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## **AI Financial Virtual Assistant**

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Master in Computer Science and Management

Supervisor:

PhD Rúben Filipe de Sousa Pereira, Assistant Professor,  
Iscte - Instituto Universitário de Lisboa

October, 2025





TECHNOLOGY  
AND ARCHITECTURE

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Department of Information Science and Technology

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## **Agradecimento**

Concluir esta fase na minha vida representa o fim de uma etapa exigente e, ao mesmo tempo, profundamente gratificante. Este percurso foi feito de desafios, descobertas e aprendizagens, e não posso deixar de mencionar as pessoas que me acompanharam e tornaram possível chegar até aqui.

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## Resumo

A crescente complexidade da gestão financeira pessoal aumentou a procura por assistentes financeiros baseados em IA que integrem automação, personalização e acessibilidade. Esta investigação explora o desenvolvimento de um assistente virtual inteligente que utiliza aprendizagem automática, análise preditiva e processamento de linguagem natural (NLP) para automatizar o registo de despesas, o planeamento orçamental e a gestão de objetivos financeiros, fornecendo simultaneamente insights em tempo real e recomendações personalizadas. Foi realizada uma Revisão Sistemática da Literatura (SLR) para identificar as principais funcionalidades, tecnologias e desafios, com especial enfoque na segurança, privacidade e confiança dos utilizadores. O estudo também analisa o impacto dos assistentes financeiros em diferentes perfis de utilizadores, destacando a importância da literacia financeira e de soluções adaptativas. Ao abordar as lacunas existentes nas aplicações fintech, esta investigação visa desenvolver um assistente baseado em IA que melhore a tomada de decisões financeiras, garantindo acessibilidade e segurança, enquanto capacita os utilizadores a otimizar a sua gestão financeira pessoal de forma eficaz.

**Palavras-chave:** Inteligência Artificial, Assistente Virtual, Chatbot, Fintech, Automação Financeira, Gestão de Finanças Pessoais.



## **Abstract**

The growing complexity of personal financial management has increased the demand for AI-driven financial assistants that integrate automation, personalization, and accessibility. This research explores the development of an intelligent virtual assistant that leverages machine learning, predictive analytics, and natural language processing (NLP) to automate expense tracking, budget planning, and financial goal management, while providing real-time insights and personalized recommendations. A Systematic Literature Review (SLR) was conducted to identify key functionalities, technologies, and challenges, particularly focusing on security, privacy concerns, and user trust. The study also analyses the impact of financial assistants on different user profiles, highlighting the importance of financial literacy and adaptive solutions. By addressing existing gaps in fintech applications, this research aims to develop an AI-powered assistant that enhances financial decision-making, ensuring accessibility and security, while empowering users to optimize their personal finances effectively.

**Keywords:** Artificial Intelligence, Virtual Assistant, Chatbot, Fintech, Financial Automation, Personal Finance Management.



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## CHAPTER 1

# Introduction

The complexity of managing personal finances in today's digital age has increased the demand for AI-driven financial assistants that integrate automation, enhance security, and improve accessibility. The evolution of fintech solutions has led to significant advancements in optimizing expense management and investments. However, challenges such as low financial literacy, concerns about data security, and the adaptability of these solutions to user-specific needs continue to hinder broader adoption [1], [2].

Artificial Intelligence (AI) and Machine Learning (ML) are increasingly optimizing financial decision-making by enabling predictive analytics, fraud detection, and intelligent financial planning. Virtual assistants use Natural Language Processing (NLP) to analyse spending behaviours and provide tailored financial advice, which improves user engagement and financial security [3], [4].

Despite the rapid expansion of fintech solutions, many users still struggle with financial management due to limited financial literacy, a lack of personalized guidance, and insufficient technical knowledge, which often leads to inefficient financial decisions [1], [5]. Studies indicate that integrating AI with blockchain and other security frameworks can enhance data protection and build user trust [2]. However, concerns over data privacy and cybersecurity remain, as financial data breaches and regulatory uncertainties continue to hinder adoption. Another significant challenge is the limited adaptability of existing financial assistants, which often fail to account for users' unique financial behaviours and goals, reducing their overall effectiveness in decision-making [3]. Research further suggests that AI models must be capable of dynamically identifying key personalization vectors, ensuring that recommendations align with specific user financial goals and habits. Addressing these challenges is crucial for fostering greater adoption and improving the long-term impact of AI-driven financial solutions.

A further challenge lies in the lack of transparency and explainability in AI-powered financial assistants. This lack of interpretability often leads to user distrust, as individuals are unable to understand the rationale behind automated financial recommendations and may perceive AI-driven assistants as opaque 'black boxes' [6], [7].

Moreover, the lack of compatibility between traditional banking systems, digital wallets, and payment platforms creates obstacles for users seeking a seamless experience, limiting the ability of AI-driven assistants to provide a holistic financial overview [8]. While Open Banking has made strides toward solving this issue, regulatory and technical constraints continue to pose challenges [9].

User resistance to automated financial assistants hinders widespread adoption. Some individuals prefer human financial advisors over AI-driven systems due to concerns about accuracy and personalization [10]. Moreover, psychological and emotional factors also play a role, particularly when users must rely on AI for critical financial decisions regarding savings and investments [4]. We must address these issues to foster a more inclusive and efficient financial management system that leverages AI's full potential.

This study aims to develop an AI-driven financial assistant to enhance personal financial management through personalized financial advice, while exploring considerations related to data security and transparency in AI-powered fintech solutions.

The development of AI-driven financial assistants is covered in detail in each of the five major chapters that make up this study.

**Chapter 1** introduces the study and the contributions it aims to make to the field of AI-driven financial management, along with the methodological approach guiding the research.

Following the introduction, **Chapter 2** presents the State of the Art, combining the theoretical background on AI, financial services, and intelligent assistants with a systematic literature review (SLR). This chapter highlights the key benefits, challenges, and gaps identified in existing research.

**Chapter 3** describes the research methodology, explaining the application of the Design Science Research (DSR) approach and detailing the process followed for the development of the financial assistant artifact.

**Chapter 4** reports on the implementation of the artifact, presenting its architecture, core functionalities, integration with supporting technologies, and the iterative improvements made during development.

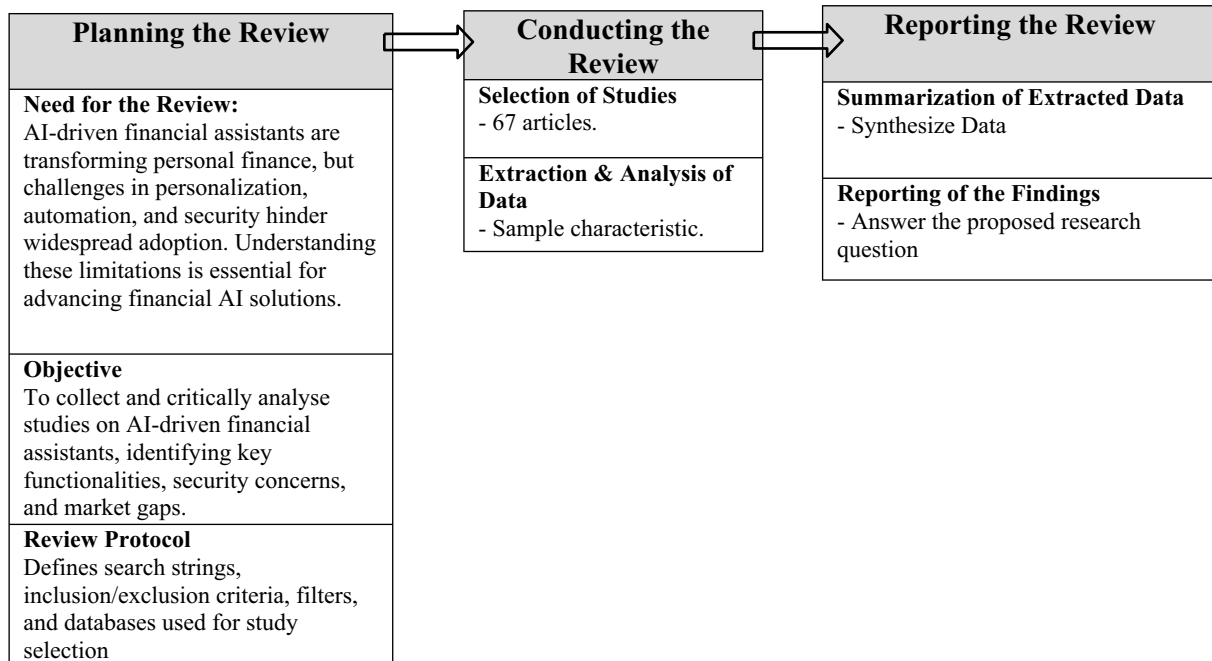
**Chapter 5** concludes with the study's main contributions, acknowledges its limitations, and suggests directions for future research in the field of AI-powered financial assistants.

CHAPTER 2

**State of Art**

To gain insight into the work already completed, a Systematic Literature Review (SLR), was conducted. This methodology, according to Kitchenham (2009), is the best way to identify and analyse all relevant research conducted up to the present, summarizing and identifying any existing gaps.

*Table 1. Phases of SLR.*



The SLR methodology follows three main stages, as illustrated in **Table 1**: planning the review, conducting the review, and reporting the findings. [11]

**2.1. Theoretical Background**

The development of financial technologies (FinTech) and the growing availability of digital services have transformed the way individuals manage their personal finances. Traditional methods of budgeting and saving are increasingly being supported - or replaced - by intelligent platforms that consolidate financial data, provide recommendations, and assist decision-making. To understand the relevance and positioning of this research, it is necessary to review the main theoretical concepts underpinning the design of such systems.

**Personal Finance Management**

Personal Finance Management (PFM) encompasses the processes and tools employed by individuals to organize, monitor, and optimize their financial resources. Traditionally supported by manual methods, such as spreadsheets or paper-based budgeting, PFM has progressively

evolved with the emergence of financial technologies (FinTech), which consolidate financial information, automate processes, and support more informed decision-making [1], [2], [3]

Recent advancements have integrated Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP) into PFM systems. These technologies enable the automatic categorization of transactions, analysis of spending patterns, forecasting of financial behaviour, and the provision of tailored recommendations aligned with individual goals [3], [10], [12], [13], [14]. In addition, AI-driven solutions allow continuous adaptation to user preferences, supporting tasks such as budget planning, goal tracking, and the generation of real-time insights [6], [8], [15], [16].

Beyond operational support, PFM systems increasingly contribute to financial literacy and inclusion. Conversational agents and intelligent assistants simplify complex financial concepts, guide users in establishing budgets, and suggest appropriate products and strategies. Their educational role is particularly relevant for users with limited financial knowledge, fostering greater autonomy in personal financial decision-making [1], [10], [17], [18], [19], [20].

The literature identifies the principal benefits of AI-powered PFM systems in four domains:

- Budgeting and Expense Tracking - automated classification and monitoring of income and expenditures.
- Financial Goal Setting - personalized support in defining and achieving savings or investment objectives [6], [15], [16];
- Predictive Analytics - forecasting of expenses, risk identification, and optimization of financial strategies through historical data analysis [3], [21], [22], [23], [24];
- Accessibility and Inclusiveness - democratization of financial advice and support for underserved populations [19], [20], [25], [26].

However, adoption remains conditioned by concerns related to data privacy, security, transparency, and personalization. Limitations such as restricted adaptability to user-specific behaviours and the “black box” nature of some AI models continue to hinder trust and broader acceptance [2], [3], [27], [28], [29]. Addressing these issues is essential for the sustainable development of PFM solutions that are secure, transparent, and user centred.

### **Financial Literacy and Decision-Making**

Financial literacy is defined as the knowledge, skills, and confidence that enable individuals to make informed and effective decisions regarding the management of financial resources. It encompasses the ability to interpret financial information, understand fundamental concepts such as interest rates, credit, investment, and risk, and apply this knowledge in daily

decision-making processes [1], [5], [10]. Inadequate levels of financial literacy are associated with suboptimal financial behaviours, including excessive debt, insufficient savings, and limited capacity to evaluate investment opportunities [1], [2].

Decision-making in personal finance is inherently complex, as it involves both cognitive and behavioural factors. Empirical studies demonstrate that individuals frequently rely on heuristics, emotional responses, or incomplete information, which may result in irrational or suboptimal financial choices [3], [4]. This highlights the importance of systems that can not only provide financial data but also guide users in interpreting and applying this information effectively.

The integration of AI-powered financial assistants offers significant potential to mitigate limitations in financial literacy. Virtual assistants and chatbots, supported by Natural Language Processing (NLP) and Machine Learning (ML), can deliver contextualized explanations, simulate scenarios, and provide adaptive guidance in areas such as budgeting, saving, investing, and credit management [10], [19], [20], [25]. By democratizing access to financial knowledge, these systems reduce dependency on professional advisors and contribute to more equitable financial inclusion [26], [30].

The literature identifies several mechanisms through which financial literacy and decision-making are enhanced by intelligent systems:

- Personalized Financial Education - interactive recommendations and explanations adapted to individual knowledge levels and objectives [1], [10];
- Decision-Support Tools - AI-based applications that simplify complex calculations, visualize alternatives, and encourage rational evaluation of financial options [3], [19], [31];
- Real-Time Guidance - conversational agents capable of responding to user queries and providing advice at critical moments of financial decision-making [20], [25];
- Behavioural Empowerment - reinforcement of user confidence and competence, reducing the likelihood of errors driven by misinformation or emotional bias [30], [32].

Despite these contributions, challenges persist. Concerns regarding trust, transparency, and over-reliance on automated recommendations remain central. While intelligent systems can provide valuable support, their “black box” nature and occasional inaccuracies may lead to misinformation or excessive dependence on algorithmic outputs [27], [33], [34]. Additionally,

disparities in digital literacy and access to technology may limit the effectiveness of these solutions for vulnerable populations [20], [25].

### **Artificial Intelligence in Finance**

Artificial Intelligence (AI) has emerged as a transformative force in the financial sector, reshaping traditional processes and enabling new forms of efficiency, personalization, and risk management. By leveraging techniques such as Machine Learning (ML), Natural Language Processing (NLP), and predictive analytics, AI systems facilitate tasks that range from automating customer service to detecting fraud and optimizing investment strategies [3], [4], [6].

The adoption of AI in finance is closely linked to the increasing complexity of financial ecosystems and the growing availability of large datasets. Financial institutions are required to process vast volumes of structured and unstructured data, including transaction histories, market indicators, regulatory documents, and customer interactions. AI algorithms enable the analysis of these datasets at scale, extracting actionable insights and supporting data-driven decision-making [11], [35], [36], [37].

A key application domain is customer service automation, where AI-powered chatbots and virtual assistants provide 24/7 support, respond to user queries, and deliver personalized financial advice [17], [18]. These systems not only improve accessibility but also reduce operational costs for institutions, increasing scalability and efficiency [6], [38], [39]. Similarly, fraud detection and risk management rely on ML models capable of identifying anomalies in real-time, flagging suspicious transactions, and assessing credit risk based on behavioural and historical data [4], [9], [40], [41].

AI also plays a vital role in personalized banking. By analysing customer profiles, preferences, and financial behaviours, AI systems can recommend tailored products, such as savings plans, loan options, and investment portfolios, strengthening customer loyalty and enhancing financial inclusion [3], [6], [14], [42], [43]. In the domain of predictive analytics, AI algorithms forecast market trends, evaluate investment opportunities, and optimize portfolio allocations, offering decision support previously accessible only to professional advisors [22], [23], [44].

Despite these advantages, AI adoption in finance presents critical challenges. The “black box” nature of advanced algorithms raises concerns regarding transparency, fairness, and accountability, as financial recommendations are often generated without clear interpretability [27], [34]. Moreover, algorithmic bias can lead to discriminatory outcomes, particularly in areas such as credit scoring and loan eligibility [28], [33]. Ethical considerations further extend to the

risks of job displacement through automation and the escalating threats of cyberattacks exploiting generative AI models [45], [46].

### **Challenges and Opportunities**

The integration of Artificial Intelligence (AI) into financial assistants brings both significant challenges and promising opportunities. These systems operate within a highly sensitive domain, where user trust, data security, and regulatory compliance are essential. At the same time, the capacity of AI to democratize financial knowledge, enhance inclusion, and optimize financial decision-making positions it as a transformative force in personal finance management.

#### **Challenges**

A recurring challenge identified in the literature is the concern with data privacy and security, given that AI-powered assistants handle sensitive financial information. Risks such as data breaches, misuse of generative AI for cyberattacks, and vulnerabilities in chatbot implementations (e.g., SQL injection or malware) undermine user confidence [14], [35], [39], [47]. Additionally, the “**black box**” nature of advanced AI models complicates transparency and accountability, as users often struggle to understand how financial recommendations are generated [15], [39], [48]. This lack of interpretability creates barriers to trust and adoption.

Another important issue is algorithmic bias, which can lead to discriminatory practices in areas like credit scoring or loan eligibility [22], [49]. Similarly, the over-reliance on automated systems can produce misinformation and misplaced trust, where users accept flawed or incomplete advice due to the persuasive nature of chatbot explanations [39], [50]. These challenges highlight the ethical and social risks associated with automation, particularly in critical financial decisions.

Practical barriers also emerge in terms of system integration and adaptability. Many AI-driven assistants remain unable to effectively connect with traditional banking systems, digital wallets, or payment platforms, limiting their capacity to provide a holistic financial overview [8]. Furthermore, they often lack the ability to handle complex queries, performing only pre-determined processes [14]. Finally, user resistance persists, with some individuals preferring human advisors due to concerns about personalization, empathy, or accuracy [10].

#### **Opportunities**

Despite these challenges, AI-powered financial assistants also present remarkable opportunities. One of the most promising is the potential to enhance financial inclusion and literacy. By providing personalized explanations, interactive education, and real-time guidance, these systems democratize access to financial knowledge and reduce dependence on

professional advisors [1], [10], [15], [17]. This role is particularly significant for vulnerable populations, such as older adults, women entrepreneurs, or individuals with low financial literacy, who may benefit from tailored advice and accessible digital tools [12], [36], [41].

AI also creates opportunities to bridge market gaps. For example, generative models like ChatGPT can significantly reduce the cost and time required to produce financial advice, making such services more accessible [37]. NLP applications can simplify financial analysis through natural language prompts, thereby lowering the entry barrier for users without specialized expertise [31]. Moreover, AI-driven assistants can address inefficiencies in financial operations by automating routine processes, detecting fraud in real time, and generating synthetic data to mitigate data scarcity problems [3], [6], [41], [51].

From a design perspective, these systems open avenues for human-centred and transparent solutions. Explainable AI (XAI) frameworks aim to make recommendations more interpretable, while value-sensitive design approaches prioritize fairness, accountability, and privacy [12], [34], [48]. Combining AI automation with human oversight creates hybrid models that preserve empathy and nuanced judgment, ensuring that financial assistants complement rather than replace professional advisors [37], [39].

## **2.2. Planning**

This section marks the initial stage in SLR methodology. It outlines the rationale for conducting the review, outlines the research questions, and establishes the review protocol.

### **2.2.1. Need for review**

The emergence of generative AI platforms, such as ChatGPT, Bard, and other large language models, has significantly transformed the financial sector in recent years [22], [35], [37], [53]. These advancements present both opportunities and challenges for personal finance management, particularly in areas such as financial literacy, automation, and trust [1], [10], [26], [42], [54]; [35], [54], [55]. Given the novelty and rapid adoption of these technologies, numerous potential applications are being explored, with financial services standing at the forefront of innovation. This SLR aims to comprehensively identify relevant research that examines the role of AI-powered financial assistants, addressing their functionalities, challenges, and opportunities. It also seeks to demonstrate that the use of generative AI to support individuals in making financial decisions has not yet been thoroughly investigated and remains an underexplored area in the literature.

### **2.2.2. Research Questions**

The primary goals of this review are to address the following questions:

**RQ1)** What are the security and privacy challenges affecting the adoption of these systems?

**RQ2)** How can AI-powered financial assistants improve financial inclusion and literacy among users?

**RQ3)** What market gaps can these solutions address?

### 2.2.3. Review Protocol

The Databases considered for the search are:

- ACM Digital Library, <https://dl.acm.org/>
- IEEE Xplore Digital Library, <https://ieeexplore.ieee.org/Xplore/home.jsp>
- SCOPUS, <https://www.scopus.com>

## 2.3. Conducting the Review

This section signifies the second stage in the SLR methodology. It describes the application of the protocol and the analysis of the extracted data.

### 2.3.1. Identification of Research

Considering the description in point 2.2.2. Research Questions, it was possible to extract the following keywords, which, when combined, form the following search string.

*Table 2. Keywords and Search String*

|                      |   |
|----------------------|---|
| <b>Keywords</b>      | Artificial Intelligence (AI), Financial Assistant, Virtual Assistant, Chatbot, ChatGPT, Bard, Fintech, Machine Learning, Financial Automation, Personal Finance Management. |
| <b>Search String</b> | (“Artificial Intelligence“ OR “AI” OR “Intelligent”) AND (((“Financial“ OR “Virtual”) AND “Assistant”) OR “Chatbot*” OR “ChatGPT“ OR “Bard”) AND (“financ*” OR “Fintech”)   |

### 2.3.2. Selection of Studies

The **Table 3** below lists the filters used to conduct the selection of studies.

*Table 3. Filter Applied*

| Filter | Type           |
|--------|----------------|
| 1      | Only Full Text |
| 2      | Abstract       |
| 3      | 2022-2024      |
| 4      | Manual         |
| 5      | Duplicates     |
| 6      | Snowball       |

The process began with an initial search using the selected string across all chosen databases, without any filters applied, yielding 39385 results. The first filter, “*Only Full Text*”, reduced this number to 33645 studies. Applying the second filter, “*Abstract*”, further narrowed the selection to 486 studies. Introducing the third filter, “*2022-2024*”, resulted in 364 studies. The fourth filter, “*Manual*”, produced a refined set of 106 studies. After removing duplicates across databases, 67 studies remained. Finally, a “*snowballing*” process was applied, which expanded the set to 68 studies, representing the final selection considered most relevant for this research.

**Table 4** summarizes the selection process in detail.

Table 4. Filtration Process

| Database                    | No Filter | Filter 1 | Filter 2 | Filter 3 | Filter 4 | Filter 5 |
|-----------------------------|-----------|----------|----------|----------|----------|----------|
| IEEE Xplore Digital Library | 326       | 10059    | 89       | 67       | 24       | 24       |
| Scopus                      | 12990     | 407      | 269      | 191      | 66       | 29       |
| ACM Digital Library         | 26069     | 23179    | 128      | 81       | 16       | 14       |
| Total                       | 39385     | 33645    | 486      | 364      | 106      | 67+1     |

### 2.3.3. Extraction and Analysis of Data

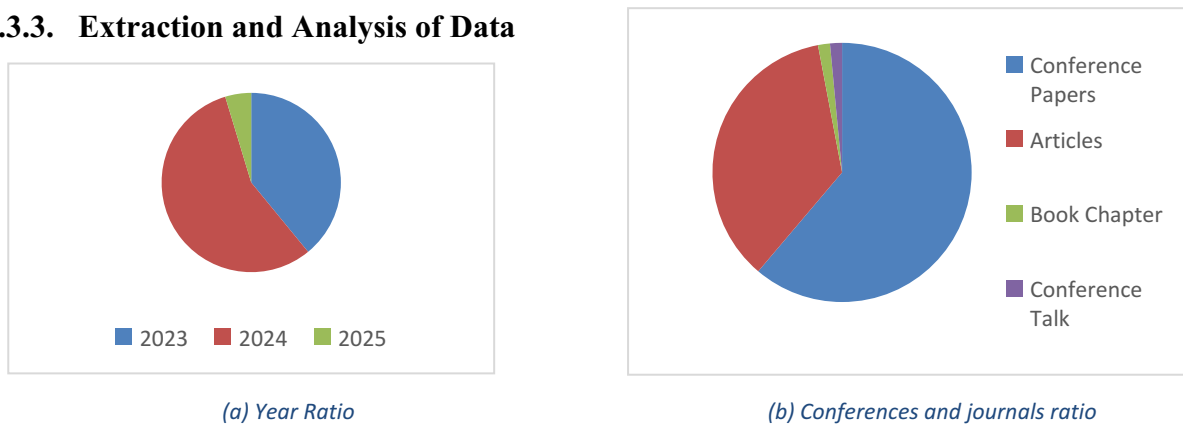


Figure 1. Statistics

Among the 67 selected studies, the distribution by type reveals that 41 are conference papers, 24 are journal articles, 1 is a book chapter, and 1 is a conference talk, as illustrated in Figure 1. While the concept of artificial intelligence has been present in scientific discussion since the 1950s, its consolidation in finance has intensified with the development of generative models and large language applications, which have transformed research and practice in recent years [33]. Notwithstanding these historical considerations, the year ratio demonstrates a clear concentration of research, with 25 studies published in 2023, 36 in 2024, and 3 in 2025. This surge, particularly in 2024, reflects the growing momentum around generative AI and its

financial applications. It underscores that this domain is still in an early but accelerating stage, marked by continuous exploration and evolution.

## **2.4. Reporting**

This section marks the concluding phase of the SLR methodology, encapsulating the extracted data and providing responses to the outlined research inquiries. Summarization of Extracted Data.

### **2.4.1. Summarization of Extracted data**

After analysing the 67 selected studies, it was possible to identify recurring themes and patterns concerning the integration of AI-powered financial assistants. The literature highlights not only the core applications and benefits of these systems but also the main design considerations that influence user adoption and, at the same time, the ethical challenges and risks associated with their deployment.

To structure these insights, the findings were grouped into three major thematic categories:

- Core Applications and Benefits, which emphasize the transformative role of AI and ML in enhancing productivity, precision, fraud prevention, and personalization in financial services.
- Design Considerations and Functionalities, which underline the importance of personalization, empathy, explainability, and inclusiveness in the design of intelligent assistants.
- Challenges and Ethical Concerns, which reflect the recurring issues of transparency, bias, security, misinformation, and the limitations of current chatbot implementations.

**Table 5** presents a summary of the articles grouped by each theme and their corresponding references

### **2.4.2. Literature Analysis**

This section presents the analysis of the selected literature, structured around three research questions that address critical aspects of AI-powered financial assistants. The aim is to identify the main challenges and opportunities reported in the literature, with a focus on

- 1) security and privacy issues that affect adoption (RQ1),
- 2) the potential of AI systems to improve financial inclusion and literacy (RQ2), and
- 3) the market gaps these solutions can address (RQ3). In addition, the analysis synthesizes design implications and highlights threats to validity and limitations emerging from the reviewed studies.

Table 5. Themes and Patterns Identified in the Literature

| <b>Main Themes</b>                     | <b>Sub-Themes/Observations</b>   | <b>Reference IDs</b>  | <b>Total</b> |
|--|--|---|--------------|
| <i>Core Applications and Benefits</i>  | AI/ML improve productivity, fraud prevention, investment management                | [3], [4], [5], [6], [9], [12], [14], [18], [19], [20], [22], [23], [31], [33], [40], [41], [46], [56], [57], [58], [59], [60], [61], [62], [63]   | 25           |
|  | Chatbots: most widely used tool in banking, reduce costs                           | [3], [4], [5], [6], [10], [12], [13], [14], [18], [19], [20], [21], [22], [24], [25], [26], [31], [40], [41], [47], [53], [57], [58], [61], [64], [65], [66], [67]  | 28           |
|  | LLMs like ChatGPT: financial advice, corporate reports, code generation            | [10], [14], [20], [21], [22], [23], [24], [26], [33], [35], [36], [37], [40], [41], [42], [49], [52], [53], [55], [59], [67], [68]  | 22           |
|  | Specialized LLMs (TAT-LLM): advantages in cost, latency, and security              | [30]  | 1            |
|  | AI-driven accounting: automation of reports, fraud detection, predictive analytics | [9], [24], [33], [35], [37], [63]   | 6            |
|  | Transform unstructured data into actionable insights                               | [18], [19], [20], [22], [26], [33], [37], [40], [41], [52], [53], [55], [63], [69]  | 14           |
| <i>Design Considerations</i>           | Personalization, empathy, sentiment analysis for user adoption                     | [1], [3], [5], [6], [8], [12], [14], [18], [19], [20], [21], [22], [24], [26], [31], [33], [37], [38], [40], [41], [46], [51], [53], [54], [55], [57], [58], [61], [62], [63], [64], [65], [66], [67], [70], [71] | 36           |
|  | Real-time retrieval and market analysis via dialog assistants                      | [3], [20], [21], [22], [23], [24], [31], [33], [35], [37], [39], [40], [42], [43], [51], [52], [53], [60], [62], [65], [66], [67], [68], [69]   | 24           |
|  | AI assistants improve financial competence   | [1], [3], [6], [10], [21], [24], [41], [42], [72]   | 9            |
|  | Importance of fairness, accountability, and privacy for vulnerable groups          | [12], [15], [18], [22], [26], [35], [42], [46], [47], [53], [54], [70]  | 12           |
| <i>Challenges and Ethical Concerns</i> | Data privacy, bias, misinformation, transparency, job displacement                 | [5], [12], [14], [15], [18], [21], [22], [23], [26], [31], [35], [36], [37], [40], [41], [42], [47], [53], [54], [56], [61], [63], [65], [67], [68], [70], [71]   | 27           |
|  | Black-box issue reduces accountability   | [12], [22], [23], [26], [35], [47], [63]  | 7            |
|  | Cybersecurity risks, misuse of GenAI, false positives in ChatGPT                   | [2], [4], [5], [12], [13], [14], [18], [22], [26], [35], [40], [41], [47], [53], [56], [63]   | 16           |
|  | Variability in responses (prompt sensitivity, recency bias)                        | [35], [37], [42], [53], [60]  | 5            |
|  | AI assistants struggle with complex financial queries                              | [18], [23], [36], [42]  | 4            |
|  | Banking chatbots limited to pre-determined processes                               | [18], [26], [61], [66]  | 4            |
|  | Bankers' reluctance due to IT perceptions (trust, reliability, privacy)            | [14], [25], [54]  | 3            |

#### 2.4.2.1. RQ1. What are the security and privacy challenges affecting the adoption of these systems?

The adoption of AI-powered financial assistants is impacted by pressing security and privacy concerns. Data privacy and security are paramount as these systems handle sensitive user information [12], [35]. The "black box" nature of some AI models, which refers to their opacity, creates substantial challenges for transparency and accountability in decision-making processes and financial services [25], [35], [47]. The literature highlights these specific challenges.

- **Misuse and vulnerabilities of generative AI** - GenAI and LLMs such as ChatGPT can be exploited for malicious activities including cyberattacks, deception, and manipulation. Despite their advanced capabilities, ChatGPT has shown a high false-positive rate in vulnerability detection (91%), underscoring the need for more robust and reliable systems [13].
- **Data handling and trust** - Digital privacy issues reduce users' willingness to disclose information to chatbots [13]. Perceptions of transparency and trustworthiness strongly shape acceptance [54], and bankers report poor views of security, reliability, and privacy, which hinder adoption [14].
- **Regulatory compliance and ethical data usage** - Implementing GenAI in the banking sector raises challenges around compliance and ethical data use, particularly when analysing client and employee data [17].
- **Security risks in chatbot implementation** - Advanced chatbots face technical vulnerabilities such as SQL injection, malware, and other exploits that risk leaking users' private data [18].
- **Transparency–accuracy dilemma** - While explainable AI (XAI) is proposed to address the "black box" problem, a trade-off remains, as "white box" models can sometimes deliver less accurate results [47].
- **Over-reliance and misinformation** - Robo-advisor explanations do not always improve user understanding, and dialogic explanations can even inflate trust, leading to over-reliance or acceptance of misinformation [73].

**Mitigation** strategies proposed in the literature include developing stronger security and privacy protocols [35], applying data obfuscation techniques to protect sensitive information [36], and designing explanations that build trust without fostering over-reliance [73]. Future research should focus on reliable AI systems where accuracy and trustworthiness are paramount for financial decision-making [36], [51].

#### 2.4.2.2. RQ2. How can AI-powered financial assistants improve financial inclusion and literacy among users?

AI-powered financial assistants have the potential to significantly advance financial inclusion and literacy by combining personalization with broad accessibility [1], [17], [18], [46], [53], [57], [59], [71], [74]. They adapt to users with varying literacy levels and financial contexts, offering tailored support rather than a one-size-fits-all solution [1], [3], [17], [21], [31], [57], [58], [65], [71], [73], [75]. Crucially, anyone with an internet connection can access these resources, enabling individuals to make informed financial decisions without depending on financial institutions or advanced education [1], [8], [18], [23], [37], [42], [46], [53], [59], [65], [73], [76]. This democratization of financial guidance removes traditional barriers [1], [23], [42], [46], [53], [57], [58], [59], [65], [73], [76], while the 24/7 availability of AI systems ensures continuous support across time and location [1], [2], [3], [17], [18], [21], [57], [65], [71]. Here are the main ways these systems advance inclusion and literacy:

- **Personalized financial education** - AI and fintech interventions such as mobile banking, gamification, robo-advising, and app-based investing platforms can strengthen multiple dimensions of financial literacy, including comprehension of financial concepts and numerical calculations. Future studies should explore tailored financial education and automated advisory [1].
- **Accessible financial management tools** - Intelligent virtual assistants, such as the ADAM model, leverage NLP and chatbots to help individuals organize personal finances and improve financial knowledge [10].
- **Support for vulnerable populations** - AI can assist older adults with retirement planning, healthcare costs, and family expenses, with evidence of willingness to adopt AI for missing financial information and self-efficacy [21]. Conversational AI can also empower women entrepreneurs in low-income communities by evaluating micro-business health, promoting credit access, and providing financial education [15].
- **Democratizing financial analysis** – NLP techniques reduce reliance on specialized expertise, expanding access to financial analysis and decision-making. This is especially relevant where financial literacy is below average [76] AI assistants can function as decision-support tools, guiding optimal spending and encouraging critical thinking in real-time shopping contexts [72].

- **Bridging Information Gaps** - AI services can deliver daily financial updates and empower users to act on their socio-economic contexts [21]. LLMs such as ChatGPT, despite current limitations, can serve as financial advisors and influence advice-taking, particularly for individuals with lower financial knowledge [22].
- **Inclusive Financial Systems** - Generative AI can help create inclusive financial ecosystems that expand access to services and products, empowering users regardless of financial background or expertise [37].

#### 2.4.2.3. RQ3. What market gaps can these solutions address?

AI-powered financial assistants are well-positioned to address several critical market gaps by improving efficiency, expanding accessibility, and enhancing the quality of financial services [ref]. These solutions not only streamline individual financial management but also strengthen institutional processes, reduce costs, and broaden access to financial expertise. Here are the main areas where they can close existing gaps:

- **Complex personal financial management** - Many individuals struggle to organize their finances and make optimal spending decisions. Solutions such as the ADAM virtual assistant provide a user-friendly way to manage personal finances and deliver financial education, distinguishing themselves from typical mobile applications [10], [72].
- **Inefficient financial operations and decision-making** - AI and ML systems enhance institutional efficiency by boosting productivity, precision, and security. These tools help reduce suspicious transactions, combat money laundering, expand investment feasibility, and strengthen customer interaction in banking [3], [6], [17].
- **High costs and time constraints in financial advice** - Traditional financial recommendations are time-consuming and expensive. ChatGPT can lower both the time and cost of producing simple recommendations, thereby reducing barriers to access and improving adviser serviceability, while also supporting the repositioning of financial advice offerings to meet evolving consumer needs [23].
- **Limited access to specialized financial expertise** - Many individuals lack the technical or coding skills needed for financial analysis, and financial literacy remains globally low. The NLP-driven Text-to-Chart application democratizes financial analysis by enabling complex evaluations through natural language prompts, reducing reliance on specialized programming skills [76].

- **Lack of trust and human contact in digital services** - Robo-advisors, though cost-effective, are often perceived as impersonal. By leveraging NLP, robotic advisors can improve recommendation quality, reduce confusion, and enhance user trust, delivering an experience that goes beyond text-based advice [8].
- **Limitations of traditional chatbots** - Current banking chatbots are restricted to pre-defined processes and cannot handle complex queries. A secured framework has been proposed to enable adaptive learning, personalized solutions, and seamless integration with other banking systems, resulting in a more cohesive user experience [18].
- **Data scarcity and market inefficiency** - Generative AI can generate synthetic data, offering solutions to scarcity in economic and financial datasets. By transforming unstructured information into usable formats, GenAI improves efficiency in financial markets and creates new opportunities for human-machine collaboration [22], [37].
- **Enhanced reporting and stakeholder communication** - Chatbot technology supports real-time financial reporting by automating data collection, analysis, and report generation. This improves transparency, strengthens stakeholder communication, and facilitates more informed decision-making [24].

#### 2.4.2.4. Design Implications for AI Finance Assistants

Based on the synthesis of findings, several design implications emerge as essential for building effective, trustworthy, and inclusive AI-powered financial assistants. These implications highlight the importance of transparency, security, personalization, and adaptability to ensure adoption and long-term impact [ref].

- **Prioritize transparency and explainability (XAI)** - To overcome the “black box” problem and strengthen user trust, AI systems should transition towards “white box” models that provide clear and understandable explanations for their recommendations [47], [54]. Explanations should mitigate over-reliance and avoid anthropomorphic cues that may mislead users. Concise graphical formats, gamified explanations, or quizzes can improve comprehension and engagement [73].

- **Integrate human-centred and value-sensitive design** - AI assistants must embed principles such as fairness, accountability, trust, and privacy, especially when supporting vulnerable populations [15]. Design should also account for users' psychological readiness and actively work to reduce bias [47]. Features such as multilingual support and human-like interactions can improve accessibility, though caution is needed to avoid over-humanization [73] [38].
- **Ensure robust security and privacy** - Given the sensitive nature of financial data, AI systems must embed security and privacy mechanisms from the outset [18], [35]. This includes data obfuscation for interactions with cloud-based services [36] and compliance with frameworks such as GDPR and DORA [17].
- **Balance automation with human oversight** - AI should complement, not replace, human advisors. A hybrid approach ensures that human empathy, nuanced judgment, and regulatory expertise are preserved while AI provides scalability and efficiency [8], [23], [35], [47].
- **Support personalized and contextualized interactions** - NLP and sentiment analysis should be used to tailor responses to individual needs and financial contexts [3], [51]. Advanced dialogue management (multi-turn intent, slot inheriting, dependency handling) enables more natural and personalized user experiences [51].
- **Address complexity and enhance usability** - While advanced AI features can be complex, interfaces must remain intuitive and user-friendly [33]. Layered architectures (classification, OCR, Q&A) simplify complex tasks such as financial document analysis, while structured prompts improve reliability in code generation [49], [52].
- **Continuously evolve and adapt** – AI financial assistants should be designed for adaptability, learning from user interactions and integrating reinforcement learning to improve performance [13], [18]. They should also support multimodal inputs, ensuring long-term scalability across diverse use cases [39], [76].

#### 2.4.2.5. Threats to Validity and Limitations

Like all research, this study is subject to certain limitations and potential threats to validity. These limitations reflect both methodological constraints and broader challenges inherent to AI technologies, which may influence the generalizability and robustness of the findings.

- **Scope and generalizability** - Although comprehensive, the literature review may have limited scope. Some studies focus specifically on contexts such as AI chatbots in the Indian banking sector [25] or conversational AI in SMEs [12], making the findings less generalizable to other financial markets or applications. Furthermore, the rapid pace of AI development means that results can quickly become outdated [47].
- **Methodological constraints of literature reviews** - As this study relies on published works, it inherits the limitations of prior research. Several sources lack systematic analysis or structured evaluation frameworks, particularly regarding robo-advisors, conversational user interfaces in banking, or comparisons between human and robotic advisors [8]. This absence reduces the depth of available insights [40].
- **Bias and Subjectivity**
  - *Expert opinion bias* – Studies relying heavily on expert models, such as the ISM model for chatbot adoption, may reflect “prejudicial views” and differ from practical outcome [25].
  - *Recency and data bias in LLMs* - Models like ChatGPT depend on web-based data and may exhibit recency bias, causing varied responses to identical prompts and raising replication concerns [35], [41]. Results can also shift with small variations in prompt wording [37].
  - *Limited negative findings* - Many reviews adopt an optimistic stance on AI’s potential, with only a few highlighting risks such as ethical concerns or possible “AI winters,” leading to an overly positive view of AI capabilities [47].
- **Inherent Limitations of AI Technology**
  - *Complexity handling* - LLMs like ChatGPT often struggle with complex financial queries and may fail to grasp intricate legal applications or complete datasets [23], [42].
  - *Transparency–accuracy trade-off* - Achieving transparency in “white box” models can come at the expense of accuracy, creating a tension between interpretability and performance [47].

- *Ethical implications* - Generative AI poses risks such as job displacement, inequality, and the amplification of socio-religious, gender, or ethnic biases. Many of these ethical challenges are still in early stages of investigation [35], [37].
- *Lack of empirical data* - Several challenges identified in the literature remain untested with large-scale empirical studies, limiting confidence in assessing their true severity [35], [41].

### **2.4.3. SLR Conclusions**

This chapter synthesized the findings from a literature review on AI-powered financial assistants, structured around three key research questions as well as design implications and limitations. The review confirmed that AI, particularly through LLMs and chatbots, is rapidly transforming the financial sector by enhancing customer experience, improving operational efficiency, strengthening security, and expanding access to financial knowledge. AI offers substantial benefits such as reduced operational costs, personalized recommendations, and improved decision-making across activities ranging from fraud detection to investment management.

Security and privacy challenges (RQ1) remain paramount, with risks including data breaches, the “black box” nature of models, and potential misuse of generative AI for malicious purposes. Literature stresses the importance of transparency, accountability, and robust security protocols. In terms of financial inclusion and literacy (RQ2), AI-powered assistants demonstrate strong potential to democratize financial knowledge, provide personalized education, and support vulnerable groups such as older adults and women entrepreneurs in low-income contexts. These tools can help bridge information gaps and empower users to manage their finances more effectively. Addressing market gaps (RQ3), AI solutions mitigate inefficiencies in traditional financial operations, reduce the high costs of financial advice, expand access to specialized expertise, and improve the limited functionality of conventional chatbots through scalable and intelligent services.

The design implications highlight the need for transparent, explainable, and human-centred AI, with a focus on mitigating biases, safeguarding privacy, and maintaining balanced human-machine collaboration. Future assistants must evolve continuously, adapt to contextual complexity, and prioritize user trust through ethical and inclusive design.

Finally, the chapter acknowledged important threats to validity and limitations, including the rapid evolution of AI technologies, methodological subjectivity, and difficulties in generalizing findings across diverse contexts. Challenges such as the transparency–accuracy trade-off and the ethical dilemmas posed by generative AI’s double-edged nature further underline the importance of rigorous empirical research and iterative development. These insights directly inform the methodological approach presented in the next chapter.

## **2.5. Main functionalities of the AI Financial Virtual Assistant**

This section outlines the core functionalities of the AI-powered financial virtual assistant. These functionalities were chosen based on their relevance to improving financial management, providing personalized advice, ensuring security in transactions, and optimizing user engagement. As summarized in **Table 6**, the assistant integrates multiple layers of intelligence, including fraud detection, personalized recommendations, portfolio optimization, and goal tracking. It leverages machine learning, natural language processing, and data analytics to deliver actionable insights and proactive support. Moreover, the functionalities emphasize accessibility and transparency, enabling real-time alerts, integration with existing financial systems, and tailored user interactions.

Table 6. Core Functionalities

| Functionality                           | Description  | Implementation  | References  |
|---|--|---|---|
| Personalized Financial Advice           | The assistant will offer financial advice based on the user's spending patterns, financial goals, and preferences, using ML algorithms to provide tailored recommendations.  | Using ML models, the assistant will categorize spending habits and forecast future financial behaviour, offering actionable insights. NLP will allow the assistant to understand and interpret user queries in a conversational manner, providing responses that feel intuitive and relevant. | [1], [6], [47], [66], [71]                              |
| Fraud Detection and Risk Management     | A critical feature of the financial assistant will be its ability to <b>detect fraudulent activities</b> and assess <b>credit risks</b> using <b>AI algorithms</b> . By analysing large volumes of transactional data in real-time, the assistant will identify anomalies, flag potential fraud, and help prevent financial losses. This functionality is crucial for ensuring <b>data security</b> and building trust in the assistant. | Supervised learning models can be applied to detect patterns indicative of fraudulent activities. By continuously learning from new data, the system will improve its ability to predict and identify fraud and will send real-time alerts to the user for immediate action.                  | [3], [4], [9], [26], [31], [54]                         |
| Automated Customer Support              | The virtual assistant will provide <b>24/7 customer support</b> through a <b>chatbot interface</b> , capable of handling common inquiries such as account balances, transaction details, and loan eligibility. By using <b>NLP techniques</b> , the assistant will interact naturally with users, answering queries efficiently and in real-time.  | The chatbot will be integrated with <b>NLP</b> to understand user queries and respond with relevant financial information. It will be able to escalate more complex issues to human agents when necessary.  | [6], [21], [41], [47], [57], [71], [72], [76]           |
| Personalized Investment Recommendations | The assistant will provide <b>customized investment recommendations</b> based on the user's risk profile, financial objectives, and market data. Using <b>AI models</b> for predictive analytics, the assistant will analyse real-time market trends and help users make informed decisions regarding their investment portfolios.   | <b>AI-based models</b> will help assess the user's risk tolerance and match them with appropriate investment strategies, such as stocks, bonds, or mutual funds. The assistant will continue to monitor market trends and adjust recommendations accordingly.                                 | [3], [6], [7], [41], [75]                               |
| AI-based Portfolio Optimization         | The assistant will optimize the user's <b>investment portfolio</b> based on real-time financial data and market trends. By dynamically adjusting portfolio allocations, the assistant will help users maximize their returns while minimizing risks.   | <b>Reinforcement learning</b> can be used to continuously adjust portfolios based on changing market conditions and user preferences. The system will evaluate asset performance and provide actionable recommendations for better portfolio management.                                      | [3], [6], [47], [62], [66]                              |
| Integration with Banking Systems        | To offer a comprehensive view of a user's finances, the assistant will integrate with both <b>traditional banking systems</b> and <b>digital wallets</b> . This integration will allow the assistant to access and manage all the user's financial data in one place, offering a holistic view of their financial situation.   | The assistant will interface with banking APIs and <b>Open Banking</b> protocols to access real-time data on accounts, transactions, and balances, consolidating the information into a single dashboard.   | [3], [4], [6], [17], [31], [47], [71], [75], [77], [78] |
| Real-time Alerts and Notifications      | The assistant will provide real-time notifications to the user, such as alerts for upcoming bill payments, unusual spending, or potential investment opportunities. These notifications will help users stay on top of their finances and act when needed.   | Alerts will be triggered by <b>predefined financial thresholds</b> , such as spending limits or savings goals. The assistant will send notifications via push notifications or emails, depending on user preferences.   | [6], [43], [44], [71]                                   |
| Financial Goal Tracking                 | Users will be able to set <b>financial goals</b> (such as saving for a down payment on a house or for retirement) and track their progress with the assistant's help. The assistant will provide feedback and suggest adjustments to the user's financial strategy to help them meet their goals.  | The assistant will use <b>data analytics</b> to monitor user progress toward financial goals and offer adjustments to savings or investment strategies to stay on track.  | [6], [8], [31], [71]                                    |



## CHAPTER 3

# Methodology

A Design Science Research (DSR) methodology was employed in this study. DSR consists of creating and evaluating innovative artifacts to address and solve real-world problems. Accordingly, this method was applied to design, construct, and assess (K. Peffers et al., 2007) an AI-driven financial assistant (LUMI) with the integration of generative AI.

The artifact is based on integrating Generative Artificial Intelligence (Generative AI) to improve financial decision-making processes and empower users in managing their personal finances. The artifact, designed for creation and presentation to stakeholders (test users and domain experts), subsequently underwent testing. Following this, an evaluation based on the results obtained took place, facilitating adjustments and improvements based on feedback. The final phase entailed documenting the evolution of this process, and the outcomes achieved through the development of this artifact.

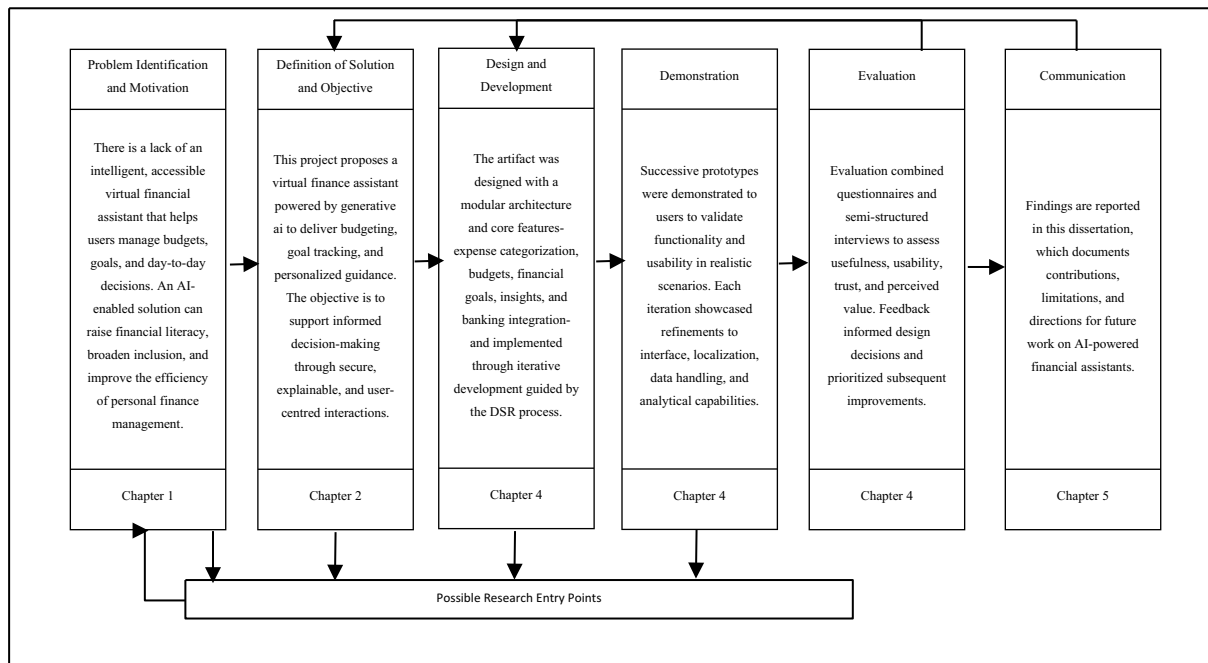


Figure 2. Application of DSR Methodology



## **LUMI: Proposal and Evaluation**

In this phase of the DSR model, an exploratory study was conducted to design a suitable and adaptable artifact for individuals seeking to manage their personal finances more effectively. The focus was placed on understanding existing practices in financial management applications, identifying their strengths, and uncovering opportunities for improvement. To achieve this, a comparative benchmarking analysis of widely used financial applications was carried out.

This investigation revealed that most applications emphasize basic functionalities such as transaction management, budgeting, and goal setting, but often fall short in areas such as integrated banking connectivity, intelligent insights, and multi-platform consistency. Furthermore, many solutions lack advanced personalization and adaptability, which are crucial for addressing diverse user needs.

From this analysis, a set of challenges and opportunities was identified. Users require not only tools to register and categorize their transactions, but also systems capable of providing proactive guidance, predictive analytics, and actionable insights. Equally important is the assurance of security, accessibility, and usability, given the sensitive nature of financial data.

The outcome of this research informed the design of LUMI, a personal financial management application that consolidates essential functionalities while introducing advanced features such as secure bank integration and AI-driven assistance. The purpose of the artifact is to create a comprehensive ecosystem where users can track their finances, plan budgets, pursue financial goals, and receive intelligent recommendations to support informed decision-making.

### **4.1. First DSR Iteration**

To initiate the first iteration of the Design Science Research (DSR) cycle, an initial set of requirements was gathered and analysed, which provided the foundation for building the first version of the artifact. The development process followed an incremental and iterative logic, where functionalities were progressively designed, implemented, and validated with reference to both existing applications in the financial management domain and early user feedback.

#### **4.1.1. Requirements Gathering**

To define the scope of the initial artifact, an exploration analysis of existing personal finance applications was conducted. This benchmarking process enabled the identification of a set of commonly adopted functionalities, as well as opportunities for differentiation through advanced capabilities such as AI-based insights and multi-platform support. Based on this comparative study, the following list of requirements was consolidated (see Table 7).

**Table 7** presents the functionalities that were prioritized for the first iteration. These include foundational features such as user authentication and transaction management, as well as higher-level modules such as budget planning, goal setting, and an AI assistant capable of generating insights. Additional supporting functionalities, including internationalization, themes, and feedback forms, were also incorporated to improve user experience, accessibility, and long-term adaptability of the system.

### **4.1.2. Mockups**

To gain a clearer perspective of the user journey and the interaction between different modules, several use case diagrams were developed. These diagrams illustrate the flows of activities associated with the core functionalities identified during requirements gathering.

The mockups were instrumental in visualizing how users would navigate the system, from the initial authentication process to more advanced interactions, such as querying the AI assistant or setting financial goals. They also provided an early opportunity to identify potential usability issues and redundancies before implementation.

The diagrams, presented in **Figures 3-7**, represent the main workflows considered during the first iteration. Although subject to refinement during subsequent iterations, these models established the baseline structure of the artifact and ensured that development is aligned with the intended functional scope. ([Full Diagram](#))

### **4.1.3. Artifact Development**

After consolidating the requirements and building the initial mockups, development of the artifact commenced. The application was implemented using React Native with TypeScript, which provided a robust cross-platform framework for delivering consistent user experience across iOS and Android devices. This choice facilitated modular development, type safety, and maintainability, while also enabling rapid prototyping and iterative refinement. To accelerate the overall process and support deployment consistency, Bolt was adopted as a rapid application development environment, ensuring the underlying architecture could scale while minimizing setup overhead. For deployment, the web version of the application was delivered through Netlify, ensuring reliable and automated continuous deployment. Expo was used to generate mobile builds, enabling testers to quickly access and validate new versions. To centralize access and streamline feedback, Lovable provided a dedicated hub ([LUMI-Hub](#)) where users could download the latest web and mobile builds and complete structured feedback forms. Combined, these tools established an efficient workflow for deployment, testing, and user feedback, supporting continuous validation and iterative improvement of the system.

The backend infrastructure was primarily managed by Supabase, which served a dual role:

1. As a relational database for storing user-specific financial data (transactions, budgets, goals, and profiles),
2. As a serverless environment through Edge Functions for handling secure backend logic. This architecture allowed the system to process sensitive operations, such as authentication and financial data synchronization, in a secure and scalable manner.

For banking integration, the application leveraged Plaid, a specialized API platform that provides secure connectivity with financial institutions. Through the Plaid Link flow, users could authenticate their accounts and authorize access to account balances and transaction histories. The integration logics such as exchanging public tokens for secure access tokens and synchronizing financial data was orchestrated via Supabase Edge Functions, ensuring that sensitive information was handled securely and efficiently.

A key differentiator of the artifact is the incorporation of AI-driven insights and conversational support, powered by Groq's API. Specifically, the system integrates the LLaMA-3.1-8B-Instant model, which enables both natural language interactions through a chatbot interface and advanced analytical insights into financial data. User queries are processed in natural language, contextual prompts are generated by Supabase Edge Functions, and the responses are returned via the Groq API. This setup allows the AI assistant to synthesize information across transactions, budgets, and goals, providing personalized recommendations such as detecting spending trends, predicting expenses, and suggesting saving strategies.

The initial set of functionalities implemented included user authentication, transaction management, budget planning, goal setting, banking integration, and the AI assistant with Groq support. Additional features such as internationalization, themes, and profile management ensured adaptability to user preferences, accessibility requirements, and different usage contexts.

Although developed incrementally, the functionalities collectively formed a coherent ecosystem. Transaction data served as the foundation for budgets and goals, while Plaid-based banking integration enriched the dataset with real-time financial information. Supabase's Edge Functions mediated interactions between these modules and the Groq API, enabling the AI assistant to generate contextualized insights and predictive analytics. This integration emphasized the interconnected nature of the system, where each module reinforced the others to deliver a comprehensive financial management experience.

To ensure continuous improvement, the development process was structured into 4 iterations, each focused on delivering a subset of features, testing them with users, and refining them based on feedback. This iterative methodology aligns with the principles of design science research, ensuring both rigor and relevance in the artifact's evolution.

#### **4.1.4. Demonstration**

After implementing the features defined for the first iteration, a demonstration of the artifact was carried out to validate the main functionalities and assess their integration within a coherent system. This stage aimed to provide a practical view of how the requirements identified in the benchmarking phase were translated into a functioning application.

The demonstration began with the authentication and onboarding process, where a user could create an account, log in securely, and configure their initial preferences such as language and currency. These settings were stored in Supabase, ensuring a personalized user experience from the start.

Once authenticated, the user accessed the transaction management module, which allowed manual input of income and expenses. Transactions were displayed in a structured list, with options for filtering, editing, and deletion. To complement this manual entry, the system also showcased banking integration via Plaid, where users could connect their bank accounts through the Plaid Link flow. This enabled the secure import of real transaction data, automatically synchronized and stored in Supabase through Edge Functions.

Next, the budget planning and financial goal setting modules were demonstrated. Budgets could be created by defining categories, amounts, and timeframes, while goals included target amounts and deadlines. Both features provided progress indicators, enabling users to monitor adherence to budgets and track savings goals effectively. These modules highlighted the structuring of financial data into actionable insights.

A central component of the demonstration was the AI assistant, powered by Groq's LLaMA-3.1-8B-Instant model. Through a conversational interface, users could ask natural language questions regarding their finances, such as spending patterns or progress toward goals. Contextual prompts were generated via Supabase Edge Functions and passed to the Groq API, which returned personalized responses. This demonstrated the system's ability to transform raw financial data into meaningful guidance, offering users predictive insights and recommendations.

Finally, the profile and settings module were presented. Users were able to adjust personal information, configure notification preferences, switch between light and dark themes, and provide feedback through integrated forms. The multilingual support was also shown, allowing for seamless transitions between English and Portuguese.

Figures 8-19 display screenshots of the application developed in this iteration, illustrating the flows from authentication to financial management, AI interaction, and customization. These visuals represent the transition from abstract requirements and mockups into a fully operational artifact, validating the progress achieved during the first cycle of development.

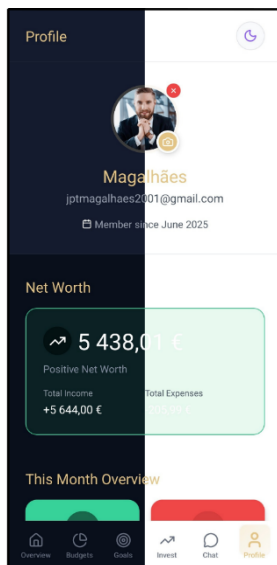


Figure 8. Profile Page

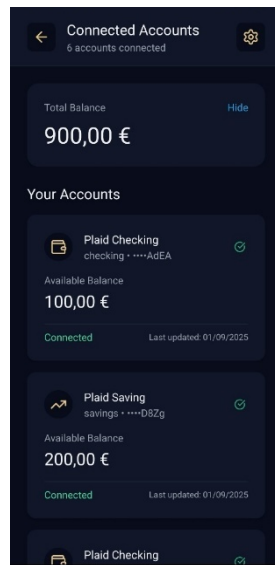


Figure 9. Bank Accounts

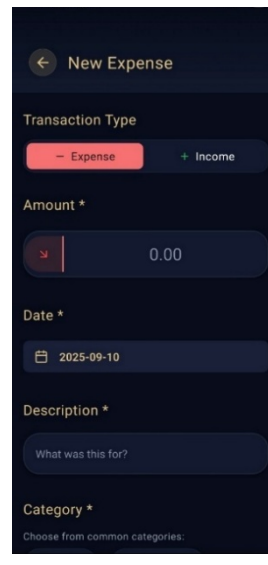


Figure 10. Expense/Income Transaction Page

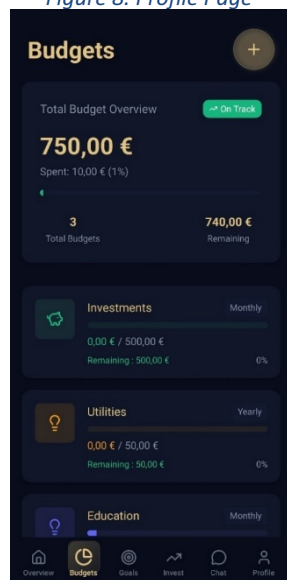
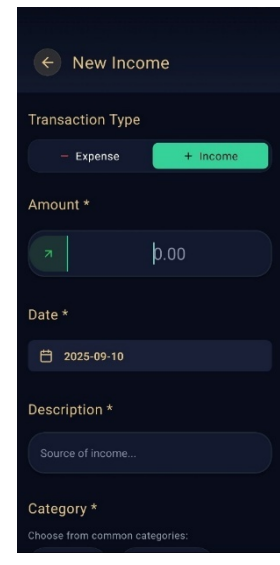


Figure 11. Budgets Page

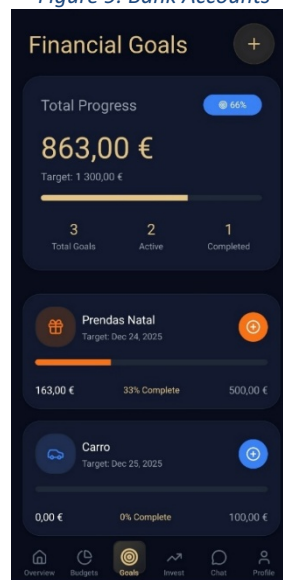


Figure 12. Goals Page

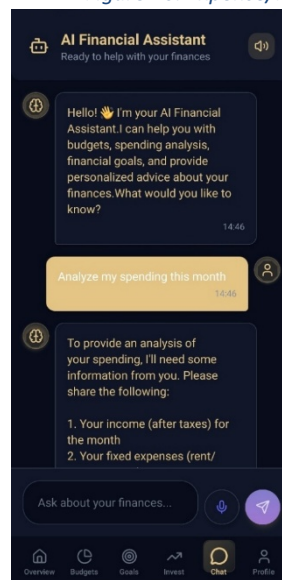


Figure 13. AI Chat Page

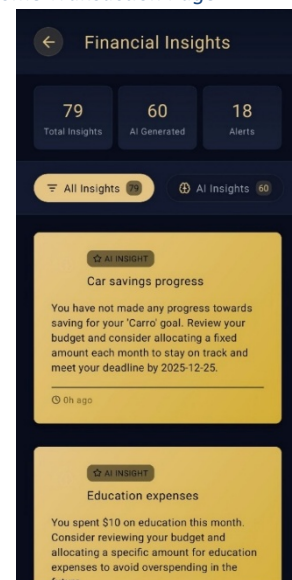


Figure 14. All Insights Page

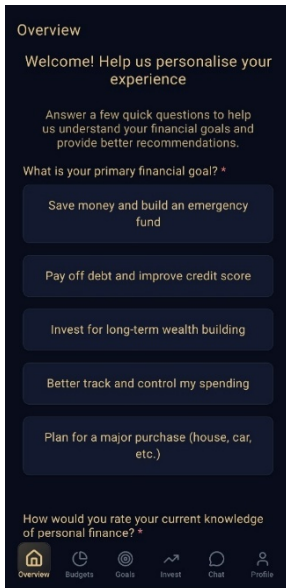


Figure 15. Onboarding Quiz

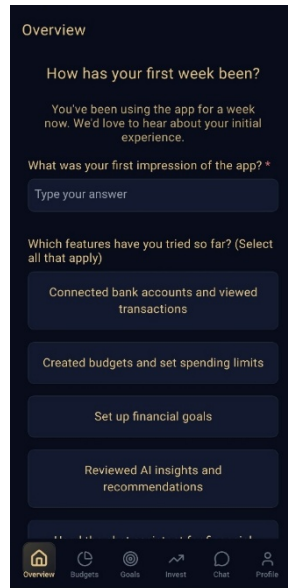


Figure 16. First Feedback Quiz

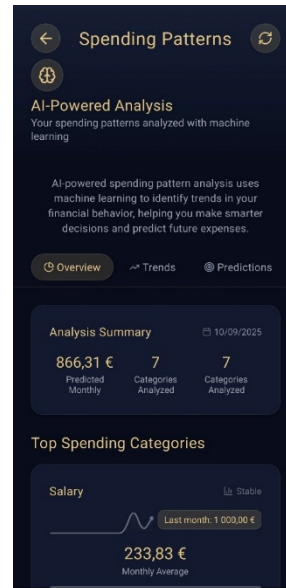


Figure 17. Patterns Page

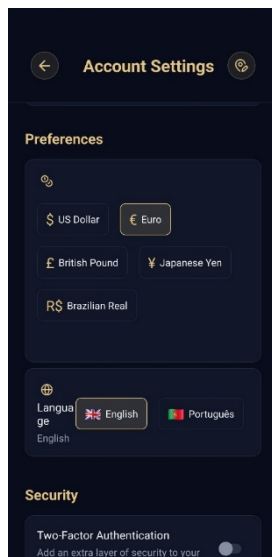
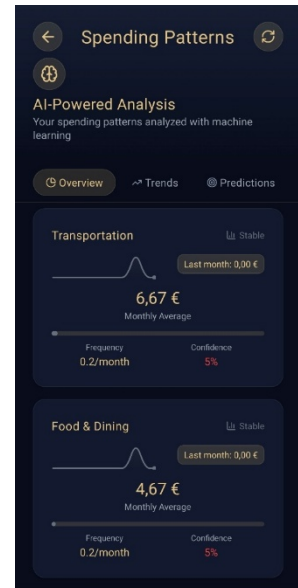


Figure 18. Account Settings Page

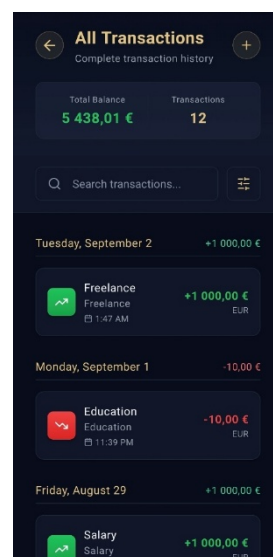


Figure 19. All Transactions Page

#### 4.1.5. Evaluation

After the first iteration of the artifact was completed, an evaluation was conducted to gather user perceptions of its usability, functionalities, and overall value. The purpose of this assessment was to verify whether the requirements defined during the benchmarking phase were successfully translated into a functional and user-friendly solution, while also identifying shortcomings and opportunities for future improvements. Participants were invited to interact with the application and explore its main modules, including authentication, transaction management, budget planning, financial goals, banking integration, and the AI assistant. The evaluation took place through guided sessions where users navigated the system and performed tasks, followed by a structured questionnaire (**Table 8**) designed to collect both quantitative and qualitative feedback.

The questionnaire included demographic and contextual questions (e.g., age, professional area, and financial knowledge) as well as evaluative questions focused on user experience, functionality relevance, and willingness to adopt the application. It also contained open-ended questions to capture opinions on strengths, weaknesses, and suggestions for improvement. Table 9 presents the questions used in this phase.

The evaluation involved multiple participants from diverse professional backgrounds, including Marketing/Communication, Technology/Computer Science, and Design. Participants ranged in age from 23 to 47 years old and reported different levels of financial knowledge (basic, intermediate, and advanced).

*Table 8. Evaluation Questions*

| ID   | Question   |
|------|--|
| Q.1  | What is your age?  |
| Q.2  | What is your professional area?  |
| Q.3  | What is your level of financial knowledge?                               |
| Q.4  | How would you rate your overall experience with the application? (1-5)   |
| Q.5  | Is the interface intuitive and easy to use?                              |
| Q.6  | Which features did you use and find most useful?                         |
| Q.7  | Which features would you like to see added?                              |
| Q.8  | Would you recommend this application to a friend?                        |
| Q.9  | Would you pay for this application?                                      |
| Q.10 | If yes, how much would you be willing to pay for a monthly subscription? |
| Q.11 | What did you like the most about the application?                        |
| Q.12 | What did you like the least about the application?                       |
| Q.13 | What would you change or improve?  |
| Q.14 | Additional comments  |

Overall, the experience with the application was positively received. On a scale from 1 to 5, the overall experience averaged 3.7, while the intuitiveness of the interface averaged 3.8. All participants stated they would recommend the application to a friend, and most indicated a willingness to pay for it, with suggested monthly subscription values between 1€ and 10€. Among the most valued aspects were the ability to categorize expenses, define financial goals, control budgets, and interact with the AI assistant. Banking integration was also considered a key strength, as it consolidates financial data into a single space. On the other hand, participants

noted areas for improvement such as interface clarity, AI contextualization of data, and support for multiple bank accounts.

The open-ended questions revealed additional insights, including minor usability issues (e.g., unclear buttons, broken layouts, and missing translations) and desired features such as spending graphs, more flexible quick actions, and improved data synchronization. These responses highlight both the strengths and the limitations of the current iteration. The table below summarizes the feedback, presenting positive aspects, negative aspects, and suggested improvements together with representative quotes.

The evaluation demonstrates that the artifact meets its core objectives by combining essential financial management features with AI-driven support. Nevertheless, the results also reveal concrete areas for refinement, particularly regarding interface usability, the breadth of banking integration, and the contextualization of insights. These findings provide a solid foundation for the second iteration of the DSR cycle, ensuring that the artifact continues to evolve in alignment with user needs and expectations.

## **4.2. Second DSR Iteration**

Gathering insights from the first evaluation was essential for guiding the development of the second iteration. User feedback emphasized the strengths of the application, such as financial goal management, expense categorization, and the AI assistant, while also revealing areas for improvement, including interface clarity, data contextualization, and multi-account visualization. These findings directly informed the refinement of the prototype.

### **4.2.1. Proposal**

The feedback collected during the first evaluation highlighted both the strengths of the application and several usability and functional issues that required improvement. Participants emphasized the usefulness of features such as categorizing expenses, managing budgets and goals, and interacting with the AI assistant. At the same time, they reported limitations related to interface clarity, missing validations, inconsistent translations, redundant buttons, and a lack of contextualization in the AI's responses.

In response, the second iteration was designed with the objective of refining the interface, improving the consistency of interactions, and extending functionality to better align with user expectations. **Table 10** summarizes the improvements made after the first iteration.

### **4.2.2. Demonstration**

Following the implementation of the improvements listed before, a demonstration was carried out to validate the refinements introduced in the second iteration of the artifact. The goal of this

phase was to showcase not only the core features already present in the first version, but also the usability enhancements and functional corrections applied after the initial evaluation.

During this demonstration, the user journey began with authentication and navigation through the main modules, including transactions, budgets, goals, and the AI assistant. Special attention was given to improvements such as the removal of redundant buttons, clearer interface hierarchies, corrected translations, and the immediate visualization of newly added transactions without requiring application reload.

The budget and goal modules were also revisited, highlighting the new progress update flows (“Update Progress” and “Adjust Progress”), the improved alignment of interface components, and the inclusion of mandatory field indicators. The overview section was presented with its updated layout, now capable of handling large income and expense values without compromising readability.

Finally, the AI assistant was demonstrated with contextual access to user data, enabling it to provide more relevant and personalized recommendations. The chatbot now allows users to mute or unmute speech output and avoid previous interface issues when typing on mobile devices.

Figures 20-29 illustrate some of the updated screens of this iteration, showing the improvements in navigation consistency, budget management, and financial insights presentation. This demonstration confirmed that the artifact had evolved into a more coherent and user-centred system, effectively addressing the usability challenges and functional limitations identified in the first evaluation.



Figure 20. View All Insights

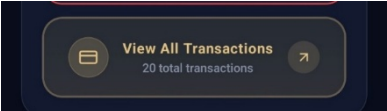


Figure 21. View All Transactions Button

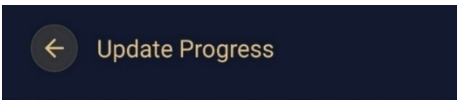


Figure 22. Update Progress Title

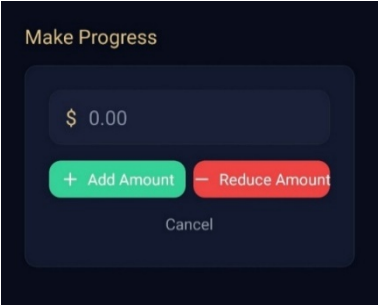


Figure 24. Make Progress Action

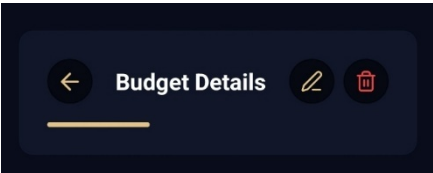


Figure 23. Budget Details Header

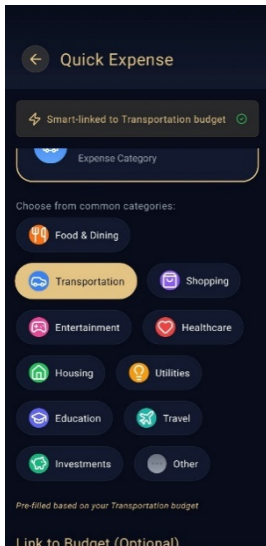


Figure 25. Quick Expense Page

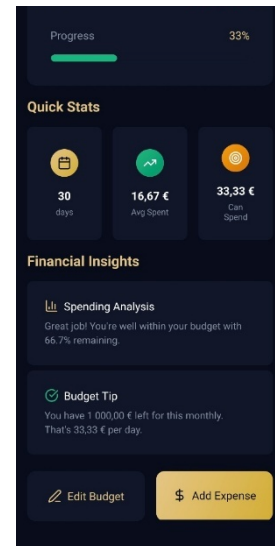
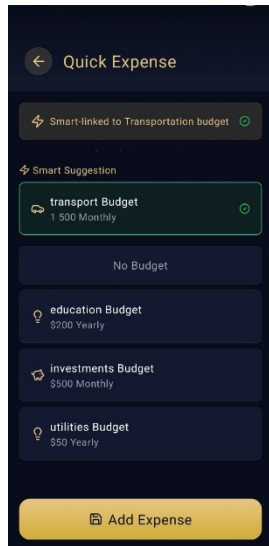


Figure 26. Budget Detail Page

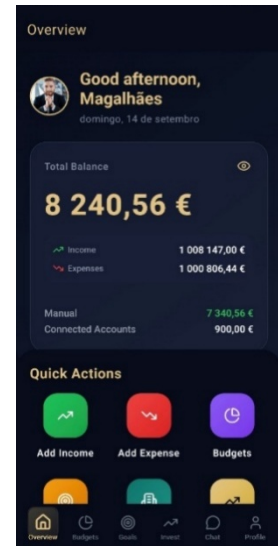


Figure 27. Overview Page

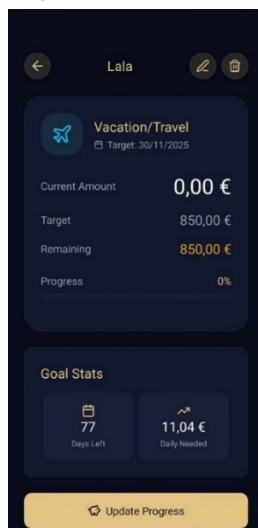


Figure 28. Goal Detail Page

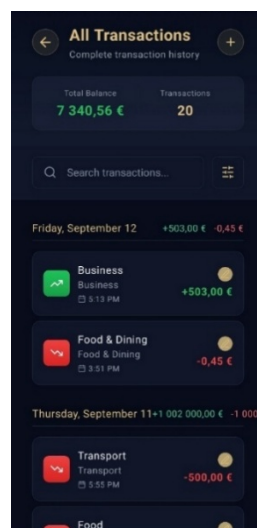


Figure 29. New All Transactions Page

### 4.2.3. Evaluation

After the second iteration of testing, feedback was collected from eleven participants, highlighting both strengths and areas for improvement. The positive points focused on the well-structured human-machine interaction, the intuitively and simplicity of organizing savings and goals, the overall ease of use, and the ability to maintain a global overview of the budget while tracking expenses effectively. At the same time, some limitations were noted, including too many available options in the interface, occasional confusion when navigating the initial screen, and difficulties in automatically associating expenses with specific budgets. Suggestions for improvement included reducing the number of options in the Button Bar to avoid overwhelming choices, refining the automatic association of expenses to budgets, and improving quick action functions in the initial interface. Additionally, participants expressed interest in expanding the application with investment-oriented features, offering personalized tips and functionalities to support financial growth. Overall, this iteration reaffirmed the value and usability of the application while providing actionable insights for guiding the next development phase.

### **4.3. Third DSR Iteration**

The third iteration focused on addressing the main challenges identified in the previous evaluation, particularly the complexity of navigation and the demand for investment-related features. Issues such as the incorrect association of expenses with budgets, reported earlier, were fixed in this cycle, improving the accuracy of financial tracking. Building on the lessons learned, this iteration aimed to refine usability, streamline the interface, and introduce enhancements aligned with user expectations. The process is described through the proposal, demonstration, and evaluation presented in the following subsections.

#### **4.3.1. Proposal**

The feedback from the second evaluation highlighted both the strengths of the application and areas requiring refinement. Participants valued features such as expense categorization, budget and goal management, and the intuitive interface. However, they also noted issues with navigation complexity, layout overlaps, translation inconsistencies, and missing features such as investment guidance.

In response, the third iteration focused on resolving these usability and functional gaps while consolidating stability across platforms. As summarized in **Table 12**, this cycle addressed incorrect expense–budget associations, translation inconsistencies, layout misalignments, and missing validations. Improvements also included profile formatting, goal visualization, and navigation within the banking module.

Some requests were not implemented in this iteration, including reducing the number of buttons in the Button Bar, automatic redirection to the app after email confirmation, and investment-related features. These remain part of the roadmap for future iterations.

#### **4.3.2. Demonstration**

Following the improvements summarized previously, a third-iteration demonstration was conducted to assess their effect on the end-to-end experience. Authentication now proceeds smoothly on web and mobile, enabling access to the application through the web version. On the Overview, localization and alignment are consistent (Portuguese titles and labels rendered correctly; quick actions aligned), and large values no longer disrupt the layout. Within AI Insights, Smart Analysis renders as intended and presents contextual outputs. The Budgets module exhibits cleaner presentation: long titles no longer overlap warnings, the four statistics appear on a grid system 2x2, and category labels are coherent across languages; in Budget Details, the header is properly contained and *Spending analysis* links to patterns. The Goals view introduces colour framing on mobile to improve visual scanning. The entire app now

benefits from compact currency formatting (1K/1M/1B, with the full value shown beneath) and a clearer monthly metric (“Transactions This Month”) on the Profile page. The Account Settings page displays a corrected layout for language and currency selectors. Finally, the Banking hub was redesigned as a clearer entry point with dedicated Accounts and Helpful Tools (with unlock rules stated), improving discoverability and flow. An informational email-confirmation screen was added; automatic post-confirmation redirection remains pending. Figures 30-37 illustrate these updates.

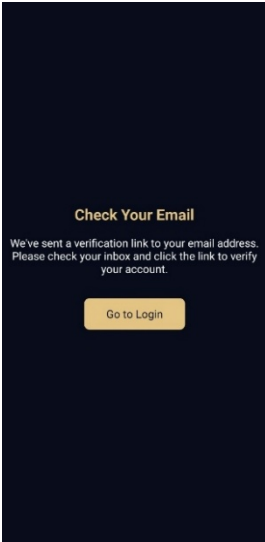


Figure 30. Confirmation email

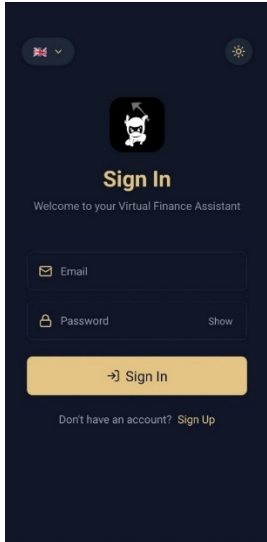


Figure 31. Sign In Page - Updated



Figure 32. Profile Page - Updated

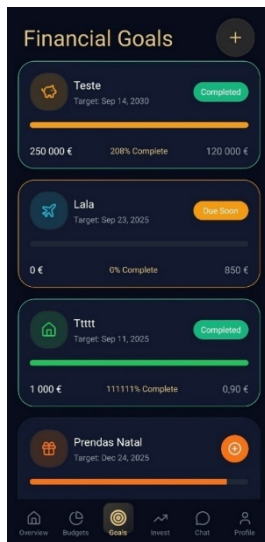


Figure 33. Goals Page - Updated

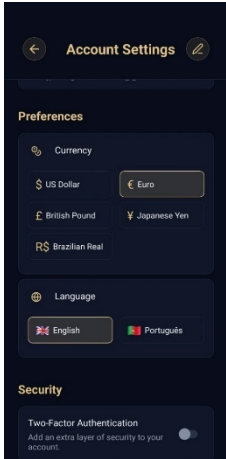


Figure 34. Account Settings Page - Updated

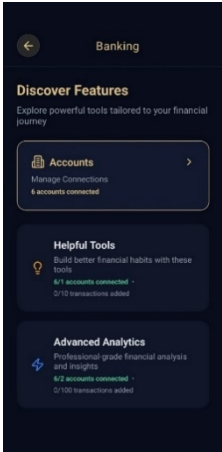


Figure 35. Banking Hub Page - Redesigned

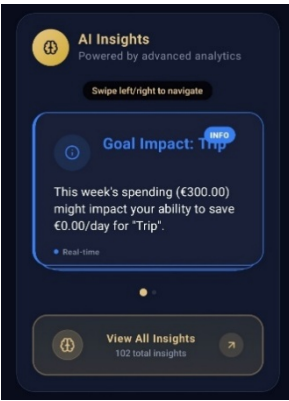


Figure 36. Insights Section - Redesigned

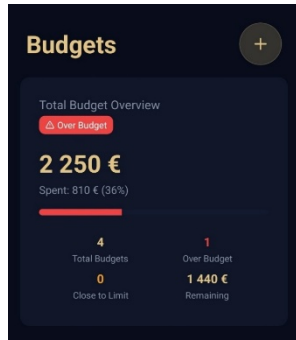


Figure 37. Budget Header - Redesigned

### 4.3.3. Evaluation

After the third iteration of testing, feedback was collected from five participants representing different professional backgrounds, ranging from technology and finance to marketing and healthcare. The results highlighted a clear improvement in the application’s stability, design, and user experience. The positive aspects focused on the application’s intuitive navigation, the clarity of the AI assistant’s responses, the usefulness of budgeting and expense categorization

features, and the overall simplicity in defining and tracking financial goals. Users particularly valued the integration of analytical graphs, the ability to manage transactions efficiently, and the coherence between different financial modules.

At the same time, some limitations were identified. Participants mentioned minor inconsistencies in currency symbols and translations, occasional navigation errors that led to inactive pages, and difficulties in scrolling through transaction filters. The budgets section was also considered less intuitive by some users, and a few participants suggested expanding the investment area and improving interface aesthetics. Recommendations for improvement included refining visual hierarchy, implementing better platform compatibility (especially for iOS), and further unifying the language and currency format across all views.

Overall, this evaluation reinforced that LUMI had evolved into a functional and user-friendly personal finance assistant, providing tangible value in financial tracking and goal management. The collected feedback, summarised in the **table 13**, guided the next iteration, focusing on addressing navigation errors, improving translation consistency, and adding requested features to enhance the overall user experience.

#### **4.4. Fourth DSR Evaluation**

The fourth iteration focused on resolving the remaining technical and usability issues identified in the previous cycle, with the goal of improving stability, coherence, and overall user experience. Problems related to registration, navigation, and inconsistent data handling were corrected, ensuring smoother interactions and greater reliability across platforms. This phase also introduced new functionalities, such as recurrent transactions, categorized spending analysis, and contextual tooltips, while refining existing components like AI-powered insights and feedback timing. Building on the results of earlier evaluations, this iteration strengthened the system's consistency, accuracy, and user engagement. The process is described through the proposal, demonstration, and evaluation presented in the following subsections.

##### **4.4.1. Proposal**

The feedback from the third evaluation emphasized both the progress achieved and the remaining issues that required resolution. Participants highlighted the intuitive navigation, usefulness of the AI assistant, and the effectiveness of budgeting and goal-tracking features, while also noting inconsistencies in currency display, missing translations, and occasional navigation errors. In response, the fourth iteration focused on addressing these functional inconsistencies, improving overall stability, and enhancing the clarity and coherence of the user experience across platforms. As summarized in **Table 14**, this cycle corrected authentication

errors on the web version, refined the registration and onboarding flow, standardized currency formatting, and completed missing Portuguese translations.

Additional improvements included the implementation of contextual tooltips, a persistent Home button for easier navigation, and a new page that displays spending grouped by category. The AI insights were recalibrated to align recommendations with the user's actual data, and the feedback system was adjusted to trigger only after ten transactions or one week of usage, ensuring more meaningful responses. Furthermore, new functionalities such as recurrent transactions and clearer investment indicators were introduced, along with visual and accessibility refinements to improve consistency and usability.

Some planned features, including advanced investment integration and automatic post-confirmation redirection after email verification, remain in development and are scheduled for future iterations.

#### **4.4.2. Demonstration**

Following the improvements summarized in **Table 14**, a fourth-iteration demonstration was conducted to validate the stability, coherence, and usability refinements introduced in this cycle. The registration and authentication flows now execute seamlessly across web and mobile, with the user's name automatically propagated to the profile setup and persistent session handling. Navigation consistency has been strengthened through the addition of a persistent Home button and the correction of inactive routes, ensuring that all tabs-particularly Active Budgets and Goals-redirect to their respective pages. The Overview section now includes contextual tooltips (“?” icons) that explain key features, and spending can be viewed by category through a newly introduced breakdown page. Currency formatting has been standardized across the interface (€, \$, etc.), complemented by completed Portuguese translations and unified axis labels within the Predictions graph. Within AI Insights, recommendations are now calibrated with the user's actual financial data, while directional arrows and refined layouts facilitate access to related analytical pages such as Patterns. The recurring transactions feature has been implemented with clear payment disclaimers, and feedback prompts now trigger only after ten transactions or one week of usage, improving timing and contextual relevance. Visual improvements extend to accessible colour contrasts and smoother transitions, while the investment area now displays an “Under Construction” banner with mock data to maintain user awareness. Overall, this demonstration confirmed that LUMI achieved a higher level of stability, accuracy, and visual coherence, providing a consistent, intuitive, and context-aware experience across all supported platforms. Figures 38-49 illustrate these updates.

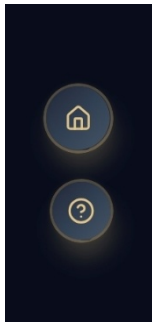


Figure 38. Tooltip and home buttons

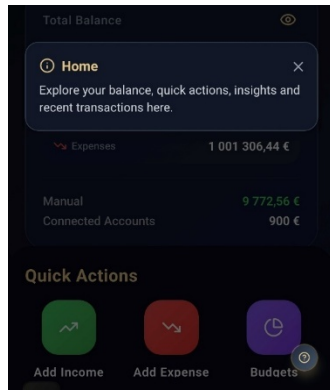


Figure 39. Tooltip Modal

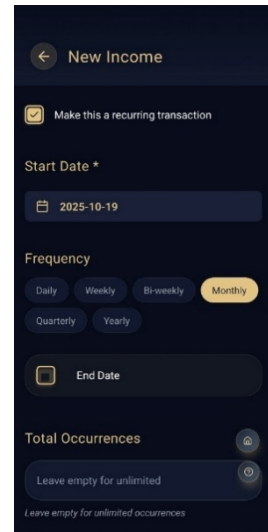
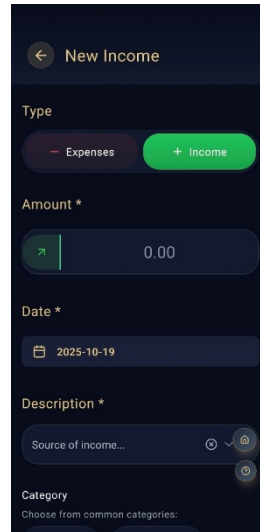


Figure 40. New transaction Layout - Updated

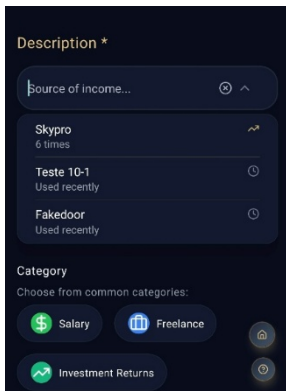


Figure 41. New Transactions descriptions- Reuse other categories

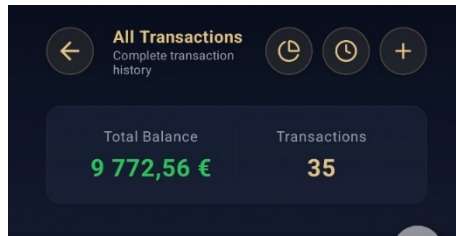


Figure 42. All transactions header - Updated

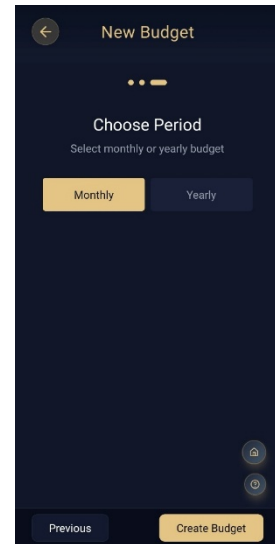


Figure 46. New Budget page - Refactor

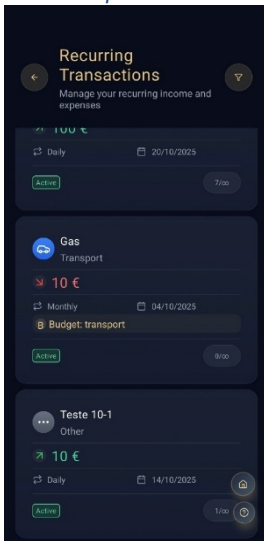


Figure 43. Recurring Transactions List

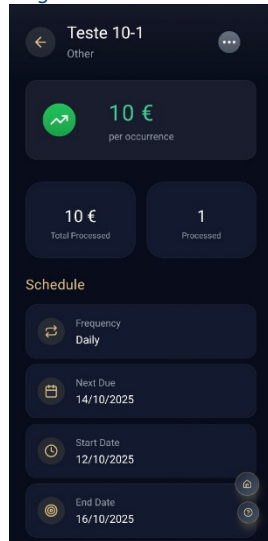


Figure 44. Recurring Transaction ID



Figure 45. Spending by Category

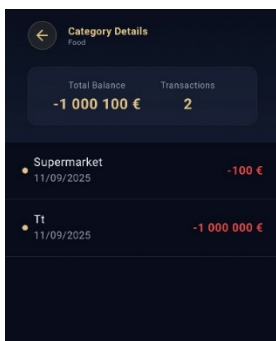


Figure 47. Category ID



Figure 48. Budget ID with new button

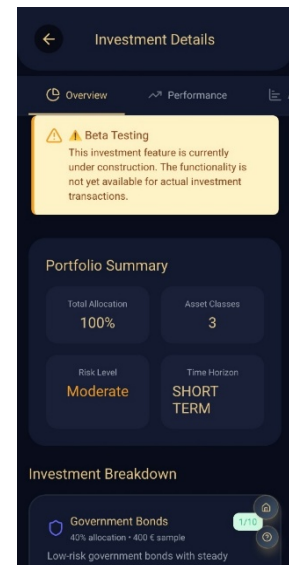


Figure 49. Investment Page - Updated

### **4.4.3. Evaluation**

After the fourth iteration of testing, feedback was collected from fifteen participants representing various professional backgrounds, including administration, construction, engineering, healthcare, marketing, social work, hospitality, and education. Participants ranged in age from 16 to 62 years old and reported financial knowledge levels from basic to advanced. All respondents interacted with the LUMI application, either by installing it or using the web version.

Overall, user feedback was highly positive. On a scale from 1 to 5, the average rating for overall experience was 4.9, while interface intuitiveness averaged 4.8. Participants highlighted the usefulness of the AI assistant for answering financial questions, as well as features that allow them to categorise expenses, set savings goals, and control monthly budgets. Several users described the system as simple, interactive, and effective for managing personal finances. The clarity of information and ease of navigation were also frequently mentioned as strengths.

Some participants identified specific aspects for improvement. Suggestions included simplifying navigation for users with less digital experience, adding a consolidated view of all expenses, and ensuring that application settings remain saved after email verification. A few users noted the absence of an iOS version as a current limitation. Others proposed the inclusion of investment-related content to complement the budgeting and savings modules.

All respondents stated that they would recommend the application to others. Most indicated willingness to pay for a monthly subscription, with preferred prices ranging from 1 € to 10 €. The results of this round, summarised in **Table 15**, confirm that LUMI has reached a stable and functional stage, combining usability, clarity, and AI-driven support in a way that users find both practical and valuable. These findings provide a solid basis for future refinements focused on accessibility, cross-platform deployment, and expanded financial guidance features.

## **4.5. Demonstrating Core Claims**

This section addresses how LUMI demonstrates the key claims stated in the research objective: personalized financial advice, data security, and transparency. These dimensions were integrated throughout the design, development, and evaluation of the artifact and are reflected in both technical implementation and user feedback collected across the four DSR iterations.

### 4.5.1. Personalized Financial Advice

LUMI delivers personalized financial advice through mechanisms that adapt to individual user contexts, behaviours, and objectives.

#### Implementation

- The AI assistant, powered by Groq's LLaMA-3.1-8B-Instant model, accesses user-specific data-transaction history, budgets, and financial goals-to provide contextualized recommendations. This integration enables natural language queries grounded in actual financial data rather than generic advice.
- The Patterns module automatically detects spending trends and generates tailored suggestions without user intervention (Ip.13, Table 10). Predictive analytics forecast future expenses based on historical data, allowing proactive financial planning.
- Budget and goal management features adapt dynamically to user progress. The system tracks spending against budgets, provides real-time feedback on goal achievement, and suggests adjustments when deviations occur.
- Adaptive quick actions on the Overview page highlight relevant tasks based on recent activity (Ip.8, Ip.22, Ip.28, Tables 10, 12), prioritizing contextual relevance.

#### Evidence

User feedback consistently highlighted personalization value:

- "Synchronization with the bank allows me to control expenses and investments in one place" (P.4, Table 9)
- "The chat to ask financial questions is very useful" (P.3, Table 9)
- "Intuitively and simplicity in organizing savings and setting goals" (P.2, Table 9)

Users rated the application 3.7-3.8 out of 5 for usability and relevance of personalized features (Table 9).

#### Iterative Refinement

The second iteration contextualized the AI assistant with user data (Ip.3, Table 10). The third iteration refined insight alignment with user behaviour (Ip.42, Ip.43, Table 12). The fourth iteration calibrated AI recommendations to ensure consistency with financial reality (Ip.65, Table 14).

## **4.5.2. Data Security**

LUMI implements security measures at multiple levels to protect sensitive financial information and ensure compliance with data handling best practices.

### **Authentication and Access Control**

User authentication is managed through Supabase Auth, providing secure registration and login with encrypted credential storage (F.1, Table 7). Passwords are hashed using industry-standard algorithms, and session tokens are managed to minimize unauthorized access risk.

The fourth iteration strengthened persistent session handling and implemented automatic profile propagation (Ip.50, Ip.51, Ip.52, Table 14).

### **Banking Integration Security**

Banking connectivity is facilitated through Plaid, which adheres to strict security and regulatory standards. Plaid manages all bank credential handling, ensuring LUMI never stores sensitive login information directly. Data exchange occurs via encrypted tokens through the Plaid Link flow, with all synchronization requests routed through Supabase Edge Functions to prevent client-side exposure (F.5).

Edge Functions act as an intermediary layer, validating requests, enforcing access controls, and securely communicating with external APIs.

### **Data Handling and Storage**

User data is stored in a Supabase PostgreSQL database with row-level security (RLS) policies enforcing strict access controls. Each user accesses only their own data. Sensitive fields are encrypted at rest, and database backups follow Supabase security protocols.

### **Privacy Considerations**

The application incorporates privacy controls aligned with GDPR principles. Users manage their data through account settings, including options for account deletion and data export. Email confirmation was introduced in the third iteration (Ip.44) to verify user identity.

## **4.5.3. Transparency**

Transparency in LUMI is addressed through clear data visualization, user control, and efforts to make AI-generated insights interpretable. While full explainable AI (XAI) frameworks remain a priority for future work, current implementation provides meaningful transparency mechanisms.

### **Data Visualization and Access**

Users view detailed financial data breakdowns across modules. The Overview page consolidates key metrics. The All Transactions page allows filtering, sorting, and reviewing individual transactions with editing and categorization support.

Budget and goal modules display progress indicators, spending breakdowns, and achievement timelines. The fourth iteration introduced Spending by Category page (Ip.56), offering visual expense breakdown by category.

### **AI Insights and Explanations**

The AI Insights module presents spending patterns, trend analyses, and recommendations with underlying data visible. The Patterns page generates financial behaviour visualizations over time, including expense predictions (Ip.71).

However, the AI assistant does not yet provide detailed explanations for specific recommendations. For example, the system may suggest budget adjustments without explicitly stating, "This recommendation is based on your 20% spending increase in the Groceries category." This limitation was noted in user feedback regarding insight contextualization (I.3, Table 9).

The second iteration improved AI contextualization by integrating user data into chatbot prompts (Ip.3, Table 10). The fourth iteration calibrated insights to align with actual financial behaviour (Ip.65, Table 14). Full XAI capabilities-such as rule-based explanations, decision trees, or counterfactual reasoning-remain in development.

### **User Control**

All AI-generated recommendations are advisory. Users maintain full control over financial decisions and data management. The system does not execute transactions or make automatic changes.

Contextual tooltips introduced in the fourth iteration (Ip.54) explain key features and functionalities, improving interface clarity.



## Conclusion

This research aimed to develop a personal finance management platform that, through the integration of artificial intelligence, assists users in making better financial decisions. The methodology chosen for this work was Design Science Research (DSR), which enabled the systematic construction, demonstration, and evaluation of the artifact across four iterative cycles.

The platform, named LUMI, was designed to address common challenges faced by individuals in managing their personal finances, such as controlling expenses, defining financial goals, creating budgets, and consolidating accounts.

This research successfully demonstrates how LUMI addresses the three core dimensions established in the research objective: personalized financial advice is delivered through AI-driven insights that adapt to individual user data, validated through consistent user feedback across all evaluation cycles (Section 4.5.1). Data security is implemented through Supabase authentication, Plaid's secure banking integration, and server-side Edge Functions with row-level security policies, though full production-level validation remains contingent on deployment beyond the sandbox environment (Section 4.5.2). Transparency is addressed through comprehensive data visualization, user control mechanisms, and AI-generated insights, while acknowledging that explainable AI (XAI) frameworks represent a critical direction for future work to enhance interpretability and trust (Section 4.5.3).

The developed solution is straightforward, accessible, and user-friendly, requiring no prior financial expertise from its users. Its design prioritizes simplicity while offering a wide range of functionalities such as transaction management, goal tracking, budget planning, and banking integration. The integration of AI enriches the user experience by providing proactive insights and helping users build healthier financial habits.

User feedback across four evaluation cycles validated that LUMI improves financial transparency and decision-making, with users rating usability 3.7-3.8/5 and consistently highlighting the value of personalized, synchronized banking integration.

The contribution of this research lies in demonstrating how DSR can be applied to develop user-centred solutions in the Fintech domain that effectively integrate personalization, security, and transparency—three critical dimensions for building trust and adoption in AI-powered financial tools. LUMI represents not only a functional artifact but also a validated approach to addressing real-world challenges in personal finance management through iterative, evidence-based design.

## **5.1. Limitations**

Despite achieving the proposed objectives, this work is not without limitations. One important constraint concerns the deployment of the application in production environments. Publishing into iOS requires a paid developer account, which limited the possibility of distributing and evaluating the artifact within the Apple ecosystem. Similarly, integration with real financial institutions through Plaid requires access to a paid production environment. Consequently, the application currently operates using the sandbox environment, even though it is technically prepared to switch to production keys. This limitation directly affects the full validation of data security measures (Section 4.5.2), as production-level security audits, penetration testing, and formal compliance assessments—essential for handling real financial data—could not be conducted within the scope of this research.

Another limitation relates to the development process itself. The artifact was entirely designed and implemented by a single developer, despite its complexity and the breadth of functionalities it integrates, including transactions, budgets, goals, accounts, and AI-driven services. This condition inevitably constrained the pace of development and restricted the opportunity to conduct parallel work in design, testing, and optimization.

Furthermore, transparency remains partially addressed (Section 4.5.3). While the application provides comprehensive data visualization and user control mechanisms, the AI assistant does not yet offer detailed explanations for specific recommendations. Full explainable AI (XAI) capabilities—such as rule-based explanations, decision trees, or interactive feedback mechanisms—remain unimplemented at this stage.

Finally, certain advanced personalization features remain underdeveloped (Section 4.5.1). Dynamic quick actions that fully adapt to user behaviour and more sophisticated predictive analytics require additional refinement and larger-scale user testing to validate their effectiveness.

## 5.2. Future Work

Several directions for future work can be identified to further advance this research and extend the capabilities of the artifact.

An essential step will be the deployment of the application into production environments. This includes acquiring an Apple Developer account to enable publication on the App Store, as well as publishing the Android version to the Google Play Store. In addition, migrating from the current Plaid sandbox environment to the paid production environment will allow users to connect their real bank accounts securely, ensuring the platform can be evaluated and validated under real-world conditions. Production deployment will also enable full-scale security audits, penetration testing, and formal compliance assessments, thereby validating the security measures described in Section 4.5.2.

Enhancing transparency through explainable AI (XAI) frameworks represents a critical priority. Future iterations should integrate rule-based explanations that clearly state the conditions triggering specific recommendations (e.g., "This budget adjustment is suggested because your Groceries spending increased by 20% compared to last month"). Visual reasoning mechanisms-such as highlighting relevant data points in charts and graphs-can further improve interpretability. Additionally, interactive feedback capabilities should allow users to query the AI assistant for explanations (e.g., "Why did you recommend this savings goal?"), thereby strengthening trust and user understanding (Section 4.5.3).

The investment module requires substantial completion and refinement. While the current version includes an "Under Construction" placeholder with mock data (Ip.59, Table 14), future work should integrate real-time market data, portfolio tracking, and personalized investment recommendations. Advanced AI capabilities, including reinforcement learning (RL), could be applied to optimize portfolio allocation dynamically based on user risk profiles, financial goals, and changing market conditions. Such enhancements would align LUMI with established investment platforms while maintaining its user-centric, educational focus.

Further personalization enhancements should include fully dynamic quick actions that adapt in real time to user behaviour and financial context (Ip.22, Table 10; Ip.49, Table 12). Expanding predictive analytics capabilities-such as forecasting cash flow, identifying potential savings opportunities, and detecting financial risks-will provide users with more proactive and actionable insights. User segmentation and behavioural modelling can also enable the system to tailor its interface and recommendations to different financial literacy levels and user personas.

Continuous improvement of usability and accessibility remains essential. This includes refining navigation flows, improving mobile responsiveness, and ensuring complete localization across all supported languages. Features such as voice-enabled interactions, enhanced data visualization, and integration with additional financial institutions will further broaden the platform's appeal and usability.

Finally, expanding the user evaluation framework to include larger, more diverse participant groups and longitudinal studies will provide deeper insights into long-term adoption, satisfaction, and impact on financial literacy and decision-making. Such research will validate the artifact's effectiveness in real-world scenarios and inform subsequent iterations with empirical evidence.

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# Appendix

## Appendix A

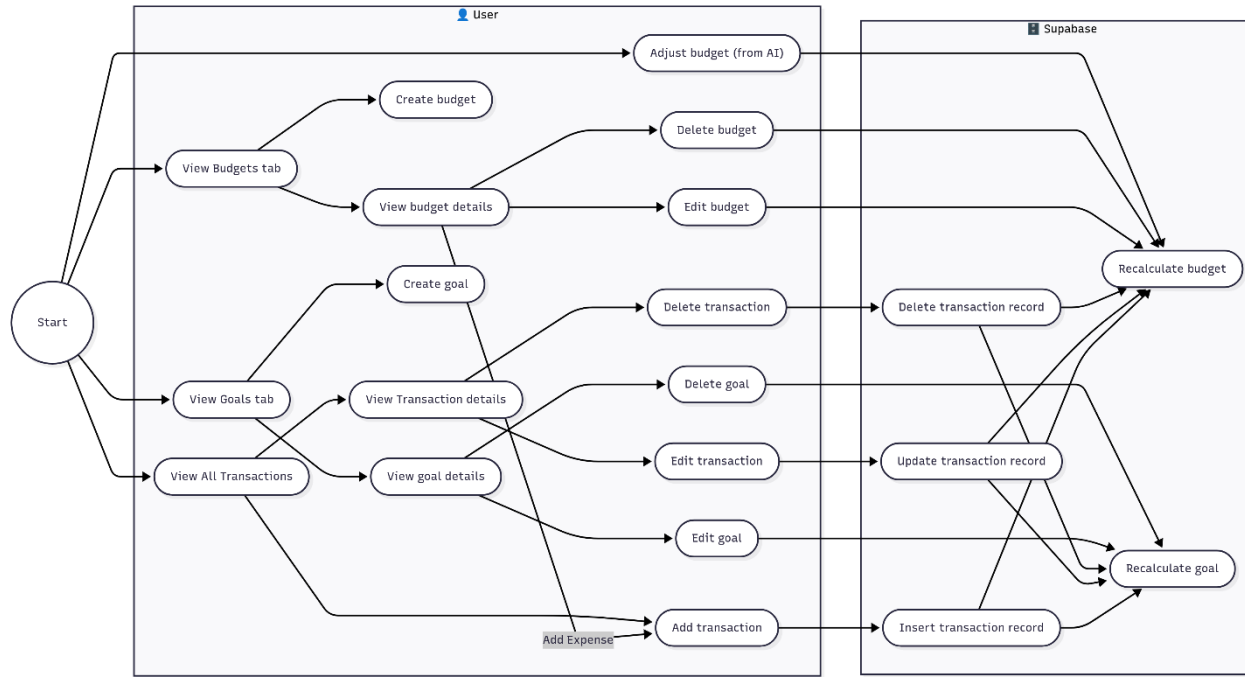


Figure 3. CRUD Flow Diagram

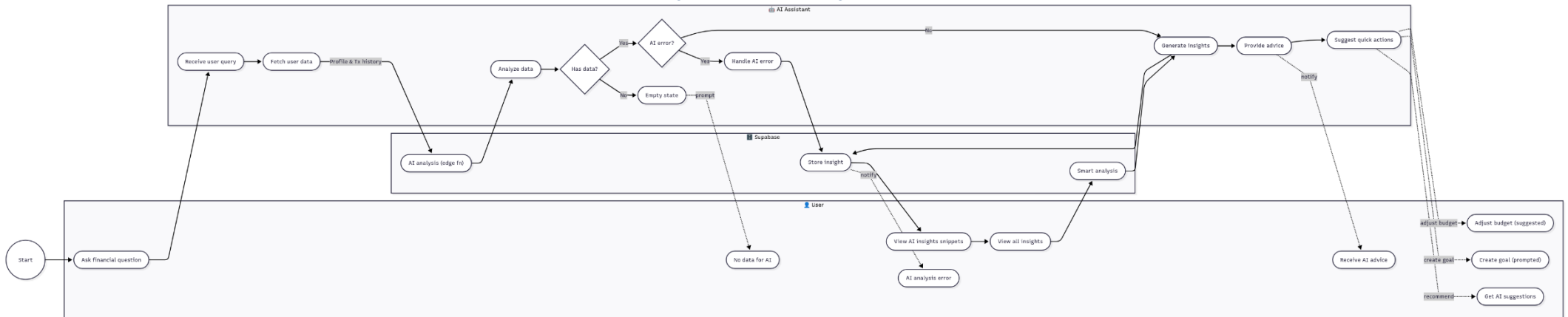


Figure 4. AI Flow Diagram

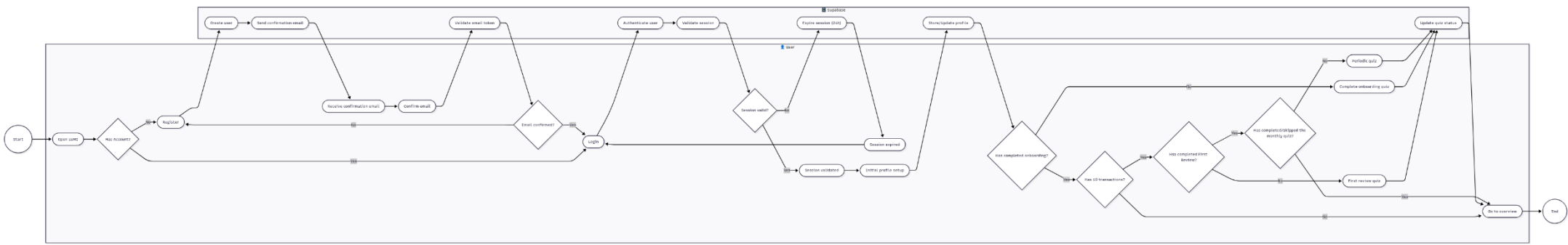


Figure 5. Onboarding Flow Diagram

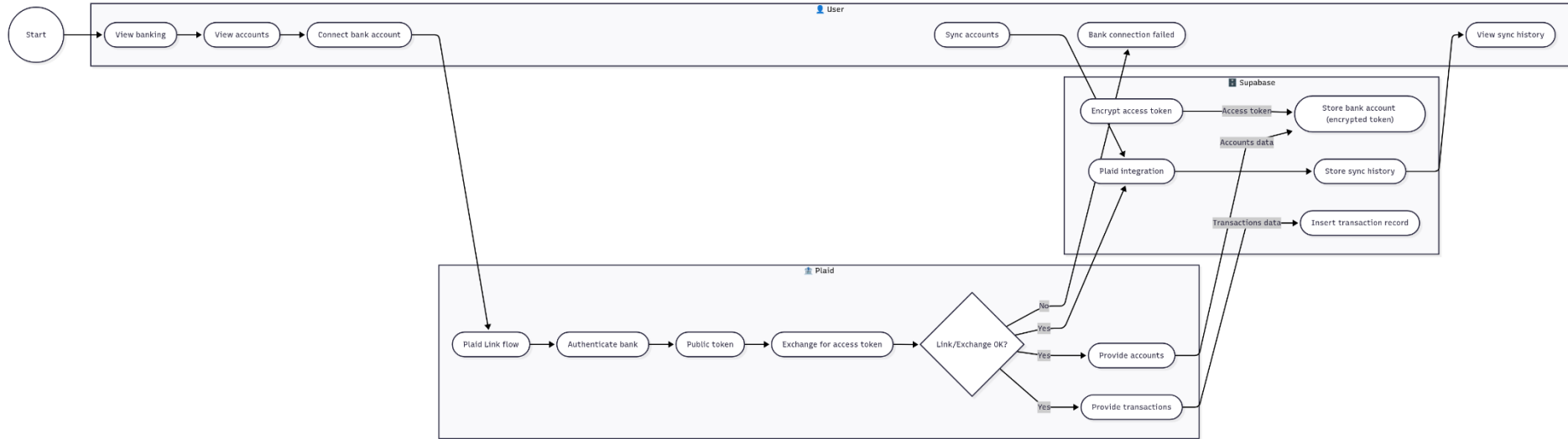


Figure 6. Banking Flow Diagram

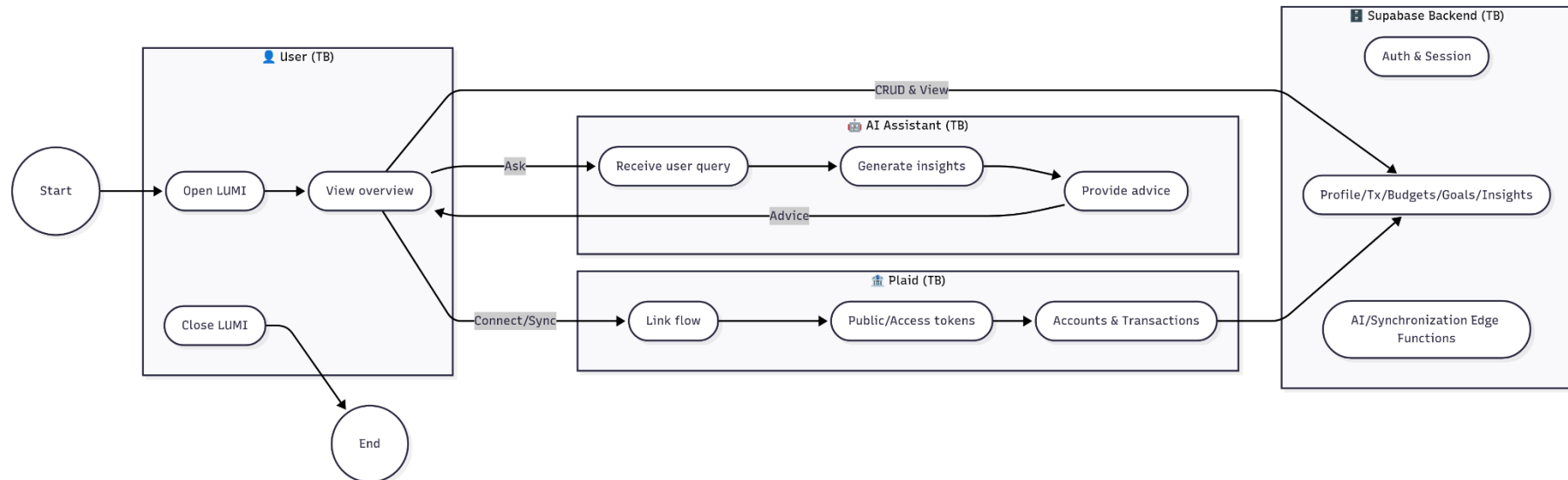


Figure 7. Overview Flow Diagram

## Appendix B

Table 7. Features gathered of LUMI

| ID   | Feature                           | Description  |
|------|-----------------------------------|--|
| F.1  | User Authentication               | Registration and login system using Supabase Auth.                         |
| F.2  | Transaction Management            | Manual input or Plaid-imported transactions with automatic categorization. |
| F.3  | Budget Planning                   | Creation of budgets with category-level monitoring.                        |
| F.4  | Financial Goal Setting            | Definition and monitoring of savings or investment goals.                  |
| F.5  | Banking Integration (Plaid)       | Secure connection to bank accounts with real-time synchronization.         |
| F.6  | Conversational AI Assistant       | Chat-based interface for financial queries and recommendations.            |
| F.7  | AI Insights & Pattern Recognition | Generation of insights and detection of spending trends.                   |
| F.8  | Internationalization (i18n)       | Multilingual support (EN/PT) with fallback to English.                     |
| F.9  | Themes                            | Light and dark modes for accessibility and personalization.                |
| F.10 | Profile View                      | Centralized access to user profile and settings.                           |
| F.11 | Feedback Forms                    | Onboarding, First Review, and Periodic forms to capture user feedback.     |

## Appendix C

Table 9. Summary of Evaluation Results

|              | ID  | Feedback  | Example Quotes  |
|--------------|-----|---|---|
| Pros         | P.1 | Intuitive and easy-to-use interface               | “Quite intuitive”; “Navigation between features is simple.”   |
|              | P.2 | Useful financial management features              | “Being able to set monthly spending limits and control them”; “Goals organized by areas.”   |
|              | P.3 | AI assistant and personalized insights            | “The chat to ask financial questions is very useful”; “Receiving personalized tips.”  |
|              | P.4 | Banking integration for consolidated view         | “Synchronization with the bank allows me to control expenses and investments in one place.”   |
| Cons         | C.1 | Interface complexity in some areas                | “Some complexity / lack of clarity with certain buttons - sometimes they don’t seem to redirect as expected.”   |
|              | C.2 | Limited account detail in overview                | “Although I can connect multiple bank accounts, in the overview I only see the total balance and cannot distinguish where the money comes from. It feels like having access to only one account.” |
|              | C.3 | Usability and translation issues                  | “Blank page when switching views, broken ‘view all’ buttons, mobile filters not fully visible, missing translations...”   |
| Improvements | I.1 | Add graphical visualizations and advanced filters | “A spending graph in the overview would be very useful”; “Sorting and filters should work better.”  |
|              | I.2 | Improve account breakdown and management          | “Add the option to manage multiple accounts separately, e.g., checking + savings, and allow transactions to be linked to the right account.”  |
|              | I.3 | Refine AI contextual knowledge                    | “When asking the AI to analyse expenses, it should already know about the data stored in the app.”  |
|              | I.4 | Improve interface design and responsiveness       | “Some visual interfaces could be more intuitive”; “On mobile, when opening the chat, the footer overlaps the text box.”   |
|              | I.5 | Enhance personalization options                   | “Quick actions should be flexible, like Google search suggestions, not fixed.”  |

## Appendix D

Table 10. Improvements after the First Iteration

| ID           | Requested Improvement  | Implemented |
|--------------|--|-------------|
| <b>Ip.1</b>  | Remove white flash when switching screens                              | Yes         |
| <b>Ip.2</b>  | Fix invalid number inputs (e.g., “2.3.4”)                              | Yes         |
| <b>Ip.3</b>  | AI chat contextualized with user data (transactions, budgets, goals)   | Yes         |
| <b>Ip.4</b>  | Add alerts and “*” markers for missing fields in Goals/Budgets forms   | Yes         |
| <b>Ip.5</b>  | Add option to mute/unmute chatbot speech                               | Yes         |
| <b>Ip.6</b>  | Clarify button hierarchy and colours in Budget pages                   | Yes         |
| <b>Ip.7</b>  | Remove redundant budget buttons, unify “Add Expense” behaviour         | Yes         |
| <b>Ip.8</b>  | Replace unclear edit icons with pencil icons                           | Yes         |
| <b>Ip.9</b>  | Fix misaligned text in Budget and Goal details                         | Yes         |
| <b>Ip.10</b> | Adjust Overview layout for large income/expense values                 | Yes         |
| <b>Ip.11</b> | Rename “Update Goal” → “Update Progress”                               | Yes         |
| <b>Ip.12</b> | Rename “Adjust Goal” → “Adjust Progress”                               | Yes         |
| <b>Ip.13</b> | Patterns auto-generate without user action                             | Yes         |
| <b>Ip.14</b> | Fix transaction sorting filters  | Yes         |
| <b>Ip.15</b> | Add dedicated page for editing transactions                            | Yes         |
| <b>Ip.16</b> | Transactions update instantly without app reload                       | Yes         |
| <b>Ip.17</b> | Fix mobile keyboard breaking chatbot input box                         | Yes         |
| <b>Ip.18</b> | Complete missing translations in New Transactions                      | Yes         |
| <b>Ip.19</b> | Unify categories between Transactions and Budgets                      | Yes         |
| <b>Ip.20</b> | Add graphical spending visualizations (overview graphs)                | No          |
| <b>Ip.21</b> | Multi-account detailed overview (separate balances per account)        | No          |
| <b>Ip.22</b> | Quick actions should be dynamic and flexible (like Google suggestions) | No          |

## Appendix E

Table 11. Summary of Evaluation Results – Second Iteration

|              | ID   | Feedback                                       | Example Quotes  |
|--------------|------|--|---|
| Pros         | P.5  | Well-structured human-machine interaction      | “The human–machine interaction is well structured.”   |
|              | P.6  | Intuitive and simple goal/savings organization | “Intuitively and simplicity in organizing savings and setting goals.”                       |
|              | P.7  | Ease of use                                    | “Easy to use.”  |
|              | P.8  | Global budget overview                         | “Synchronization with the bank allows me to control expenses and investments in one place.” |
|              | P.9  | Expense tracking                               | “Counting expenses.”  |
| Cons         | C.4  | Too many options                               | “Having too many items.”  |
|              | C.5  | Confusion in initial interface                 | “Some confusion in the initial interface.”  |
|              | C.6  | Difficulty associating expenses                | “Difficulty associating expenses automatically to the budget.”                              |
| Improvements | I.6  | Reduce number of options in Button Bar         | “Reduce the number of options in the Button Bar to 4 or 5.”                                 |
|              | I.7  | Improve expense association                    | “Improve the association of expenses with a specific budget.”                               |
|              | I.8  | Improve quick actions in initial interface     | “Improve quick action login on the initial interface.”                                      |
|              | I.9  | Add investment tips                            | “Add tips on how and where to apply money.”   |
|              | I.10 | Feature request for investments                | “How to invest and make my money grow.”   |

Table 12. Improvements after the Second Iteration

| ID           | Requested Improvement  | Implemented |
|--------------|--|-------------|
| <b>Ip.23</b> | Fixed bug where expenses were associated with the wrong budgets                            | Yes         |
| <b>Ip.24</b> | Fixed Login/Register inputs not working in web version                                     | Yes         |
| <b>Ip.25</b> | Fixed Portuguese description outside the screen in Transaction section                     | Yes         |
| <b>Ip.26</b> | Fixed overlapping layout with big numbers on All Transactions page                         | Yes         |
| <b>Ip.27</b> | Fixed English elements showing in Portuguese version on All Transactions page              | Yes         |
| <b>Ip.28</b> | Fixed “Quick actions” title in English when app set to Portuguese.                         | Yes         |
| <b>Ip.29</b> | Fixed misaligned labels “Adicionar Despesa/Receita” (Overview page)                        | Yes         |
| <b>Ip.30</b> | Fixed long budget title overlapping warning (Portuguese version)                           | Yes         |
| <b>Ip.31</b> | Fixed stats layout (4 in one line) on Budgets page (Portuguese version)                    | Yes         |
| <b>Ip.32</b> | Fixed layout when changing language/currency on Accounts Settings page                     | Yes         |
| <b>Ip.33</b> | Fixed categories in English on Budgets page (Portuguese version)                           | Yes         |
| <b>Ip.34</b> | Fixed header buttons outside wrapper on Budget Details page                                | Yes         |
| <b>Ip.35</b> | Fixed periods (Monthly/Annual) and status in English on Budget Details page                | Yes         |
| <b>Ip.36</b> | Added colours around goals-on-Goals page (mobile)  | Yes         |
| <b>Ip.37</b> | Improved Profile currency formatting (1K, 1M, 1B; full number shown below in smaller size) | Yes         |
| <b>Ip.38</b> | Changed Profile stat from “This Month/Este Mês” to “Transactions This Month”               | Yes         |
| <b>Ip.39</b> | Linked Budget Details “Spending analysis” to patterns                                      | Yes         |
| <b>Ip.40</b> | Redesigned Banking hub (separate buttons for Accounts and Helpful Tools with unlock rules) | Yes         |
| <b>Ip.41</b> | Fixed Goals Details categories (Portuguese version showed English)                         | Yes         |
| <b>Ip.42</b> | Smart analysis was not displaying results  | Yes         |
| <b>Ip.43</b> | AI Insights section layout was redesigned  | Yes         |
| <b>Ip.44</b> | Added confirmation screen after registration (informs user to confirm email)               | Yes         |
| <b>Ip.45</b> | Redirect user into the app automatically after confirming email (no re-login)              | No          |
| <b>Ip.46</b> | Reduce number of buttons in Button Bar (4–5)   | No          |
| <b>Ip.47</b> | Add tips on how and where to invest/apply money  | No          |
| <b>Ip.48</b> | Improve investment functionality   | No          |
| <b>Ip.49</b> | Improve quick action “logon” on initial interface  | No          |

## Appendix F

Table 13. Summary of Evaluation Results – Third Iteration

|              | ID   | Feedback                                   | Example Quotes   |
|--------------|------|--|--|
| Pros         | P.10 | Intuitive and seamless navigation          | “The app is very intuitive and allows seamless navigation through different areas.”    |
|              | P.11 | Useful financial management tools          | “Categorizing my expenses and controlling my monthly budget is very practical.”        |
|              | P.12 | Clear goal setting and savings tracking    | “Easy to define and follow savings objectives.”  |
|              | P.13 | Integrated AI assistant                    | “The chat is very useful to ask finance-related questions.”                            |
|              | P.14 | Visual and analytical components           | “Graphs and analysis tabs are helpful; the investment section looks promising.”        |
| Cons         | C.7  | Inconsistent currencies and translations   | “Some screens show \$ instead of €, and parts of the interface are not in Portuguese.” |
|              | C.8  | Navigation and layout errors               | “Some routes lead to ‘This screen doesn’t exist’; filters don’t scroll to the end.”    |
|              | C.9  | Complexity in budget management            | “Budgets are not very intuitive.”  |
|              | C.10 | Limited compatibility and platform support | “Add an option for iOS.”   |
| Improvements | I.11 | Improve investment section design          | “Having the investment section more like Degiro or Invest.com would be useful.”        |
|              | I.12 | Standardize currencies and translations    | “Uniformize symbols and language across the interface.”                                |
|              | I.13 | Add contextual and navigation aids         | “Add a Home button, tooltips, and deep links between pages.”                           |
|              | I.14 | Enable recurring transactions              | “Add the option for monthly or weekly recurring income/expenses.”                      |
|              | I.15 | Improve feedback interaction               | “Add a close button to the monthly feedback form.”                                     |

Table 14. Improvements after the Third Iteration

| <b>ID</b>    | <b>Requested Improvement</b>   | <b>Implemented</b> |
|--------------|--|--------------------|
| <b>Ip.50</b> | Fixed Register/Login not working on web version                                      | Yes                |
| <b>Ip.51</b> | Fixed “Something Went Wrong” error after profile setup                               | Yes                |
| <b>Ip.52</b> | Registration name now automatically used in profile setup                            | Yes                |
| <b>Ip.53</b> | “Active Budgets/Goals” buttons now open their respective tabs                        | Yes                |
| <b>Ip.54</b> | Added tooltip “?” buttons with page explanations                                     | Yes                |
| <b>Ip.55</b> | Added persistent Home button for easier navigation                                   | Yes                |
| <b>Ip.56</b> | Created new page displaying all spendings grouped by category                        | Yes                |
| <b>Ip.57</b> | Set chat voice to “off” by default   | Yes                |
| <b>Ip.58</b> | Added close (“X”) button to periodic feedback form                                   | Yes                |
| <b>Ip.59</b> | Added “Under Construction” warning for investment features (testable with mock data) | Yes                |
| <b>Ip.60</b> | Implemented recurrent transactions with payment disclaimer                           | Yes                |
| <b>Ip.61</b> | Standardized currency formatting across all pages                                    | Yes                |
| <b>Ip.62</b> | Fixed navigation errors leading to “This screen doesn’t exist”                       | Yes                |
| <b>Ip.63</b> | Fixed horizontal scroll issue in “See All Transactions” filters                      | Yes                |
| <b>Ip.64</b> | Completed missing Portuguese translations  | Yes                |
| <b>Ip.65</b> | Calibrated AI insights to align with actual user data                                | Yes                |
| <b>Ip.66</b> | Delayed first feedback form to trigger after 10 transactions or one week             | Yes                |
| <b>Ip.67</b> | Fixed “Other” category not displaying user-defined title                             | Yes                |
| <b>Ip.68</b> | Fixed “Something Went Wrong” error when creating new goals                           | Yes                |
| <b>Ip.69</b> | Added explicit instructions for unlocking banking features (10/100 transactions)     | Yes                |
| <b>Ip.70</b> | Updated Financial Insights to include directional arrow to Patterns page             | Yes                |
| <b>Ip.71</b> | Translated axis labels (X/Y) on Predictions graph in Patterns page                   | Yes                |
| <b>Ip.72</b> | Refined minor UI inconsistencies and accessibility issues                            | Yes                |
| <b>Ip.73</b> | Advanced investment integration (real data)  | No                 |
| <b>Ip.74</b> | Automatic redirection to app after email confirmation                                | No                 |

## Appendix G

Table 15. Summary of Evaluation Results – Fourth Iteration

|              | ID   | Feedback                                     | Example Quotes  |
|--------------|------|--|---|
| Pros         | P.15 | Intuitive and easy-to-use interface          | “The app is simple, interactive and easy to understand.”                            |
|              | P.16 | Effective financial management tools         | “Categorizing my expenses and controlling my monthly budget is very practical.”     |
|              | P.17 | Clear goal definition and tracking           | “Easy to define savings objectives and follow them month by month.”                 |
|              | P.18 | Helpful AI assistant                         | “The chat is useful for financial questions and gives good suggestions.”            |
|              | P.19 | Perceived value and usability                | “It’s very useful to manage personal finances.” / “I would recommend it to others.” |
| Cons         | C.11 | Lack of iOS version                          | “Not available for iOS.”  |
|              | C.12 | Limited configuration persistence            | “Settings don’t stay saved after email verification.”                               |
|              | C.13 | Slight complexity for less experienced users | “It could be simpler for people with less experience.”                              |
| Improvements | I.16 | Simplify navigation                          | “Make navigation easier for users with less digital experience.”                    |
|              | I.17 | Add consolidated expense view                | “Include a single-page overview of all expenses.”                                   |
|              | I.18 | Ensure settings persistence                  | “Keep configurations saved when logging in or verifying email.”                     |
|              | I.19 | Expand investment and learning content       | “Add information about how to invest or make money.”                                |
|              | I.20 | Extend platform compatibility                | “Release an iOS version.”   |