NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

EDUARDO MENDES VENTURA

BSc in Sciences of Industrial Engineering and Management

ASSESSING THE TANGIBLE AND INTANGIBLE IMPACTS OF EMPLOYEE CENTERED RETAIL INNOVATION

INTEGRATED MASTER IN INDUSTRIAL ENGINEERING AND MANAGEMENT

NOVA University Lisbon

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INTEGRATED MASTER IN INDUSTRIAL ENGINEERING AND MANAGEMENT

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Assessing the Tangible and Intangible Impacts of Employee Centered Retail Innovation

To my family, that always believed and keeps believing in me.

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To all my friends who were part of this stage of my life, whether they were from university, Erasmus, past internships, housemates, or long-time friends.

Lastly, to my family. To my mother, my father, my sister, my two grandmothers, my two grandfathers, my uncle, and of course, my dog.

“E se corre bem?” (Rúben Amorim).

ABSTRACT

In a world where technological advancements occur at an exponential rate, innovation is no longer optional but has become essential for the survival and growth of companies. This dissertation aims to holistically explore the impact of implementing an employee centered innovation in the retail sector. Extending beyond financial aspects, it prioritises intangible factors such as employee satisfaction and corporate social responsibility.

The research methodology follows a mixed approach, integrating cost-benefit analysis to quantify tangible financial impacts, along with Likert scale-based questionnaires to assess intangible benefits like employee satisfaction. This holistic perspective led to the creation of an innovative framework, which served as the basis for the empirical part of the dissertation, combining the key elements of cost-benefit analysis with Design Thinking models.

This dissertation, conducted in collaboration with Jerónimo Martins, a major company in the food retail sector, presents a tangible and intangible assessment of the KIWI application, a digital innovation designed to improve operational efficiency and the quality of life for employees in Pingo Doce stores. The results indicate that the KIWI application generates positive financial returns within 25 months and achieves a 99% return over a seven-year period. Furthermore, it contributes to a significant increase in employee satisfaction, fostering greater efficiency and engagement in the workplace.

The conclusions offer valuable insights for decision-making regarding KIWI's future and provide a solid foundation for evaluating future innovative products, with a particular focus on employee satisfaction, sustainability, and social responsibility.

Keywords: Innovation, Retail, Employee Satisfaction, Cost-Benefit Analysis, KIWI

RESUMO

Num mundo em que os avanços tecnológicos ocorrem a um ritmo exponencial, a inovação deixou de ser opcional, tornando-se necessária para a sobrevivência e crescimento das empresas. A presente dissertação tem como objetivo explorar de forma holística, o impacto da implementação de uma inovação no setor do retalho, centrada no colaborador. Indo para além de aspetos financeiros, será dada primazia a aspetos intangíveis como a satisfação do colaborador e responsabilidade social corporativa.

A metodologia de investigação segue uma abordagem mista, integrando uma análise custo-benefício para quantificar os impactos financeiros tangíveis, juntamente com questionários baseados numa escala de Likert para avaliar os benefícios intangíveis, como a satisfação dos colaboradores. Esta visão holística motivou a criação de uma Framework inovadora, que serviu de base para a parte empírica da dissertação, integrando os principais aspetos de uma análise custo-benefício com a ideologia dos modelos de Design Thinking.

Esta dissertação, realizada em colaboração com a Jerónimo Martins, uma grande empresa do setor de retalho alimentar, apresenta uma avaliação tangível e intangível da aplicação KIWI, uma inovação digital concebida para melhorar a eficiência operacional e a qualidade de vida dos colaboradores nas lojas da cadeia Pingo Doce. Os resultados mostram que a aplicação KIWI gera retornos financeiros positivos em 25 meses e um retorno de 99% num prazo de sete anos. Além disso, contribui para um aumento significativo da satisfação dos colaboradores, promovendo uma maior eficiência e envolvimento no local de trabalho.

As conclusões oferecem informações valiosas para a tomada de decisões sobre o futuro da KIWI e proporcionam uma base sólida para a avaliação de produtos inovadores no futuro, com foco especial na satisfação do colaborador, sustentabilidade e responsabilidade social.

Palavras chave: Inovação, Retalho, Satisfação de Colaborador, Análise Custo-Benefício, KIWI

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ACRONYMS

AI	Artificial Intelligence
BCG	Boston Consulting Group
CBA	Cost-Benefit Analysis
CAPEX	Capital Expenditures
DD	Double Diamond
DT	Design Thinking
FTE	Full-Time Equivalent
IPAF	Iterative Product Assessment Framework
IoT	Internet of Things
JM	Jerónimo Martins
NPV	Net Present Value
NESTA	National Endowment for Science, Technology and the Arts
OPEX	Operational Expenditures
PBP	Payback Period
ROI	Return on Investment
TD	Triple Diamond
UNEP	United Nations Environment Programme

1 INTRODUCTION

The urgency of innovation, which in simple terms implies introducing something new or making changes to something already established [1], has been particularly pronounced across various industries, further amplified recently by the rapid rise of digital technology [2]. The expression "Innovate or die," attributed to Peter Drucker, clearly reflects the current situation faced by companies today, as the shift to digital technology (encompassing cloud computing, mobile, Internet of Things (IoT), data analytics, DevOps, and artificial intelligence and machine learning) has drastically transformed the way businesses operate, fostering a strong desire to be agile and continuously seek ways to leverage technology for business improvement [2].

1.1 Relevance of the Topic

This boom in innovation and technological development is transforming the way people live and work. It is the responsibility of leaders and managers to continuously evaluate emerging solutions to ensure a successful future in an era where the transformation of the present is constant [3]. And, if they fail to do so, they risk becoming an example of the expression mentioned in the previous paragraph ("Innovate or die"). Blockbuster Entertainment Inc. (video game and home movie rental service provider) and Toys "R" Us are two prominent examples of this. Their insistence on maintaining a physical store presence, coupled with a refusal to invest in digital platforms, led to the decline of their once-successful businesses. These companies clearly exemplify the notion that reluctance to innovate can crush a business [4].

More specifically, the retail industry has experienced a growing trend in the adoption of new technologies over the past decade, primarily driven by digitalization. In a report from April 2024 about "The Innovation edge for retailers", BCG (Boston Consulting Group) states that the change in consumer habits and preferences is resulting in the need for more innovation by retailers, and at a fast pace [5]. According to a recent research conducted by BCG and the World Retail Congress, retailers with industry-leading innovation practices outperform their competitors by a significant margin [5].

Furthermore, the development of digital solutions with a focus on **sustainability** and **social responsibility**, understood as the integration of good social, environmental, and labour practices into a company's daily operations [6], is becoming increasingly important [7]. The

United Nations Environment Programme (UNEP) advocates for the use of digital technologies to ensure a sustainable future, asserting that by following this path, it will be possible to address environmental challenges, ensure the well-being of the planet, and mitigate climate change [8].

1.2 Motivation and Expected Contribution

Monitoring the performance of innovation, both socially and financially, is as important as investing in it. This dissertation explores how the implementation of an employee centered innovation in the retail sector can be assessed comprehensively. Beyond financial metrics, it examines the intangible benefits, particularly employee satisfaction. This is significant because empowered retail employees, whose primary role is customer service, are a key differentiator among competitors. Additionally, companies are increasingly committed to creating positive social impacts, aligning with corporate social responsibility.

The focus on employee centered innovation remains underexplored in the current literature, presenting a valuable opportunity to expand knowledge in this area. The novelty of this dissertation is its emphasis on employee satisfaction, particularly for those directly serving customers, without neglecting other key factors such as financial performance and operational efficiency. While employee satisfaction is crucial, especially in the service sector, the study also provides insights applicable across industries aiming to enhance customer experience and overall business outcomes.

Additionally, the dissertation includes a Case Study developed in collaboration with Jerónimo Martins, which evaluates the tangible and intangible benefits of implementing an innovative application, named KIWI, in Pingo Doce stores. The study focuses on how store employees perceive the application, both generally and in relation to specific functionalities.

The contribution of this dissertation is to underscore the significance of an innovation in enhancing employee satisfaction within the retail sector.

1.3 Research Questions

In order to promote a cohesive and focused dissertation, it is crucial to define from the outset the research questions that drive this study. Thus, a set of general questions was defined to provide a broad theoretical context, allowing the study to explore the larger implications of innovation, employee satisfaction, sustainability, and social responsibility. Those questions are the following:

- **What evaluation framework could be used to assess the impact of an employee centered retail innovation, considering both tangible and intangible factors?**
    - How can a retail innovation impact employee satisfaction?
    - What metrics and methods can be used to measure the impact of retail innovation on employee satisfaction?

- **How does the implementation of an employee centered innovation in the retail sector affect corporate sustainability goals and social responsibility?**

In order to deeply understand the proposed research questions, an empirical Case Study is presented. It approaches the tangible and intangible impacts from the implementation of an innovation in the retail sector, more specifically at Jerónimo Martins (JM), with the innovative application called KIWI, directed to employees. These questions are closely aligned with the practical aspects of the project and facilitate a concrete evaluation of the innovation's performance within the company, providing both a theoretical grounding and practical relevance. Thus, the two following questions were considered:

- **What is the Payback Period and Return on Investment of an employee centered retail innovation called KIWI, for a single store?**
- **How satisfied are retail sector employees with the implementation of the KIWI application and its functionalities?**

These research questions provide a comprehensive framework for the dissertation, balancing both theoretical exploration and practical application. The general questions set the stage for understanding the broader implications of innovation, while the specific questions focus on evaluating the tangible and intangible outcomes of the KIWI application in the real world. **This dual approach ensures that the study contributes meaningfully to both academic theory and business practice**.

1.4 Research Methodology

The methodology employed in this study integrates both theoretical research and empirical analysis to comprehensively assess the impact of employee-centred retail innovation. The research adopts a mixed-methods approach, combining both quantitative and qualitative data to provide a holistic view of the innovation's effects. The theoretical foundation is built on core concepts such as cost-benefit analysis (CBA), employee satisfaction, and design thinking. These frameworks guide the development of an evaluation model that addresses both the tangible and intangible impacts of the KIWI application.

For the intangible aspects, particularly employee satisfaction, Likert-scale questionnaires were developed to capture detailed feedback from employees about their experiences with the KIWI application. These surveys measured various aspects, including ease of use, perceived usefulness, and overall satisfaction. The collected responses were analysed using statistical tools, specifically JASP, to conduct reliability tests such as Cronbach's alpha, ensuring the consistency and validity of the survey results. Descriptive statistics, normality checks, and comparative analyses were then performed to examine employee satisfaction across different stores, focusing on differences between those with and without KIWI. This analysis provided valuable insights into how the innovation affected employee engagement, motivation, and productivity.

To assess the tangible, financial impacts of the KIWI application, a detailed cost-benefit analysis (CBA) was conducted. This analysis focuses on key financial metrics including net present value (NPV), return on investment (ROI), and payback period (PBP). These indicators were calculated using data from the company's records, which provided insight into the costs associated with the implementation and the resulting benefits. The CBA considered both capital expenditures (CAPEX) and operational expenditures (OPEX), with particular attention given to operational efficiencies, labour cost savings, and the longer-term financial impact of the innovation. In addition, scenario analyses were employed to test the robustness of the financial outcomes under different assumptions and environmental factors, providing a comprehensive financial assessment of KIWI's value.

This study's methodology was also guided by the principles of design thinking, allowing for an iterative and flexible approach throughout the research process. The use of feedback loops and continuous refinement ensured that the evaluation framework remained aligned with both theoretical insights and real-world data. By combining the financial rigour of cost-benefit analysis with the nuanced understanding of employee satisfaction, this methodology offers a comprehensive and balanced assessment of the KIWI application, providing a deeper understanding of the multifaceted impact of employee-centred innovation in the retail sector.

1.5 Dissertation Structure

To clearly outline the organization throughout the document, the following list presents each chapter along with a summary of its content:

CHAPTER 1 - INTRODUCTION

This chapter outlines the objectives of the dissertation, and the research questions it aims to address, as well as the context and relevance of the chosen topic. It also covers the motivation behind the study, the research methodology, and limitations. Additionally, it includes the current section on the structure of the dissertation, which aims to inform the reader about how the topics are organized and presented throughout the document.

CHAPTER 2 - DIGITAL AGE AND INNOVATION

The first chapter of the literature review explores different facets of innovation, starting with a broad overview before focusing on its application in the retail sector and the current state of key technologies in this field. It combines theoretical concepts with real-world case studies, drawing on insights from recent research. The chapter concludes with an introduction to Design Thinking, a concept closely linked to innovation that inspires the practical component of this study.

CHAPTER 3 - A FRAMEWORK TO ASSESS INNOVATION IMPACT

This chapter advances the literature review by merging theoretical and practical aspects relevant to the dissertation. It begins with an overview of cost-benefit analysis (CBA), detailing its traditional phases and its use in economic and financial evaluations. The focus then shifts to the significance of employee satisfaction, emphasizing the need to incorporate intangible factors into these assessments. Finally, the chapter presents a novel framework developed by the author, integrating Design Thinking and CBA for a holistic product evaluation.

CHAPTER 4 - CASE STUDY: KIWI APPLICATION VALUE ASSESSMENT

In this chapter, the entire Case Study designed to address the research questions and achieve the proposed objectives is explored in detail. The chapter follows the traditional Case Study structure, including context, methodology, analysis, results, and discussion. The primary focus is on developing and analysing KIWI satisfaction surveys and evaluating the application's financial performance. The approach to the project described in this Case Study was driven by the Framework outlined in the previous chapter.

CHAPTER 5 - CONCLUSIONS

This chapter provides the final considerations of the dissertation, including a detailed analysis of its functions and conclusions. It reflects on the limitations of the employed methodology, offers suggestions for future research, and presents a critical interpretation of the study as a whole.

2 DIGITAL AGE AND INNOVATION

The digital era has revolutionized industries, driving innovation to the forefront of business strategy. This chapter explores the concept of innovation, tracing its evolution and examining its implications within the retail sector. By connecting theoretical foundations with real-world applications, it lays the groundwork for understanding the role of technology and design thinking in shaping innovative solutions.

2.1 The concept of Innovation

Innovation is inherently interdisciplinary, often examined through the lenses of economics and management. It encompasses not only the creation of new products and the commercialization of inventions but also humanitarian, social, and institutional changes [9].

In [10], the author clearly distinguishes between innovation and invention, stating that the former can be seen as a derivation of the latter. Invention involves creating new products or processes with potential industrial applications, though many do not impact production or markets. Innovation, however, is a social phenomenon occurring when an invention significantly affects production and markets, transforming scientific and technological knowledge into economic wealth, social well-being, and human development.

A clear definition of innovation is given by Everett Rogers in [11], where he states that "an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption". The different speed at which an innovation spreads is a subject of Rogers' study and will be addressed later in this literature review.

Furthermore, it can be useful to Introduce the topic disruptive innovation early on. Defined by Harvard Business School professor Clayton Christensen in the early 1990s [12], disruptive innovation is defined as a process where a smaller company with fewer resources successfully challenges established incumbent businesses [13]. However, according to article [14] this term is often misunderstood and misapplied. In the same sense, the author of [15] argues that disruptive innovation has been overgeneralized, confusing business model innovation and radical product innovation, emphasising that business model innovation, like Amazon's redefinition of book selling, and radical product innovation, such as personal computers, are distinct phenomena requiring different management approaches.

In 2022, McKinsey & Company published an article titled "What is Innovation" [16], stating that innovation is crucial for substantial net new growth and economic profit. The article asserts that companies excelling in innovation tend to significantly outperform their competitors.

In a survey aimed at assessing the proficiency level of 183 companies concerning innovation, it was concluded that companies utilising essential elements of innovation achieve a substantial performance advantage. **Mastering innovation can result in profits 2.4 times greater** compared to other competitors [16]. According to the same article, successful innovation has historically derived from a union of various elements, with the three most important being the "who," the "what," and the "how".

Firstly, the "who" is related to an unmet customer need, where it is necessary to define who the consumer is and what problems they want to see resolved. Secondly, the "what" pertains to the solution, requiring consideration of whether it is convincing and can indeed be executed. Lastly, the "how" is associated with the challenge of creating a business model that allows value creation with the defined solution, specifically considering how the solution can be monetised [16].

2.1.1 Innovation Adoption Phases: from Innovators to Laggards

Once the topic of innovation has been introduced, it is important to focus now the attention on the various perspectives regarding innovation. Product diffusion and adoption are crucial for understanding how different consumer segments respond to new innovations in products and services as various categories of consumers begin to explore and adopt the novel solution when it emerges [17].

Rogers' [11] seminal theory of the diffusion of innovations examines how users within an organization accept and integrate new innovations into their practices. In the same article he states that the four main elements in the diffusion of new ideas are not only innovation, but also communication channels, time and the social system. A key aspect of his theory is addressing the uncertainties that individuals face when considering replacing existing designs with new alternatives [17]. Rogers classified adopters into distinct categories based on their likelihood to embrace innovations.

In Figure 2.1, a graphical representation of the product adoption curve is shown, an important object derived from the theory of diffusion of innovations.

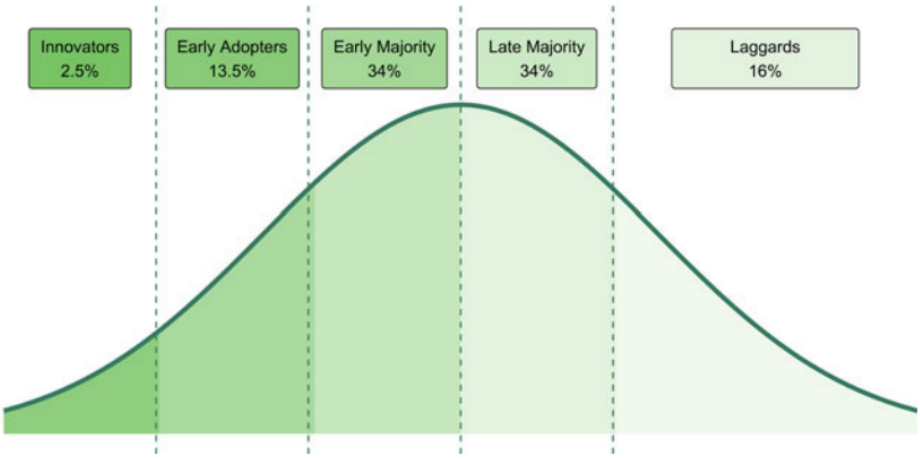

Figure 2.1 - Product adoption curve [18]

Innovators represent the first 2.5% of individuals in each system to adopt a particular innovation. The interests and new ideas of members of this group make them more likely to build relationships with a wide range of individuals, including those outside their immediate community, rather than just their immediate, familiar surroundings [11]. In [19, p. 1] it is stated that Innovators tend to be risk-takers and are often well-educated with higher socioeconomic status, introducing the innovation to the broader social system and facilitating the early diffusion process.

Next are the early adopters, who make up 13.5%. Members of this category are those with the highest degree of opinion leadership within each system. Typically, it is to this group that potential adopters turn for advice or information about a given innovation [11].

Representing a total of 68% of the system are the early majority and late majority groups, each with equal weight. Finally, the last to adopt a given innovation are the laggards, who represent 16% of the system. Members of this group only accept a new idea after their peers have not only adopted it but also shown satisfaction with it [11]. It can be considered that the last two groups in the represented graph (late majority and laggards) are sceptical and conservative towards new ideas [20].

The article [18] presents a study focused on the linguistic innovation of the -ene plural forms in Swiss German, with the aim of investigating how personality traits influence the adoption of linguistic innovations, specifically concentrating on the diffusion of the -ene plural forms in Swiss German. A large and balanced sample (n = 1000) was used. The study concluded that there is indeed a relationship between certain personality traits and the stance taken towards innovation, in this case, the adoption of new linguistic forms. It was found that conscientiousness is negatively correlated with adopting the -ene plural forms, meaning that individuals with lower conscientiousness adopted new forms earlier. In contrast, extraversion is positively correlated with adopting the -ene plural forms, indicating that more extraverted individuals adopted new forms earlier.

2.1.2 Digital Transformation for Sustainability and Social Responsibility

Firstly, in this segment, it is important to clarify that although they are often considered synonymous, the concept of digital transformation goes beyond that of digitalization [21]. It can be considered that the latter involves the use of digital technologies to alter business operations, without being directly related to social aspects [21]. On the other hand, digital transformation is the comprehensive rewiring of an organization to create value by continuously deploying technology at scale, and it involves rethinking how an organization operates, integrates technology, and interacts with customers and stakeholders, reshaping processes, culture, and even business models [22].

In a study published by the European Central Bank in 2018 [23], conducted with 74 leading non-financial companies from the euro area (producers of goods and providers of services), the urgency for digital transformation was already evident, with the most prominent adoptions being Big Data and Cloud Computing, E-commerce, Artificial Intelligence, and the Internet of Things. From the same study, it is relevant to highlight that the vast majority of respondents (over 80%) expected digitalization to positively affect their sales over the next three years, and almost all companies saw digitalization as a means to boost productivity.

Indeed, the need for digital transformation within companies has increasingly proven to be essential. In this context, according to a Forbes article published in 2024 [17], digital transformation is a priority for CPG (consumer packaged goods) manufacturers and retailers, with an expected investment of $24 billion in this area by 2030.

However, the need for digitalization and digital transformation extends beyond purely economic and business concerns. The European Digital SME Alliance emphasizes the urgency for a sustainable digital transformation, advocating for a process that involves digitalizing the economy in a long-lasting, green, and organic way [24]. Along the same lines, the article [25] published by EY argues that digital transformation supports sustainability by enhancing ESG (Environmental, Social, and Governance) integration through technologies like AI, big data, and blockchain, which leads to improved ESG data management, transparency, and long-term investment decisions. The article also highlights that 80% of ESG-compliant stock indexes outperformed non-compliant ones during the pandemic, and firms in industries like finance are increasingly adopting digital tools to promote green credit and renewable energy investments, thereby driving both competitive advantages and sustainability outcomes.

Finally, the article [26] demonstrates that digital transformation plays a crucial role in driving sustainability and corporate social responsibility by improving efficiency, reducing waste, and creating innovative business models. In fact, it is reported that digital technologies like IoT and AI help companies monitor and reduce their carbon footprint. This segment clearly justifies the impact that an application like KIWI can have when properly implemented in a company, in terms of sustainability and social responsibility, which is essential for promoting a better world.

2.2 Innovation and Digitalization in the Retail Sector

Once the themes of innovation and digitalization have been contextualised as a whole, it is time to narrow the concepts to the retail sector. This focus is necessary as the primary subject of the current study fits within the context described, having emerged from an attempt to innovate within a food retail environment.

Stated in the same report introduced in the first chapter [5], BCG carried out a survey of more than 400 executives (n = 436) from several retail sectors, from which resulted some insightful information about the relationship between the investment in innovation by a company and the ROI achieved.

It was possible to conclude that innovation leaders invest an average of 13% annual revenue innovation, achieving a 21% ROI, while retail laggards (companies that increased innovation spending at least 20% from 2021 to 2024) invest, on average, 3% of revenue in innovation earning a ROI of only 9% [5]. The results obtained are displayed more in detail in Figure 2.2.

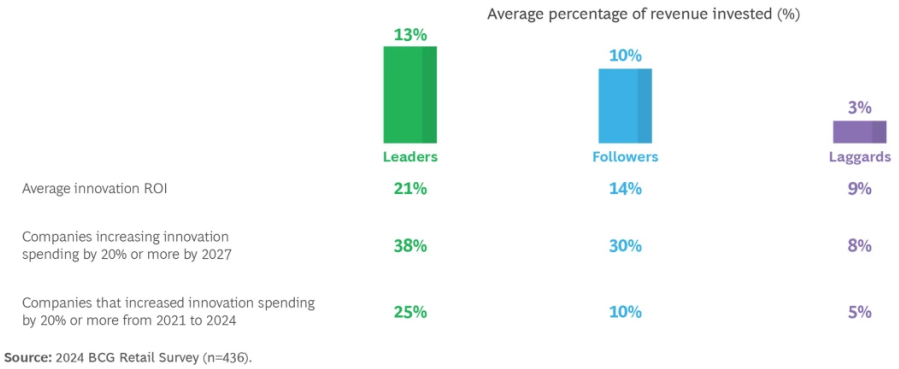

Figure 2.2 - ROI vs investment in innovation [5]

The sense of urgency for Innovation is supported by the fact that in the next three years, both leaders and laggards expect to increase the investment in innovation, the first ones by 38% and the last ones by 8% [5].

The report also revealed that innovation leaders are prioritising investments in three areas: operational improvements (71% of leaders); e-commerce (60%); and Big Data, AI and analytics (58%). The detailed results are displayed in Figure 2.3.

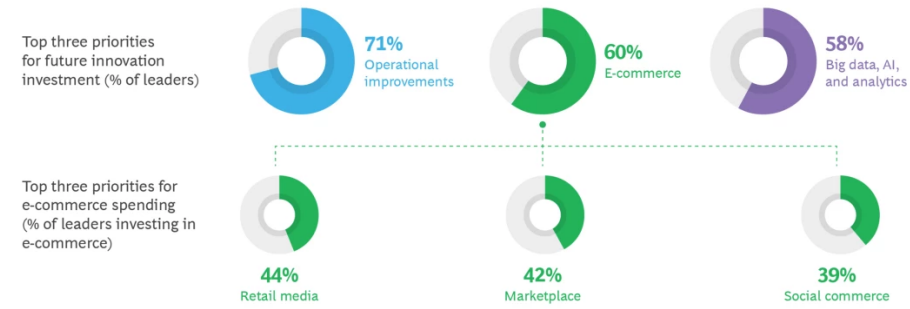

Figure 2.3 - Priorities for future investments in innovation [5]

2.2.1 Digital Solutions and Their Role in Retail Operational Efficiency

Among the various technologies that have marked the recent past in the sector under analysis are the Internet of Things (IoT) and Artificial Intelligence. These technologies are often used together [27], enabling significant levels of automation in different processes.

IoT technology, which is based on connecting physical objects to form an information network between objects and the cloud [28], is often used in the retail sector with the help of RFID technology, mainly to simplify the shopping process [29].

The retail industry also uses AI, which has had a big impact on various fields and enterprises. Specifically, machine learning and deep learning techniques are used to anticipate annual product demand [30].

Furthermore, several companies have started investigating the implementation of blockchain technology at various points along the supply chain, particularly in transaction processes and the tracing of commodities [31], in an attempt to improve the security and legality of these operations.

These three technologies are explored in greater detail in the following sections. The underlying concepts are clarified, and real-life examples of their potential applications in the retail sector are provided for each one.

2.2.1.1 IoT Applied to Retail Sector

Although the use of RFID technology in the retail sector through sensors has been explored for several years, it has been further boosted by the emergence of Covid-19 [32], with the aim of minimising human interaction throughout the purchasing process. The main motivation is the creation of "smart shopping trolleys", where there is the possibility of constant monitoring and control, and above all, the ability to carry out the checkout process autonomously, for example in a supermarket [32].

With the consolidation of this technology, it has been possible to build unstaffed supermarkets in different territories. One such example was in Sweden, but according to [33], it was necessary to deal with a major and expected downside of an unstaffed supermarket: the occurrence of theft by customers pretending to work for the chain in question. The author states that the use of surveillance cameras visible to customers made it possible to offset the damage that could arise from the possible offence identified.

Another example of the direct application of RFID technology is the case of one of Pingo Doce's most recent and innovative establishments, the restaurant at the Instituto Superior Técnico, in Lisbon [34]. At the beginning of the counter circuit, as in a traditional canteen, there are trays for customers to place the items they want to buy, the great novelty being that these trays are equipped with an RFID tag. The idea is to associate the customer's order with the tray so that payment, which is done autonomously, is less time-consuming [34].

Considering one of the main results of the application of RFID technology, "smart shopping carts", it is estimated that there are several adjacent advantages, both in terms of health and hygiene, as well as in terms of costs and operational efficiency. The aforementioned reduction in human interactions enhances security, while the absence of traditional cashiers leads to cost reductions and a less constrained shopping experience, eliminating the long queues typically encountered [32]. Furthermore, another factor comes into play: differentiation. In a world of constant innovation, there is a need for modernisation on the part of the various sectors and industries, and automating the purchasing process is something that will allow a brand to raise its competitive level and especially attract the younger generations and those eager for technology.

In short, RFID technology makes it possible to automate the entire shopping process, improving efficiency and the customer's shopping experience [29]. Also, IoT technology is now mature and inexpensive enough to lead companies to impressive results [35].

2.2.1.2 Artificial Intelligence in the Retail Sector

According to the article [36], there is a clear conflict between automation and employability. The author asks the following questions: "If machines can do our jobs, why are we still working? Will it stay that way in the future?". The fact is that the need and demand for automation using AI has been exponential, and that although there is an expected decrease in jobs available in some sectors, there is, on the other hand, an increase in the value of specialised positions [36]. There is no doubt that automation is going to cause huge changes in the labour market. However, this is a good thing, and human beings will have to find a way to adapt and find a healthy balance [36].

A real case of this reallocation of people due to machine adoption is presented by the KAIZEN Institute [37], which states that the McDonald's chain has sought to take advantage of free labour due to the introduction of automatic payment machines. As a result, part of the workforce has been reallocated to table service, a new activity perceived as differentiating by customers [37].

Also in the food retail sector, there are already concrete examples of AI being applied to various processes, such as the already mentioned autonomous checkout, stock control or even transport efficiency [38]. However, as this is an up-and-coming technology with countless untapped potentials, bolder approaches are sometimes taken.

This is what happened with an Australian supermarket chain, where a robot resembling a human being was built, with the aim of improving the shopping experience and also making it possible to analyse the interactions that customers would have with this Digital Human, called "Paula" [39]. After analysing the inputs collected, it was possible to conclude that some customers felt tense and anxious, or even judged by other customers or members of staff, because they felt they were not interacting correctly with "Paula". On the other hand, many considered that this is the type of technology that will change human buying habits, in a good way [39].

Another current example of the use of artificial intelligence in the retail sector is related to demand forecasting using deep leaning (DL) and machine learning (ML) methods [30]. To summarise, different artificial neural network (ANN) models are used, which are properly trained and tested using DL and ML for specific product categories, and based on demand information from previous years, as well as factors that may influence it [30]. After applying this model, optimisation is expected in the process of ordering from suppliers and better management of sales and marketing campaigns. According to [40], demand forecasting has shown great benefit from adopting an AI/ML-based strategy, which typically yields 50% more accuracy than older methods and tools.

This last topic is especially relevant as it is directly related to one of KIWI's application most relevant and disruptive functionalities. Production maps were something that appeared in the Pingo Doce's chain only with the advent of KIWI, and they make it possible to visualise in-store the quantities of each product to be produced, based on personalised forecast models for each store, section and product, an information provided by Pingo Doce's Innovation Department.

More recently, with the rapid rise of Generative AI in 2023, numerous companies, not just in the retail sector, have embraced this technology to enhance various areas, including customer service, marketing, and trend forecasting and analysis [41].

2.2.1.3 The Use of Blockchain in the Retail Sector

The agricultural sector has served as a platform for investigating the application of blockchain technology inside the food retail industry. This is because there is typically a lack of trust and transparency among the different supply chain (SC) elements, which makes information management challenging [42]. Furthermore, most traditional traceability systems are centralized, which makes it difficult for the retailer to get information about the numerous transactions involved. Having said that, integrating blockchain technology in a supply chain offers a platform for information sharing among all SC stakeholders, fostering transaction

security and transparency [43]. As a result, information flows from the producer to the customer swiftly and credibly, boosting competitiveness and improving traceability management [42].

In addition, this technology, which is crucial for strengthening cybersecurity in the retail sector [43], offers other benefits as well. Blockchain technology can store customer data, helping retailers analyse buying patterns and forecast demand. It also facilitates real-time evaluation of loyalty points, cashback offers, and personalized promotions [44]. Moreover, by enabling customers to verify product authenticity, blockchain can help combat counterfeiting, thereby boosting confidence in product quality [44].

IBM is one of the main players when it comes to providing blockchain solutions for supply chains. By using this technology, they claim to be able to optimise inventories with total visibility of the SC, since one of the major problems of a traditional SC in the retail sector is that manufacturers and distributors are not aware of real consumer demand, which translates into waste and inefficiency throughout the SC [45], the so called Bullwhip Effect. Furthermore, they point out that it is possible to increase the operational efficiency of the SC through digitalization, removing paper-based processes from the equation [45]. This last topic is especially relevant to this dissertation, since KIWI is a clear result of digitalization, and one of the main motivations behind its creation was to make in-store operations paperless.

2.3 Design Thinking as a Catalyst for Innovation

The objective of this subchapter is to introduce a key innovation framework, that is crucial for approaching processes from ideation to execution: Design Thinking (DT). Delving deeper into this topic, two different models are explored, the Double Diamond (DD) and Triple Diamond (TD) models, which consist of a series of phases involving the expansion and subsequent narrowing of scope during the innovation process.

It is essential to justify from the outset that the inclusion of these topics in this literature review is due to their significant influence on the empirical approach of the present study. There was a substantial need to understand and empathize with the main object of the Case Study (a significant component of field observation and collaboration with the product's users), as well as to undertake various iterations at different stages, involving a continuous expansion and narrowing of scope until reaching a final, coherent result.

2.3.1 Context of Design Thinking

The expression "Design Thinking" (DT) was popularised by Tim Brown, CEO of IDEO [46], however, the concept adjacent to the term in question began to be used several decades earlier. IDEO is an international design and innovation consultant [47] and was founded in 1991 as a merger between David Kelley Design, which created Apple Computer's first mouse in 1982, and ID Two, which designed the first laptop computer that same year [48].

There isn't necessarily an unanimous definition for the concept of DT [49], but in general, it consists of a human-centered innovation process that emphasises observation, collaboration, fast learning, visualisation of ideas, rapid concept prototyping, and concurrent business analysis [50]. In [48], Tim Brown highlights the strong correlation between DT and the ability of human beings to be intuitive and recognise patterns, in order to build ideas with emotional meaning as well as functional character.

The application of DT consists of five successive phases, each of which represents an essential step in the process and should not be abandoned in order to prioritize the next [51], which does not rule out the possibility of returning to earlier stages later on. On the contrary, it often encourages revisiting previous phases [52]. Figure 2.4 graphically illustrates the procedure on which this methodology is based, with an emphasis on the iterative component.

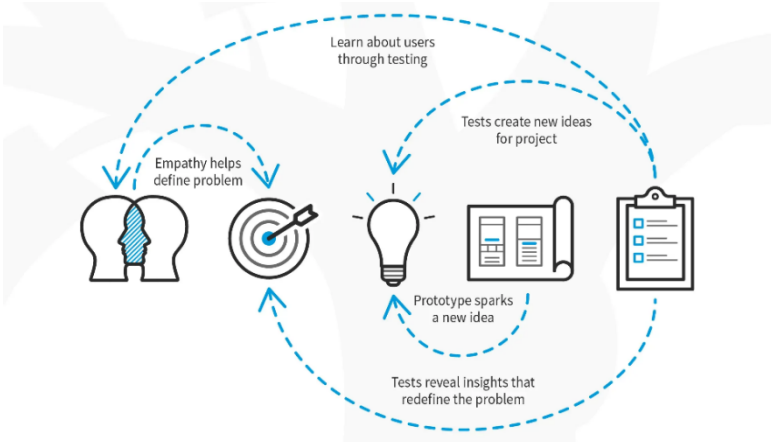

Figure 2.4 - Phases of Design Thinking [52]

Thus, the usual five stages of DT are, in sequential order, as follows: Empathize, Define, Ideate, Prototype, Test.

2.3.2 Double Diamond Model

Once the field of DT has been introduced, it is pertinent to explore the two models mentioned at the beginning of this subchapter. First, the Double Diamond (DD) model is presented, followed by an examination of the Triple Diamond (TD) model, as the latter represents an adaptation or, in some respects, a deepening of the former.

The DD model, created in 2005 by the British Design Council, is graphically based on a diagram with little complexity, where the divergent thinking and convergent thinking phases of design processes are represented, giving rise to a model in the shape of two diamonds [53], as can be seen in Figure 2.5.

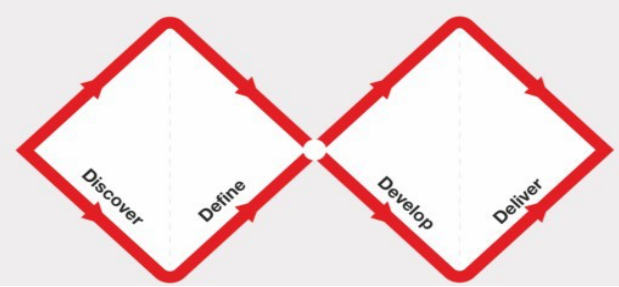

Figure 2.5 - Double diamond model [53]

The model is based on four consecutive phases: discover, define, develop, deliver. The first half of the first diamond concerns the phase in which the designer investigates new opportunities, markets and information, as well as new trends and insights [54]. Then, in the second half of the same diamond, there is a filtering stage, where the insights obtained are reviewed and consequently selected or discarded [54].

In the third stage of the model (the first half of the second diamond) it is expected that a wide range of design solutions will be generated, and different possibilities explored. Among the tools frequently used in this phase are sketching, brainstorming and prototyping [54]. The latter, which is very relevant and commonly used, represents the process of creating a preliminary version or model of a product or system that allows its design and functionality to be tested [55].

In the last quarter of the model (deliver phase) the final solutions are tested, resulting in the future rejection of those that don't work and the improvement of those that have shown positive results [53]. In the deliver phase, it is common to use visual resources such as high-fidelity prototypes, detailed design specifications, usability test results and user feedback. Once the concept behind the DD model has been fully explained, it is relevant to introduce a more detailed and slightly more complex framework.

2.3.3 Triple Diamond Model

The TD model was developed by NESTA (National Endowment for Science, Technology and the Arts) and is an adaptation of the DD model, previously created by the British Design Council [56]. Compared to the DD, it can be concluded that this more complete model, which consists of three diamonds instead of two, shows changes, especially in the initial phase of the process. In general, it can be assumed that a new diamond is introduced before the "Discover" phase [55]. Figure 2.6 shows the traditional process of the TD model.

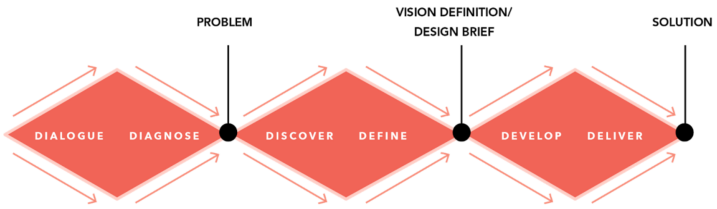

Figure 2.6 - Triple diamond model [57]

The new diamond already mentioned is divided, as was the case for both diamonds of the DD model, by a spontaneous and fluid approach (divergent thinking), represented in the previous figure by the "Dialogue" phase, followed by a more grounded, analytical and deductive approach (convergent thinking), represented by the "Diagnosis" phase [57]. This first diamond is associated with a period of problem discovery, and it is during the time dedicated to the two halves of the diamond (Dialogue and Diagnosis) that the possible problems, areas, themes and challenges to be faced will be explored [56].

In order to start a creative process in a robust way, the first stage of the process ("dialogue") should result in a number of possible problems to explore [56]. Subsequently, in order to reduce the scope in the "diagnosis" stage, various filtering techniques can be used, such as " The 5 Whys", one of the most common and effective techniques [57], and the "Is/Is not matrix" [56], another very useful tool that makes it possible to intuitively filter out the results that have been scrutinised, promoting the search for their root causes [58]. Once the two phases of the first diamond have been completed, the process progresses to the "discover" phase. From this point onwards, the path suggested by the model under analysis mirrors that of the Double Diamond model, which was explored in the previous subchapter.

To summarize, by incorporating iterative cycles of divergent and convergent thinking, the TD model not only supports continuous improvement but also encourages radical innovation, making it a critical tool for organizations aiming to stay competitive in a rapidly changing environment. The model's adaptability to different types of problems and its emphasis on a structured yet creative approach to innovation highlight its significance in the broader context of design thinking and process improvement [56]. It is relevant to retain the expression "structured yet creative approach," as it summarizes the approach employed in the current dissertation, a point that is further corroborated before the start of the practical section, in section 3.3.

This theoretical chapter focused on the theme of innovation. The aim was to provide a context for the current and recent past scenarios concerning the various fields related to innovation. The approach followed a narrowing methodology, moving from the general to the specific. However, it did not overly restrict the scope, seeking to avoid excessive specificity while consistently relating the study to the empirical part that follows.

Since the main subject of the dissertation is an employee centered application of a retail company, created and maintained daily by the company's Innovation Department, the chapter begins by providing a general context of what innovation is and how it should be leveraged

for success before defining the state of innovation within the retail context. From these topics, an irrefutable conclusion emerges: **companies must innovate in various areas if they wish to remain competitive in the market over the years**.

Subsequently, current trends in the main technologies used by companies to promote innovation were examined. It can be argued that among IoT, Blockchain, and AI, the latter has been particularly subject to advances and disruptive applications, with notably positive impacts and an exponential level of adoption, a pattern expected to continue in the near future [59].

Finally, still within the field of innovation but introduced to more strongly serve as a bridge to the practical section, the literature review on Design Thinking and two of its models led to the conclusion that **iteration is a key element for innovation**. This is particularly relevant given that KIWI itself is in a constant state of iteration, always seeking to meet user needs more efficiently. Furthermore, it served as a clear inspiration for the approach to the empirical part of the dissertation.

3 A Framework to Assess Innovation Impact

Just as was done for the subchapter "Design Thinking as a Catalyst for Innovation", it is essential to justify the inclusion of this theoretical chapter by relating it to the empirical part of the dissertation. To ensure coherence and organization, an effort was made to integrate the methodology associated with Design Thinking and its models/frameworks (which served as a reference from a social perspective and for approaching the various stages of the study) with a methodology that provides guidelines from a more technical standpoint, considering the economic and financial aspects of the project that are described in the Case Study.

In response to the proposed challenge, a detailed exploration of the cost-benefit framework was undertaken to understand, based on research and conducted studies, how to leverage it for evaluating a product or project from an economic/financial perspective. To this end, a structured overview of the general functioning of such frameworks is provided, including an overview of their traditional phases.

At a later stage in the chapter, the focus shifts back to a more social aspect: the importance of employee satisfaction with a product. This topic is particularly relevant as KIWI is an application intended for employees rather than end customers. Thus, it underscores the importance of considering social and intangible factors when conducting a CBA. It is also important to highlight that this segment includes a detailed exploration of an effective method for measuring employee satisfaction.

Finally, in the end of this theoretical chapter a novel theoretical framework is presented. This framework aims to offer an innovative approach to evaluating the value of a product or project. The creation of this framework was inspired by the other two frameworks under scrutiny (Design Thinking and cost-benefit), integrating key aspects of both into a single, holistic model to provide a more comprehensive evaluation of an innovative product.

3.1 The Cost-Benefit Analysis Approach

Before delving deeper into the subject of CBA, it is important to clarify an aspect that often causes some confusion among individuals. Frequently, the term ROI, return on investment (which is a key element of this study and it is explored in detail later) is confused with

the term CBA, the acronym for cost-benefit analysis [60]. In fact, ROI is an important tool for making informed investment decisions, but it is only one of the several methods that can be used to perform a CBA [61].

A CBA is a systematic approach that makes it possible to estimate the strengths and weaknesses of a project or alternative, with the ultimate aim of achieving benefits while keeping costs down. In other words, it is a strategy often used to estimate or evaluate the value of a decision or project in relation to its cost [62].

Being a tool commonly used while assessing the efficiency of activities, CBA´s also represent a choice to assess smart solutions. CBAs are considered to be the most suitable method for carrying out a ratio approach in decision-making processes [63]. The European Union, which views a CBA as a helpful analytical tool for evaluating investment decisions, has also determined that it is legitimate to utilize one when making decisions on a project's efficiency [63].

In a CBA, the most popular methods for estimating key performance indicators of a projection include discounting cash flows, figuring out the amortization period, and computing return rates [64].

3.1.1 Phases of a Cost-Benefit Analysis

3.1.1.1 The Framework Definition

The first step for an accurate CBA is generally to establish a framework for the analysis, which may vary according to the organization characteristics [65]. In this first phase it is important to outline the goals and objectives that are trying to be addressed. In this regard, understanding the full scope helps to ensure that all the relevant costs and benefits are being considered [66].

Still at an early stage of a CBA, there are three important questions that need to be answered: who will be affected by the decisions arising from the results of the analysis, what time horizon is being considered, and also, what are the sources for the analysed data [67].

When answering the first question, the stakeholders will be identified, which makes it possible to consider various perspectives when the analysis is being carried out. In addition, having a clear view of the time frame serves as a guide to knowing which costs and benefits to include. Lastly, it is important to know the sources of information and what kind they are. This can come from market research, expert opinions, or historical data, for example. Regardless of the type of source, it is important that they are credible in order to reach a result as accurate as possible [67].

3.1.1.2 Identify the Costs and Benefits

After establishing the framework for the CBA, it is time to tackle the construction of two separate lists: the projected costs and the expected benefits of the project [65]. Although it is

common to start with the direct costs when drawing up the list of costs [65], both the costs and the benefits of the project go beyond just direct aspects [66]. Thus, the types of costs generally considered in a CBA are as follows: direct; indirect; intangible; ongoing (or future); opportunity costs; and costs of potential risk [65] [66] [68].

In simpler terms, cost-benefit analyses often consider two distinct groups of costs: capital expenditures (CAPEX) and operational expenditures (OPEX) [69]. Aspects such as acquisition or installation costs are included in the first group, while maintenance and personnel costs fall into the second group [70]. It is relevant to note that there is a term frequently used in the analysis of personnel costs, known as full-time equivalent (FTE). FTE is the number of full-time employees during a certain period of time, for example in one month or one year [71].

On the other hand, the types of benefits considered in a CBA are generally the following: direct; indirect; intangible; competitive [65] [66]. It is common to consider savings as benefits in cost-benefit analyses, as they are associated with a reduction in costs, even if they do not, for example, mean an increase in sales value. In an energy sector project, the savings resulting from the reduction in the cost of unprovided energy serve as an example of such cases [69].

3.1.1.3 Assign a monetary value to costs and benefits

After compiling comprehensive lists of all costs and benefits, the next step is to assign, ideally, a monetary amount to each one. Without valuing every cost and benefit, accurate comparison becomes challenging [65].

It is easy to assign values to direct costs and benefits, however, this is not the case for indirect and, especially, intangible aspects [72]. That said, it does not mean that the conversion of intangible costs and benefits into monetary values should not be attempted, if there are indeed any such aspects [65]. This topic is as relevant as it is delicate and will be addressed again later, focusing solely on intangible benefits.

3.1.1.4 Costs vs Benefits Analysis

Once the respective values have been assigned to all the costs and benefits considered, it is time to compare them [65] by carrying out a cost vs benefit analysis, which can be done using various metrics, including the following: Net present value (NPV); Benefit-cost ratio (BCR); Payback period (PBP or PbP); Internal rate of return (IRR); Return on investment (ROI) [64].

The list presented covers the most commonly used success indicators, and the one or ones chosen for analysis must be in line with the requirements of the company/organisation.

3.1.1.4.1 Net Present Value (NPV)

The NPV represents the cumulative value of cash flows throughout the project years in present value [73], in other words, compares the amount invested today in the present value

of the future cash receipts from the investment [74]. Simply put, NPV analysis is used to help determine how much a project is worth, taking into account revenues, expenses and capital costs [75]. A profitable project is associated with a positive value for NPV, while a negative value suggests a non-profitable project. If there is a case of NPV equal to 0, it means that the investment earns a return equal to the discount rate [76].

3.1.1.4.2 Benefit-Cost Ratio (BCR)

The BCR, one of the several metrics commonly used in CBAs [77], evaluates and contrasts the present value of all expenditures and benefits received from a project or asset [78]. These costs and benefits are handled as monetary cash-flows [79]. As with the NPV, a BCR value greater than 0 indicates a profit-making investment, less than 0 a loss-making investment and a BCR equal to 0 an investment that generates neither profits or losses [79].

3.1.1.4.1 Payback Period (PBP)

The PBP measures the time needed to recover an investment [80], in other words, a period in which an amortization or payment of an investment is fully achieved [81]. Because of its nature, the payback time is frequently utilized as a preliminary analysis that is easily comprehended by non-technical people. This computation, sometimes known as the "back of the envelope" calculation, is simple to do, and a straightforward indicator of risk [39].

3.1.1.4.2 Internal Rate of Return (IRR)

The IRR is an often used metric for project evaluation, which is defined mathematically as the interest rate that brings the present value of a sequence of cash flows to zero [82]. Relating it to another metric introduced earlier, the IRR can also be defined as the discount rate that makes a project's NPV equal to zero [83].

3.1.1.4.1 Return on Investment (ROI)

Finally, the ROI consists of a metric used to indicate how much profit has been generated from an investment that has been made [84]. It is one of the most commonly used indicators due to its simplicity and the ease with which the information transmitted can be understood [85]. According to [78], top managers are interested in understanding ROI data, being one of the most desired metrics by some CEOs of large companies.

3.2 The Importance of Employee Satisfaction in the Retail Sector

When discussing innovation, particularly in the retail sector, the focus is predominantly on the end customer, likely because the economic impacts for companies stemming from innovation are more easily visible and analysed when something disruptive is applied with this end customer in mind.

Contrarily, the aim of this section is to highlight the importance of putting employees first, especially through innovation. There is a contextualisation of the intangible benefits, emphasising how relevant these are. This dissertation is particularly innovative in its focus, as it centres on employees and aims to assess the impact of implementing an innovative application, KIWI, on employee satisfaction.

3.2.1 Understanding and Valuing Intangible Benefits

Intangible benefits are perceptions and attitudes that are felt about a company and that are not expressed in monetary terms on a balance sheet, despite the fact that they improve the value of a company's business [86]. This type of benefits is both an important and delicate part of a product value assessment. One of the most challenging parts of the Case Study that follows was converting these benefits into monetary values.

Intangible benefits are difficult, or even impossible in some cases, to quantify. However, although they are often considered to be a source of unimportant business value, they represent a very relevant field [72]. Typical examples of these intangible benefits are more efficient work processes, greater business knowledge or even more effective interpersonal relationships [72].

The distinction between tangibles and intangibles dates back to the 17th century, when some economists, such as Adam Smith, author of "Wealth of Nations" in 1776, one of the most influential books ever written [87], identified the differences between goods and services, considering the former as something material and the latter as something intangible [72]. Services, whose nature is transitory, could not be valued as assets, unlike goods. From this line of thinking emerged a dominant theory that wealth can be defined as objects that can be owned by an individual, contributing to the generally accepted accounting principles (GAAP) that prioritise material assets when calculating income and profits [72]. However, these principles fail to recognise that many investments made by companies fall into this intangible category, representing a major source of potential profits [72].

For the purposes of market competition, although the tangible value associated with some products may be similar, especially in relation to the most direct competitor, it is the intangible benefits that can result in competitive differentiation [88]. For this reason, in some scenarios, intangible benefits prove to be more important than tangible benefits. In general,

intangible aspects influence customer loyalty, which in turn directly impact the economic aspects of companies [88].

3.2.2 Employee Satisfaction as a Driver of Competitive Advantage

It is not just the intangible aspects felt directly by the consumer that have an impact on a company, as there's something arguably even more central. The secret to ensuring the satisfaction of end customers lies in putting the employees themselves first [89]. Only with empowered and motivated frontline employees, who feel valued and engaged, it is possible to achieve a superior customer service [89]. This topic is particularly relevant to this dissertation because **KIWI is designed for employees, not end customers.** Its creation was motivated not only by paperless advantages and the need for greater control, with the aim of promoting efficiency, compliance, and informed decision-making, but also by the goal of improving the quality of life of employees in the workplace.

In an article published by Mckinsey in 2016 [89], it is explored a real case of the impact that the intangible benefits felt by employees have on the customer, and consequently on the company's business. The case analysed took place in a Latin American bank, whose name is not identified in the article, and allowed several examples to be identified in which investment in intangible aspects proved to be essential.

Firstly, the importance of listening to the needs of employees, which allowed the bank, through polls, surveys (a key player in evaluating the intangible benefits arising from the implementation of KIWI) and focus groups, to adapt value propositions for its employees, such as the introduction of a system of redeemable points for non-financial benefits, resulting in a significant increase in their satisfaction and motivation [89].

Secondly, the bank adopted a new recruitment strategy, giving priority to attitude over aptitude, achieved through an overhaul which included a simulated branch for role-play situations to test candidates' attitudes and behaviours towards customers and colleagues. This change in the philosophy behind recruitment, which has already been tested by other companies such as JetBlue Airways or Disney, has made it possible to increase the level of satisfaction of customers served by new bank employees by between 5 and 10 per cent [89].

Finally, the bank promoted a culture based on purpose rather than rules, as well as room for creativity. This new vision has given employees not only a sense of ownership and alignment with the company's objectives, but also empowerment, resulting in greater satisfaction on the part of the employees, which has consequently translated into better business performance [89]. By valuing its employees, the bank managed to increase profits by more than 10 per cent per customer and reduce the churn rate (rate at which subscribers or customers stop transacting with a business [90]) by between 10 and 20 per cent, which translated into widespread recognition for the satisfaction of both employees and customers.

In order to fit the theme with the subject of the Case Study that follows, it is important to identify that there are direct links between technological innovation and intangible gains

for a company. According to a Harvard Business Review about employee retention [91], there are five pillars that significantly enhance the employee experience, one being specially relevant for this study: **seamless technology**. It is stated that it is essential to provide technology that lowers daily friction and increases efficiency, and that companies should make sure that their tech solutions are intuitive and well-integrated to reduce the amount of complexity and annoyance that workers may experience in their daily tasks. Also, efficiency and job satisfaction can be greatly increased by the effective use of technology. KIWI falls perfectly in this category.

3.2.3 Likert Scales as a Method of Measuring Employee Satisfaction

Once the importance of evaluating the intangible benefits involved in a project within a company, especially employee satisfaction, has been justified, it is relevant to address in more detail one of the most commonly used methods in these measurements: the Likert scale questionnaires. This method constitutes one of the essential components of the empirical part of this dissertation.

3.2.3.1 Likert Scales Contextualisation

The origin of the Likert scale dates back to the publication of Rensis Likert's 1932 paper titled "A Technique for the Measurement of Attitudes." As indicated by the title, the paper introduced a method for measuring attitudes and the author's name subsequently became associated with the method still in use today [92]. In his 1932 paper [93], Likert outlined an effective and straightforward technique for creating an attitude scale. This method is based on the concept that a series of related questions can collectively assess an individual's attitude towards a specific issue. Likert demonstrated that summing the responses from these related questions yielded a useful and manageable measure of the underlying attitude.

A typical use of Likert scales occurs in the field of medical education and medical education research. Common applications include end-of-rotation trainee feedback, faculty evaluations of trainees, and assessments of performance following educational interventions [94].

3.2.3.2 How Likert Scales Work

One of the response formats presented by Likert was the option to choose one of the following for each question: strongly disagree, disagree, undecided, agree, and strongly agree [92]. Figure 3.1 illustrates an example of the scale in question.

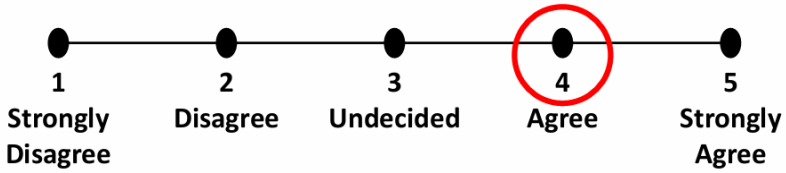

Figure 3.1 - Likert-type question example [92]

However, it is important to note that this type of response format alone does not constitute a Likert scale. A single response to a question is considered a Likert-type item, while a Likert scale consists of a series of four or more Likert-type items that are combined into a single composite score/variable during the data analysis process [95].

In [94], the authors confirm this by stating that researchers frequently develop multiple Likert-type items, group them into a "survey scale," and then compute a total or mean score for the scale items. It is also stated that this approach is especially recommended for measuring abstract concepts like trainee motivation, patient satisfaction, and physician confidence, where a single item may not fully capture the concept.

To clarify this distinction, Figure 3.2 presents an example of a Likert scale, constructed as the sum of Likert-type responses from related questions.

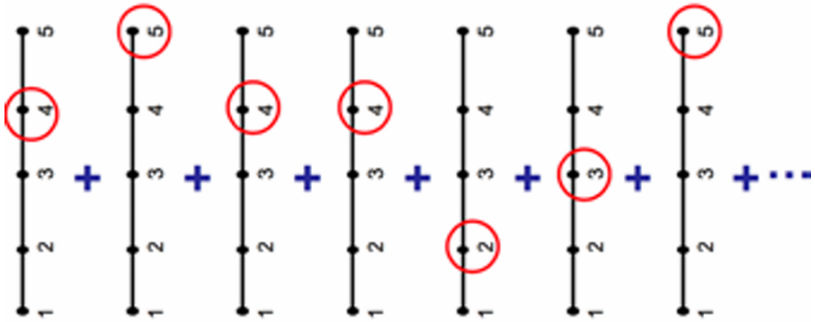

Figure 3.2 - Likert scale example [92]

The fact that Likert-type responses reflect ordinal data (since the distance between each response choice is not necessarily constant or well-defined) rather than interval data makes the application of parametric statistical methods inappropriate. On the other hand, when designed correctly, Likert scales (i.e., the aggregation of Likert-type items) approximate interval data, making them suitable for traditional statistical analysis methods [95] [96]. It is of utmost relevance to note that, as an alternative to summing the various Likert-type items, the average can be used. In this case, the Likert scale values for the different response groups will remain between one and five [97].

Although the use of five response options has been the most common approach over the years, scales with a different number of options can also be employed. Scales with three, four, six, or seven response options are frequently used as well [97]. There is even some debate

regarding the fact that, in certain scenarios, a seven-point scale may perform better than the traditional five-point scale [98].

3.2.3.3 How to Analyse Likert Scales Data

Once the concept behind a Likert scale has been explained, it is crucial to understand the aspects related to the analysis of the data obtained from a questionnaire where this scale is used.

3.2.3.3.1 Reliability Test

The validation of the questionnaire construction is an essential step before the analysis. It is necessary to verify it using reliability measures that assess the extent to which the individual items are evaluating a single attitude dimension [97]. One of the tests used for this purpose is the Cronbach's Alpha test, one of the most common estimators of reliability in psychology [99]. The same author emphasizes in [100] that validity is not a property of the test itself but of the inferences made from the test scores. This perspective, although introduced several decades ago, continues to be supported by various authors, as is evident in the article [101].

Although, as previously mentioned, it is a commonly used test for validating questionnaire construction, it has some limitations. An example of a limitation is discussed in [102], where it is stated that, in practical scenarios, items rarely have equal true score variances, making the tau-equivalence assumption (one of the Cronbach test's assumptions) impractical and leading to inaccurate reliability estimates. Similarly, in [103], the author argues that the alpha (resulting from the test) is sensitive to the number of items in the scale, with fewer items often resulting in lower reliability estimates.

In conclusion, the article [94] asserts that experts consider the Cronbach's Alpha test (besides the Kappa test or factor analysis) to be a robust tool for demonstrating that the components of the scale are sufficiently intercorrelated and that the grouped items measure the underlying variable.

3.2.3.3.2 Data Analysis Procedures

Recapping what was mentioned earlier regarding Likert-type data and Likert scale data, the items of the first group fall into the ordinal measurement scale, whereas Likert scales should be analysed as interval measurement scales. Taking this into consideration, [95] presents various types of data analysis methods (descriptive statistics and additional analysis) suitable for the two groups considered. This information is provided in Table 3.1.

Table 3.1 - Likert-type vs Likert scale data analysis [95]

	Likert-Type Data	Likert Scale Data
Central Tendency	Median or mode	Mean
Variability	Frequencies	Standard deviation
Associations	Kendall tau B or C	Pearson's *r*
Other Statistics	Chi-square	ANOVA, t-test, regression

The decision on data analysis for Likert items is typically made during questionnaire development. It is important to determine whether there are individual questions with Likert response options or a series of questions that, when combined, describe a personality trait or attitude. If the questions are unique and stand-alone, they should be analysed as Likert-type items using modes, medians, and frequencies. If the questions collectively measure a particular trait, they form a Likert scale, which should be described using means and standard deviations. Once the distinction between Likert-type items and Likert scales is made, the appropriate statistical methods will naturally follow [95].

However, there is no definitive agreement on which statistical methods should be used for the analysis of Likert scale data [94]. In the article [104], it is described that, for ordinal data, some experts advocate prioritizing the median and frequency (which aligns with the information presented in Table 3.1), as well as using Chi-square tests, contingency tables, Spearman's rho, or the Mann-Whitney U test, all non-parametric methods. On the other hand, other experts believe that, even with ordinal data, if the sample size is adequate (at least 5 to 10 observations per group) and the data is approximately normally distributed, parametric tests may be used for statistical analysis.

In the article [105], Geoffrey Norman, one of world's leaders in medical education research methodology, provides complete evidence that parametric tests can be used with ordinal data, even if statistical assumptions, such as a normal distribution of data, are violated to an extreme degree. He also states that parametric tests are robust enough to provide largely unbiased and accurate results when analysing Likert scale responses. Bottom line, each author must decide how they intend to describe and analyse the data in the initial phase of their project or research [94].

3.2.4 Including Employee Satisfaction in Financial Assessments

After the presentation and discussion of topics covered in the previous sections, this section assesses how intangible benefits can be integrated into a financial analysis. In this case, a clear perspective is provided on how employee satisfaction and engagement often translate into quantifiable benefits for a company, specifically through a metric known as the turnover rate.

In this context, the turnover rate is defined as the percentage of employees who leave an organization during a given time period, a metric frequently calculated quarterly by organizations [106]. The calculation of this rate occurs in two steps: first, it is necessary to estimate the average number of employees during the period considered; subsequently, the number of employees who left during that period is divided by the obtained value and the result is multiplied by one hundred.

Given this, there have been several examples over recent years demonstrating a clear relationship between employee satisfaction and engagement and the reduction of turnover rates. In a report released in 2024 by Gallup [107], it is noted that, in low-turnover organizations, units with high engagement experience a 51% lower turnover rate, while in high-turnover organizations, the reduction is 21%. The same report further indicates that higher employee engagement is associated with a 10% improvement in customer loyalty and is linked to an 18% increase in productivity based on sales metrics and a 14% increase based on production records and evaluations. Finally, it is stated that there is a 28% reduction in wastages, which refers to the loss of products due to factors such as theft, errors, or damage.

Regarding this topic, article [108] discusses the relationship between job satisfaction and turnover intention in a hospital setting. For a sample of 268 employees ($n = 268$), it was concluded that the job satisfaction variable was significantly related to the employee turnover intention variable, as the p-value of the relationship between job satisfaction and turnover was found to be 0.000, which is smaller than the threshold of 0.05. Furthermore, the study concluded that employees with higher job satisfaction were less likely to intend to leave the organization, while those with lower satisfaction were more likely to consider leaving. The study also states that aspects such as motivation and a conducive work environment should be targeted for improvement in order to reduce the turnover rate, two aspects that are considered in the analysis of questionnaires conducted in the empirical part of the dissertation.

Finally, articles [109] and [110] also corroborate this negative correlation between job satisfaction and turnover rates, with the latter indicating that this negative relationship is consistent and generalizable across various companies and industries, suggesting that the findings are robust and widely applicable. The author of article [110] also states that the negative relationship between job satisfaction and turnover is significant enough to have practical implications for businesses.

In summary, by improving job satisfaction, companies can reduce turnover rates, potentially leading to improvements in other business outcomes such as productivity and profitability [110].

3.3 Proposed Framework for Innovation Impact Assessment

The purpose of this section is to present a framework developed by the author, aimed at the holistic assessment of the impacts from the implementation of an innovative product. The motivation for this segment arose from two conclusions drawn from the existing literature: financial assessments often overlook intangible aspects; and these latter aspects are frequently

cited as the true key to a company's differentiation. As such, it was decided that it would be highly appropriate to draw on the ideologies of empathy and iteration from Design Thinking and associate them with the classical cost-benefit analysis approach.

The major innovation offered by this framework lies in the inclusion of a strong emphasis on empathy and the importance given to intangible aspects, aiming, through a series of iterative processes, to arrive at robust financial metrics that go beyond the traditional. In this way, the proposed framework for evaluating the value of an Innovative product is represented in Figure 3.3.

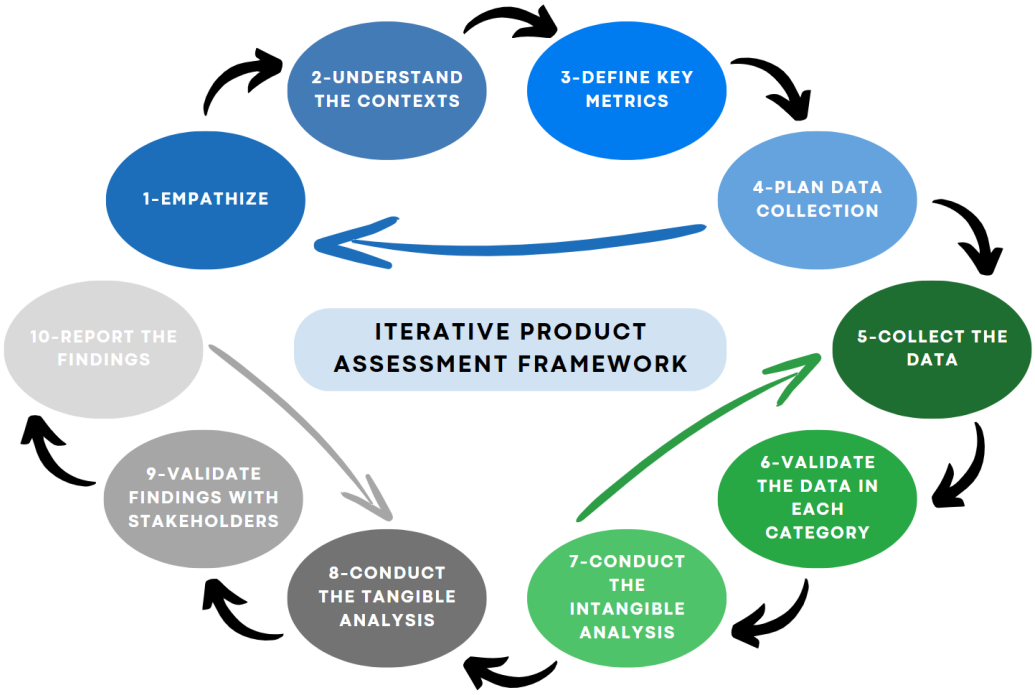

Figure 3.3 - Iterative Product Assessment Framework

As can be observed, three major groups were established where iteration is encouraged, although it is highly recommended and feasible at any point in a project. The first group pertains to stages 1 to 4 and consists of tasks aimed at creating a solid foundation for the subsequent data collection and analysis phases. This is a highly theoretical group, but one of utmost importance, where time should be invested to "tackle" the problem in an assertive manner.

The second group encompasses the data collection phase and the analysis of the intangible aspects surrounding the product in question. One of the key features of this framework is the decision to position this analysis before the tangible, or financial, analysis. The rationale behind this choice is that the initial analysis will likely employ qualitative methods such as questionnaires or interviews, with a high probability that the insights gained will prompt the need to collect new data to address aspects of the financial analysis that had not been previously considered.

The final group comprises three stages typical of any cost-benefit analysis, covering the period from tangible analysis to the reporting of insights. To clarify the approach suggested for each stage of this proposed framework, a description of each one is provided in Table 3.2.

Table 3.2 - Iterative Product Assessment Framework Guidelines

Nº	Name	Description
1	Empathize	Immerse in the product. Engage with users and stakeholders in order to understand the product's features, purpose, and how it fits into the company business.
2	Understand the contexts	Assess the situation and conditions with and without the presence of the product. This provides a baseline and helps to identify the areas that the product impacts.
3	Define key metrics	Determine which metrics are crucial for the analysis. From the goal metrics, a breakdown should be conducted with the aim of identifying the minor variables at play.
4	Plan data collection	Think through and develop the strategies for collecting the necessary data defined in stage 3, including sources and methods, ensuring the reliability of the collection process.
5	Collect the data	Collect the data using the planned methods.
6	Validate the data in each category	Allocate the collected data to the respective categories for the analysis.
7	Conduct the intangible analysis	Analyse qualitative data and other non-monetary aspects or quantitative data from questionnaires using Likert scales or similar.
8	Conduct the tangible analysis	Conduct the necessary analysis and calculations based on the organized data.
9	Validate findings with stakeholders	Ensure the findings and insights are validated with key stakeholders to confirm accuracy and relevance.
10	Report the findings	Synthesize findings, derive insights from the analysis, and document the conclusions and recommendations.

It was deemed highly appropriate to employ this innovative framework, as it represents a novel contribution in a dissertation area already related to the theme of innovation. Consequently, it serves as the foundation for the empirical approach of the current dissertation. For the sake of simplicity, **from this point onwards, this framework will be referred to as IPAF** (Iterative Product Assessment Framework).

3.3.1 Advantages of the Proposed Framework

The IPAF offers several advantages over the frameworks it is based on, CBA and DT models. These same advantages, along with the reasoning behind them, are presented in Table 3.3.

Table 3.3 - Advantages of the IPAF

Advantage	Rationale
Dynamic and Iterative	This framework's iterative approach ensures continuous refinement, making it more adaptable than static CBA, while it adds rigor to DT by including data validation.
Balanced Approach to Qualitative and Quantitative Data	It effectively combines empathy-driven qualitative insights with robust quantitative analysis, unlike CBA, which skews toward numbers, and DT, which often prioritizes qualitative insights.
Data-driven Empathy	Starting with empathy and following with the definition of metrics bridges the gap between human-centered design and data-driven validation, something both CBA and DT approaches typically lack.
Holistic Evaluation of Metrics	The broad KPI approach ensures that various aspects like user experience and ROI are considered, surpassing CBAs narrow financial focus and DT's emphasis on design without quantifiable outcomes.
Contextual Understanding	Focusing on context integrates external factors early on, addressing a gap in CBA and offering more comprehensive insight than DT's user-centric approach.
Social Responsibility Focus	This framework prioritizes social and ethical considerations by integrating empathy, contextual understanding, and both tangible and intangible analyses. Unlike CBAs financial focus and DT's user-centric view, it ensures societal impacts are addressed throughout, with stakeholder validation and iterative reassessment reinforcing this focus.

The aim of this second theoretical chapter was to present a literature review grounded in articles, relevant studies, and publications from reputable sources, supporting the practical approach detailed in the Case Study of the following chapter. The intention was for this review to provide a foundation for the methodology used to evaluate the KIWI application, which directly addresses one of the research questions posed in the dissertation and presented as a challenge by the partnering company.

A key focus of the chapter was justifying the importance of intangible factors in evaluating a product's value, particularly employee satisfaction, since conducting and analysing satisfaction questionnaires is a major component of the practical evaluation. The chapter also laid out the typical sequential steps of a cost-benefit analysis (CBA), from defining costs and benefits to calculating the relevant metrics needed for strategic decision-making. At the same time, it emphasized the necessity of including intangible aspects to ensure a more holistic evaluation, which can ultimately lead to superior business performance.

In conclusion, this chapter introduced an innovative proposal by deconstructing the traditional, linear approach of CBA. By combining the most effective elements of CBA with Design Thinking principles, a new framework (IPAF) was developed. This framework is rooted in iteration and emphasizes understanding both the technical and financial dimensions, as well as the more human and qualitative aspects, of innovative product evaluation.

APPENDICES

For confidentiality reasons, the Chapters 4 (“Case Study: KIWI Application Value Assessment”) and 5 (“Conclusions”), as well as the appendices of this thesis, will not be published, as they contain sensitive information about Jerónimo Martins' business.

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