- Capability to understand a potential problem and deliver a solution for an initial project endeavour: Have a methodology that can initially identify potential problems from a project endeavour and provide a potential solution to mitigate the problem based in the identification of the causes and impacts.
- Possibility to indicate an initial assumptions and predictions of potential benefits, impacts and causes of an initial project proposal: Capability to measure and identify potential benefits based in the impacts of a project.
- Creation of Project Matrix and initial quantification of risk: Provide a matrix, which will allow the preparation for possible risks and threats that may occur in the future from both a market and technological perspective.

The last domain, Cost-Benefit Estimation, are related with the following context:

- Increase Effectiveness for each benefit in terms of digital adaptation: Have a methodology that can measure the effectiveness of a benefit in terms of project contribution by correlating the different benefits.
- Reduce Operating Costs by determine the different probabilities level: Capability to reduce and measure the operating costs of a project based in the conjunction of benefits and costs and the probability of them to increase, decrease or being stable

- Monitor Benefits Estimation using correlation metrics in order to measure the association between the different benefits: Have the capability to understand the level of association between the different type of benefits will ensure the understanding what the project involves and will provide crucial information to stakeholders whether to take on the project.
- Forecasting Cost Benefits to support the business decision: Have the possibility to provide future information that will support the project endeavour based in a data-driven decision-making approach as well to provide a crucial business decision support.

The output collected from the first round of the iteration process was shared with the participants for the second round, ensuring that all expert´s had the same understanding of the initial collected inputs on the first round.

6.2.2. Second Round Outputs

In the second round, the expert panel evaluates the clustered proposals presented in table 44. These proposals were evaluated using the Likert Scale and Relevance. According to the output of the second-round iteration from several experts, the author calculated the average of the Likert classification provided by each expert. Regarding the evaluation by the column "Relevance", it was used the frequency of words attributed by each expert. Thus, Table 45 reflects the average Likert score and the frequency of words attributed by each expert.

Table 45 - Balanced Scorecard KPI-Second Round of Iteration output

Second Round of Iteration							
Domain	**Proposal**	**Likert**	**Relevance**	**Domain**	**Proposal**	**Likert**	**Relevance**
Economic Evaluation	Capability to measure different types of economic evaluation transition phases	4.2	High	**Project Request**	Understand the project frame in terms of potential added value	3.5	Moderate
	Possibility to quantify the risk, using several different indexes that can be applied to digital projects	4.3	High		Capability to understand a potential problem and deliver a solution for an initial project endeavour	3.6	High
	Construction of a method to integrate the output from Benefits, Cost and other relevant variables	3.9	Moderate		Possibility to indicate an initial assumptions and predictions of potential benefits, impacts and causes of an initial project proposal	4.3	High
	Introduce the SROI measurement as an indicator for digital projects	3.6	Low		Creation of Project Matrix and initial quantification of risk	3.9	Low

Decision-Making	Capability to assists decision makers in order to understand digital business proposals	4.1	High	**Cost-Benefit Estimation**	Increase Profitability of each benefit in terms of digital adaptation	4	Moderate
	Demonstrate the viability of the project in the frame of the digital transformation	4	Moderate		Reduce Operating Costs by determine the different probabilities level	4	Moderate
	Increase speed and flexibility in the digital project's evaluation	4.5	High		Monitor Benefits Estimation using correlation metrics in order to measure the association between the different benefits	4.3	High
	Clearly defined criteria and objectives metrics in line with the digital transformation requirements	3.8	Low		Forecasting Cost Benefits to support the business decision	4.2	High

From the output, it was decided to remove the proposals which had a mean value of the Likert scale less than 4 and conjugated with a low relevance. Consequently, the results from the initial evaluation of Scoreboard card are presented in Table 46.

Table 46 - Balanced Scorecard KPI-Second Round of Iteration final output

Second Round of Iteration							
Domain	**Proposal**	**Likert**	**Relevance**	**Domain**	**Proposal**	**Likert**	**Relevance**
Economic Evaluation	Capability to measure different types of economic evaluation transition phases	4.2	High	**Project Request**	~~Understand the project frame in terms of potential added value~~	~~3.5~~	~~Moderate~~
	Possibility to quantify the risk, using several different indexes that can be applied to digital projects	4.3	High		~~Capability to understand a potential problem and deliver a solution for an initial project endeavour~~	~~3.6~~	~~High~~
	Construction of a method to integrate the output from Benefits, Cost and other relevant variables	3.9	Moderate		Possibility to indicate an initial assumptions and predictions of potential benefits, impacts and causes of an initial project proposal	4.3	High
	~~Introduce the SROI measurement as an indicator for digital projects~~	~~3.6~~	~~Low~~		~~Creation of Project Matrix and initial quantification of risk~~	~~3.9~~	~~Low~~

Decision-Making	Capability to assists decision makers in order to understand digital business proposals	4.1	High	**Cost-Benefit Estimation**	Increase Profitability of each benefit in terms of digital adaptation	4	Moderate
	Demonstrate the viability of the project in the frame of the digital transformation	4	Moderate		Reduce Operating Costs by determine the different probabilities level	4	Moderate
	Increase speed and flexibility in the digital project's evaluation	4.5	High		Monitor Benefits Estimation using correlation metrics in order to measure the association between the different benefits	4.3	High
	~~Clearly defined criteria and objectives metrics in line with the digital transformation requirements~~	~~3.8~~	~~Low~~		Forecasting Cost Benefits to support the business decision	4.2	High

Thus, of the 16 proposals presented by the expert panel, five were removed in accordance with the panel's decision. The remaining 11 proposals provided valuable input for the development of the theoretical model. The Cost-Benefit Estimation domain kept all proposals, and three proposals were eliminated from the Project Request since they did not meet the defined requirements.

6.2.3. Third Round Outputs

The third and final round began with the presentation of the final theoretical model (Figure 28), which incorporated the previous proposals. Several questions were then asked about the new model version to obtain a second validation.

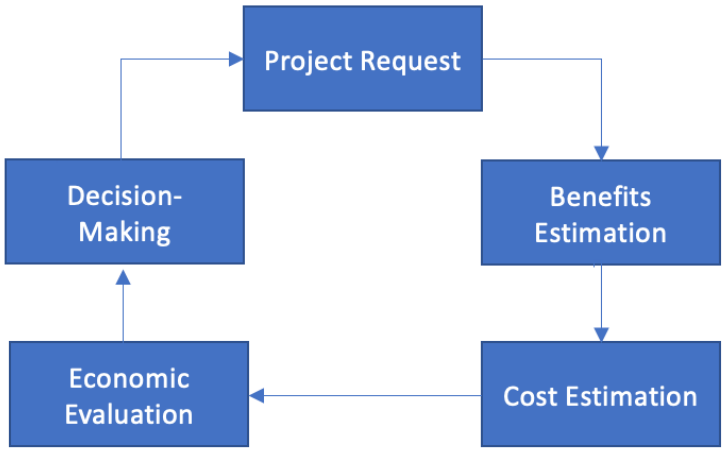


Figure 28 - Theoretical Model Proposal (Source: Author)

Different techniques are employed by each method of the theoretical model, with the aim of addressing current literature gaps, interview outputs and proposals from the expert panel. The different techniques provided for each method are presented in Table 47. These techniques are described in detail in different sections of Chapter III.

Table 47 - Methods and Techniques of the Theoretical Model

Method	Techniques
Project Request	Problem Solving using Natural Language Processing
Benefits Estimation	Friedman Test
Cost Estimation	Simple Moving Average
	Pearson Correlation
	Bayes Theorem
Economic Evaluation	Markov Chain
Decision-Making	Multi-criteria scenarios

The final proposals that have been presented and validated are replied to within the proposed techniques. For instance, in Project Request, the proposal “Possibility to indicate an initial assumptions and predictions of potential benefits, impacts and causes of an initial project proposal” is replied by the Problem-Solving; In the Benefit Estimation, the Friedman test replies to “Increase Profitability of each benefit in terms of digital adaptation”; In Cost Estimation, the “Reduce Operating Costs by determine the different probabilities level” is replied by the Bayes Theorem, the “Monitor Benefits Estimation using correlation metrics in order to measure the association between the different benefits” is linked with the Pearson Correlation and the “Forecasting Cost Benefits to support the business decision” is replied by the Simple Moving Average. In terms of Economic Evaluation, the proposals “Capability to measure different types of economic evaluation transition phases”, “Possibility to quantify the risk, using several different indexes that can be applied to digital projects” and the “Construction of a method to integrate the output from Benefits, Cost and other relevant variables” are replied by the Markov Chain. For the last domain, the “Decision-Making”, the proposal “Capability to assists decision makers in order to understand digital business proposals”, “Demonstrate the viability of the project in the frame of the digital transformation” and “Increase speed and flexibility in the digital project’s evaluation” are replied by the multi-criteria scenarios.

The model presented was explained to the expert panel as well as the concept of scientific management and its relevance and bases to the model. Afterwards, three questions were asked:

1 – Can scientific management contribute to create a Digital Business Case to support the evaluation process of digital projects?

2 - Does this digital Business Case reply to the current digital evaluation project needs?

3 – The current methods and techniques available match the current needs for evaluating digital projects?

For the first question the expert panel was unanimous that incorporating the scientific component will improve the efficiency of the several modules due to capability to solve complex management problems and improvement of the accuracy of the estimations. In the second question, the panel agree that the current Digital Business Case replies to the current needs of digital projects since it covers the whole spectrum of validation. Regarding the third question, most of the techniques were consistent but suggesting alignment between the outputs in order to guarantee a proper project evaluation metric as well a sustained workflow of the digital project evaluation.

The expert panel also agreed that further rounds would not add further value to the theoretical model.

CHAPTER VII

Discussion and Findings

This chapter addresses the main research question and the sub-questions that align with the thesis objectives. In order to answer the research question, data was collected from interviews and model development, as well as different perspectives on the outputs being discussed.

7.1. Research questions findings

The main research question aimed to test if the scientific management concept can reply to the current needs of the digital evaluation project.

How do scientific management theories inform the design and implementation of effective processes for Digital Business Case development?

The next section will answer this main question, with the sub-questions providing part of the answer. In fact, scientific management is a precise and fundamental method for solving complex management problems and overcoming the need for a methodology to support digital project evaluation.

7.2. Sub-questions and objectives

Several sub-questions have been defined to answer the main research question. These will be addressed using the data collected and in line with the thesis objectives. The following paragraphs will address each sub-question, linking it to one or more of the thesis objectives.

1. What is the state of the art in academic research regarding Business Case formulation and evaluation for digital transformation projects in the context of the COVID-19 pandemic?

R: This question was mainly addressed in Chapter 2 (Literature Review). The current structure of the Business Case is unable to meet the current digital demands, particularly with regard to projects involving process, business model, domain and organisational transformation. Thus, the proposed theoretical model responds to current trends and needs in digital project evaluation. The first sub-question is linked to research objective 1.

2. What is the contemporary relevance and contribution of commonly employed Business Case methods in facilitating organisational decision-making?

R: The response to this question was supported by the interview outputs, in which several questions were asked, mainly with the following specification: 'Based on your experience, how relevant do you consider method X to be in a Business Case?' Eight methods were evaluated in response to this question, providing a final output on their current relevance. All of the following were considered relevant in terms of their contribution to project evaluation: Problem Solving, Strategic Alignment, Benefits Forecast, Cost Forecast, Economic Evaluation, Organisation Readiness Analysis, Sensitivity Analysis and Project Evaluation and Measurement. However, Sensitivity Analysis was considered less relevant than the other methods. The second sub-question is linked to general objectives 1 and 2, as well as research objective 2.

3. How effectively can a dynamic Digital Business Case respond to the changing requirements of ongoing digital projects within organisations compared to traditional static Business Case methodologies?

R: Using multiple scenarios can support the dynamic environment created by digital transformation. This theoretical model uses several different methods and techniques to sustain a probability matrix, diverse scenarios and transition methods. One of this theoretical model's main capabilities is its ability to understand dynamic environments and the multiple scenarios that can support dynamic processes. The second sub-question is linked to general objectives 1 and 2, as well as research objectives 4 and 5.

4. How can principles derive from Scientific Management be operationalised within the different steps of a Business Case to create an effective Digital Business Case framework for the evaluation of digital transformation projects?

R: The theoretical model was developed to support the decision-making process in project evaluation. The scientific method adds to the model the capability to respond to current trends and needs by applying a scientific approach to solving complex problems. The expert panel validated this sub-question and their outputs regarding the methods to be applied in Table 34. This sub-question is linked to general objectives 3 and 4, as well as research objectives 3 and 4.

5. Which are the current methods and techniques most relevant in a Business Case for project evaluation that contribute to testing assumptions about operating costs and expected benefits?

R: In response to the final sub-question, the interviewees emphasised the fundamental importance of the Benefits and Cost Forecasts as essential tools for supporting digital evaluation projects. The presented techniques provide proper evaluation measurements that guarantee fundamental support for the decision-making process. This sub-question is linked to general objectives 3 and 4, as well as research objectives 3, 4 and 5.

7.3. Business Case Problem Deep Analysis and Theoretical Contribution

Identifying gaps in the literature review and analysing the outcome of the interviews led to a thorough examination of the Business Case problem. It was described as such since this was the methodology applied in this thesis for digital evaluation projects. In addition to the assumptions created from the gap analysis, the interview output was fundamental in developing the theoretical model, which addressed the current gaps.

7.3.1. Interviews Problem Identification

The outcomes of the interviews allowed the identification of several problems linked with the identified gaps from the literature review and presented in Table 3. In this case more than one identified problem was linked to more than one identified gap on some occasions.

The first identified GAP (ID1) mentioned that the findings from both the literature and the interviews converge on a critical deficiency in the evaluation of digital transformation projects. While Barthel *et al*., (2021) attribute this gap to the lack of evaluation metrics specifically designed for digital transformation initiatives, interviewees further articulated this issue as a practical *problem-solving failure*. Interviewed participants reported limited capabilities to identify the main benefits of projects, difficulties in measuring project impacts, and an inability to recognize critical project factors. This lack of evaluative clarity also translated into challenges in defining the core project problem itself. Empirically, this suggests that the absence of structured evaluation mechanisms not only constrains theoretical assessment but also directly undermines managerial sense-making and benefit articulation during project decision-making.

For GAP ID2 and in line with Margherita and Heikkilä (2021), the literature emphasizes the importance of aligning digital projects with business objectives, particularly under crisis conditions requiring business continuity and innovation. Interviewed stakeholders, however, framed this gap as

a *strategic alignment problem*, characterized by poorly defined business objectives, lack of productivity, and weak goal articulation. From the interview perspective, project alignment with organizational strategy was not guaranteed due to the absence of alignment metrics and ineffective communication among decision-makers. This empirical evidence reinforces the literature by demonstrating that misalignment is not merely conceptual but manifests operationally through fragmented governance and inconsistent evaluation practices.

GAP ID3 and 7, the literature identifies organizational uncertainty and unforeseen scenarios as key challenges for project evaluation (Zackery *et al*., 2022; Carracedo *et al*., 2021; Harel, 2021). Interviewed participants translated this into a *benefits estimation problem*, where estimation practices were largely empirical and intuitive. Interviewees highlighted the absence of critical success factors, the lack of confidence-based benefit measurements, and the inability to estimate benefits across multiple scenarios, including worst-case and high-confidence conditions. These findings indicate that uncertainty is compounded by insufficient analytical rigor, limiting the organization's capacity to evaluate projects under volatile and complex conditions.

In GAP ID 4 and 10 and consistent with Harel, (2021) and PMI, (2020), the literature associates poor cost estimation with negative impacts on business performance and project implementation. Interview data further reveal that this gap is experienced as a *cost estimation problem*, driven by empirically derived assumptions rather than validated methodologies. Interviewees reported an inability to define cost–benefit relationships during project initiation, generate reliable cost projections, or apply transparent estimation methods that support scenario validation. This misalignment between theoretical cost frameworks and practical estimation capabilities constrains informed investment decisions and weakens financial governance.

GAP 5 and 6, the literature stresses the importance of data-driven decision-making and long-term value realization (Elrefaey *et al*., 2022; Hashemi *et al*., 2022). From the interview perspective, this gap materializes as an *economic evaluation problem*. Interviewed participants emphasized the lack of evidence-based processes to support decision-making, the inability to validate assumptions, and the absence of criteria to assess the economic consequences of delaying or rejecting projects. Additionally, interviewees reported difficulties in forecasting project investments, thereby limiting their capacity to assess long-term returns and strategic value creation.

In GAP 8, Donthu and Gustafsson, (2020) highlight the need to reassess existing technologies and business models to enhance digital value creation. Interview findings frame this gap as an *organizational readiness problem*. Interviewed stakeholders reported an inability to clearly establish the added value generated by project benefits, difficulty in prioritizing projects within the organizational context, and limited clarity regarding project priorities. Furthermore, the absence of validation mechanisms for quality control during project evaluation suggests that readiness

assessments remain underdeveloped, weakening organizational preparedness for digital transformation initiatives.

The last two GAP´s, 9 and 11, Khlystova *et al*., (2022) argue for the creation of new evaluation metrics to sustain business continuity which lead to the assumption of the need to assume a project evaluation methodology and benefits definition for project implementation. Furthermore, PMI, (2020) identified that the ability of your current project(s) to realize more than 75% of their identified of intended benefits is uncapable to cope with the dynamic environment of projects. The interviewers identified this gap as a *sensitivity analysis problem*, marked by the absence of structured processes to calculate estimations and evaluate critical variables. Interviewees also highlighted limited knowledge extraction from assumption-based indexes and an inability to define current processes for deriving estimations from project data. These findings suggest that without sensitivity analysis capabilities, organisations struggle to understand project vulnerability and robustness under changing conditions.

7.3.2 Theoretical contribution

This section describes how the theoretical model contributes to each gap identified in the literature review. For each gap, represented by the ID code provided in Table 3, the corresponding GAP is also presented for easier interpretation.

ID 1 (Evaluation of digital transformation projects contributions remains largely elusive)

Theoretical Model - The model lifecycle along the five different methods provides the relevant metrics for a systematic project evaluation since the current techniques are based in probabilities matrix, forecasting, correlation, Friedman test and Problem solving. All these techniques minimise assumptions, avoid empiricism and provide to decision makers technical and managerial capabilities within the business and scientific approach.

ID 2 (Management and Business Problems related with project and business objectives; Need to create a new business value as well business continuity and business model innovation for value creation)

Theoretical Model - The model based in the economic evaluation can provide a relevant metric to measure the lack of productivity since it relies in the Friedman test, which can evaluate how each benefit contributes to the success of the Business Case, and act as a guidance tool for the benefits evaluation. Also, since the theoretical model consist in a few steps it reduces the complexity of the process and reduces the possibilities for errors between the several steps. This is added value to guarantee the alignment and business organisation during the evaluation phase. In order to support the project goals, the applicability of a Problem-Solving structure will reduce significantly the entropy between the problem goals and the solutions.

ID 3 (Frameworks to assess the readiness of organization uncertainty) & 7 (Unforeseen scenario and business uncertainty)

Theoretical Model - The model provides several relevant methods that can overcame the uncertainty by creating several potential scenarios and providing metrics to evaluate the project feasibility starting from a deep understand of the project using a Problem-Solving approach. To deal with the uncertainty and risks associated with the project evaluation the available techniques allow to know which variables in a Business Case contribute most to the uncertainty based on the probability distribution of the variable.

ID 4 (Affect the Business Performance of an organisation and consequent project development and implementation) & 10 (General Business Impact)

Theoretical Model - The model provides a workflow that delivers a comprehensive initial evaluation assessment before a project development or implementation. In order to contribute to the effectiveness of the organisation performance the scientific management principle with corresponding techniques can increase the monitorisation of reduce administrative cost, turnover, liability and organisation alignment. It also adjusts the optimism and provides a better estimate earlier on of key project parameters for the evaluation.

ID 5 (Data-driven decision-making) & 6 (Long term effects in management-related fields)

Theoretical Model - The model relies on its final decision in the decision-making process sustained with considerable volume of data provided by the four previous methods and final multicriteria analysis. Regarding the Benefits this step (Benefits Forecast) relies in the Friedman test which aims to determine if there are statistically significant differences for comparisons of multiple groups with different factors for each benefit. The Problem-Solving method from the Project Request also contributes to a precise initial evaluation of the project in terms of problem, benefits, impacts, causes, solutions and trend analysis. Besides this theoretical model allow to identify the expected benefits outcome as well to predict its evolution for each scenario.

ID 8 (The need to identify, optimize, and re-access existing technologies and business models)

Theoretical Model - The model was developed in order to reply to the DT and digitalization concepts by providing several statistical methods based in a scientific management concept, which will increase the project evaluation efficiency in all stages of the project evaluation. The Theoretical model was design and developed in order to provide faster decision-making, improve communication and competitive advantage.

ID 9 (Creation of new and proper evaluation metrics in order to sustain their business continuity)

Theoretical Model – The model based in the multiple scenarios approach can sustain a Business Monitoring during the project duration. It also allows to measure and quantify the benefits in the long term. The Cost Forecast method compromise several metrics, for instance it will support the process

that aims to quantitatively assess whether a particular initiative has costs that are not aligned with the benefits and the metric Cost Breakdown Structure process, which aims to get a cost estimate for the project. This Cost Breakdown estimate should include not only the cost of the project, as well as the new operational costs. This will contribute as project evaluation metrics to sustain a business decision.

ID 11 (Ability of your current project(s) to realize more than 75% of their identified of intended benefits)

Theoretical Model – The model provides techniques that allow the creation of probabilities matrix from different states of transition that can reply to the current dynamic environment, future trends and scenarios. In fact, this theoretical model will manage to capture the operational behaviour, create predictions and multi-scenarios that allow the combination past information about a parameter and form a prior distribution for future analysis and evaluation. Adjustments for optimistic scenario may be reduced accordingly as more reliable estimates of relevant costs are built up and project specific risk work is undertaken.

7.4. Research Problem and Thesis Contribution

The research problem initially mentioned by several authors such as Berghaus and Back, (2017); Wiener *et al*., (2019); Barthel *et al*., (2021); Barthel *et al*., (2020) and Gimpel *et al*., (2018) provided several inputs regarding the current problem of evaluation digital projects. Although, this current problem is mainly due to the specificities and characteristics of digital projects, which differ from the typical project, starting from a project management approach which is different from a traditional management project based on the 5 levels (initiation, project planning, project execution, performance/monitoring, and project close). Contrary, the digital projects rely on 6 (Veldhoven & Vanthienen, 2022). The proposed theoretical model contributed with the following steps to minimize the research problem found by the previous authors in section 1.2.

In Table 48, it is described the problem as the contribution from this thesis and the Level of probability defined by the expert panel during the validation process. This validation purpose was based on the Likert scale (Level of Probability) as described in Chapter III.

Table 48 - Research Problem Contribution Validation

Author	Problem	Contribution	Level of Probability
Berghaus & Back, 2017; Wiener *et al*., 2019	Capabilities, Framework and Methodologies to evaluate digital projects	The theoretical model based in 5 steps congregates and analyse the most relevant information using scientific methods that allows modular modifications and adaptation to specific organisational contexts based in	5

		the creation of multiple scenarios and probabilities matrix. This model includes a set of knowledge, skills, tools and techniques that, when properly applied, enable quality and sustainable decisions to be made in alignment with overall objectives and the requirements of the investment initiative or project.	
Barthel *et al*., 2021	Evaluation of digital projects remains vague	The effectiveness of the scientific method as an approach to solve complex management problems integrated in a Business Case allow the integration of several techniques and methods which will minimise the assumptions and projects subjectivity during the process of digital evaluation as well it will ensure that the evaluation process is aligned with the initial strategic objectives. Thus, besides the techniques that reduce the uncertainty and increase the value creation, this theoretical model will include simulation scenarios having in mind the dynamic context of future trends.	5
Barthel *et al*., 2020; Gimpel *et al*., 2018	Lack of suitable practices	The theoretical model will guarantee the development of an evaluation method based in a logical manner (scientific method) following a defined structured based in 5 steps. Each one of the steps will guarantee a proper project initial analysis, cost-benefit estimation, a suitable economic evaluation and measurements of the benefits and goals of the project implementation. Moreover, it will follow the 3 elements of the common Business Case (Existence, monitoring and	4

		tracking) adapted to digital projects.	

The expert panel evaluate each one of the contributions with the highest level of probability, except the last identified research problem. This was derivate to the current applicability of the 3 elements of the Business Case, which are currently in practice. Somehow the expert panel recommended in a future version to update the current elements in order to face the digital trend. For instance, the “Existence” currently incorporates these theoretical developments, but the monitoring and tracking need to be adapted to the current digital transformation mechanisms.

CHAPTER VIII

Conclusions

According to Kane *et al*., (2015), it is strategy, not technology, which drives digital transformation. Based in this sentence, this thesis aimed to contribute to the context of strategy by developing a new theoretical model for digital evaluation projects. Using the concept of strategic agility, in which the scientific management contributed. In fact, Scientific management made a significant contribution to strategic ability within this thesis by providing a systematic, evidence-based foundation for managerial decision-making, coordination and long-term organisational alignment. By analysing processes, performance indicators and resource utilisation in a structured way, it improved organisations' ability to formulate and implement efficient and adaptive strategies. It transformed strategy from an intuition-driven activity into a disciplined managerial capability grounded in data, standardisation, and continuous improvement. By reducing operational uncertainty and information asymmetry, scientific management strengthened strategic foresight, improved forecasting accuracy and ensured closer alignment between operational activities and strategic objectives. Furthermore, it supported organisational learning by embedding feedback mechanisms that enabled the continuous refinement of strategic choices.

This thesis begins with a comprehensive literature review and state of the art regarding the concept of Business Case. To accomplish this literature review it has been extracted a dataset as well as an extensive review of the existing literature. From the overall study and after analysing the corresponding dataset it could be drawn some conclusions. The first conclusion is the fact that the Business Case can be applied in a variety of fields which the author designated by components. In the section Business Case Components, the author exposes several examples of this dimensionality. In second, the Business Case evaluation is not only focused on benefits management through a quantitative analysis but also focused on a qualitative analysis. Thus, it can be understood as a hybrid solution complementing several areas of knowledge with a variety of methods. In third, the connection between the keyword Business Case and other keywords presented in the same publications can create several clusters from different thematic. For instance, in this study it was create 4 main clusters containing different keywords present in the same papers than the keyword Business Case. These clusters were designated as Scientific Business Decision, Technology Centricity, Business Management and Cultural Knowledge. The fourth, conclusion was based in the fact that “Business Case” is a trendy word with a considerable relevance. The level of interests is considerable high with an average score of 74 which indicates a relatively good level of popularity. It is possible to affirm there are several relevant papers that can act as a reference in terms of Business Case methodology and framework as

well some reference journals and organizations. In terms of digital transformation, it was identified some papers in the literature review as described during the second query to measure the connection between project evaluation and digital transformation.

It is important to mention that this study is only focused on one single dataset extracted from Scopus. There are other databases that could be added to this study as well to adopt a methodology based in a metasearch engine where several datasets could be explored in order to provide a considerable added value as well as a more comprehensive analysis and validation of the datasets. Although, the available data was validated though is possible that among the 1293 records could be some papers that do not have such strong relation with the real concept or study objectives.

The second part of this thesis was the development of the questionnaire interview based in the gaps found during the literature review process. It was interviewed 29 decision-makers and the elaborated questionnaire developed for the interview consisted in three parts. The first part of the questionnaire was a brief introduction, the second part was dedicated to extract common metrics regarding the participants, and the third part was the focus of the interview. The questions made aimed to gather as much knowledge as needed regarding the most applied techniques from each method and the problems and difficulties associated from those methods in terms of the evaluation of a digital project. The same two questions were asked from step 2 until the final step (7) of the third part of the interview, in order to maintain the same structure and purpose. The fact that seven different methods were presented does not mean that they should all be incorporated into the theoretical method, but rather to understand the current status of a Business Case as it is. Input from the interviews was fundamental to developing the theoretical model and validating which methods should be incorporated in order to address the current gaps and needs when evaluating digital projects using a Digital Business Case.

According to the author's professional practice, it is quite difficult to reply to an interview invitation email without having been proposed by a mutual friend or colleague first. This is especially the case nowadays when dealing with experts, decision-makers or top managers from large companies. The thousands of emails and lack of time mean that any answer or potential participation is neglected. If the request is for a direct interview, it is an even worse scenario. Thus, the approach via LinkedIn offers considerable added value, since the response rate to private messages was 100%, with an average response time of one week. Moreover, having enough time to respond to the questionnaire developed for the interview provides a significant advantage, as highlighted by several authors and referenced in section 3.4.2. The questionnaire was developed based on a literature review, as well as on questions considered relevant by the author, in order to understand the applicability of the Business Case in evaluation projects. The results obtained contributed greatly to the development of the theoretical model and its framework structure, although not all questions

were answered by the participants. Those who did not reply considered the questions to be outside their area of expertise. In part, the fact that some participants did not reply was fundamental to this thesis, as it avoided bias.

The third stage involved developing the theoretical model. This model aimed to provide considerable added value for future project investments, particularly for strategic projects that generate wealth for the company/organisation. Due to the lack of references, models or strategies related to digital evaluation, developing a Digital Business Case oriented towards project management that incorporates a variety of statistical models is crucial. This theoretical model will produce highly reliable information for evaluation purposes. This theoretical model was developed based on several identified gaps that highlight the difficulty organisations face in adopting a project evaluation method that responds to current digital demands. It is intended to support organisations in properly evaluating digital projects, helping them to gain a competitive advantage and promote value creation.

This theoretical model will provide a set of methods oriented towards the development of a Digital Business Case that will allow greater strategic agility in order to overcome changes in the business environment and to take actions points to control uncertainty (Tallon & Pinsonneault, 2011). Thus, the proposed concept to the Digital Business Case is a scientific tool which incorporates the scientific management philosophy, to solve the decision-making problems regarding the acceptance or rejection of an investment decision.

The several modules integrated in the framework, presented in Figure 28, aimed to go through all process of evaluation of a digital project decision. Each module compromised a clear structure and function. The initial step of the theoretical model is the Project Request. This module integrates a strategic planning phase based in the outputs provided by the Problem-Solving method, which confirms, initially, that the project is strategically aligned. The purpose of this output is to assess the strategic context for the project and to demonstrate how it provides synergy and holistic fit with the other steps in support of the organisation's business strategy. Moreover, this first step outlines the problem the Business Case seeks to solve. The initial project gaps should be fulfilled as they appear and identified factors that impact the problem. Thus, the problem should be analysed based in the project needs in terms of the organisation. The complementary measurements to Project Request and the Problem-Solving technique should incorporate information from initial datasets and quantitative or qualitative research methods. Since this step involves a thorough analysis of the initial project and provides important metrics, it can be concluded that the initial analysis of the Project Request is crucial for a successful project. The second module, Benefits Estimation, was incorporated to measure tangible and intangible benefits. Thus, the provided technique can validate whether a certain benefit contributes positively to the Business Case in terms of benefits versus costs. Although conventional wisdom affirms that intangible benefits cannot be quantified, this method can quantify them.

However, this method can create a trap which circumvents the value of effort expended on disciplined cost/benefit calculations, since decisions tend to be based on unquantifiable intangibles. However, intangibles can and should be quantified, since the decision is whether to incur quantified costs to achieve the intangible benefit.

Cost estimation is an essential third step for any project. While many production costs can be controlled, it is important to understand these costs in order to increase profit margins. Accurate cost estimates and strategies for reducing operating costs increase the probability of project success, since understanding the actual market costs involved in the task you wish to undertake is fundamental.

The concept of Cost and Benefits Estimation is fundamental to overcoming potential errors and achieving a clear understanding of the project. An estimate is a more detailed version of a budget which covers a project's expenses before it begins. Moreover, current techniques integrated into the benefits and cost methods contribute to prior prediction, simplification, avoiding errors and checking profitability. This involves preparing for any situation in terms of costs and benefits, simplifying the process of cost and benefit estimation, providing more accurate estimation and considering different scenarios, and knowing profit margins, accurately estimating the time that the project should take and considering the risks involved in completing the project.

The Economic Evaluation of an Investment Decision or Project Evaluation module is the final step before the GO/NO-GO decision is made. The technique applied at this stage was the Markov chain. Using this technique enables the different transition states to be measured and provides a better overview of the project's economic evaluation in terms of the GO/NO-GO decision. For example, using a three-year threshold as input provides an output of risk analysis. The transition probabilities are obtained using the forecasted benefits, cost estimation and two other numerical variables as input. The transition probability matrix is devised based on the memoryless property of stochastic processes, whereby the conditional probability distribution of the future state of a process depends only on its current state. The output of this technique provides a high-risk analysis of the current Digital Business Case, indicating whether or not the Business Case will have the expected economic evaluation.

The final step in the theoretical model was the decision-making process for making a final decision about potential investment in a project, based on the outputs provided by the remaining methods. Investing in any project requires significant capital and incurs associated costs throughout its economic life. It is usually possible to achieve the same result in a variety of ways, and there are numerous examples of engineering systems with great physical design but little economic value. This final step provides the decision on whether or not to proceed with the project. The outcome of this step focuses on the goals that should be achieved during and at the end of the project. The final decision will be made based on data and the available information. Unforeseen risks and overcoming scenarios should

be considered. The final decision should establish a realistic project implementation process that is easily understood.

In terms of theoretical model validation, the Delphi method proved to be highly relevant and capable of providing considerable added value. Indeed, the purpose of the Delphi method is to validate theoretical models based on a panel of experts. It is important to note that this validation is theoretical rather than experimental, since the model developed in this thesis is also theoretical. Three rounds of iterations were defined for validation purposes. Depending on the complexity of the topic and the content provided by the panel of experts, this number could be considerably higher. In the thesis presented here, however, only three rounds were sufficient to validate the model. For instance, the contribution of the experts allowed a new step/method to be created in the theoretical model (Decision-Making), which was fundamental to the final evaluation of a digital evaluation proposal. This proposal used techniques that could be integrated into the final decision-making process. The results obtained from the three rounds of iteration can be considered a success. Although the Delphi method presupposes a questionnaire, this validation process took a simpler approach: a question combined with a scorecard to extract the expert panel's potential knowledge. This considerably increased the probability of improving model efficiency. On the one hand, the expert panel responds to a specific need, but on the other hand, it provides in-depth knowledge in the form of several proposals that have a significant positive impact on model development and subsequent validation.

In answer to the main question, a detailed analysis of the current methods of the business model was performed through 29 written interviews with decision-makers and relevant stakeholders, in addition to an analysis of the most recent literature review. The main conclusion is that a digital Business Case for project evaluation is a valuable framework that can certainly adapt to changing times, enhancing the value creation of projects and enabling organisations to capitalise on new market opportunities arising from digital transformation. Applying scientific management principles guarantees the feasibility of each step-in project evaluation by merging social science with scientific knowledge.

This thesis aimed to develop a theoretical model for evaluating digital projects based on a Business Case. The proposed contributions enable a traditional workflow and framework to be updated in line with current trends in digital projects. The model includes a problem/opportunity statement and strategic alignment between the different steps to guarantee the sustainability of the workflow. It also includes an initial project request, which should provide an initial explanation of the project. Implementing the digital Business Case requires user research and engagement throughout its development.

Thus, the assumption is clear: scientific developments provide a more comprehensive view due to their ability to process information in a repetitive, predictable and rigorous manner, as well as

increasing the efficiency with which projects are evaluated. It is important to note that the Business Case should be based on data rather than assumptions. This thesis demonstrates a critical lesson obtained using these new developments. The lesson is that changes implemented in a project evaluation method using the scientific management philosophy will effectively improve the Business Case if all processes in each step are aligned with the entire project evaluation and are complementary at each stage. Therefore, the aim of this theoretical model with its five steps is to provide a comprehensive model that incorporates the scientific method and adds value to current and future digital evaluation projects.

In conclusion, the proposed theoretical model, which is based on a scientific management approach, has improved operational efficiency, reinforced strategic coherence and organisational resilience, and created sustained competitive advantage and continuous value for stakeholders.

8.1. Research Contributions

This research made several contributions to an academic level.

A) The first contribution was to strategic agility. In fact, the main definition and objective of this concept was put into practice by the environment created by the pandemic, which provided an opportunity to test the methodology behind strategic agility. The proposed theoretical model responds to these changes by merging scientific management terminology with the social sciences, thereby creating considerable value and promoting sustainability in uncertain scenarios, exceptional conditions and emerging markets.

B) Digital projects require different metrics for understanding problems, estimating benefits and calculating costs. The developed theoretical model, the Digital Business Case, will fulfil this gap and enhance the current scientific methodology for evaluating digital projects.

C) The advantage of merging the scientific method with the social sciences is that it introduces statistical models to overcome current trends using a social approach. This can provide multiple scenarios for decision-making, rather than using simplistic evaluation methods such as ROI, cost-benefit analysis and payback period.

D) The capability to have a reliable project evaluation metric in place before the project begins, rather than at different stages of project planning and implementation.

E) The development and adaptation of the digital concept to a common Business Case is a considerable achievement and a relevant step in updating the current concepts usually applied to Business Cases, such as cost-benefit analysis. It also involves creating a completely new project evaluation structure that combines several different methods and techniques into a single workflow.

F) Finally, this work makes a considerable contribution to academia and organisations, as it addresses a gap that is currently affecting both the academic world and organisations, where correct initial project evaluation is crucial for success. The lack of relevant methodology to address the increase in digital projects may lead to serious constraints.

G) The first empirical contribution of the theoretical model was to provide a clear structure for the project's goals and objectives. This will be achieved by creating an initial project assessment using a problem-solving technique, and by identifying the main benefits of project development.

H) The second empirical contribution was supported by the 5 modules and techniques applied, which provide consistent output based on the multiple scenarios created. This makes it possible to access the value created by the project for an organisation.

8.2. Future Research

In terms of future research, this study could benefit from a more extensive literature review incorporating additional databases such as Web of Science (although most of the journals are included in the Scopus database), Dimensions (considered by Singh *et al.*, (2021) to be the most exhaustive), Lens or PubMed. A very interesting analysis could be conducted on the actual dataset if it were segmented into 10-year periods. This would allow the evolution, applications, trends and concepts associated with the Business Case to be traced. Another important topic would be to segment the principal areas of publication every 10 years. Although the Business Case is a highly heterogeneous topic applied to several cross-disciplinary areas, highlighting the major areas of incidence in the thesis could add considerable value to the literature review. In the future, the use of natural language processing could add value when analysing the entire dataset and validating the effective relationship between the content of each paper and the Business Case in terms of area of application and keywords. Finally, it would be interesting to analyse and measure the real contribution and effectiveness of the Business Case in projects oriented towards digital transformation.

Another aspect to consider is developing a digital structure to accommodate the three elements of the Business Case: existence, monitoring and tracking. As described during the evaluation, the first element can be based on the proposed theoretical model, although the last two elements need to be updated using the principles of scientific management in order to complete the overall lifecycle of a Business Case and respond to DT projects from initial evaluation to final project delivery.

Due to current market demand, scientific developments and digital transformation, the theoretical model is predicted to include two new steps: Decision Analysis and Cost Effectiveness Analysis, as well as a Times Series Forecasting System based on the exponential moving average. These

two new steps aim to increase value creation and project evaluation, as well as supporting the decision-making process, since their output will contribute to measuring conditions of uncertainty and addressing potential trade-offs in terms of added costs. They will also enable the creation of models based on historical analysis, which can then be used to inform future strategic decision-making.

8.3. Limitations of the Study

The main limitation of this thesis was that the theoretical model could not be tested in a real-life scenario. Although an expert panel validated the theoretical model, it was not possible to apply it to a digital evaluation project. Clearly, testing the model would generate empirical research based on observed and measurable phenomena, adding considerable value by deriving knowledge from actual experience rather than theory or belief.

Three limitations were identified during the interviews. The first was the time it took some interviewees to reply; some of them had to be reminded. Although email interviews are considered advantageous, responses depend on the interviewee's mood, which can change from one day to the next, as well as on their availability. Another limitation was that the author took everything that came up in the questionnaire as true without asking for evidence or artefacts to confirm the replies. The third limitation was related to the sample. Although the target number was reached, the objective of collecting information from top managers at the Big 4 was not accomplished.

The questionnaire was designed to include closed questions, which would facilitate comparison of the answers and allow for a quicker response. However, in some cases, the answers were difficult to interpret, which limited the scope of the statistical analysis.

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APPENDICES

Appendix A – Written interview second part

Question	Reply options
1.1 - Please indicate your role in your current Organization	Top Management: C-Level
	Management-Intermediate Level
	Operational-Technical Level
1.2 - Please select below the industry according to the CAE-Rev.3 where you perform your role	Accommodation, catering and similar
	Administrative activities and support services
	Agriculture, animal production, hunting, forestry and fishing
	Artistic, entertainment, sporting and recreational
	Collection, treatment and distribution of water; sanitation, waste management and depollution
	Construction
	Consulting, scientific, technical and similar activities
	Education
	Electricity, gas, steam, hot and cold water and cold air
	Extractive Industries
	Financial and insurance activities
	Human health activities and social support
	Information and communication activities
	Manufacturing Industries
	Other service activities
	Public Administration and Defense; Mandatory Social Security
	Real Estate Activities
	Transport and Storage
	Wholesale and retail trade; vehicle repair cars and motorcycles
1.3 Please Indicate for how many years you have been involved in digital evaluation project	<1
	1-2
	2-3
	3-4
	>5
1.4 - Please Indicate for how many years you have been involved in the elaboration of a digital project?	<1
	1-2
	2-3
	3-4
	>5

Appendix B – Written interview third part

Question	Reply options
2.1 – Which are the main techniques from Problem-Solving that you apply for digital evaluation project?	Creative Problem Solving
	Fishbone Diagram
	Root Cause Analysis

	Five Why's
	Layout generation problem
	Pereira Problem Solving
	Problem Definition Process
	Six Thinking Hats
	Lightning Decision Jam
2.2 - Which are the main problems or difficulties of Problem-Solving in the evaluation process of a digital project?	Open question
3.1 - Which are the main criteria of Strategic alignment that you apply for digital evaluation project?	It is not rated
	It is evaluated according to the request source
	It is evaluated by the top management perception
	It is evaluated by a voting process
	It is evaluated by a scoring model
	It is evaluated by an analytic hierarchy process
	Other
3.2 (Which are the main problems or difficulties of Strategic Alignment in the evaluation process of a digital project?	Open question
4.1 – Which are the main techniques from Benefits Estimation that you apply for digital evaluation project?	Expert judgment
	Focus group
	Market Research
	Trend Analysis
	Regression Analysis
	The Gap Analysis
	Interviews
	Benchmarking
	Observation
	Surveys
	Monte Carlo Simulation
	Other
	I do not apply
4.2 - Which are the main problems or difficulties of Benefits Estimation in the evaluation process of a digital project?	Open question
5.1 - Which are the main techniques from Cost Estimation that you apply for digital evaluation project?	Expert Judgment
	Estimation by Analogy
	Bottom - Up Approach (sum of micro estimates)
	Independent estimation
	Parametric Estimation
	Performing independent estimates
	By creating scenarios
	Via Monte Carlo Simulation
	Asking other party to review it
	It is not rated
	Other
5.2 - Which are the main problems or difficulties of Cost Estimation in the evaluation process of a digital project?	Open question

6.1 - Which are the main techniques from Economic Evaluation that you apply for digital evaluation project?	No index is used
	Payback
	NPV
	BCR
	ROI
	IRR
	Breakeven
	Other
6.2 - Which are the main problems or difficulties of Economic Evaluation in the evaluation process of a digital project	Open question
7.1 - Which are the main techniques from Organisation Readiness Analysis that you apply for digital evaluation project?	Empiricism
	Force Field Analysis
	Stakeholder Analysis
	Cost/Benefit Matrix
	Scenario Analysis
	Other
7.2 - Which are the main problems or difficulties of Organisation Readiness Analysis in the evaluation process of a digital project?	Open question
8.1 - Which are the main techniques from Sensitivity analysis that you apply for digital evaluation project?	I do not know any method of sensitivity analysis
	Deltas Logs
	Betas Sector
	Beta Triangular Distributions
	Monte Carlo Simulation
	Other
8.2 - Which are the main problems or difficulties of Sensitivity Analysis in the evaluation process of a digital project?	Open question