CHALMERS
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User-Centered Dashboard Design

Leveraging Design Thinking and Game Design Principles for Improving User Engagement

Master's thesis in Computer science and engineering

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CHALMERS UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF GOTHENBURG
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Abstract

In this thesis, I explore the integration of design thinking and game design principles to enhance the functionality, user engagement, and accessibility of corporate dashboards. Amidst the backdrop of the rapid evolution of big data and advanced analytics, the need for effective data visualization tools has become paramount. I employ a mixed-methods approach, combining qualitative interviews with dashboard developers and user testing of a dashboard prototype that incorporates gamification elements.

The findings reveal that well-designed gamification can significantly increase user engagement and improve data interaction, although the effectiveness varies depending on user demographics and the specific context of the application. I propose a set of design guidelines and demonstrate through prototyping how these can be implemented to create more engaging and user-friendly dashboards.

This study contributes to academic and practical knowledge in the fields of user experience (UX) design and business intelligence by showing how integrating elements typically found in games can address common usability challenges in dashboard design. I suggest avenues for further research, particularly in the areas of personalized user experiences and the scalability of gamification strategies across different corporate environments.

Keywords: Dashboard Design, Gamification, Business Intelligence, User Engagement, Data Visualization, User Experience (UX), Design Thinking, Corporate Dashboards.

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Krystyna Ziobro, Gothenburg, 2024-06-09

Contents

List of Figures **xv**

List of Tables **xvii**

1 Introduction **1**
1.1 Context . . . 1
1.2 Research Problem . . . 2
1.3 Aim . . . 2
1.4 Research Question . . . 3
1.5 Stakeholders . . . 3
1.5.1 Dashboard Developers . . . 3
1.5.2 Corporate Dashboard Users . . . 3
1.5.3 Company Management . . . 3
1.5.4 Academic Community . . . 4
1.6 Ethical considerations . . . 4
1.6.1 Participant consent and privacy . . . 4
1.6.2 Participant well-being . . . 4
1.6.3 Business practices and confidentiality . . . 4
1.6.4 Reflection on potential impact . . . 4

2 Background **5**
2.1 What is a dashboard? . . . 5
2.2 User experience in dashboards . . . 7
2.3 User-centric approach in dashboard design . . . 7
2.4 Game design principles in corporate settings . . . 8
2.4.1 Examples of gamification in dashboards . . . 8
2.4.2 Examples of dashboards in games . . . 8
2.5 Design thinking in dashboards . . . 10
2.6 Guidelines and methodologies . . . 11
2.6.1 General guidelines . . . 11
2.6.2 Incorporating user feedback . . . 12
2.6.3 Employing a GQM model . . . 12
2.6.4 Iterative development . . . 12
2.6.5 Accessibility and inclusivity . . . 13
2.6.6 Data Visualization Principles . . . 13

2.7 Challenges and limitations . . . 13
2.7.1 Scope of Research . . . 13
2.7.2 Technological Advancements . . . 14
2.7.3 Quantitative Analysis Limitation . . . 14

3 Methods **17**
3.1 Overarching methodology . . . 17
3.2 Design framework . . . 17
3.2.1 Design Thinking . . . 17
3.3 Analysis methods . . . 18
3.3.1 Semi-structured interviews . . . 19
3.3.2 Interview process . . . 19
3.3.3 Participant selection criteria . . . 20
3.3.4 Ethical Considerations for data handling . . . 20
3.3.5 Inductive coding and thematic analysis . . . 21
3.4 Ideation methods . . . 22
3.4.1 Mind mapping . . . 22
3.5 Tools . . . 22
3.5.1 Power Platform . . . 22
3.5.1.1 Power BI . . . 22
3.5.1.2 Power Apps . . . 22
3.5.2 Tableau . . . 23
3.5.3 Figma . . . 23
3.5.4 Procreate . . . 23
3.5.5 Accessibility evaluation tools . . . 23
3.6 Prototyping . . . 23
3.6.1 Rapid prototyping . . . 24
3.6.2 MoSCoW prioritization . . . 24
3.6.3 Sample data in prototyping . . . 25
3.7 Evaluation methods . . . 25
3.7.1 User testing . . . 25
3.7.2 Participant selection criteria . . . 25
3.7.3 Testing procedure . . . 26
3.7.4 Ethical considerations . . . 26
3.7.5 Outcome and evaluation . . . 26

4 Planning **27**
4.1 Agile framework integration . . . 27
4.2 Visual planning tools . . . 27
4.2.1 Gantt Chart . . . 27
4.2.2 Sprints . . . 27
4.3 Iterative Writing Approach . . . 28
4.4 Adaptability to changes . . . 28

5 Process and Execution **29**
5.1 Empathize . . . 29
5.1.1 Interview preparation . . . 29

5.1.2 Participant selection . . . 30
5.1.3 Execution . . . 30
5.1.4 Challenges . . . 30
5.1.5 Findings . . . 30
5.2 Define . . . 30
5.2.1 Challenges identified . . . 30
5.2.2 Exploration of tools . . . 31
5.2.3 Objectives . . . 32
5.3 Ideate . . . 32
5.3.1 Mind mapping . . . 32
5.4 Prototype . . . 33
5.4.1 Design exploration . . . 34
5.4.2 Building the prototype . . . 37
5.4.3 MoSCoW prioritization . . . 37
5.4.4 Challenges and limitations . . . 38
5.4.5 Initial prototype . . . 38
5.5 Test . . . 41
5.5.1 User testing . . . 41
5.5.2 Preparation . . . 41
5.5.3 Findings . . . 42

6 Results **45**
6.1 Interview analysis . . . 45
6.1.1 Design Principles . . . 46
6.1.2 Data Presentation . . . 48
6.1.3 Feedback Integration . . . 48
6.1.4 Gamification Techniques . . . 49
6.1.5 Technological Innovation . . . 49
6.1.6 Design Challenges . . . 50
6.1.7 User Training . . . 51
6.2 User testing analysis . . . 52
6.3 User testing: Part 1 . . . 52
6.3.1 Feedback summary . . . 52
6.3.2 Insights and reflections . . . 53
6.3.3 Strategic recommendations . . . 53
6.3.4 Changes . . . 54
6.3.5 Additional features proposed . . . 55
6.4 User testing: Part 2 . . . 57
6.4.1 Feedback summary . . . 57
6.4.2 Insights and reflections . . . 57
6.4.3 Additional features proposed . . . 58
6.5 Conclusion of user testing . . . 58
6.6 Broader implications . . . 59
6.7 Final dashboard prototype . . . 59
6.7.1 App structure and interface . . . 59
6.7.2 Features and functionalities . . . 60

7 Discussion **65**
7.1 Reflections . . . 65
7.1.1 Ethical considerations . . . 65
7.1.2 Integration challenges and solutions . . . 66
7.1.3 Evaluation of development process . . . 66
7.2 Dashboard design best practices . . . 67
7.2.1 Clarity and simplicity . . . 67
7.2.2 Consistency . . . 68
7.2.3 Flexibility . . . 68
7.2.4 Interactivity . . . 69
7.2.5 Understanding pervasive needs . . . 69
7.2.6 Accessibility . . . 70
7.2.7 Giving feedback to users . . . 70
7.2.8 Transparency . . . 71
7.2.9 Contextual user support . . . 71
7.2.10 Gathering feedback from users . . . 72
7.2.11 Use of Power Apps . . . 73
7.2.12 Integrating Artificial Intelligence . . . 73
7.2.13 Strategic integration of gamification . . . 74
7.3 Conclusion . . . 74
7.4 Future work . . . 75

8 Conclusion **79**

Bibliography **83**

A Appendix: Interview preparation **I**
A.1 Data collection and privacy disclosure . . . I
A.2 Key interview categories and example questions . . . II

B Appendix: Sketches in prototyping **V**

C Appendix: Interview transcriptions **VII**
C.1 Ethical disclosure . . . VII
C.2 Interview 1 . . . VII
C.3 Interview 2 . . . X
C.4 Interview 3 . . . XV
C.5 Interview 4 . . . XVIII
C.6 Interview 5 . . . XXI
C.7 Interview 6 . . . XXV
C.8 Interview 7 . . . XXVIII

D Appendix: User testing plan **XXXIII**
D.1 User Testing Plan for ZeroError Tracker . . . XXXIII
D.1.1 Objective . . . XXXIII
D.1.2 Participants . . . XXXIII
D.1.3 Data collection and privacy disclosure . . . XXXIII

D.1.4 Tasks for Users XXXIII
D.1.4.1 Task 1: Log In and Explore the Main Dashboard . . XXXIII
D.1.4.2 Task 2: Report an Error XXXIV
D.1.4.3 Task 3: Use the Error Detail Screen XXXIV
D.1.4.4 Task 4: Interact with Gamification Features XXXIV
D.1.5 Questions for Users XXXIV
D.1.5.1 Usability and Interface XXXIV
D.1.5.2 Engagement and Gamification XXXIV
D.1.5.3 Effectiveness XXXIV
D.1.5.4 Suggestions for Improvement XXXV
D.1.5.5 Overall Satisfaction XXXV

List of Figures

2.1 Sample Procurement Dashboard [9] 6
2.2 Sample Corporate Spend Dashboard [9] 6
2.3 Design thinking dashboard development framework [6] 11
2.4 GQM model [36] 12

3.1 Design Thinking: a Non-Linear Process [43] 18
3.2 Similarities between Design Thinking and Agile Methodologies [43] . 19

4.1 Thesis planning: Gantt chart 27
4.2 Thesis planning: Sprints 28

5.1 Mind map with a central theme of gamification in dashboards 33
5.2 Mind map with a central theme of user-centered design in dashboards 34
5.3 PowerApps: default data visualization after inserting an Excel sheet . 35
5.4 PowerApps: interactive data visualization 35
5.5 Embeding PowerBI visuals in PowerApps 36
5.6 Inclusion of a PowerApps app in PowerBI 36
5.7 Exploring implementation of a point system in PowerApps 37
5.8 Login page 39
5.9 Main dashboard screen 39
5.10 Error detail screen 40
5.11 Submission screen 40
5.12 User profile screen 41

6.1 First version of the Main Dashboard screen 54
6.2 Changes in the second version of the Main Dashboard screen 55
6.3 First version of the Profile screen 56
6.4 Changes in the second version of the Profile screen 56
6.5 Login page 60
6.6 Main dashboard screen 61
6.7 Error detail screen 61
6.8 User profile screen 62
6.9 Submission screen 62

B.1 Sketch of a typical dashboard layout VI
B.2 Sketch of a typical dashboard layout VI

List of Tables

6.1 Interview participants 45
6.2 Themes identified from inductive coding and thematic analysis 46
6.3 User testing participants and their self-reported interest in games . . 52

7.1 Guidelines for dashboard design identified during the course of the thesis project 77

1

Introduction

1.1 Context

The integration of game design principles into non-gaming contexts and the concurrent rise of big data analytics are two pivotal trends in the modern business landscape, reflecting a broader shift towards more interactive, user-centric technology applications across various sectors.

The concept of gamification, which involves the application of game design elements in non-game contexts, has seen a significant evolution over the past decade. Originally a novel approach in user engagement, gamification has now become a prevalent strategy in various sectors, particularly within the corporate world [1]. This evolution traces back to the mid-2000s, a period marked by the emergence of digital business models, advancements in web technology, and the popularity of online and location-based games. Platforms like Foursquare and StackOverflow, drawing inspiration from social networking games and gaming platforms such as Xbox Live, have successfully employed gamification elements such as points, badges and leaderboards to foster user participation and loyalty. [2]

Parallel to this development has been the rise of big data and advanced analytics, which have revolutionized the way businesses handle information. Analytics and data visualization have become essential to the decision-making process across various industries, facilitating a deeper understanding and clearer communication of complex data insights. [3] Data visualization, in particular, plays a crucial role in presenting significant data in ways that are both comprehensible and visually appealing, integrating principles from psychology, usability, graphic design, and statistics [4]

Within this context, corporate dashboards have become critical tools. These dashboards, essential in monitoring, analyzing, and visualizing key performance indicators, have evolved significantly. From their beginnings as simple, static displays, they have transformed into dynamic and interactive platforms, reflecting the growing complexity and richness of the data they handle [5].

This evolution emphasizes enhancing user experience and interactivity in technology and data visualization, underscoring the importance of engaging users and making complex information both accessible and actionable. By doing so, it not only boosts the functionality and effectiveness of digital tools but also strengthens the connec-

tion between data analysis and decision-making. Moving towards a user-centered design approach ensures that technology is not only powerful but also intuitive and engaging, fostering a more meaningful interaction with information.

1.2 Research Problem

Despite the critical importance of dashboards in various industries, numerous challenges persist in their design and implementation. Key issues include:

1. User Engagement and Understanding: Many dashboards fail to engage users effectively, leading to underutilization and misinterpretation of data.

2. Inconsistency in Accessibility and Usability: Dashboards often lack consistent standards in terms of accessibility and usability, particularly for users with varying levels of expertise and visual literacy.

3. Adaptability to User Requirements: Dashboards frequently struggle to adapt to evolving user needs and requirements, leading to a mismatch between the dashboard functionality and user expectations.

I aim to address these problems by exploring the current state of user experience in corporate dashboard design, leveraging both design thinking and gamification as potential tools for improvement.

1.3 Aim

In this project, I aim to explore how design thinking and game design principles can be leveraged in corporate dashboard design and analyze how elements of game design can be integrated to enhance user experience. In todays data-centric business environment, the role of dashboards is integral, serving as key tools for data visualization and decision-making [6]. However, common challenges such as user engagement, data comprehension, and accessibility persist, undermining the effectiveness of these tools [5].

Addressing these challenges is crucial for advancing knowledge in dashboard design, where traditional approaches often overlook the nuances of user experience. By exploring the intersection of interaction design and game design, I seek innovative solutions that enhance dashboard interactivity and usability. Such advancements have wide-ranging implications, not only enriching academic understanding in the fields of UX and data visualization but also offering practical applications across various industries reliant on data-driven decision-making. The knowledge gained from this study could inform future dashboard development, leading to more intuitive, engaging, and effective data visualization tools. This is essential in a world where data interpretation is key to organizational success and decision-making processes.

1.4 Research Question

In what ways can the integration of design thinking and game design principles be leveraged to enhance the functionality, user engagement, and accessibility of corporate dashboards?

1.5 Stakeholders

The stakeholders of this research include various groups that will benefit from the insights and findings provided. Each group gains unique benefits from the improved design and user-centered approach to dashboards.

1.5.1 Dashboard Developers

Relevance: Dashboard developers can greatly benefit from creating user-friendly interfaces that encourage user engagement and minimize the learning curve. Their challenge lies in balancing complexity and usability, ensuring that dashboards are powerful enough for advanced users while still being accessible to novices.

Research Contribution: Developers can use these findings to reduce user frustration, increase adoption rates, and enhance overall user satisfaction.

1.5.2 Corporate Dashboard Users

Relevance: Users in corporate environments require dashboards that efficiently convey critical information for decision-making. They often face time constraints and need to quickly understand complex data.

Research Contribution: By improving dashboard design, this research will aid these users in quicker data comprehension and more effective decision-making. Enhanced user experience can lead to increased productivity and better business outcomes.

1.5.3 Company Management

Relevance: Enhanced UX in dashboards is of strategic interest to company management, aiming to improve operational efficiency and establish a data-driven culture. Better-designed dashboards facilitate deeper data engagement, leading to more informed organizational decisions and strategies.

Research Contribution: The research provides management with a deeper understanding of how UX improvements can lead to more effective data utilization across the company, supporting the achievement of broader business objectives through enhanced data analysis capabilities.

1.5.4 Academic Community

Relevance: Despite the widespread usage of dashboards, there is a noticeable discrepancy between their popularity and the extent of academic research dedicated to them [5].

Research Contribution: This research will contribute new knowledge to the field and analyze existing literature regarding dashboards from an innovative standpoint.

1.6 Ethical considerations

Ethical considerations are crucial to ensure the integrity of the research and the well-being of the participants. This section outlines the measures taken to address participant consent and privacy, participant well-being, business practices and confidentiality, and reflection on potential impacts.

1.6.1 Participant consent and privacy

Participants will be briefed on the specifics of the data collection process, including the type of data being gathered, its intended use, and their rights concerning data privacy. Prior to data collection, participants will be explicitly asked to consent to the level of data sharing they are comfortable with. This includes decisions about disclosing personal details such as their job role or team affiliation, as well as sharing materials related to the research such as screenshots of dashboards.

1.6.2 Participant well-being

In conducting interviews, considering the well-being of the participants will be the top priority. Efforts will be made to create a research environment that is respectful, inclusive, and considerate of the diverse backgrounds of the participants. Furthermore, they will be informed that they have the freedom to discontinue the interview at any point or retract any statements they make if they so choose.

1.6.3 Business practices and confidentiality

Special attention will be paid to the confidentiality of any business-related information shared during the research process. Measures will be taken to ensure that sensitive data, competitive insights or industry-specific business practices disclosed during the interviews or observed in dashboards are kept confidential and used solely for academic purposes.

1.6.4 Reflection on potential impact

The research will include a short reflection on the potential impact of gamification in dashboards on users and organizations. This includes considering the short-term and long-term implications of introducing game elements on user behavior, decision-making and well-being.

2

Background

2.1 What is a dashboard?

In the data-driven landscape of the modern world, dashboards serve as indispensable tools, synthesizing complex data into comprehensible visual representations. They are a space where data from various sources is combined, analyzed, and displayed in an easy to access format. This allows the viewers to get an overview of the most relevant or significant information in a time-efficient way [5]. Whether in corporate settings, educational environments, or personal contexts, dashboards facilitate the understanding and management of critical information [7].

The concept of a dashboard draws its analogy from the automotive dashboard, designed to provide drivers with the most crucial information at a glance, such as speed, fuel level, and warning signs [8]. Similarly, in the context of data analysis and business intelligence, a dashboard aggregates essential information and presents it in a user-friendly manner, often employing graphs, charts, and indicators for easy interpretation. To provide further context, examples of corporate dashboards are presented in Figure 2.1 and Figure 2.2.

Definitions of a dashboard often highlight its compact display and potential to facilitate rapid comprehension and analysis of complex data. As Stephen Few, an expert in data visualization, puts it: a dashboard is a single-screen display that shows this important information about a company so that the whole situation, for example, in a factory or on a production line, can be quickly understood. [10]

The popularity of dashboards has led to the need for tailored displays focused on specific requirements, user roles, and contexts. This has resulted in new approaches to address personal requirements and foster individualization in dashboards [11].

This evolution towards personalized dashboard design is indicative of a broader shift in the landscape of data visualization and business intelligence. Dashboards are becoming more than just tools for data representation; they are platforms for interaction, exploration, and deeper insight. In this context, there is a significant opportunity to explore new approaches in guiding users to use dashboards more effectively.

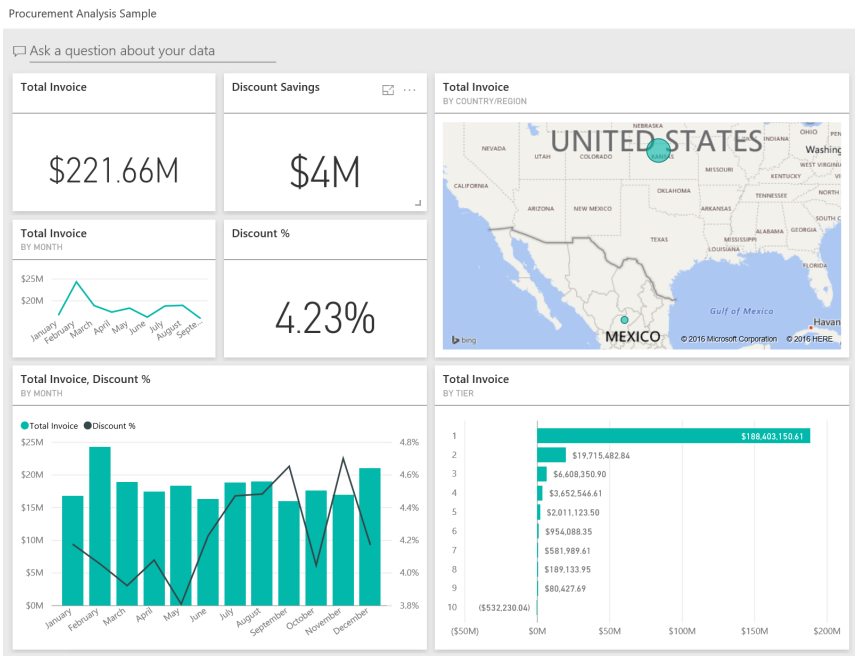

Figure 2.1: Sample Procurement Dashboard [9]

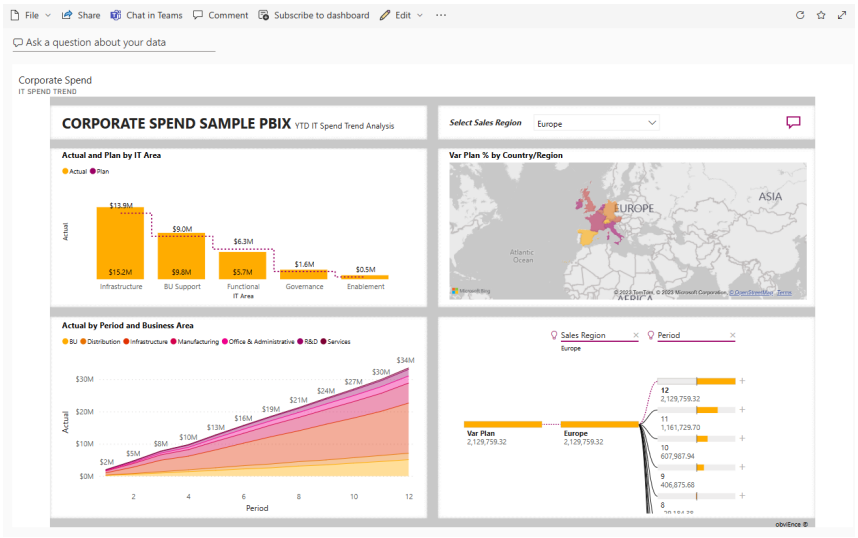

Figure 2.2: Sample Corporate Spend Dashboard [9]

2.2 User experience in dashboards

The current state of user experience in corporate dashboards is marked by a significant challenge: the gap between the level of data literacy that effective dashboard use requires and the actual data literacy levels possessed by users [12]. Data literacy can be defined as "the ability to collect, manage, evaluate, and apply data, in a critical manner" [13].

In comparison, the games industry has been recognized for its significant advancements in user experience, catering to a wide and diverse audience [2]. Nowadays, as the demographic of the games market is becoming broader and broader, game designers have to adapt to players with all levels of experience and data literacy [14]. This is achieved through intuitive design informed by fields such as psychology and visual design [15], effective tutorial design [16], adaptive difficulty levels [17] and thorough evaluation of user experience [18] ensuring that players are gradually introduced to more complex game mechanics in a manner that feels natural and enjoyable.

The success of the gaming industry in this regard offers valuable lessons for corporate dashboard design. By adopting similar principles, such as personalized user interfaces, contextual guidance, and adaptive content presentation, dashboards can be made more accessible and engaging for all users, regardless of their data literacy levels. Incorporating gamification elements, such as progress indicators, achievement badges, and interactive visualizations, can also enhance the user experience, motivating users to explore and interact with the data more deeply.

Moreover, the games industry's emphasis on user feedback and continuous improvement serves as a model for dashboard development. Regularly soliciting user input and employing agile development processes can ensure that dashboards evolve in response to user needs, enhancing their relevance and effectiveness over time.

2.3 User-centric approach in dashboard design

Recent advancements in the field of visualization and computer graphics underscore the imperative for dashboards to adopt a user-centric design philosophy [7]. Dashboards must not only present data but do so in a user-centric manner, emphasizing ease of understanding and relevance to specific organizational goals. This necessitates a design approach that is both informative and intuitive.

In support of this, a study on design patterns for dashboards highlights the necessity for flexible design strategies that adapt to diverse user requirements [5]. Such strategies should consider various aspects, including the layout, user interaction, and engagement. An effective dashboard design must balance functional utility with user engagement, ensuring that users can interact with the dashboard in a meaningful and efficient manner. The layout should be structured in a way that highlights critical information while facilitating easy navigation through different data sets.

2.4 Game design principles in corporate settings

The application of game design principles in corporate settings, commonly referred to as 'gamification', has become increasingly significant. While the use of game elements in non-game contexts has been practiced for many years, the actual term "gamification" only became widely recognized with the advent of sophisticated technology platforms and the widespread adoption of social media. [1] Gamification involves the use of game-like mechanics, such as point scoring, competition, and achievement systems, in a non-gaming context to motivate and enhance user engagement. In the corporate environment, these principles are applied to various aspects, including employee training, human resource management [19], business processes [20], and potentially dashboard design.

While the application of gamification methods has demonstrated efficacy in enhancing participation and engagement [21], it is equally critical to acknowledge the potential drawbacks associated with these practices. There exists a risk that employees may perceive the integration of gamified elements into their work environment as a form of micromanagement or a trivialization of their professional roles [22]. Furthermore, the competitive nature of gamification can inadvertently introduce stress, as individuals strive to excel within this gamified context. Such stress may adversely impact their well-being and performance, underscoring the necessity for a balanced and considerate implementation of gamification strategies.

2.4.1 Examples of gamification in dashboards

Despite the growing interest in integrating gamification elements within various digital platforms, the exploration of gamification in dashboards remains relatively underexplored. Despite this oversight, there are a few examples that demonstrate how gamification principles can be applied to dashboard design.

1. A platform aimed at promoting energy efficiency within office environments utilized gamified dashboards for energy consumption awareness, competitions, and peer comparisons, demonstrating significant energy savings [23].
2. Another instance involved the application of gamification principles in data analytics tools, enhancing user engagement and providing valuable insights into customer behaviors and preferences [24].

2.4.2 Examples of dashboards in games

Examples of dashboards across the spectrum of gaming genres illustrate the versatility and effectiveness of well-designed dashboards in providing essential information and enhancing the user experience in various gaming environments.

Strategy

Europa Universalis IV presents a complex dashboard that provides players with detailed information about their nation's political, economic, military, and diplomatic status [25]. This includes treasury balance, manpower, military strength, stability,

technology levels, and relations with other nations. The dashboard is essential for making informed decisions, managing resources, and strategizing expansion or warfare. It allows players to dive deep into the intricacies of running a nation, from negotiating political treaties to engaging in complex diplomatic relations, making it a core component of the gameplay experience.

Multiplayer Online Battle Arena (MOBA)

In "League of Legends" (LoL), the in-game dashboard is crucial for players during matches [26]. It displays real-time stats such as the player's current gold, items purchased, and abilities cooldowns. Additionally, the mini-map, part of the dashboard, shows the position of allies, visible enemies, and important objectives, allowing players to make strategic decisions based on the state of the game. Outside of matches, LoL offers a player profile dashboard that tracks overall performance, including win/loss records, champion mastery levels, and ranked progression, helping players to assess their growth and areas for improvement.

Massively Multiplayer Online Games (MMO)

"Guild Wars 2" utilises dashboards that allow players to directly influence gameplay mechanics or better understand in-game impact of those mechanics [27]. While permanent on-screen display is quite minimalistic, player can control what additional parts of the dashboard will be displayed allowing game-changing mechanics or in-game statistics to be shown simultaneously.

Educational

In "Duolingo," the dashboard serves as a central hub for tracking language learning progress [28]. It displays daily streaks, XP (experience points) earned, skill levels, and lesson completion status. The dashboard encourages consistent practice by showing progress towards daily goals and overall fluency in the chosen language. It also offers insights into weak areas that need revision, ensuring that learners focus on improving their language skills effectively.

Fitness

"Ring Fit Adventure" integrates a fitness dashboard that tracks players' workout progress, including calories burned, distance traveled, and exercise completion time [29]. This dashboard motivates players by showing their physical activity achievements alongside the game's adventure mode progress. It also provides recommendations for daily workouts and adjusts the game's difficulty based on the player's fitness level, making the experience personalized and challenging.

Simulation

"The Sims" series features an interactive dashboard that players use to monitor their Sims' needs (hunger, hygiene, social interaction, etc.), aspirations, skills, and financial status [30]. This dashboard allows players to manage their Sims' lives effectively, making decisions that affect their happiness, career progression, and relationships. By providing a comprehensive overview of various aspects of a Sim's life, the dashboard is integral to the gameplay, guiding players towards fulfilling

their Sims' desires and achieving long-term goals.

The impact of well-designed dashboards extends beyond data presentation; they act as a conduit between the player and the game's world, enhancing understanding, engagement, and immersion. By effectively bridging the gap between complex data sets and intuitive gameplay, dashboards empower players to make informed decisions, pursue personal growth, and engage with content on a deeper level. On the other hand flawed utilisation of dashboards can become a major point of user critique [31].

Furthermore, the adaptability of dashboards across various genres demonstrates the versatility of this tool in meeting diverse user needs and preferences, underscoring its significance in the evolution of game design. As games continue to evolve and become more sophisticated, the role of dashboards as a critical interface for enhancing player interaction and experience is likely to grow, driving innovation in dashboard design.

2.5 Design thinking in dashboards

Design thinking, an approach rooted in creativity and problem-solving, holds significant potential in the realm of dashboard creation. It involves a user-centric methodology that encourages experimentation, prototyping, and iterative feedback [32]. In dashboard design, this approach can lead to innovative solutions that are not only aesthetically pleasing but also highly functional and user-friendly.

The essence of design thinking in dashboard design lies in its empathetic approach towards understanding user needs and experiences [33]. By actively engaging with users, designers can gain insights into how individuals interact with dashboards, what information they prioritize, and the challenges they face in navigating and interpreting data.

A case study by Cahyadi and Prananto [6] shows how design thinking can be leveraged to help align dashboard design with the organization's vision and goals. Figure 2.3 shows a design thinking framework originally proposed by Cross [34], which was then adapted by Cahyadi and Prananto to the specifics of dashboard development.

Ultimately, the potential of design thinking in dashboard creation lies in its ability to foster a deep connection between the dashboard and its users. By grounding the design process in empathy, experimentation, and iterative feedback, designers can create dashboards that are not only visually appealing and functional but also deeply aligned with user needs and experiences. This user-centric approach ensures that dashboards serve as effective conduits for data, enhancing the overall user experience and facilitating a more insightful interaction with information.

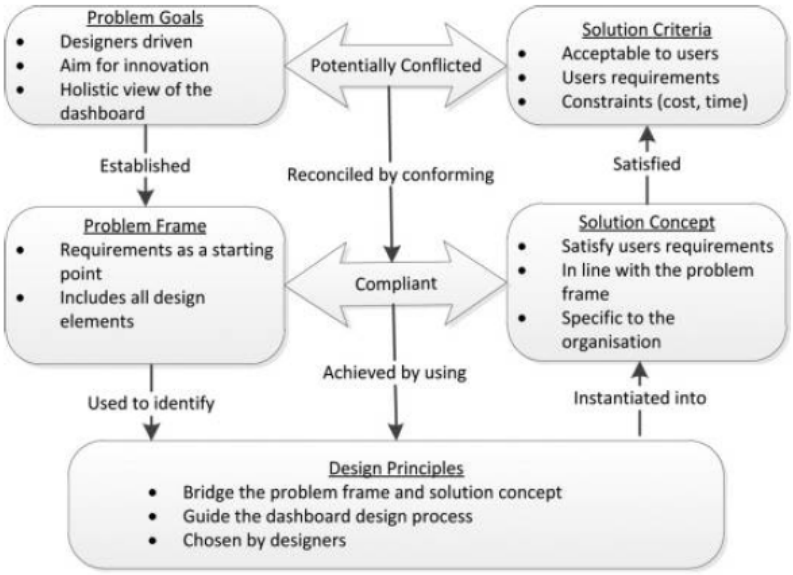

Figure 2.3: Design thinking dashboard development framework [6]

2.6 Guidelines and methodologies

Dashboard design is a complex endeavour, given the vast array of data sources, visualization options, and presentation methods available to designers. The abundance of choices can be daunting, highlighting an urgent need for clear guidance on designing dashboards [7].

Although research on comprehensive guidelines for dashboard design is not exhaustive, exploring the existing literature can reveal insights and principles that can inform effective dashboard creation. These guidelines are crucial for addressing the challenges of presenting complex data in an accessible and user-friendly manner, especially when targeting a broader, non-expert audience. The literature on dashboard design emphasizes several key considerations that can serve as a foundation for designers, even those without specialized training in data visualization or interface design.

2.6.1 General guidelines

Central to effective dashboard design is the principle of simplicity and focus. A dashboard should aim to inform rather than overwhelm, carefully selecting and presenting Key Performance Indicators (KPIs) to avoid clutter and information overload. The design should integrate seamlessly with users' existing workflows, offering relevant information without unnecessary detail. A balance between functionality emphasizing what the dashboard can do, and aesthetics - how information is visually presented, is essential. Consistency in design, clear navigational cues, and a structured approach to handling data complexity ensure a coherent and intuitive user experience. The organization of visual elements should be logical and symmetrical, with thoughtful grouping, clear demarcations between data sets, and a logical

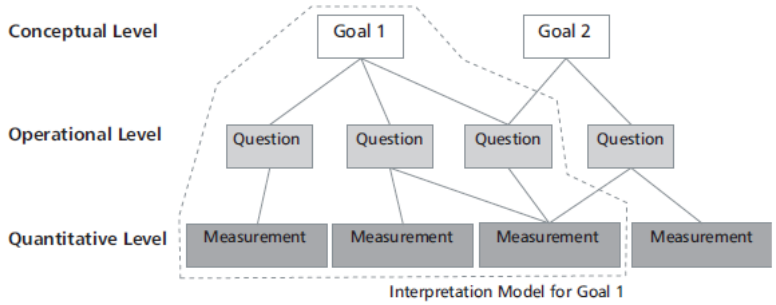

Figure 2.4: GQM model [36]

sequence that guides the user's understanding [7].

2.6.2 Incorporating user feedback

Incorporating user feedback early and often in the dashboard development cycle is crucial for aligning the end product with user needs and expectations, enhancing usability, fostering a sense of ownership among users, and encouraging more active engagement with the dashboard. Research supports this approach by highlighting the benefits of user involvement throughout the innovation process, especially in high-tech industries. For example, Bosch-Sijtsema and Bosch developed a conceptual framework on user data-driven innovation, emphasizing the importance of collecting and applying user feedback throughout the entire innovation process. This approach has been found to be beneficial for ensuring that products meet user requirements and expectations, ultimately leading to more successful and user-centric innovations [35].

2.6.3 Employing a GQM model

Janes et al propose the adaptation of a GQM (Goal-Question-Measurement) model in dashboard development [36]. This model consists of three levels:

1. The goal - conceptual level - defines what we want to study and why
2. The questions - operational level - defines which parts of the object of study are relevant and
3. The measures - quantitative level - defines which data has to be presented in order to answer the question in an objective (quantitative) way

Figure 2.4 illustrates how the model might look and the potential relationships between the goals, questions and measurements.

2.6.4 Iterative development

Iterative design and testing are fundamental to creating effective dashboards. This approach emphasizes refining designs through cycles of creation, evaluation, and

modification based on user feedback and test results. It aligns with the principle of continuous improvement, ensuring the final product meets user needs and expectations. The concept of iterative enhancement, a cornerstone in software development, underscores the value of adaptability and responsiveness in the creation process. As highlighted by Basili and Turner, iterative development facilitates a dynamic environment where adjustments are not merely reactive but are anticipated and planned as an integral part of the development lifecycle [37].

2.6.5 Accessibility and inclusivity

Ensuring dashboards are accessible and inclusive is crucial for reaching the widest possible audience. Adhering to the Web Content Accessibility Guidelines (WCAG) is fundamental in this endeavor.These guidelines are designed to make web content, including dashboards, more accessible to people with disabilities. This encompasses ensuring that text, images, sounds, and the structural code of dashboards are presented in ways that can be perceived, operated, and understood by users with diverse abilities [38].

2.6.6 Data Visualization Principles

Data visualization principles guide the effective presentation of information, helping users to interpret and understand data at a glance. Below are some foundational principles derived from current research in the field:

1. Clarity and simplicity: Ensure that visualizations are easy to understand at a glance, avoiding unnecessary complexity and clutter. Use straightforward designs and limit the use of colors and patterns to those that meaningfully differentiate data points or categories [4].
2. Effective use of color: Use color strategically to highlight significant data points or trends [10].
3. Consistency: Maintain consistency in the use of visual elements across visualizations to help users learn the meaning of symbols, colors, and patterns, improving their ability to quickly interpret new charts or graphs [39].

2.7 Challenges and limitations

While my aim is to to provide comprehensive guidelines and insights into effective dashboard design, particularly focusing on enhancing user experience and incorporating game design principles, it is important to consider challenges and limitations that shape the scope of this research.

2.7.1 Scope of Research

In order to narrow down the scope of research in a comprehensive manner, this thesis will intentionally not take into consideration the following elements:

1. Data privacy and security in dashboard development.
2. Technical infrastructure and backend development of dashboards.
3. Data engineering techniques and ensuring data quality.
4. Differences in dashboards across various industries, departments and specific use cases.

While each of these areas plays a crucial role in the effective development and utilization of dashboards, they fall outside the primary focus of the thesis. Addressing these topics requires specialized expertise and would significantly broaden the scope of the research. Therefore, while recognizing their importance, I chose to concentrate on the design, user experience, and the application of gamification principles in dashboards, aiming to provide a focused exploration within these domains.

2.7.2 Technological Advancements

The rapid pace of technological advancement presents a challenge to the long-term applicability of specific design recommendations. While principles of good design may remain constant, the tools, platforms, and methods for implementing these principles are continually evolving. This research may not capture the latest technological innovations in dashboard design and user interaction, particularly the rapidly increasing use and potential of Artificial Intelligence (AI). The evolving capabilities of AI in enhancing dashboard functionality, predictive analytics, and user interaction add a dynamic layer to dashboard development. However, it is crucial to underscore the importance of maintaining a user-centered approach when integrating AI technologies. Ensuring that AI implementations enhance rather than complicate the user experience is vital. As AI becomes more embedded in dashboard development, designers and developers must prioritize intuitive design, clear data presentation, and seamless user interactions to leverage AI's benefits fully while minimizing potential usability challenges.

2.7.3 Quantitative Analysis Limitation

In this thesis, I primarily adopts a qualitative analysis approach, exploring concepts, theories, and principles related to dashboard design and user experience. As such, I may not provide a quantitative measurement of the effectiveness of specific design elements or game mechanics in enhancing user engagement or dashboard usability.

Incorporating quantitative analysis could potentially add value by providing measurable data to support the findings. I identified two areas where quantitative methods could be particularly beneficial:

- Assessing Current Dashboard Usage: Quantitative analysis could be employed to gather data on how corporate users currently interact with dashboards. This would provide a clear picture of user satisfaction, common pain points, and areas for improvement. Understanding these metrics could help in identifying

specific user needs and preferences, thereby informing more targeted design enhancements.

- Evaluating the Prototype: Quantitative methods could be used to evaluate the effectiveness of the dashboard prototype developed in this research. By measuring user engagement, satisfaction, and usability metrics, it would be possible to validate the impact of the proposed design elements and gamification strategies. This approach would offer concrete evidence to support the qualitative insights and demonstrate the tangible benefits of the new design.

By quantifying user interactions and experiences in both the current and prototype dashboards, it would be possible to identify specific metrics that correlate with increased engagement and usability, offering a more comprehensive evaluation of the design's impact.

3

Methods

3.1 Overarching methodology

In this thesis I chose to utilize Agile development as the overarching methodology of the project, chosen for its emphasis on flexibility, collaboration, and iterative refinement. Agile's principles are particularly beneficial for projects that must navigate evolving requirements and aim for the rapid delivery of high-quality results [40]. This approach ensures a continuous engagement with the user's needs and preferences, making it suitable for developing solutions that are both innovative and aligned with user expectations.

To put this methodology into practice, the project will implement structured sprint planning sessions and retrospectives at regular intervals. This setup allows for continuous evaluation and adaptation based on feedback, ensuring that the project remains agile and responsive to new insights and developments.

Each sprint will focus on specific objectives, moving the project forward through incremental progress. This method not only facilitates a clear organization of tasks but also ensures that each phase of the project receives focused attention and effort.

Through the application of Agile methodologies, I aim to maintain a dynamic and flexible approach to research and development.

3.2 Design framework

This section presents the design framework used to guide the research and development process. By leveraging an established framework, such as Design Thinking, the research aims to ensure a structured and effective approach to problem-solving and design.

3.2.1 Design Thinking

Design thinking is the primary framework to guide the design process of this thesis. Design thinking is in its essence a creative approach to identifying and solving problems. It is most applicable in situations where a problem is complex or not well defined and a breakthrough idea or concept is needed [41].

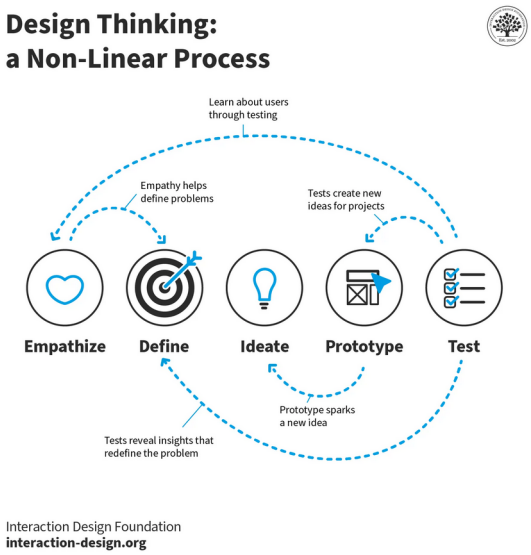

Figure 3.1: Design Thinking: a Non-Linear Process [43]

The five phases of Design Thinking are as follows:

1. Empathize: Understanding stakeholder needs through engagement and observation.
2. Define: Clearly articulating the problem.
3. Ideate: Generating a wide range of creative solutions.
4. Prototype: Developing tangible representations of ideas for testing.
5. Test: Evaluating prototypes.

All of those phases will be incorporated into this thesis.

Figure 3.1 demonstrates the dynamic flow between the phases of Design Thinking, highlighting that the process is not a set sequence but a flexible path that adapts to emerging insights and ideas [42]. Accordingly, during the course of this project I will adopt an adaptable approach to the Design Thinking phases, allowing for non-linear iteration, parallel execution and revisiting phases as new insights emerge.

Figure 3.2 shows the similarities between Design Thinking and Agile Methodologies, such as embracing iteration and flexibility, illustrating how those approaches can be complementary to each other. Leveraging both of them will guide the thesis toward innovative solutions that are both practical and aligned with user expectations.

3.3 Analysis methods

This section describes the methods used to analyze the qualitative data collected during the research. The primary method employed is semi-structured interviews,

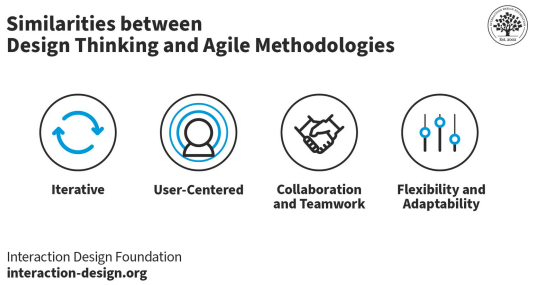

Figure 3.2: Similarities between Design Thinking and Agile Methodologies [43]

supplemented by coding and thematic analysis process to identify key insights and patterns.

3.3.1 Semi-structured interviews

Semi-structured interviews will be the primary method for gathering qualitative insights in this study, specifically from dashboard developers. The focus on developers is strategic as understanding their perspectives early on provides insights into the design and development processes that shape dashboard functionality and user interaction. This foundational knowledge is crucial to guide the following phases of the research, especially before engaging with dashboard users in the testing phase.

These interviews aim to explore the perspectives, experiences, and challenges encountered by dashboard developers in their efforts to create user-friendly and effective dashboard solutions. The emphasis is on understanding their design processes, the obstacles they face in making dashboards more accessible and engaging, and the strategies they employ to incorporate user experience principles into their work.

The technique used in this stage, semi-structured interviews, is the most frequently used interview method in qualitative research, being both versatile and flexible. This approach requires the interviewer to possess a certain level of knowledge in the field and formulate an interview guide based on it [44]. Consequently, the interviews were planned to be conducted after an extensive literature review and a preparation stage, detailed in later sections. These steps aimed to facilitate discussions that reveal innovative approaches to enhance dashboard usability and engagement, contributing to the overall dashboard design practices.

3.3.2 Interview process

Following a comprehensive literature review, an interview guide will be developed, containing open-ended questions that facilitate rich, informative discussions. Interviews will be scheduled at participants' convenience, recorded for accuracy, and transcribed automatically using Artificial Intelligence tools to support detailed analysis.

3.3.3 Participant selection criteria

Employees of Novo Nordisk were primarily selected for participation in this study due to my current internship at the company, which facilitated easy communication, encouraged participation and offered insights into its operations. Novo Nordisk, known for its significant role in the healthcare industry and commitment to innovation and quality in data-driven solutions, offers an ideal setting for exploring UX best practices in dashboard development [45].

The reasons for choosing Novo Nordisk employees are multifaceted:

- Global Leadership: As a leading international company, Novo Nordisk provides a comprehensive foundation for exploring the integration and impact of UX design principles in dashboard development across various domains.
- Complex Data Integration: Employees at Novo Nordisk navigate complex data environments, making their insights invaluable for understanding UX challenges and strategies in sophisticated dashboard applications.
- Innovative Culture: The company's focus on innovation makes it an ideal case for studying the integration of UX principles in IT solutions.
- Broad Applicability: Lessons learned from Novo Nordisk can inform UX best practices across industries.

This participant selection aims to leverage Novo Nordisk's example to generate findings that are broadly relevant and capable of informing UX best practices in diverse organizational contexts. Additionally, the proximity and access afforded by my internship facilitated in-depth interactions with participants, ensuring rich and relevant data collection.

3.3.4 Ethical Considerations for data handling

This research will adhere to strict confidentiality and privacy standards. The following ethical considerations outline commitment to responsible data handling:

1. Anonymization of data: To ensure the privacy of participants, all interview data will be meticulously anonymized. Identifiable information will be removed, with the exception of role and organizational context (e.g., "Senior Data Analyst at Novo Nordisk") to maintain the relevance of insights. Specific identifiers such as names and other data that could reveal the participants' identity will be omitted to protect privacy while still preserving the integrity and context of the data collected. This method balances the need for rich, contextual understanding with the paramount importance of safeguarding participant privacy.
2. Securely storing data: All digital recordings, transcripts, and notes will be stored on encrypted, password-protected devices and servers.
3. Disposing of data in a timely manner: Voice recordings will be reviewed for transcript accuracy and subsequently destroyed to ensure the confidentiality of

the dialogue. The transcripts themselves will be securely disposed of following the completion of the research project to uphold our commitment to participant privacy. However, anonymized quotes extracted from these transcripts may be used within the thesis to illustrate findings and will be included in the publicly available research documentation. This practice ensures that while the essential insights are preserved and shared, the identities and privacy of participants are protected.

4. Informed Consent: Participants will be fully informed about the study's purpose, the nature of their participation, how their data will be used, and their rights to withdraw at any time.

3.3.5 Inductive coding and thematic analysis

In the analysis of the qualitative data gathered from the interviews, an inductive approach to thematic analysis will be employed [46]. This process allows for the identification of emergent patterns and themes relevant to the research question, as an example to gather insights into practices employed by dashboard developers to ensure usability of their dashboards.

The inductive approach allows for themes to emerge directly from the raw data rather than being imposed based on preconceived ideas or theories [46]. The coding and thematic analysis process will follow the following sequence as it has been described by Braun and Clarke [46] in their paper:

1. Initial Coding: after transcribing the interviews and reviewing the documents, the next step will be to read through the data multiple times, taking an open-minded approach to assign initial codes to segments of text that seem to capture key thoughts or concepts. This stage of coding is data-driven, and the goal is to stay as close to the data as possible.

2. Focused Coding: Following the initial coding, the codes will be reviewed, compared and grouped together to form potential themes. This stage is more interpretative, allowing for organizing the codes into meaningful groups.

3. Theme Development: The groups of codes will be examined for their relationships and patterns.

4. Review and Refinement: The identified themes will be reviewed and refined in relation to the coded extracts and the entire data set. This iterative process ensures that the themes are representative of the data and accurately address the research question.

This inductive approach will provide a rich and detailed account of the data, allowing for an in-depth exploration of the perspectives of stakeholder groups on user-centered dashboard design. It aligns with the broader aim of this thesis to inform user-centered design practices through empirical insights.

3.4 Ideation methods

This section presents the ideation methods used to generate creative solutions and concepts for the dashboard design.

3.4.1 Mind mapping

Mind mapping is a tool that facilitates organization of ideas during the ideation phase, helping in visualizing connections between concepts [47]. In the context of this thesis, mind mapping will be used in following steps:

1. Defining a central concept, e.g. "User engagement through gamification"
2. Branching out ideas, exploring the depth and breadth of the central concept
3. Highlighting opportunities for innovation and potential themes to explore

This technique will offer a clear visual guide to navigate through various ideas, ensuring a structured approach to uncovering innovative solutions. By identifying connections and themes, mind mapping will help focus the thesis on the most promising areas for enhancing user interaction, making the exploration of complex concepts more manageable and directed.

3.5 Tools

This section presents tools that will be used in the prototype development, such as data visualization software, design tools and accessibility evaluation tools.

3.5.1 Power Platform

The Power Platform is a suite of Microsoft products that offers a set of tools for innovative digital business solutions [48].

3.5.1.1 Power BI

Power BI is a business analytics tool that enables interactive data visualization and dashboard creation, useful for handling complex datasets [49]. This tool is particularly suited for this thesis due to its widespread use in corporate settings, making it a relevant choice for developing prototypes that could be realistically implemented in a business environment. The ability to quickly model data and create visualizations aligns with the rapid prototyping phase, allowing for iterative design and feedback loops with stakeholders.

3.5.1.2 Power Apps

Power Apps, a component of Microsoft Power Platform, enables the creation of custom apps to enhance dashboard functionality, supporting tasks like data input and feedback collection [50]. It will potentially be employed to develop custom

applications that complement the dashboard prototypes, enhancing interactive user engagement. Power Apps' ability to integrate with Power BI makes it a practical tool for dashboard developers to enhance their existing data visualizations with minimal hassle.

3.5.2 Tableau

Tableau is a data visualization tool known for its ability to simplify complex data into accessible and interactive visuals [50]. While Tableau is considered a major alternative to Power BI, its exploration in this thesis is motivated by the interest in comparing its features and usability against Power BI's capabilities, particularly in the context of dashboard development and user experience.

3.5.3 Figma

A collaborative interface design tool that offers features for wireframing, prototyping, and user testing, enhancing UI/UX design tasks [51]. Figma will be used for wireframing and testing the usability of dashboard designs, including the integration of gamification elements. The decision to use Figma is based on its versatility in simulating user interactions and its effectiveness in conveying design concepts to both technical and non-technical stakeholders.

3.5.4 Procreate

A digital painting app useful for creating detailed graphics and illustrations [52]. In the context of this thesis, Procreate will be used to add artistic and engaging elements to dashboard prototypes, enhancing their aesthetic appeal and user engagement. This tool's choice is motivated by the need to explore the visual aspects of gamification in dashboards, where appealing graphics play a crucial role in user experience.

3.5.5 Accessibility evaluation tools

There are several accessibility evaluation tools that help designers evaluate web pages with the WCAG (Web Content Accessibility Guidelines) [38] principles, as an example WAVE Web Accessibility Evaluation Tools or WCAG-EM Report Tool. These tools provide automated checks and guidance on accessibility issues, enabling the identification and rectification of potential barriers for users with disabilities. Although implementing accessibility features is not the primary focus of this thesis, the inclusion of these tools underscores the commitment to creating inclusive and accessible dashboard designs.

3.6 Prototyping

The aim of this part of the thesis is to develop a digital prototype that explores the feasibility and user reception of incorporating game design elements into dashboards.

The prototyping phase will explore various fidelity levels, starting with low-fidelity sketches to quickly conceptualize ideas, moving towards higher-fidelity digital prototypes using tools such as Figma and the Power BI platform. These prototypes will be designed to test specific aspects of the user interface and interaction design, reflecting the iterative insights gained from the ideation and feedback phases.

3.6.1 Rapid prototyping

Rapid Prototyping is a swift and effective methodology for visualizing and materializing concepts with an emphasis on speed and iterative development [53]. It involves bringing concept details, forms, and nuances to life in a crude and unfinished appearance for early testing. The primary advantage of Rapid Prototyping is early failure detection within the concept development phase, significantly reducing costs in later development stages. It is an approach allowing for continuous refinement and improvement. Rapid Prototyping aims to produce a tangible artifact that can be discussed with others, enhancing the collaborative and iterative nature of the design process.

3.6.2 MoSCoW prioritization

The MoSCoW method is a requirements prioritization technique used to order features identified for a system based on their importance for the project and stakeholders [54]. This method will be used to complement the rapid prototyping process, ensuring that the focus will be on essential parts of the prototype while also considering potential enhancements that could be implemented if time allows.

1. Must have (M): These requirements are non-negotiable for the project's success. Failure to include these features would result in the project not meeting its core objectives.

2. Should have (S): High-priority items that are important but not vital. These features significantly contribute to the project objectives and are expected to be included if possible.

3. Could have (C): Desirable features that are not critical. Including these would enhance the product but are the first to be omitted if time or resources are constrained.

4. Won't have (W): Features that have been explicitly excluded from the current development cycle due to various constrains but are identified as potentially relevant to the project.

For the scope of this project, the prioritization will take a different approach from that of a dashboard meant for deployment.

The "Must Have" and "Should Have" categories will center on the foundational implementation of the dashboard, with an emphasis on the inclusion of interactive functionalities and introductory gamification elements.

The "Could have" category may include more advanced gamification and personalization features.

Conversely, the "Won't Have" category will encompass features critical to a full-scale production environment but of lesser relevance to the academic goals of this project.

This approach will ensure efficient use of time and resources during the project, while acknowledging other necessary considerations for dashboard developers in the corporate setting.

3.6.3 Sample data in prototyping

All digital prototypes will be developed using sample data to ensure that the focus remains on the usability and user experience aspects of the designs, rather than on specific business cases. This approach allows for a broader exploration of game design elements in dashboards without the constraints of real-world data, which may contain sensitive or proprietary information. The use of sample data ensures that prototypes can be freely shared and discussed with stakeholders and users during feedback sessions, without the risk of disclosing confidential information.

3.7 Evaluation methods

This section outlines the evaluation methods used to assess the potential of the dashboard prototype and gather actionable insights from users.

3.7.1 User testing

User testing will play an important role in evaluating the potential of the dashboard prototypes developed and concepts presented in this research. The primary objective is to gather actionable insights from actual dashboard users across various industries to ensure the findings are comprehensive and broadly applicable.

3.7.2 Participant selection criteria

For this study, 5-8 participants will be invited to partake in the user testing phase. Participants will be selected based on the following criteria:

1. Occupation: Individuals employed in corporate settings where dashboards are a regular part of their workflow.

2. Experience: Users with varying levels of experience with dashboards to capture a wide range of interactions and feedback.

3. Interest in games: Efforts will be made to include participants with varying levels of interest in games to explore how familiarity with game mechanics affects people's perception of gamification.

3.7.3 Testing procedure

The user testing process will be meticulously designed and executed as follows:

1. Preparation: This stage involves creating a detailed plan for each testing session, including the selection of specific dashboard prototypes to be tested, crafting tasks for participants, and preparing a set of semi-structured interview questions.
2. Execution: User testing sessions will be conducted in a controlled environment, either in-person or remotely, depending on the participant's location and availability. For remote sessions, participants will be asked to share their screens, allowing for real-time observation of their interactions with the dashboard prototype. In-person sessions will provide an opportunity for direct observation of user behavior and interaction with the prototype.
3. Feedback collection: Feedback will be gathered through a combination of direct observation and recordings of participants answers to interview questions.

3.7.4 Ethical considerations

The ethical framework established for conducting interviews will also be applied to the user testing phase. This includes ensuring informed consent, guaranteeing anonymity, and adhering to data protection regulations. Participants will be fully briefed on the purpose of the testing, the nature of their involvement, and their rights to withdraw at any time without consequence.

3.7.5 Outcome and evaluation

The outcome of the user testing phase will be a dataset of user experiences, preferences, and feedback regarding the dashboard prototypes and the integration of gamification elements. This data will be analyzed using affinity diagraming [55] to identify patterns, themes, insights, and areas for improvement. Affinity diagramming is a technique used to make sense of and organize large amounts of unstructured and seemingly dissimilar qualitative data, facilitating a deeper understanding of user interactions and experiences with prototypes.

The evaluation will focus on usability, engagement, and the effectiveness of gamification in enhancing the dashboard user experience. Insights gained from this phase will inform the refinement of the dashboard prototypes.

Given the iterative nature of design and development, the necessity for subsequent feedback rounds will be determined based on the initial session's findings. If the analysis will reveal significant areas for enhancement or if user feedback suggests the potential for further optimization, an additional round of user testing may be conducted.

4

Planning

4.1 Agile framework integration

The planning phase of this thesis is structured around an Agile framework, ensuring flexibility and responsiveness to evolving research insights and stakeholder feedback. The project timeline is divided into monthly sprints, at the end of which the progress will be evaluated and adjustments will be made. Each sprint will consist of a specific set of tasks aligned with the methodologies outlined in previous sections.

4.2 Visual planning tools

This section describes the visual planning tools used to organize and track the progress of the research project.

4.2.1 Gantt Chart

A Gantt chart shown in Figure 4.1 is a visual representation of this timeline, showing the estimated duration of each activity.

4.2.2 Sprints

A list of sprints shown in Figure 4.2 specifies the dates for sprints and expected deliverables for each of them.

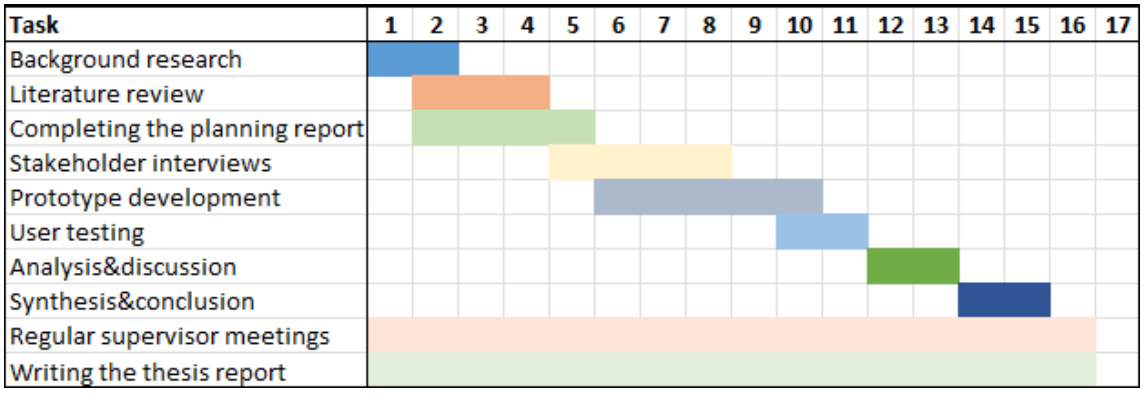

Figure 4.1: Thesis planning: Gantt chart

Sprint	Date	Detail
1	22/01/2023	Background research
2	29/01/2023	Literature review
3	05/02/2023	Methods
4	12/02/2023	Completing planning report
5	19/02/2023	Interview preparation
6	26/02/2023	Starting prototype development
7	05/03/2023	Interview & development
8	12/03/2023	Interview & development
9	19/03/2023	Prepare for user testing
10	26/03/2023	Last interviews finalized
11	02/04/2023	User testing conducted
12	09/04/2023	Interview analysis done
13	16/04/2023	User testing analysis&feedback done
14	23/04/2023	Report writing
15	30/04/2023	Conclusion
16	07/05/2023	Completing thesis report
17	14/05/2023	Buffer week/improvements

Figure 4.2: Thesis planning: Sprints

4.3 Iterative Writing Approach

Recognizing the importance of integrating writing into the research process, an iterative writing approach is adopted. This involves drafting sections of the thesis as research progresses, allowing for the continuous refinement of the narrative and the integration of feedback.

4.4 Adaptability to changes

Incorporating Agile principles, the plan remains flexible to accommodate changes or new insights that may arise during the research process. Regular meetings with stakeholders and advisors will ensure ongoing alignment. Incremental writing of the thesis report will allow for adaptability to shifting the approach based on new feedback, ideas or insights.

5

Process and Execution

This chapter outlines the execution and process of the project, structured around the Design Thinking and Agile methodologies. This approach is described in alignment with the Design Thinking phases; however, given its non-linear nature, the stages are not presented in a chronological order. This structure of the chapter reflects the iterative and flexible nature of this process, where phases are often revisited or undertaken simultaneously as insights evolve.

5.1 Empathize

The Empathize phase is a foundation for understanding the stakeholders' experiences, needs and challenges. This phase has been informed by a detailed literature review outlined in Chapter 2, and further enhanced by firsthand observations during the author's internship within the Business Intelligence team at Novo Nordisk. The literature review provides a scientific foundation, exploring existing knowledge in the domain. Meanwhile, the workplace observations offer practical insights into the business environment and daily challenges faced by the stakeholders at the workplace. This approach ensured a comprehensive understanding of the stakeholder experiences, creating a baseline of theoretical and practical evidence.

5.1.1 Interview preparation

In this phase, various key areas to explore during the interviews were identified, aligning with objectives of the study. Furthermore, sample questions for each of the key areas were prepared in line with the semi-structured interview methodology. An additional preparation step involved drafting a list of ethical disclosure points. This list was designed to be presented at the beginning of each interview, ensuring participants were fully informed about the study's purpose, the confidentiality of their responses, and their rights within the research process, including the freedom to withdraw at any time without consequence. All materials related to the interview preparation, including the identified key areas, sample questions, and the list of ethical disclosure points, are comprehensively detailed and attached in Appendix A for reference.

5.1.2 Participant selection

Participants were carefully selected based on their roles and experiences with dashboard usage, aiming for a diverse group that could provide a broad spectrum of insights. The participants have been contacted through professional channels such as Teams and Outlook, leveraging existing work-related networks to facilitate engagement.

5.1.3 Execution

A total of 7 semi-structured interviews were conducted using Microsoft Teams, leveraging the platform's automatic transcription function. Complementary to this, voice recordings were taken in order to verify the accuracy of automatic transcription. Additionally, brief notes were taken in order to highlight key points of the interviews and aid in memorization of personal reflections.

5.1.4 Challenges

One notable challenge encountered during the interview process was the varying accuracy of Teams' automatic transcription function. While convenient, the transcripts produced by this feature lacked precision, necessitating careful reviews and corrections. This challenge highlighted the importance of utilizing multiple data capturing methods such as voice recordings and note taking.

5.1.5 Findings

Every interviewee emphasized the significance of the user experience in dashboard design, identifying it as a critical aspect. They highlighted several consistent concerns and potential areas for enhancement, acknowledging the varied needs of their stakeholders. The importance of user engagement varied among respondents, closely tied to the specific objectives of their dashboards. Consequently, their attitudes towards incorporating a higher amount of interactive elements, integrating new technologies, and including gamification elements also varied. However, there was a consensus that such features could be particularly beneficial in educational contexts.

A comprehensive discussion of these interview insights will be presented in the Results chapter.

5.2 Define

In the Define phase, insights from the Empathize phase are synthesized into actionable challenges and objectives, setting a clear direction for solution development.

5.2.1 Challenges identified

The challenges outlined below were identified through an analysis of insights from the literature review as well as interviews with dashboard developers. This combination

of sources provided a comprehensive understanding of the prevalent issues faced in the field of dashboard design, particularly in the integration of gamification elements.

1. Flexibility in visualization tools: Commonly used data visualization tools such as Power BI or Tableau are not flexible enough to incorporate a variety of gamification elements.
2. User engagement: A frequent challenge is designing dashboards that not only present data efficiently but do so in an engaging manner. This includes intuitive design, interactive elements, and the novel concept of gamification to maintain user interest.
3. Understanding the role of gamification: There is an identified gap in understanding how gamification could potentially be appplied within the context of corporate dashboards to enhance user experience. This extends to assessing its feasibility, potential benefits, and any perceived limitations from a developer and user perspective.

5.2.2 Exploration of tools

Due to the identified lack of flexibility in leading data visualization tools such as Power BI and Tableau, research on different tools that could allow for integration of game elements into dashboards has been conducted. Several tools and methods have been considered, which are discussed below:

1. Integrating Power BI visuals with web development tools (HTML, CSS and JavaScript): This method would offer the highest degree of customizability and allow for implementation of a variety of game elements. However, it would highly increase the complexity of the development, not fitting in within the timeline of this project.
2. Figma: Figma is a versatile tool for design and prototyping, however it is not suitable for adding various functionalities without additional development work.
3. Adobe XD: Similarly to Figma, this tool allows for great flexibility and creating high-fidelity prototypes, however it would need additional development for game functionalities.
4. Power Apps: The software offers a good mix of design flexibility and functionality. It supports the direct integration of gamification elements without needing external development, making it a practical choice for developing interactive dashboard features.

As a conclusion, Power Apps has been identified as the best-suited tool for the scope of this research. Although Power Apps provides a suitable environment for integrating basic game elements into dashboards, it also presents challenges in terms of the complexity of gamification that can be achieved compared to custom development with web technologies. Despite this, Power Apps stands out for its numerous advantages.

A key benefit of Power Apps is the possibility to integrate it with other Microsoft applications, making it a practical option for businesses to leverage their current infrastructure and enhance their dashboards within the existing Microsoft ecosystem. This integration simplifies the process of adding new functionalities, including gamification, to dashboards created with Power BI.

Another significant advantage of Power Apps is its low-code development environment and user-friendly interface, which significantly reduces the time and technical expertise required to build an application. This characteristic makes it a highly suitable choice for rapid prototyping and iterative development, fitting for both this project and the dynamic needs of modern businesses.

Furthermore, the platform's strengths include supporting broad customization options, allowing developers and analysts to create applications that precisely align with specific organizational requirements. The customization can also include adding simple gamification components.

This project will further explore the capabilities of Power Apps, highlight ways in which it can be useful in the corporate setting and explore the extent to which it can support gamification elements.

5.2.3 Objectives

1. Exploring developer approaches: Delve into how dashboard developers currently address user experience challenges, aiming to consolidate best practices and investigate the potential of innovative strategies, including gamification.
2. Gamification opportunities: Identify where and how gamification elements can be meaningfully integrated within corporate dashboards without compromising their analytical utility.
3. Prototype design: Develop a prototype dashboard that includes some gamification elements to test their effectiveness in enhancing user engagement and data interaction.

5.3 Ideate

The Ideate phase aims to leverage insights from the Define phase to generate a wide variety of creative solutions. In this stage, mind mapping was identified as the most suitable ideation technique to be conducted independently, allowing for a focused exploration of potential solutions. This approach facilitates a structured yet flexible process for brainstorming, enabling both in-depth exploration and and the generation of a wide array of ideas.

5.3.1 Mind mapping

Mind maps have been constructed without a time restriction, allowing for adding concepts when new insights emerged. This approach was chosen as it fits in with the

Figure 5.1: Mind map with a central theme of gamification in dashboards

iterative nature of agile methodology and the flexibility of design thinking. These mind maps were constructed using the platform Miro which provides a virtual space for visualization of creative ideas. This digital approach further enabled easy adjustments and expansions thanks to using a specific template for mind mapping which automatically adapted to the changes.

Distinct mind maps have been developed to address different aspects of the project:

- User-centered dashboard design: This mind map focused on the broad theme of aligning dashboards with user needs and experiences, laying the groundwork for a deep understanding of user interactions with dashboards. This has been illustrated in Figure 5.2.
- Gamification in dashboards: The second mind map had a specific focus on exploring the integration of gamification within dashboards, investigating which particular game elements could potentially be integrated into a dashboard. This has been illustrated in Figure 5.1.

5.4 Prototype

This phase involves the development of tangible representations of ideas generated during the Ideate phase. The emphasis on iterativity in this phase is very high, as it involves the evolution of initial low-fidelity prototypes into more detailed and interactive representations.

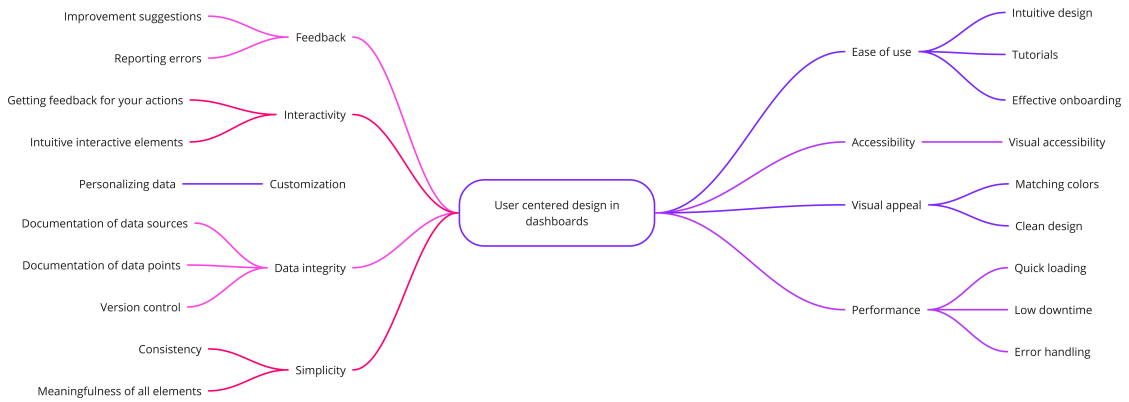

Figure 5.2: Mind map with a central theme of user-centered design in dashboards

5.4.1 Design exploration

In this stage, rapid prototyping was employed to efficiently explore and test various design concepts and functionalities.

The prototyping phase was initiated with the creation of low-fidelity sketches using ProCreate, providing a visual blueprint of a typical dashboard layout. These sketches served as a preliminary visualization tool to conceptualize a dashboard's structure and main components. The sketches, illustrating different layout options and dashboard elements, are documented in Appendix B for detailed reference.

Subsequently, the phase focused on exploring different functionalities of PowerApps, which has been identified as the primary tool for development during the Define phase. Using the rapid prototyping method was particularly fitting due to the authors' lack of previous familiarity with the tool. To begin with, a sample Excel dataset has been used to create a default visualization illustrated in Figure 5.3. It automatically creates a "Gallery" where each Excel row is transformed into a record. The Gallery view itself is simple but intuitive to use. It offers limited interactive elements, enabling the user to scroll through the list of records, click on them to see details or use the search function based on the records' titles.

In the following steps, different sample datasets have been used in order to explore the system's functionalities. The focus areas here were as follows:

1. Interactive features: Investigating PowerApps' capabilities for user interaction within the dashboard, such as editing data, sorting and filtering, navigation, etc. This is illustrated in Figure 5.4, where the app allows the user to edit the records, automatically updating the Excel file that it is connected to.

2. Data visualization integration: Assessing how different data visualizations can be integrated into PowerApps, as well as the potential to connect PowerApps to Power BI. Both approaches are functional, presented in Figure 5.6 and Figure 5.5, however including Power BI visuals in PowerApps has been identified as the more optimal solution. This approach allows for leveraging the flexibility of PowerApps and the analytical strength of Power BI.

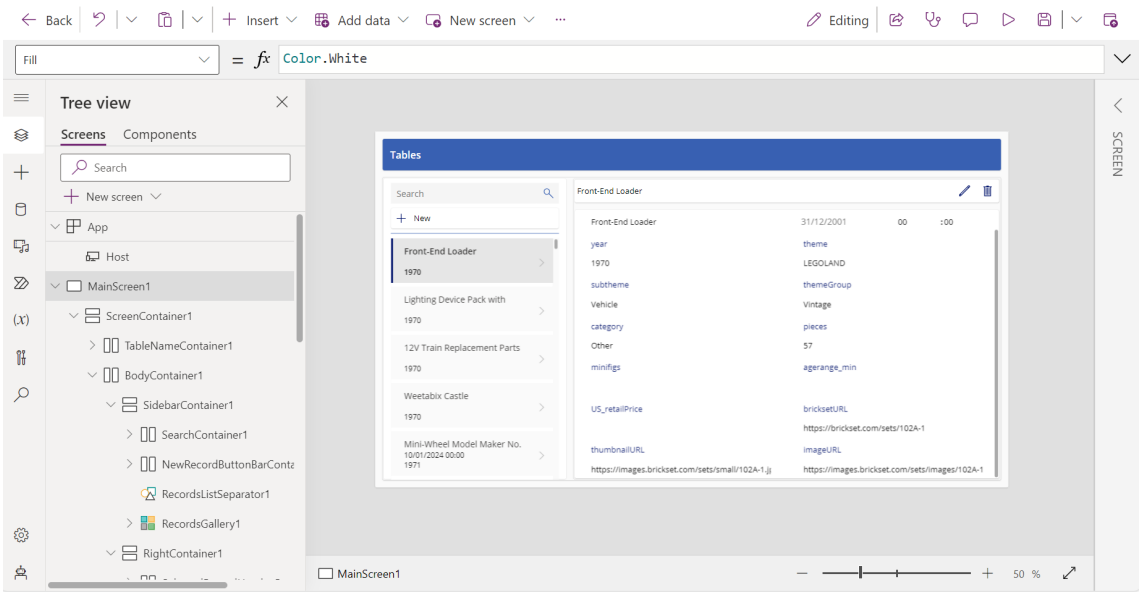

Figure 5.3: PowerApps: default data visualization after inserting an Excel sheet

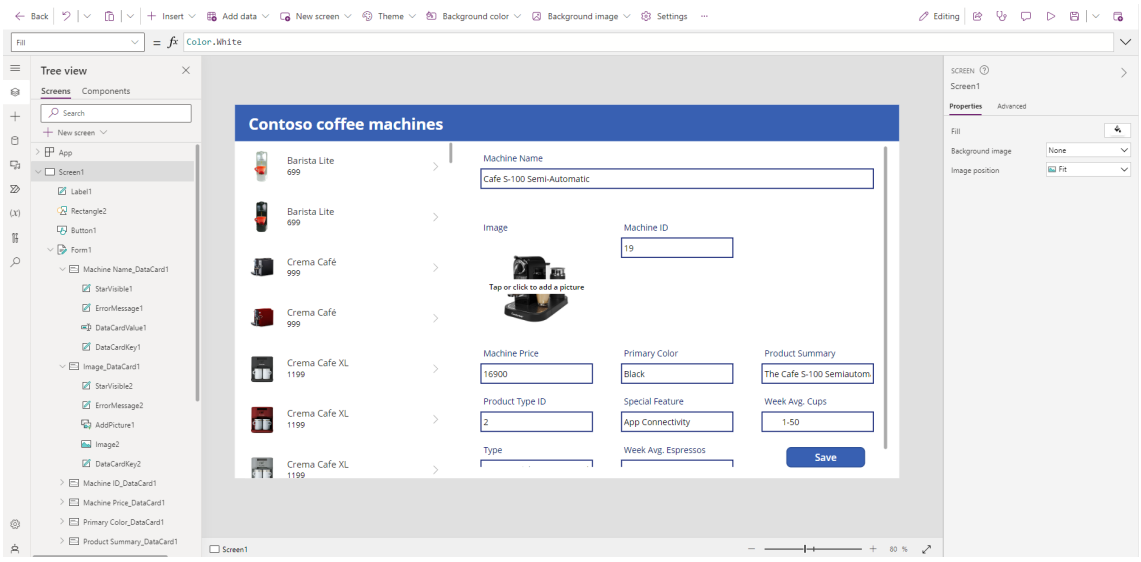

Figure 5.4: PowerApps: interactive data visualization

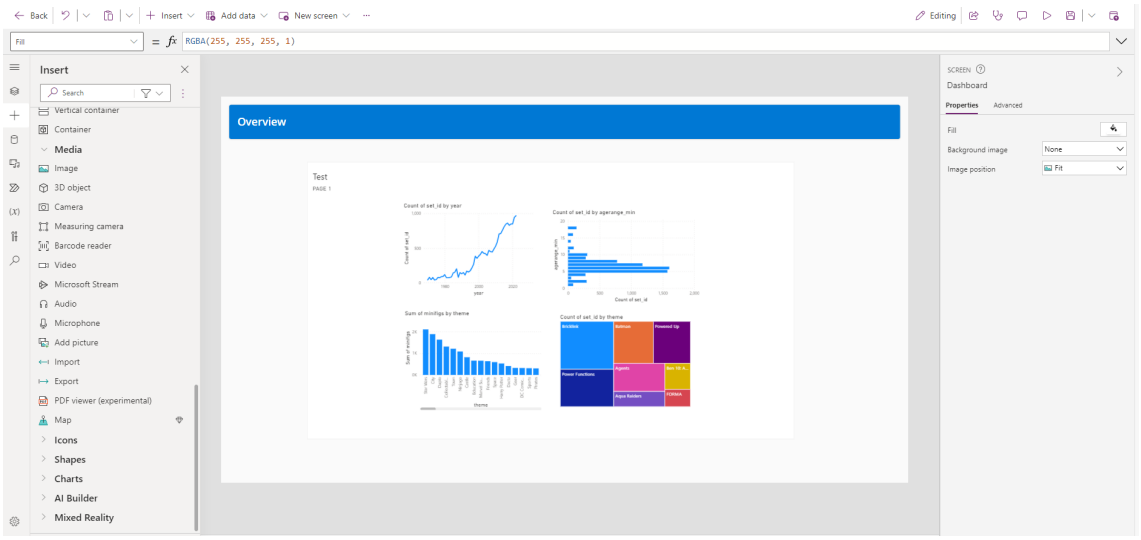

Figure 5.5: Embeding PowerBI visuals in PowerApps

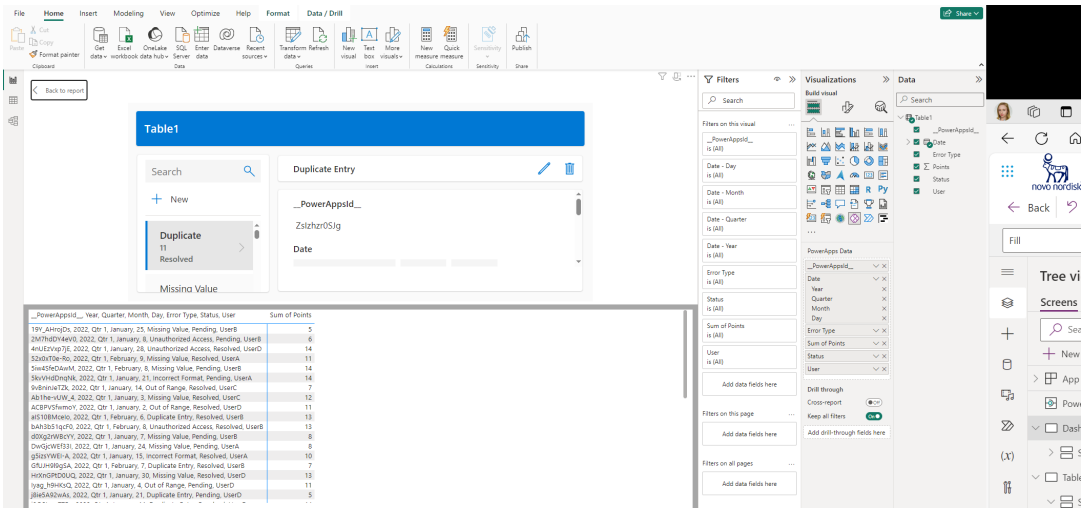

Figure 5.6: Inclusion of a PowerApps app in PowerBI

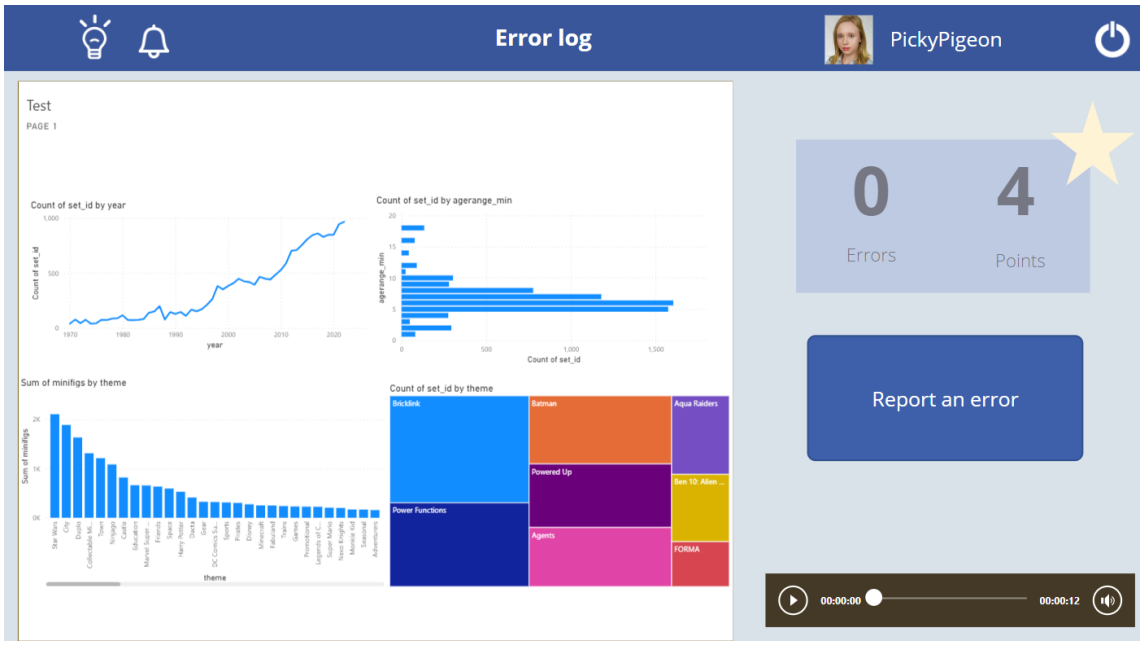

Figure 5.7: Exploring implementation of a point system in PowerApps

Furthermore, creating charts in PowerApps has been examined, however it only included basic analytical functions and does not support data visualization on the same level as Power BI.

3. Gamification possibilities: Identifying and testing the feasibility of integrating game design elements to increase user engagement and improve the overall experience. Figure 5.7 illustrates the implementation of a point system, where user receives a point for reporting an error.

5.4.2 Building the prototype

The prototype was built using ideas and components from the early prototyping stage. The objective for this prototype was to resemble a real tool that could be used in workplaces, making it directly useful for improving corporate dashboards. This approach ensures that the prototype is practical and meets the real needs of users in a professional environment.

5.4.3 MoSCoW prioritization

The development process was guided by the MoSCoW method of prioritization in order to effectively manage the scope and focus on essential features.

1. Must have: Core features necessary for the prototype to function, including basic data visualization capabilities, user interaction features such as editing and filtering data, and initial gamification elements like a points system.

2. Should have: Important but not essential features that enhance the prototype, such as advanced gamification elements (leaderboards, badges) and integration

with external data sources.

3. Could have: Desirable features that were considered for inclusion if time and resources allowed, including customizable user avatars and more complex game mechanics.

4. Won't have: Features identified as out of scope for the current development phase include: security measures such as a functional login page, comprehensive accessibility features, cross-platform optimization and advanced customization for end users. Those features, while important for a fully operational system will not be implemented in this project due to time and resource constraints.

5.4.4 Challenges and limitations

Several challenges and limitations were encountered during the prototype development process:

1. Resource constraints: The scope of the project was ambitious, aiming to explore a range of interactive and gamification features. However, time and expertise limitations necessitated a focus on achievable goals within the project timeline.

2. Technical limitations: PowerApps, while versatile, presented some constraints regarding the depth of data visualization customization and the complexity of gamification elements that could be integrated. This limitation required creative problem-solving to implement the desired functionalities within the available toolset.

5.4.5 Initial prototype

The initial prototype was developed using the rapid prototyping technique to quickly establish a functional base for further refinement. This approach was chosen to ensure that the design remained flexible, allowing for significant modifications based on feedback from user testing. The primary goal at this stage was to create a simple interactive prototype that could be iteratively enhanced based on user interactions.

The interfaces of the initial prototype include:

1. Home/Login screen (Figure 6.5).

2. Main dashboard screen (Figure 6.6).

3. Error detail screen (Figure 6.7).

4. User profile screen (Figure 6.8).

5. Submission screen (Figure 6.9).

Details of the final prototype and the development changes made throughout the process will be explored in the Results chapter. Additionally, as the app's overall

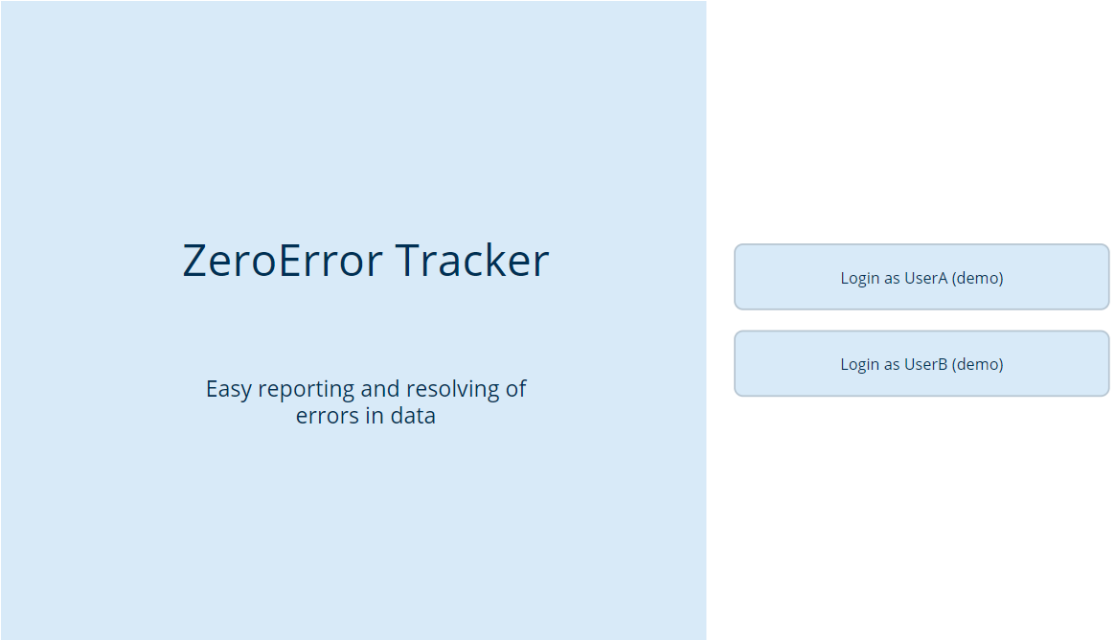

Figure 5.8: Login page

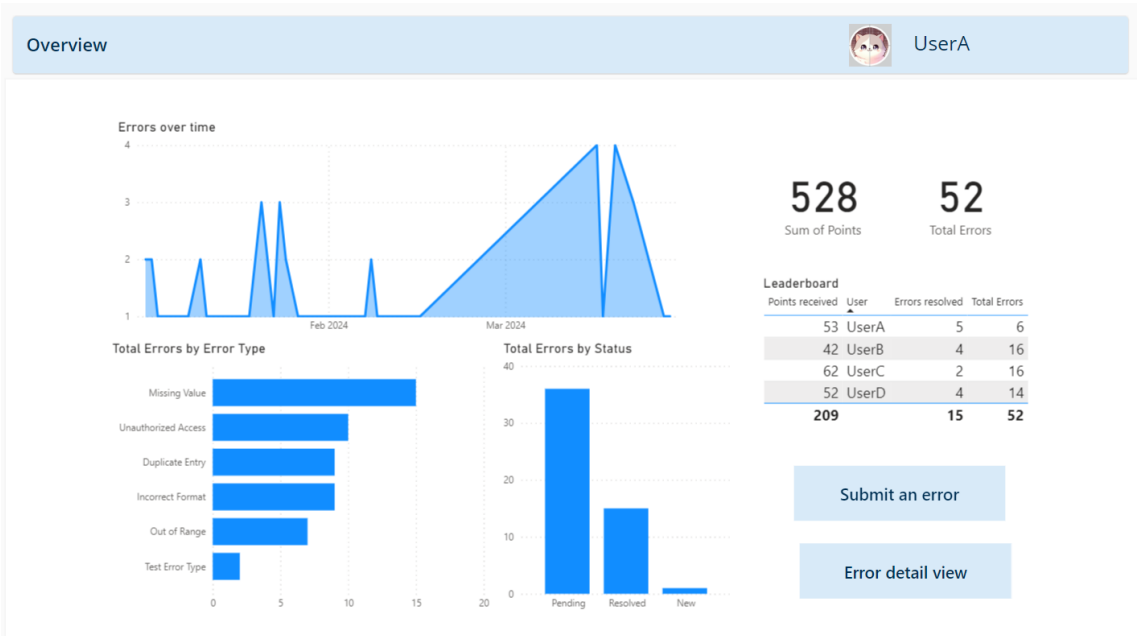

Figure 5.9: Main dashboard screen

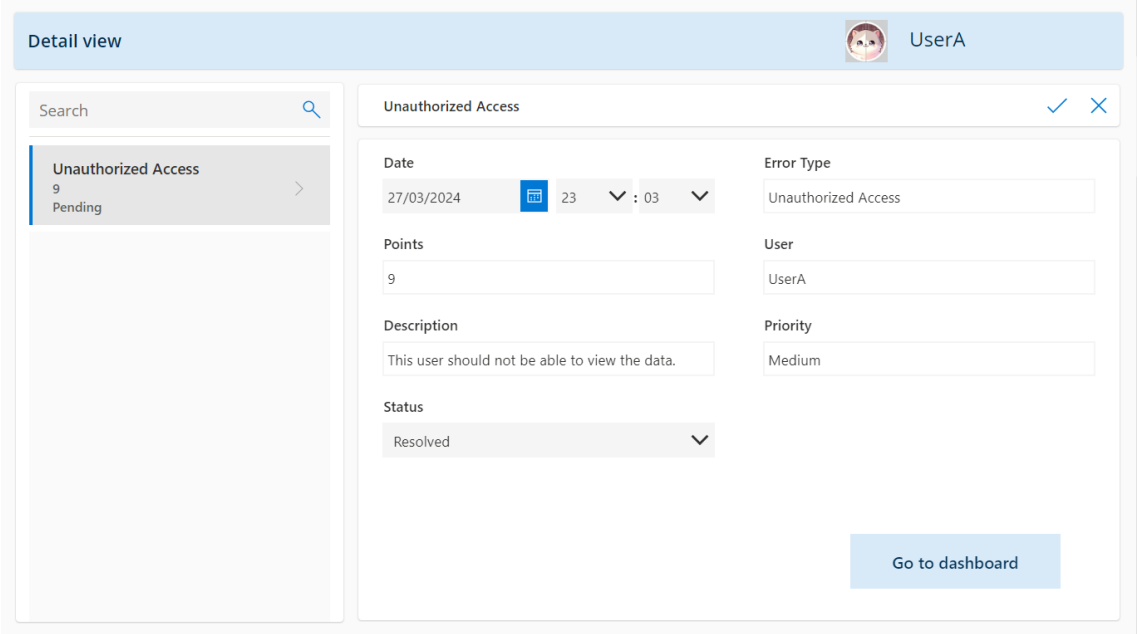

Figure 5.10: Error detail screen

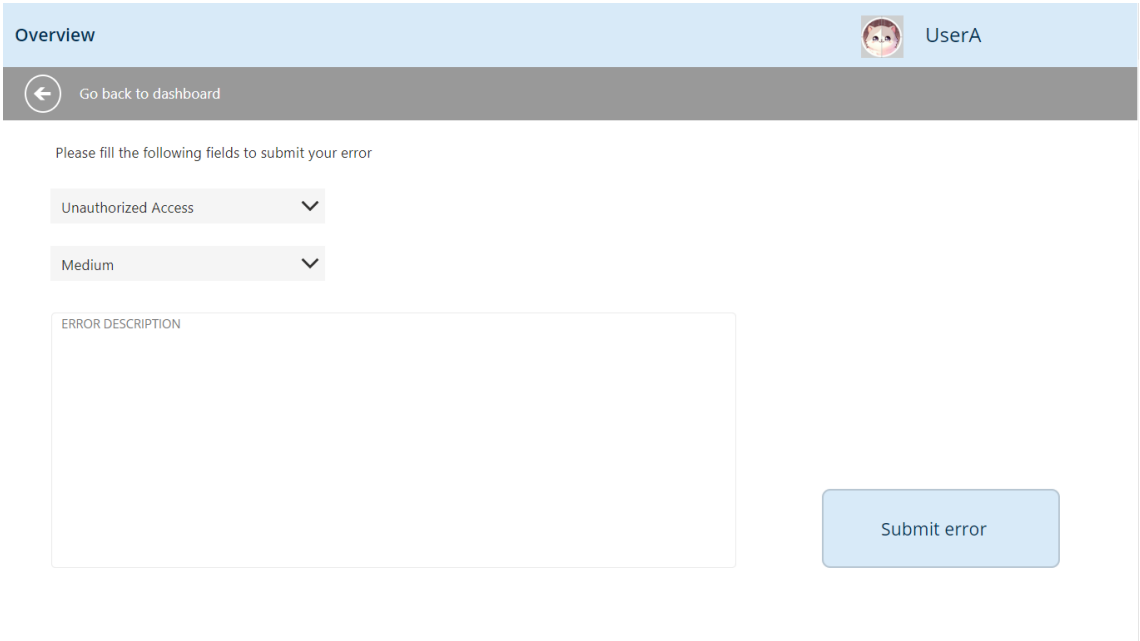

Figure 5.11: Submission screen

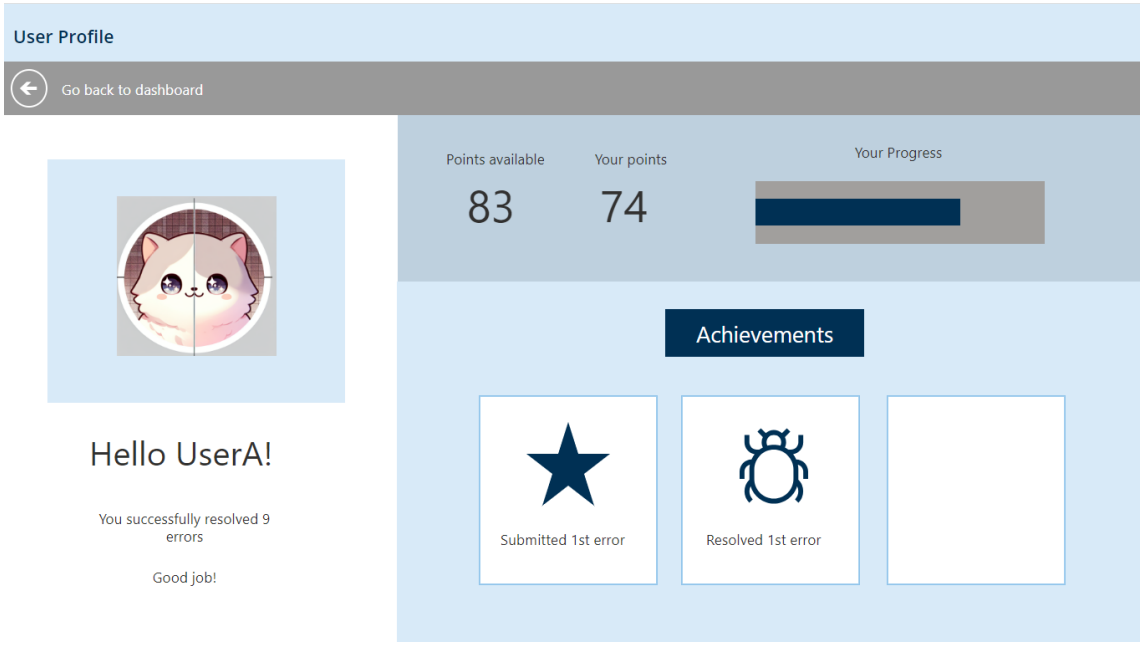

Figure 5.12: User profile screen

structure, features, and functionalities remained the same from the initial to the final prototype, it will also be further described in the Results chapter.

5.5 Test

The Test phase centers on the evaluation of the developed prototype through user testing, aiming to gather feedback and insights on its usability and effectiveness.

5.5.1 User testing

Conducting user testing is crucial for evaluating the effectiveness and usability of the developed dashboard prototype. In this step, the aim was to gather qualitative insights from potential users of corporate dashboards to identify areas for improvement and validate the design choices made during the Prototype phase.

5.5.2 Preparation

Preparation for user testing involved several key steps to ensure the sessions were efficient and effective.

Objectives

1. Evaluate the intuitiveness and ease of use of the dashboard interface.
2. Assess the impact of gamification elements on user engagement and motivation, as well as evaluate users' perceptions of the potential and relevance of incorporating gamification into the dashboard context.

3. Gain insights on the user perspective of what elements are generally the most important for user experience in dashboards.
4. Identify opportunities for improvement.

Participants

Participants were selected to represent a wide range of views on dashboard usability. Selection was based on the participants' familiarity with using dashboards, their interest in games and their years of work experience. Participants were approached through both professional and personal networks to ensure a diverse demographic. The aim was to include users who might interact with dashboards regularly in their professional roles as well as those who might see them less frequently but still have relevant insights.

Execution

The testing sessions were planned to be conducted in person, offering a controlled setting for participants to interact with the dashboard prototype. Each session was designed to last no more than 30 minutes, including a brief introduction, prototype interaction, and a feedback discussion.

The execution of user testing session was set up to include the following phases:

1. Introduction: Each session starts with an explanation of the study's goals, an overview of the testing process and mentioning privacy considerations.
2. Interaction: Participants engage with the dashboard prototype, completing predefined tasks to explore its various features and functionalities.
3. Feedback: Following interaction, participants are asked questions to gather feedback on their experience.

To effectively capture immediate reactions and feedback from the participants, note-taking during and immediately after the session was employed. This method was designed to ensure that all observations, insights, and participant comments were accurately documented.

For an exhaustive overview of the user testing protocol, the specific tasks assigned to participants and the feedback questions have been included in Appendix D.

5.5.3 Findings

The user testing participants were interested in exploring the prototype and expressed interest in the gamified elements. They were particularly interested in the leaderboard as a method of encouraging friendly competition and a way to potentially introduce small rewards at their workplace. The consensus was that the prototype's concept, along with the integration of gamification, could transform mundane work tasks into more enjoyable activities. This approach was seen as a valuable strategy to enhance workplace satisfaction and motivation, suggesting that gamified elements have the potential to significantly improve the user experience by making routine tasks more engaging and rewarding.

Further analysis of the findings will be conducted in the Results chapter, highlighting reflections and changes made in the prototype due to feedback from the testing process.

6

Results

This chapter presents the outcomes of the project, analyzing data from interviews, detailing the final dashboard prototype, and reflecting on user testing. It aims to synthesize the insights gained throughout the project.

6.1 Interview analysis

The interview data analysis yields significant insights into how dashboard developers at Novo Nordisk perceive user experience, tackle design challenges, and see the role of gamification in making dashboard engagement more compelling.

For a detailed exploration of individual responses to the interview questions, the full transcripts of these interviews have been attached in Appendix C.

Table 6.1 presents the professional roles of Novo Nordisk employees who were interviewed for the purpose of this project. This diversity in professional backgrounds enriches the analysis, providing a broad spectrum of perspectives on dashboard development.

Interviewee	Occupation
1	Business Analyst
2	Business Analyst
3	Data Analyst
4	Advanced Data Analyst
5	BI Partner
6	Business Intelligence Analyst
7	BI Analyst

Table 6.1: Interview participants

The qualitative study significantly enriched this project by delving into the experiences and expertise of dashboard developers. It highlighted how developers orchestrate a balance between catering to user needs, leveraging technological advancements, and applying innovative design principles to craft effective dashboards.

The thematic analysis of the interview data revealed key themes that capture the complexity of corporate dashboard development, as seen in 6.2 These themes reflect

the diverse challenges faced by developers, their strategies for navigating these challenges, the innovative solutions they employ, and their thoughts on future directions for dashboard design.

Theme	Description
Design Principles	Insights into how dashboard developers prioritize and implement design elements to enhance user interaction and satisfaction.
Data Presentation	Strategies employed by developers to present complex data in a user-friendly and accessible manner.
Feedback Integration	The importance of incorporating user feedback into the iterative design process to refine dashboard functionality.
Gamification Techniques	The use of game-like elements within dashboards to increase user engagement and motivation.
Technological Innovation	How developers integrate new technologies, such as AI and predictive analytics, to enhance dashboard capabilities.
Design Challenges	Common challenges faced in balancing functionality with aesthetics and the approaches taken to address them.
User Training	Methods for educating users about dashboard features and functionalities to maximize the effectiveness of their training.

Table 6.2: Themes identified from inductive coding and thematic analysis

6.1.1 Design Principles

Design Thinking

Interviewee 2's exploration of Design Thinking through "solution refinement sessions" underscored the importance of empathizing with users to understand their needs and challenges:

> "What we started doing like half a year ago is the so-called solution refinement sessions. So, it is more about taking a design thinking approach. This is more for the cases when there is maybe something vague for the end user, so the stakeholders do not know exactly what they want to do. So, in this case we are having this framework where first we are focusing on what is the problem, we are trying to understand the problem. Here we are asking a couple of questions. Like, what is actually the problem? This is to understand if a digital solution is something that will help solve their problem. Then we are going into the solution mode or trying to think how we can then solve this problem in the best way."

The interviewee emphasized the positive outcomes of this shift in approach, high-

lighting the significant impact of Design Thinking on enhancing the design and functionality of corporate dashboards.

Consistency

Consistency emerged as a foundational design principle, with developers underlining its importance in creating a seamless user experience. Interviewees disclosed that development teams have adopted specific dashboard templates to achieve a standardized look and feel across the platform. This strategy simplifies the user interface, fostering user comfort and familiarity. Despite these efforts, challenges in achieving organizational-wide consistency remain, primarily due to the disparate templates used across various teams and departments. This diversity, while reflective of department-specific needs, underscores the broader challenge of harmonizing dashboard aesthetics and functionality across the enterprise. A strategic move towards a more unified approach in template design and application could mitigate these inconsistencies, enhancing overall user experience.

Interviewee 4's comment on habitual UI design and Interviewee 6's concern about the constraints of strict templates provided valuable perspectives on balancing consistency with flexibility:

> "An important step is to see what tools they are used to already, this is to understand habits. Habitual UI design is also a thing, because then users will find it convenient to adapt to the new tool."

> "Because I am using a template it is also hard for me to have the freedom and try to change it how I think it would make it faster or more efficient/optimized."

Those insights highlight that while striving for consistency across the dashboards, it is essential to maintain a degree of flexibility and allow for customization and optimization.

Intuitive design

The importance of intuitive design, as highlighted by a practical example of adding user-friendly features provided by Interviewee 4, reaffirmed the necessity of prioritizing convenience and ease of use in dashboard design:

> "Another important thing would be to sort of make it convenient in terms of where to find certain things. I tend to sometimes add even something like a download button. They could right click on the visual and go and get it, but it is about making it convenient for them, right? The whole reason why you have the dashboard is so that they are not scrambling through excels and trying to get stuff from there, it is for conveniences sake."

This insight from Interviewee 4 not only showcases the value of intuitive design but also highlights the broader goal of dashboard development: to streamline processes and enhance efficiency for users.

6.1.2 Data Presentation

Simplicity

A common thread among the discussions was the importance of simplicity in dashboard design. Developers emphasized that the key to a successful dashboard lies in its ability to present complex data in an accessible and straightforward manner. Interviewee 3 emphasized the necessity to view the dashboard from diverse user perspectives, ensuring clarity and simplicity regardless of the users' age or familiarity with data tools.

> " You have to think from the perspective of users who might be 25 or 60 years old... A dashboard needs to be straightforward, focusing on the core message."

This focus on simplicity serves as a guiding principle for developers, ensuring that dashboards are designed not just for data experts but for anyone who needs to make informed decisions, bridging the gap between complex datasets and actionable insights.

Data quality over aesthetics

Developers advocated for presenting data in a manner that is immediately understandable, advocating for prioritizing data clarity and accuracy over elaborate aesthetics. This principle aims to make complex information accessible, ensuring that users can easily grasp and act on the data presented.

> " I will always prioritize the functional part instead of it looking good... The precise, the accurate number is the most important. And the story the data can tell is more important than how they look visually."

These insights reflect a pragmatic approach to dashboard design, where the ease of use and reliability of information are paramount.

6.1.3 Feedback Integration

Developers emphasized the critical role of various feedback mechanisms in enhancing the functionality and user experience of dashboards. These mechanisms are essential for fostering an ongoing dialogue between the development team and users, thereby ensuring that the dashboard continuously aligns with user needs and expectations.

Interviewees shared the following methods of getting feedback:

1. Frequent Stakeholder Feedback Sessions: Interviewee 1 and Interviewee 4 highlighted the practice of scheduling regular touchpoints with stakeholders. This approach ensures that the development process remains closely aligned with stakeholder expectations and requirements.
2. A/B Testing with Dashboard Versions: Interviewee 3 discussed the method of presenting two distinct versions of a dashboard to users and collecting feedback on their preferences. This strategy aids in understanding which design or functionality elements resonate most with users.

3. Broad Stakeholder Representation: Interviewee 5 detailed a method for encompassing a wide range of perspectives by identifying and soliciting feedback from representatives across different stakeholder groups. This inclusive approach ensures that the dashboard caters to the diverse needs and preferences within the organization.
4. Project Manager Feedback: Interviewee 6 underlined the importance of obtaining feedback from project managers. Given their oversight role, project managers can provide valuable insights into the dashboards strategic alignment and operational effectiveness.

These feedback-gathering methods underscore the importance of a multi-faceted approach to understanding and meeting user needs, facilitating a collaborative and iterative development process.

6.1.4 Gamification Techniques

The concept of gamification was explored as a potential avenue for enhancing user engagement with dashboards. The discussions with interview participants suggested that incorporating game-like elements could make data interaction more intuitive and enjoyable. Interviewee 5 expressed the belief that dashboards could be treated as puzzle games in which the users actively interact with and discover information. Furthermore, the interviewee mentioned that some examples of game-like elements could be achievements awarded to users to mark their progress and increase their motivation.

The participants underlined the fact that they believe that not all dashboards could benefit from gamified elements. Quoting interviewee 1:

> "So, for example, I do not expect the line of business, as in, operators or line managers to spend time on playing around with the user interface, what they need to do is to just to input the data or read the data very efficiently, I would say because the time is so valuable in these cases."

This feedback underscores a significant challenge in applying gamification to dashboards: while it can enhance engagement, it must be balanced with the practical needs of business users who value efficiency over interactivity. The contrasting views presented in these initial interviews highlight the nuanced approach needed when integrating game-like elements into professional tools. This topic will receive more comprehensive treatment in subsequent sections, particularly when discussing the testing of the prototype, to better understand how gamified features can be optimized for user engagement without compromising functional efficiency.

6.1.5 Technological Innovation

An important point of the discussions was the integration of new technologies into dashboards, particularly predictive AI. Innovations like Copilot, Power Apps, and Power Automate were mentioned as tools that are currently changing the broader approach to dashboard development. Interviewee 5's comments on the incorporation

of chatbots into dashboards represent a forward-thinking approach to user assistance and engagement:

> "One thing that I think people are working on is these chatbots that you can kind of talk to and they like will explain where do you find this? What does this mean? In very easy to understand language."

Furthermore, interviewee 3 mentioned having integrated a Power BI dashboard into a Power Apps tool, suggesting that leveraging the integration capabilities of various BI tools is highly worth considering.

6.1.6 Design Challenges

Data literacy

Addressing varying levels of data literacy among users is a key challenge. Interviewee 4 observed a positive trend towards improving data literacy, which plays a significant role in dashboard design and functionality.

> " Absolutely, I agree that data literacy is increasing, especially as we provide reports that are easy to understand, supplemented by descriptive fields wherever possible. This helps users grasp the information in context, like channel comparisons, for instance. When we enrich our reports with these details, users often return with requests for additional data insights, indicating a growing awareness and curiosity about what's possible. It's about encouraging questions and then, on our part, determining feasibility. So yes, there's a noticeable growth in data literacy among our users, and that's a very positive development. "

This evolution in user engagement not only demonstrates a growing curiosity and understanding of data among users but also underscores the importance of dashboard designs that support and nurture this literacy. As users become more knowledgeable and inquisitive about data, the demand for deeper, more nuanced insights grows, guiding developers to constantly innovate and adapt their dashboards to meet these evolving needs.

Accessibility considerations

Accessibility in dashboard design, as highlighted by the interviewees, often receives inadequate consideration. Interviewee 1 specifically pointed out a common practice in dashboard design that may not be accessible to all users:

> "So we have either green or red to indicate the status of the KPI... we are all assuming that whoever is looking at this dashboard can see if it is either red or green, but it is a very good point that could it will be worth to invest some time on investigating how many users have issue when reading the dashboard."

This insight highlights the unintentional exclusion that can occur when design decisions rely heavily on color differentiation, potentially making dashboards less accessible to users with color blindness. Interviewee 1 suggested dual coding in tooltips

as a mitigation strategy, where information is conveyed using both color and text labels or icons, enhancing accessibility for all users.

Technical challenges

A prominent technical challenge in dashboard development, as mentioned by Interviewee 6, revolves around managing the high volume of data without compromising the dashboard's performance, particularly its runtime:

> "I think the challenge is mostly at the data level and its the speed... If it is too heavy, too big calculations, then they affect the speed of the dashboard, so that affects the performance of it... we have that standard that we want to stay under 10 seconds for any dashboard when they are opening or operating."

Although the specifics of managing data volume and enhancing runtime do not directly align with the primary focus of this thesis, it is important to note their significance for ensuring user satisfaction. Slow response times and lagging dashboards can frustrate users, potentially diminishing the value and utility of the tool, regardless of both its analytical capabilities and otherwise user-friendly interface.

6.1.7 User Training

The discussion on user training revealed current practices such as onboarding sessions and regular training sessions, as well as adding comprehensive information pages to the dashboards. Additionally, the potential for leveraging gamification in training processes was highlighted, suggesting an innovative approach to enhancing user familiarity and proficiency with new dashboards. Interviewee 1 mentioned:

> "When I had to conduct some trainings, the ones that were the most interesting were the ones where I felt engaged as if I was in a game."

Building on this, Interviewee 5 discussed the practical benefits of gamification in making educational content more engaging:

> " I think that would be engaging, and it would meet the need to educate people... It could replace the long powerpoints that no one pays attention to and they are easily forgettable so we get multiple questions about complex topics like for example, savings methodology, so if the user could get a tutorial or an explanation while in the dashboard. I feel like that could save us many emails. "

This feedback highlights a shift towards making training not just informative, but also engaging and interactive through gamification. Incorporating game-like elements can make the training more effective and enjoyable, potentially reducing the need for follow-up questions and making the learning process more efficient.

6.2 User testing analysis

This section delves into the user testing phase of the dashboard prototype, a critical step towards understanding its usability, effectiveness, and overall user experience. The feedback gathered during this phase was further considered in the iterative design of the prototype, allowing for integration of enhancements as well identification of features to be developed in future iterations.

The participants represented a diverse range of professional backgrounds and interests in games, as outlined in 6.3. This diversity ensured a broad spectrum of feedback on the prototype's gamification elements and usability.

Tester	Occupation	Interest in Games
1	Supply Planner	High
2	Category Manager	Medium
3	Chemical Engineer	Medium
4	Research Assistant	High
5	Operations Associate	Low
6	Supply Planner	Low

Table 6.3: User testing participants and their self-reported interest in games

6.3 User testing: Part 1

Part 1 involved two separate sessions with participants 1 and 2, providing valuable initial feedback on the prototype. Both sessions lasted 30 minutes and were conducted in person.

6.3.1 Feedback summary

Testers provided generally positive feedback, especially appreciating the prototypes gamification features like the leaderboard, which was noted for encouraging friendly competition and enhancing engagement and motivation. Participants were satisfied with the design and functionality, believing it could significantly boost employee motivation and engagement with tasks.

One of the participants mentioned that it seems clear that the points would not be one of the employees' KPIs, but rather a casual way to make daily tasks more enjoyable. The participant also highlighted the possibility for introducing small tangible rewards based on points accumulated, suggesting an innovative approach to recognize employees' efforts.

Navigation through the dashboard was found to be intuitive, partly due to participants' familiarity with Power BI visuals, facilitating ease of use and comfortable data filtering and analysis, akin to their professional tasks. However, some content was not immediately clear to users, indicating a need for more detailed explanations

or guidance within the dashboard. The clarity and transparency of the points system were emphasized as critical for the gamification elements to effectively motivate and engage users.

Mixed feedback was received about the progress bar's effectiveness as a motivational tool, with suggestions for its reevaluation to enhance user engagement. No immediate solutions were proposed for its redesign, highlighting an area for further exploration.

One tester proposed replacing the term "errors" with less negatively perceived phrases such as "open tickets," "tasks," or "issues" to soften the connotation. However, the tester also recognized the potential marketing advantage of using "errors," suggesting that it could effectively capture users' attention and serve as a strategic choice for promoting the the tool.

6.3.2 Insights and reflections

The positive reception of gamification elements and intuitive navigation underscores their potential to significantly improve user engagement and satisfaction. However, the feedback points towards essential areas for improvement, particularly in enhancing guidance within the dashboard and ensuring the points system's mechanics are clear and understandable.

Concerns about the progress bars role as a motivational tool stress the need for clear, intuitive design in gamification elements to maximize their effectiveness and user satisfaction. This insight directs attention to refining these features to better meet user needs and preferences.

Lastly, the different perspectives around the phrases used within the dashboard shows the impact of language on user perception and engagement. While using the term "errors" can draw attention and could be seen as a marketing strategy, it is crucial to ensure that the terminology aligns with the intended user experience and company culture.

6.3.3 Strategic recommendations

- Enhanced guidance: Incorporate detailed written instructions to facilitate user understanding and navigation.
- Points system clarity: Provide a comprehensive explanation of how points are allocated to clearly explain the gamification mechanics.
- Profile interactivity: Make the user profile's "clickability" more apparent, encouraging users to explore their stats and achievements.
- Navigation improvements: Correctly place the "return" button, enhancing the dashboard's navigability and user flow.

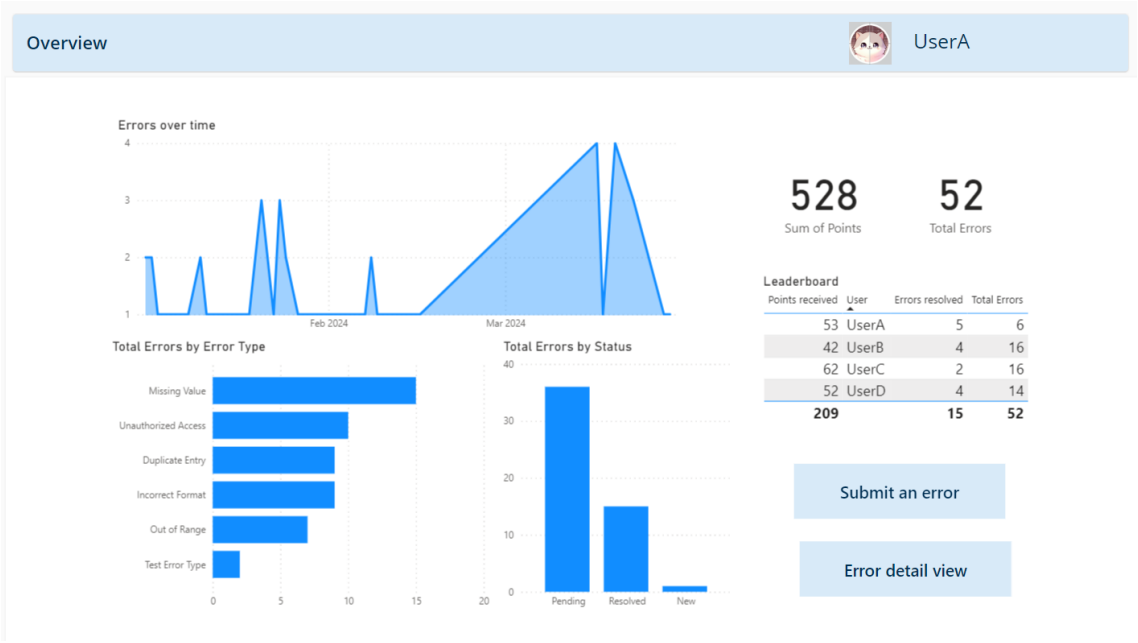

Figure 6.1: First version of the Main Dashboard screen

6.3.4 Changes

The revisions between the previous version of the Overview page (Figure 6.1) and the new version (Figure 6.2) focused on enhancing user interaction and visual coherence. The changes include:

- Navigation enhancements: Introduction of a navigation bar at the top of the screen, improving accessibility and user flow.
- Interactive elements: Enhanced interactivity by highlighting clickable elements and implementing responsive hover effects, which help guide the user's actions.
- Color scheme: Adoption of a consistent and visually appealing color scheme that is easy on the eyes, aiming to reduce visual fatigue and enhance readability.
- Leaderboard placement: Repositioning the leaderboard to a more central location within the dashboard, making it a focal point to foster a competitive atmosphere among users.
- Enhanced descriptions: Additional descriptive text and tooltips have been integrated throughout the dashboard, providing users with more context for the data presented.

Furthermore, consistent navigational improvements were made across all screens of the dashboard, exemplified by the Profile screen's transitions from the previous version (Figure 6.3) to the new version (Figure 6.4):

- Consistent navigation: Implementation of the navigation bar across all dashboard screens, ensuring a consistent user interface experience.

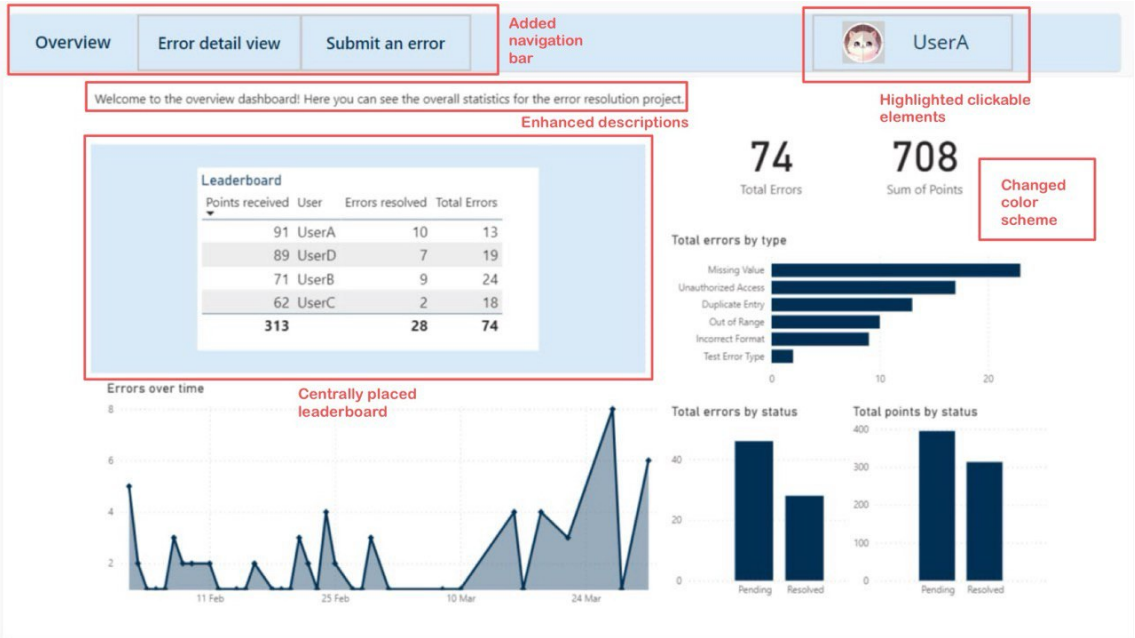

Figure 6.2: Changes in the second version of the Main Dashboard screen

- "Go back" arrow: Addition of a "go back" arrow on Detail and Add New Error screens, facilitating easy navigation back to the main screen.

- Intuitive indications: A question mark has been introduced to indicate unachieved achievements, visually signaling to users which goals are still pending, thereby enhancing user guidance and providing clarity.

These changes were directly informed by user feedback gathered during the initial user testing phase and through close observation of user interactions with the prototype. The modifications aim to address specific usability challenges identified by testers, enhancing the overall ease of use and functionality of the dashboard.

6.3.5 Additional features proposed

- Dedicated information page: Create a page for detailed guidance on the features, methodology and processes of error submission.

- Enhanced notifications: Notify the users about new changes, achievements and updates.

- Interactive animations: Introduce subtle on-click animations, making the interactions more engaging and visually pleasing.

- Bonus points for speed: Award more points to the users if they resolve an error quickly, motivating them to act promptly and efficiently.

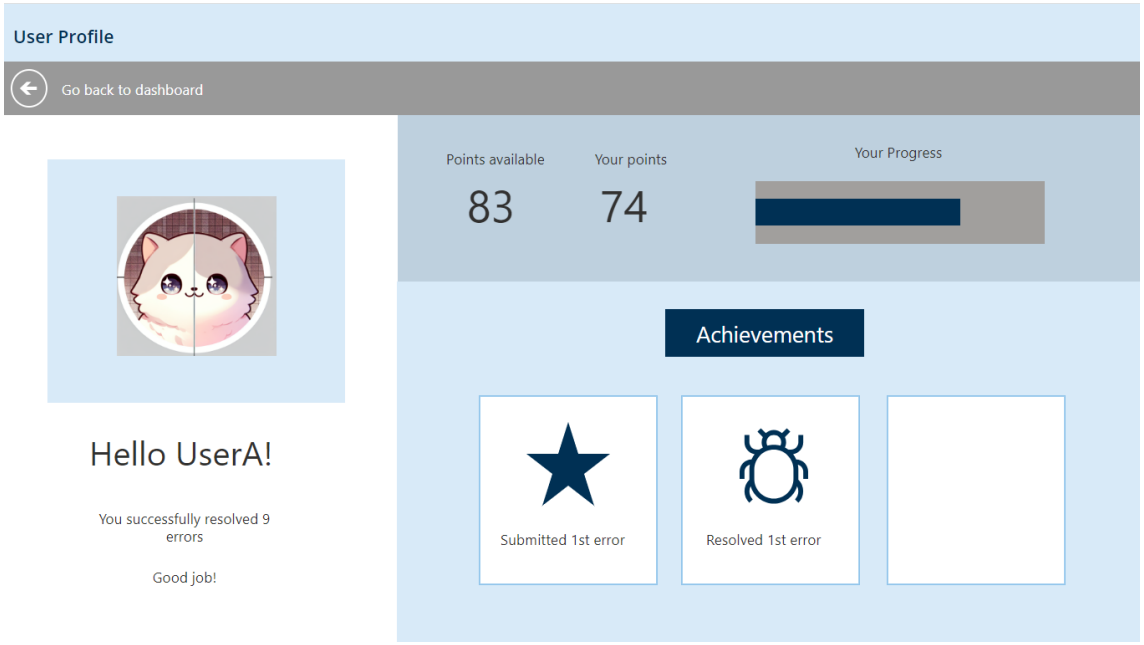

Figure 6.3: First version of the Profile screen

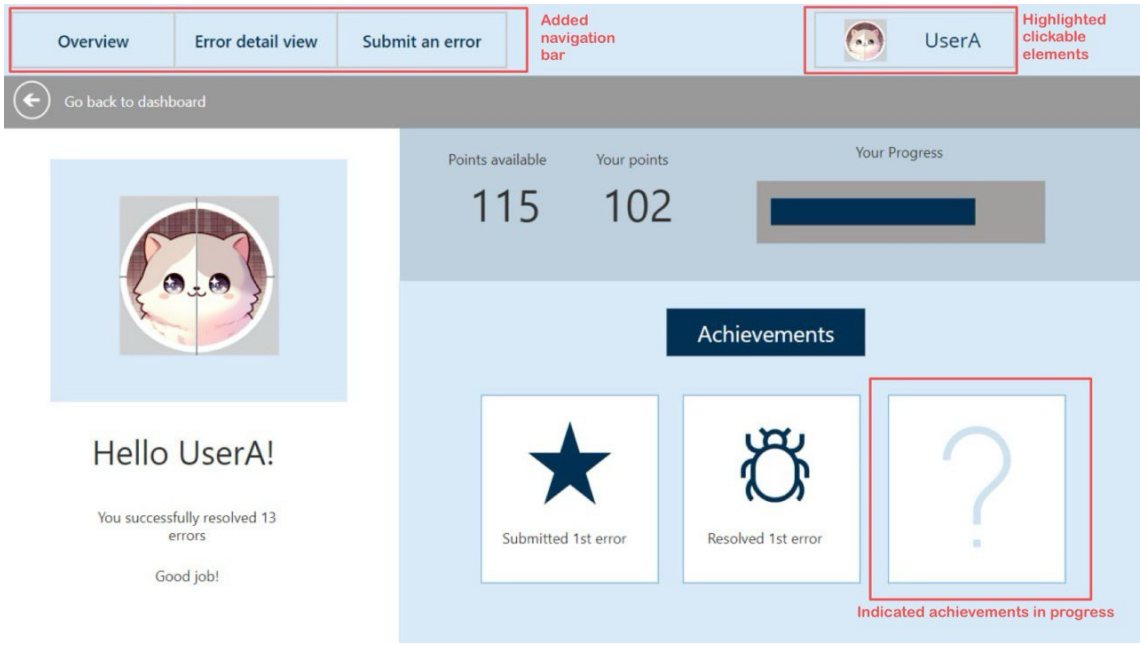

Figure 6.4: Changes in the second version of the Profile screen

6.4 User testing: Part 2

Conducted on Version 2 of the prototype, Part 2 involved participants 3, 4, 5, and 6. These sessions were similarly structured to provide continuity in testing while broadening the feedback received on the prototypes overall impact on user motivation and system usability.

6.4.1 Feedback summary

Testers in this phase responded positively, especially appreciating the clean, straightforward design of the interface and the motivational impact of the leaderboard feature.

However, similar to feedback from earlier sessions, the utility of the progress bar was questioned. Participants 5 and 6 suggested adding more detailed descriptions to clarify its purpose. Participant 4 expressed concerns about its potential to induce stress if it seldom showed full completion, recommending reframing it as a level progression bar.

A new concern regarding the potential for users to "spam" the system by submitting an excessive number of errors was brought up by participants 3 and 4. Tester 3 proposed a daily submission limit and tester 4 proposed a confirmation prompt such as "Are you sure you want to submit this error?" to encourage thoughtful submissions.

Participants reacted positively to the aesthetic and functional updates between the prototype versions. They appreciated the improved navigability and visual appeal, which facilitated easier task performance. However, some participants encountered difficulties in quickly locating the user profile screen, suggesting the need for more intuitive navigation cues. They have also echoed the feedback from user testers in Part 1 about adding an information page on top of the integrated descriptions and tooltips.

6.4.2 Insights and reflections

The continued positive feedback on the design and gamification confirms their role in enhancing motivation and engagement. However, the repeated concerns about the progress bar and the risk of system "spamming" through excessive error submissions highlight critical considerations for feature design. These insights emphasize the balance required between encouraging active user participation and maintaining system integrity and effectiveness.

Suggestions to address excessive submissions reveal the practical value of user testing in identifying and solving real-world challenges, ensuring the dashboard remains a productive and valuable tool for its intended purposes.

Observations made during user tasks execution suggested that while general usability has improved from Part 1 to Part 2, there may still be a need for more intuitive navigation paths or better signaling within the dashboard. Furthermore, while adding

additional descriptions and tooltips was also beneficial for the user experience, it does not replace adding a designated information page.

6.4.3 Additional features proposed

- User levels and roles: Differentiate users by levels or roles, introducing a hierarchy or specialization to motivate engagement and contribution. Potentially allow experienced users to become moderators or system administrators, recognizing their reliability and trustworthiness.
- Customization options: Offer a dark mode and customizable backgrounds, catering to user preferences for visual appearance.
- Multi-page accessibility: Enable users to open multiple dashboard pages simultaneously for efficient data comparison or multitasking.
- Options menu: Provide a menu with various options for dashboard customization, settings, and help.
- Background music: Consider the addition of background music options to enhance the dashboard ambiance, with attention to user control over this feature for personalization.
- Profile picture options: Provide various profile picture options, allowing the user to customize their profiles and express their identity without needing to upload personal photos.
- Integrated chats: Establish communication channels directly within the prototype. This would include chat features between users and error resolvers to easily clarify issues, as well as peer-to-peer chat among resolvers to foster a collaborative problem-solving environment.
- Access to past versions: When making future enhancements, enable users to choose whether they want to use the newest version of the dashboard or revert to previous versions. This flexibility can be crucial for users who may need familiarity for efficiency or prefer features from earlier iterations.

6.5 Conclusion of user testing

The insights gathered from both phases of user testing provide an extensive foundation for future enhancements. The positive feedback underscores its potential to significantly impact workplace dynamics and operational efficiency positively.

While the prototype was well-received overall, the detailed feedback highlights specific areas where further development could enhance functionality and user satisfaction, ensuring the dashboard not only meets but exceeds user expectations.

Additionally, all participants responded "yes" to the question "Do you think implementing a system like this prototype would enhance error resolution and increase

motivation at your workplace?". This universal agreement underscores the prototype's potential to positively impact workplace dynamics and efficiency.

6.6 Broader implications

The enthusiastic reception of the prototype suggests that adoption of similar technologies could be beneficial. It provides an indication that gamification, when thoughtfully applied, can significantly enhance not just the usability of complex systems but also the motivation and engagement of users in their daily tasks.

6.7 Final dashboard prototype

The ZeroError Tracker aims to enhance user engagement and accuracy in error reporting and resolution within a corporate setting by incorporating gamification elements. Its purpose is to make the often tedious task of tracking and resolving errors more interactive and rewarding, subsequently improving both data quality and user participation.

This final version of the ZeroError Tracker incorporates changes based on feedback from the initial user tests (User Testing Part 1). The insights gained from these initial tests were pivotal in refining the prototype's structure and interface, tailoring the integrated gamification elements to better meet user needs and enhance the overall user experience. Feedback from subsequent user tests (User Testing Part 2) was also overwhelmingly positive, indicating a strong user acceptance of the gamification approaches implemented. Notably, this feedback did not include critical changes, and therefore has not been integrated into this version of the prototype. These insights will be considered for future development.

6.7.1 App structure and interface

1. Home/Login screen: Introduces the user to the app and allows them to log in (Figure 6.5).
2. Main dashboard screen: Displays an overview of error tracking metrics, including visuals showing trends over time such as new errors and breakdown of errors by type and by total points accumulated. A prominently displayed leaderboard highlights top users based on points, encouraging a competitive spirit. All visual components on the dashboard are interactive, allowing users to filter and sort the information according to their specific needs and interests (Figure 6.6).
3. Error detail screen: Features a table containing error details with fields such as date, user responsible, error type, priority, status, description and points to earn. Includes search functionality that allows users to find specific errors. The table is personalized to the currently logged in user, showing their requests that currently have the "In Progress" status (Figure 6.7).

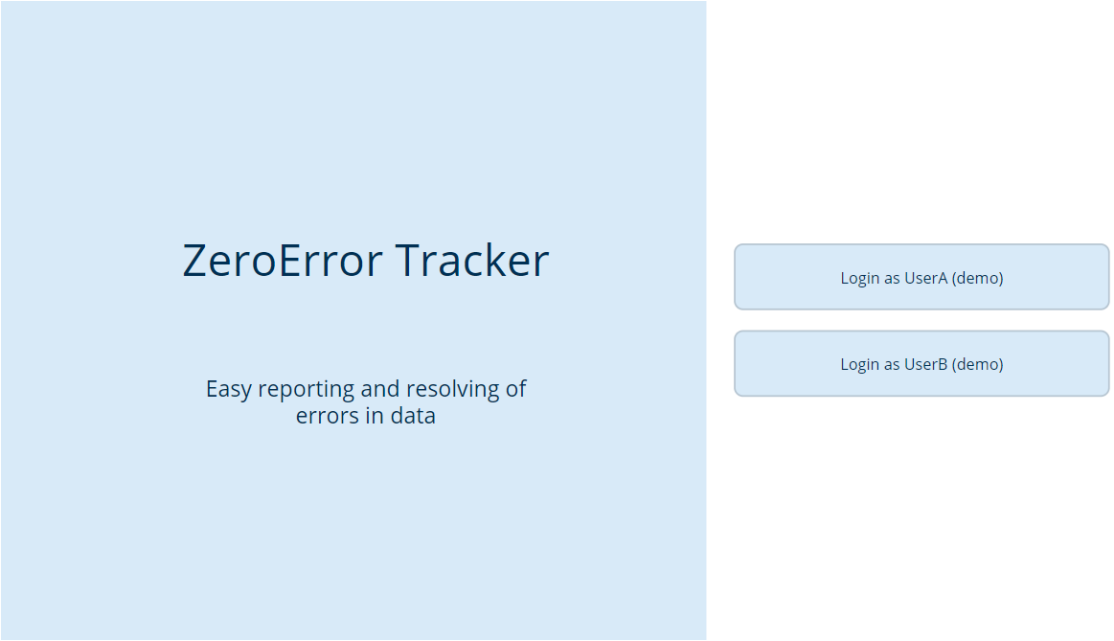

Figure 6.5: Login page

4. User profile screen: Allows users to view their profile, including their points earned, a progress bar showing how close they are to completing all of their tasks, as well as their earned achievements. This screen also hints at unearned achievements through "empty" achievement spaces, subtly motivating users to continue their engagement (Figure 6.8).

5. Submission screen: Provides a screen for users to add new errors, including input fields for error type and priority. When a user submits an error, points are assigned automatically based on error priority, seamlessly integrating gamification into the error reporting process. This functionality not only incentivizes user participation but also aids in the efficient categorization and prioritization of issues (Figure 6.9).

6.7.2 Features and functionalities

- Interactive dashboard: Provides users with dynamic, customizable visualizations that make it easy to interpret and act on data.
- Adjustable error table: Automatically updates to display errors relevant to the logged-in user, making the information more personalized and accessible.
- Notifications: Inform users about the outcomes of their actions, offering immediate feedback and engagement.
- Points system: Engages users by attributing points for the submission and resolution of errors, fostering active participation.
- Achievements: Celebrates user progress by awarding badges for achieving set milestones, adding a layer of recognition and motivation.

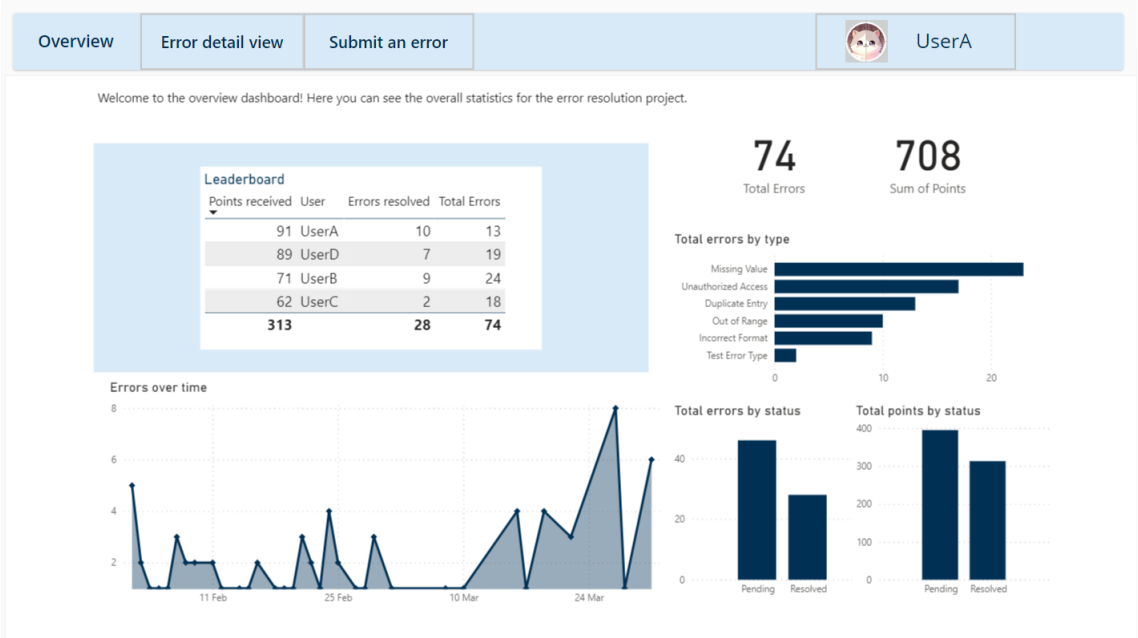

Figure 6.6: Main dashboard screen

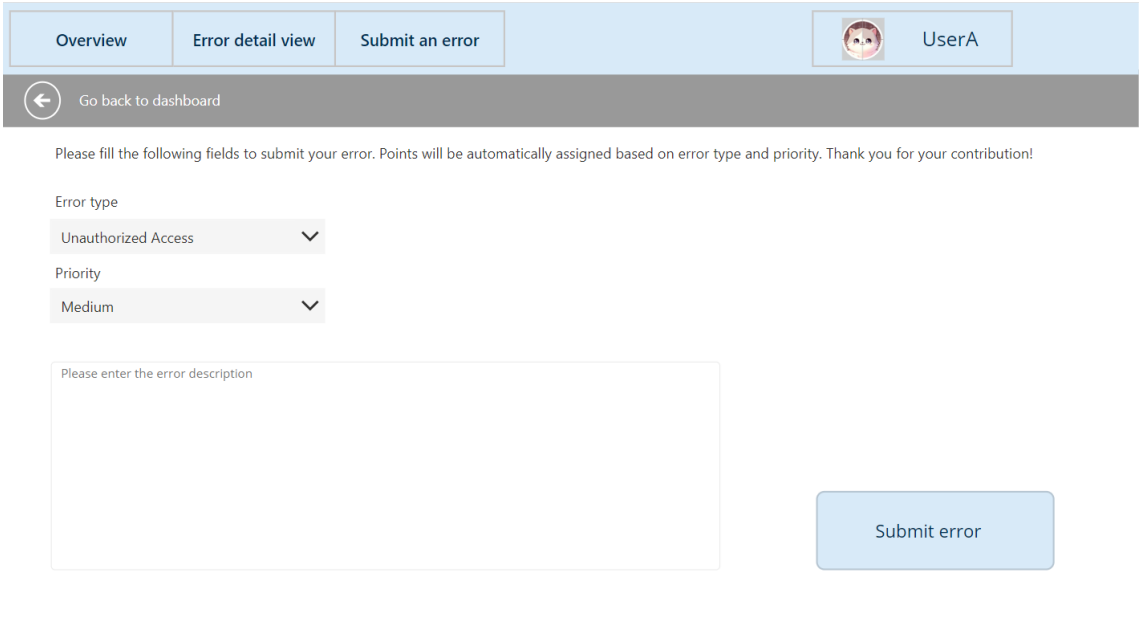

Figure 6.7: Error detail screen

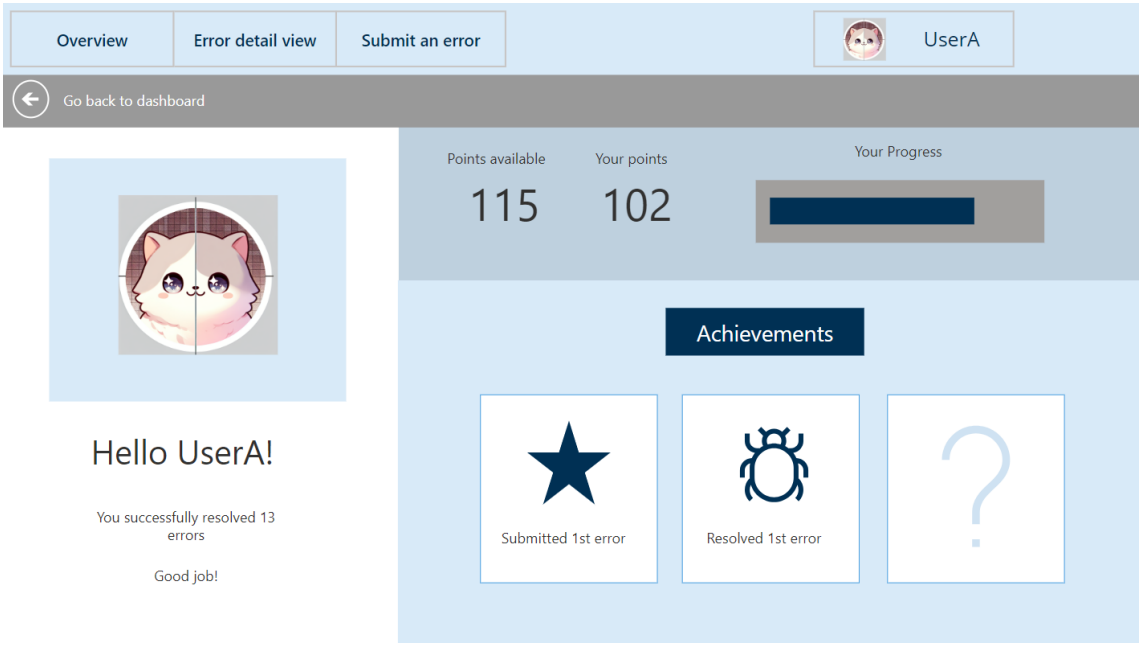

Figure 6.8: User profile screen

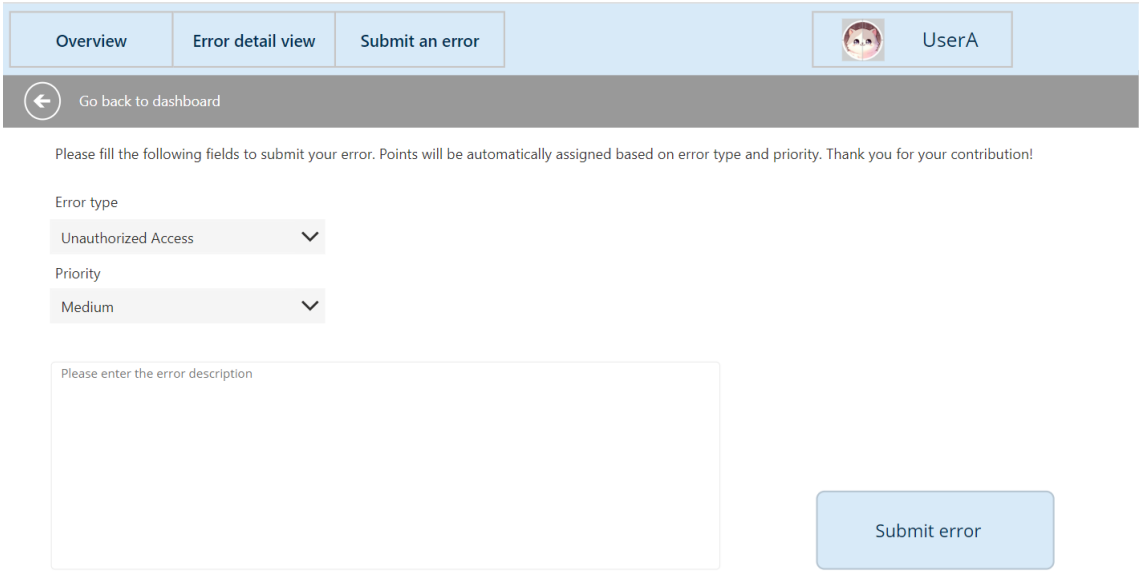

Figure 6.9: Submission screen

- Leaderboard: Encourages friendly competition by ranking users based on their points, encouraging continuous engagement.
- Progress bar: Visually indicates how close users are to completing their required actions, enhancing motivation by showing progress.

This prototype's design emphasizes enhancing user engagement and data accuracy through gamification, making error reporting and resolution, which can be a tedious task, an engaging part of the daily workflow.

7

Discussion

This discussion delves into the integration of gamification into organizational dashboards, emphasizing ethical considerations and best practices in design. It explores integration challenges and solutions identified during the course of this project, while also pointing to future directions for research and innovation in dashboard technologies.

7.1 Reflections

This section offers reflections on integrating gamification into organizational dashboards, emphasizing ethical considerations and addressing the integration challenges encountered during the project. It focuses on the insights gained and outlines potential directions for future research. By examining the process and outcomes of gamification, this reflection aims to inform ongoing discussions about enhancing dashboard usability and the responsible application of game elements in a professional setting.

7.1.1 Ethical considerations

In the context of introducing gamification elements into dashboards, it is essential to address ethical considerations to ensure that these implementations serve to enhance user experience without unintended negative consequences. A primary ethical concern is the potential for gamification to be utilized as a tool for micromanagement [22], inadvertently creating a competitive atmosphere that could contribute to increased stress levels among employees. Such a competitive environment, while potentially boosting short-term engagement, may lead to long-term negative impacts on workplace morale and individual well-being.

Moreover, it is crucial to consider the implications of data privacy and consent. The collection and analysis of user data, fundamental to customizing and improving gamified elements, must be conducted transparently, respecting user privacy and adhering to relevant data protection regulations. Users should be fully informed about what data is collected, how it is used, and have control over their participation in gamified systems.

Another ethical aspect involves ensuring inclusivity and accessibility in gamified dashboard designs. It is important that these systems do not inadvertently exclude

or disadvantage users with different abilities, preferences, or levels of technological proficiency. This includes providing alternatives or accommodations for users who may not engage with gamification in the intended manner due to disabilities or personal preferences.

Finally, it is essential to acknowledge and mitigate any potential for exacerbating existing workplace inequalities. Gamification strategies should be carefully designed to avoid reinforcing biases or creating situations where certain groups of employees, whether due to job role, location, or other factors, are unfairly advantaged or disadvantaged by the system.

In summary, while gamification presents a promising avenue for enhancing dashboard engagement, it is crucial to approach its implementation with a thoughtful consideration of ethical implications, ensuring that it contributes positively to the work environment and respects the rights and well-being of all users.

7.1.2 Integration challenges and solutions

The initial setup utilized an Excel sheet stored on OneDrive as the primary data source, which was connected to both Power BI and Power Apps simultaneously. While this configuration was straightforward and functional, a superior alternative would be the creation of a Dataverse table. This method remains within the Microsoft ecosystem and offers better integration capabilities and scalability. Leveraging Dataverse allows for the utilization of its robust infrastructure, advanced data management features, and seamless integration with other Microsoft services, enhancing the efficiency and functionality of the solution.

7.1.3 Evaluation of development process

Reflecting on the development journey from initial concept to the creation of the prototype, the process has been informative and largely successful in achieving its objectives. The prototype has served its purpose well by illustrating the potential application of gamification in dashboard design. Despite acknowledging that the prototype is not ready for practical deployment, its value as a proof of concept is clear.

The focus of this project was to explore the effectiveness of gamification in engaging users with a dashboard, rather than delivering a fully operational tool. In this light, the prototype has met the initial expectations. It has successfully demonstrated how gamification can be integrated into dashboards to potentially enhance user interaction and experience.

Throughout the development phase, there was a considerable exploration of the tools and technologies available for dashboard creation. This exploration was both challenging, mostly due to lack of previous familiarity with the systems, and informative, offering a practical understanding of the technical possibilities and limitations. While not every aspect of the development process was smooth, navigating through these challenges provided valuable insights into the complexities of gamification and

process optimization.

This exploration has not only contributed to a better understanding of gamification's role in dashboard design but also highlighted the practical applications of the tools used. The experience gained from this project has laid a groundwork for future endeavors in similar areas.

In sum, the development process of the prototype, despite minor challenges, has been a constructive phase of the thesis project. It achieved its goal of demonstrating the principles of gamification within a dashboard environment and sparked further interest in exploring these concepts. The learnings from this process are anticipated to be beneficial for future projects, positioning this phase as a valuable step in the ongoing exploration of interactive dashboard design.

7.2 Dashboard design best practices

Synthesizing insights from my literature review, interviews, hands-on development experience and user feedback, a comprehensive list of guidelines has been developed. Those guidelines are designed to support developers and help them create dashboards that combine functionality, user engagement and aesthetic appeal.

7.2.1 Clarity and simplicity

General principle

Emphasize the importance of designing dashboards that transform complex data into clear, concise visuals. The goal is to minimize user effort in understanding the data, supporting quicker and more accurate decision-making. Design choices should focus on clarity to ensure that all users can easily comprehend the information presented without confusion.

Application in gamification

When integrating gamification, ensure that all elements such as leaderboards, points systems, badges, and progress indicators are designed with clarity in mind. These elements should:

- **Be visually distinct:** Ensure that gamification components are easily distinguishable and understood at a glance.
- **Support data understanding:** Gamification should not overshadow the primary data but rather complement it, helping to illustrate and simplify complex information through engaging visual cues.
- **Enhance user experience:** Design gamification features in a way that enhances, rather than complicates, the users interaction with the dashboard. This includes using intuitive symbols for achievements and straightforward metrics for progress tracking.

7.2.2 Consistency

General principle

Maintain uniformity in visual elements and workflows across the dashboard to reduce the learning curve and enhance user experience. Consistency in design helps users become quickly familiar with the dashboard's layout and functionality, thereby increasing their efficiency and confidence in using the tool. This uniformity should also reflect the brands visual identity, which aids in building trust and fostering a sense of reliability.

Application in gamification

When applying gamification to the dashboard, consistency is key to ensuring that game-like elements are integrated seamlessly and maintain a coherent look and feel with the rest of the dashboard. This includes:

- **Uniform design language:** Use consistent visual styles, fonts, and colors for gamification elements like badges, leaderboards, and progress bars to integrate smoothly with the overall dashboard design.
- **Consistent user interaction:** Ensure that interactions with gamification features follow the same principles as the rest of the dashboard. For example, if tooltips are used to provide information on charts, similar tooltips should explain gamification elements.
- **Reliable user experience:** Gamification features should be predictable in their behavior and rewards, aligning with the users' expectations based on their experiences with the rest of the dashboard. This helps in maintaining a seamless user journey across the dashboard.

7.2.3 Flexibility

General principle

Accommodate varying user needs by offering customizable views and controls, allowing users to adjust dashboards to fit their specific work preferences and requirements. Flexibility in dashboard design is crucial in environments where user roles and their corresponding data needs vary widely. It empowers users by giving them control over how they interact with the dashboard, which can enhance their efficiency and satisfaction.

Application in gamification

Incorporating flexibility into the gamification aspects of a dashboard ensures that these elements cater to diverse user preferences and enhance their overall experience. This includes:

- **Customizable gamification settings:** Allow users to personalize gamification features such as the visibility of leaderboards, the types of notifications they receive, or the complexity of challenges. This customization makes gamification more relevant and engaging for each user.

- **Scalable challenges:** Implement gamification challenges that can adapt to varying degrees of user skill and commitment. This flexibility ensures that all users, from novices to experts, find the challenges rewarding and appropriate to their levels of expertise.

7.2.4 Interactivity

General principle

Engage users by incorporating interactive elements such as drill-downs, sliders, and dynamic charts, which facilitate active exploration of the data. This kind of engagement encourages users to interact more deeply with the information, leading to richer insights and a more personalized experience. Effective interactivity helps users feel more connected to the data, enhancing their ability to make informed decisions based on their findings.

Application in gamification

When integrating gamification into dashboards, interactivity plays a crucial role in making these features more engaging and effective. Consider the following approaches:

- **Interactive challenges:** Create challenges that users can engage with directly within the dashboard. These could involve completing tasks to unlock data visualizations or interactive elements that reveal more complex layers of data.
- **Dynamic reward systems:** Use interactive elements to visually represent progress towards earning rewards or unlocking achievements. For example, dynamic progress bars or visual transformations of avatars/icons as users advance.
- **Real-time feedback:** Incorporate real-time interactive feedback for user actions related to gamification. This could be instant visual or textual feedback on user progress towards a goal, adjustments to leaderboards, or updates to points and rewards statuses.

7.2.5 Understanding pervasive needs

General principle

Focus on identifying and addressing the common and critical needs across all user groups to ensure that the dashboard design is aligned with overarching organizational goals and user expectations. This approach guarantees that the dashboard serves its fundamental purpose effectively by meeting the essential requirements of its users, thus supporting better decision-making and increasing overall user satisfaction.

Application in gamification

Incorporating gamification into dashboards should directly address these widespread needs by enhancing user engagement in a meaningful way. Consider the following approaches:

- **Needs-driven design:** Tailor gamification strategies to address specific user needs and challenges. For instance, if users need encouragement to complete routine tasks, introduce gamification elements like daily challenges or goal-setting with rewards.
- **Alignment with goals:** Ensure that all gamified elements support organizational objectives. This might involve gamifying the tracking of key performance indicators (KPIs) or critical metrics that reflect organizational priorities.

7.2.6 Accessibility

General principle

Ensure that the dashboard is accessible to all users, including those with disabilities. This involves adhering to web accessibility standards like WCAG (Web Content Accessibility Guidelines) and considering diverse user interfaces to accommodate different needs. By ensuring accessibility, you enhance user inclusivity, allowing everyone, regardless of their physical or cognitive abilities, to interact with the dashboard effectively and efficiently.

Application in gamification

When integrating gamification into dashboards, it's crucial to consider how these elements can be made accessible to all users. This includes:

- **Adaptive design:** Design gamification elements that can be adapted for various accessibility needs. For instance, ensure that leaderboards and progress bars are readable with screen readers and provide alternative ways for users to receive gamified feedback if visual or auditory elements are not suitable.
- **Customizable interfaces:** Allow users to customize how gamification elements are displayed, such as changing color contrasts, font sizes, or even the method of interaction, to accommodate their personal accessibility needs.

7.2.7 Giving feedback to users

General principle

Implement mechanisms within the dashboard that provide immediate and clear feedback based on user interactions. This includes data input validations, success messages, and interactive prompts that help users understand the consequences of their actions in real-time. Effective feedback mechanisms are crucial for reinforcing positive behaviors, correcting errors, and enhancing the overall user experience by making interactions more intuitive and informative.

Application in gamification

When integrating gamification, feedback becomes an essential component of the design, contributing significantly to user engagement and motivation. Effective feedback in a gamified context should:

- **Be timely and relevant:** Provide feedback immediately after user actions to maintain engagement and relevance. For example, updating a progress bar or awarding points right after a task is completed helps users see the direct results of their actions.
- **Be visually engaging:** Use visual cues such as badges, animations, or colorful displays to make feedback more noticeable and enjoyable. This not only makes the interaction more satisfying but also helps in retaining user attention and interest.
- **Encourage positive behavior:** Design feedback to reinforce desirable behaviors within the dashboard. For instance, giving extra points for completing tasks ahead of schedule or providing virtual trophies for achieving high accuracy can motivate users to maintain or improve their performance.

7.2.8 Transparency

General principle

Enhance user trust and engagement by transparently displaying information about data sources, collection methods, and analytical methodologies. Providing clear and accessible information about the data's origins and processing helps users understand and trust the data presented. This transparency is crucial for users to rely on the dashboard as a primary decision-making tool, ensuring they make informed decisions based on accurate and comprehensible data.

Transparency extends into the gamification aspects of the dashboard, ensuring that users understand how their interactions affect their scores and achievements:

- **Explain scoring mechanisms:** Clearly describe how points are calculated and what actions influence these scores. This helps users understand the fairness and rationale behind the gamification elements, enhancing their engagement and trust in the system.
- **Detail achievement criteria:** Provide explicit criteria for how badges or other rewards are earned. This transparency helps users understand what is expected of them and the rewards' significance, making gamification features more meaningful and motivating.

7.2.9 Contextual user support

General principle

Incorporate easily accessible and context-sensitive help resources directly within the dashboard. Tools such as tooltips, instructional overlays, and comprehensive help pages provide users with necessary guidance as they navigate and interact with

various features. Such support not only enhances usability but also empowers users to utilize the dashboard more effectively and independently.

Application in gamification

When gamification elements are integrated, the support provided must specifically cater to explaining these features:

- **Guidance on gamification elements:** Offer detailed explanations of how gamification mechanisms work within the dashboard, such as how points are earned or what achievements represent. This helps demystify the process and enhances engagement.
- **Interactive tutorials for game features:** Provide step-by-step interactive tutorials that guide users on how to interact with game elements, making the learning process engaging and informative.
- **Real-time support for challenges:** Implement real-time aids or hints that can assist users when they engage with challenges or tasks related to gamification, ensuring they understand the objectives and can achieve them effectively.

7.2.10 Gathering feedback from users

General principle

Establish a continuous feedback loop that incorporates user insights both before and after dashboard deployment. This approach is essential for refining functionality, enhancing usability, and ensuring the dashboard remains responsive to evolving user needs and technological advancements. Regular feedback helps developers understand user experiences in real-time, allowing for timely adjustments that improve the overall effectiveness of the dashboard.

Application in gamification

In the context of gamification, feedback mechanisms should specifically address user interactions with gamified elements:

- **User engagement metrics:** Collect and analyze data on how users interact with gamification features, such as frequency of engagement with challenges, points systems, or achievement unlocks. This information can guide enhancements to make these elements more appealing and effective.
- **Qualitative feedback on game dynamics:** Solicit direct user opinions through surveys or interviews about their experiences with the gamified aspects of the dashboard. Understanding user sentiments can reveal whether gamification adds value or distracts from the core objectives of the dashboard.
- **A/B testing for gamification strategies:** Implement A/B testing to compare different approaches to gamification, assessing which methods most positively influence user behavior and dashboard utility. This testing can help refine game design elements to better suit user preferences and enhance engagement.

7.2.11 Use of Power Apps

General principle

Employ platforms like Power Apps to expedite the development and deployment of custom dashboards. Leveraging such tools is especially beneficial in agile development settings where quick iteration and responsive design adjustments are crucial. Power Apps enables developers to rapidly prototype, test, and deploy solutions, thereby reducing development cycles and allowing for faster feedback integration.

Application in gamification

When integrating gamification features into dashboards:

- **Rapid development of gamified features:** Use Power Apps to quickly prototype gamification components such as leaderboards, points systems, or custom rewards. This allows for immediate testing and refinement based on user feedback.
- **Easy integration and scalability:** Power Apps supports seamless integration with other Microsoft services, making it easier to scale gamification features across different parts of the organization. This compatibility ensures that gamified elements can grow with user demand and organizational needs.
- **Customizability:** The platforms flexibility allows developers to tailor gamification elements to the specific needs and preferences of their user base, ensuring a more engaging and relevant user experience.

7.2.12 Integrating Artificial Intelligence

General principle

Explore the integration of Artificial Intelligence (AI) to automate complex data processes, enhance predictive analytics, and personalize user interactions. Employing AI can elevate the sophistication and utility of dashboards by enabling advanced data analysis, facilitating proactive decision-making, and tailoring experiences to individual user preferences.

Application in gamification

When utilizing AI within gamification contexts in dashboards:

- **Personalized challenges:** AI can analyze user behavior to tailor challenges and tasks to individual capabilities and improvement areas, ensuring that gamification elements are engaging and appropriate for each user.
- **Dynamic leaderboards:** Use AI to dynamically adjust leaderboards based on real-time performance data and user engagement levels, creating a more competitive and motivating environment.
- **Automated rewards and feedback:** Implement AI systems to automatically distribute rewards based on user achievements and provide instant feedback, enhancing the immediacy and relevance of gamified interactions.

7.2.13 Strategic integration of gamification

General Principle

Consider the overarching goals and context of the dashboard when integrating gamification elements. Ensure that these elements enhance user engagement meaningfully without compromising the dashboard's functionality or cluttering the user interface. Proper integration should align with the specific objectives of the dashboard, such as increasing data interaction, improving task completion rates, or boosting user satisfaction.

Application in Gamification

Apply gamification techniques thoughtfully to complement and enhance the dashboard's core functions. This includes:

- **Context-specific design:** Tailor gamification strategies to fit the particular context of the dashboard and its users. For instance, a dashboard used primarily for tracking performance metrics might benefit from competitive elements like leaderboards, while one used for educational purposes might better utilize achievement systems to encourage learning and retention.
- **Balance and relevance:** Ensure that gamification elements do not overwhelm the primary content and functionality of the dashboard. They should provide a balanced enhancement that keeps users engaged without detracting from the main purposes of the tool.
- **Incremental implementation:** Start with minimal gamification features and expand them based on user feedback and measurable success. This approach allows for adjustments and enhancements based on actual user interaction and satisfaction, reducing the risk of overusing gamified elements.

7.3 Conclusion

In this project I explored the integration of gamification into dashboard design, responding directly to the research question. The research I conducted - encompassing a comprehensive literature review, developer interviews, hands-on development, and extensive user testing - has not only affirmed the utility of gamification but also allowed me to create a set of actionable guidelines that can significantly enhance dashboard functionality and user interaction.

The findings indicate that gamification, when thoughtfully integrated, substantially increases user engagement and satisfaction. This enhancement is particularly evident in the ways users interact with data - gamification elements such as leaderboards, badges, and points systems make data exploration more intuitive and engaging. These elements transform routine data interaction into a more dynamic and rewarding experience, thereby encouraging deeper user involvement and promoting sustained engagement.

Based on the insights gathered, I have formulated a series of best practice guidelines aimed at guiding developers in the effective incorporation of gamification into dashboards. These guidelines emphasize the importance of aligning gamification strategies with both user goals and the specific operational contexts of dashboards. They advocate for a balance where the motivational aspects of gamification complement the practical requirements of data representation, thus ensuring that the integration of gamification supports rather than distracts from the decision-making process.

By adhering to these principles, developers are equipped to create dashboards that are not only more engaging but also functional. Such dashboards leverage the motivational benefits of gamification while maintaining a clear focus on data usability and user experience. This strategic approach ensures that dashboards not only meet but exceed user expectations in terms of functionality and engagement, thereby significantly enhancing the decision-making process and overall user satisfaction.

In conclusion, the potential for integrating design thinking and gamification into dashboard development offers promising avenues for enhancing user engagement and dashboard functionality. The guidelines and insights presented here serve as a solid foundation for future exploration and development, aiming to better understand how gamification can be effectively utilized in corporate dashboard design to transform mundane data interactions into engaging and productive experiences. This research contributes to the field by providing actionable insights for developers looking to leverage the benefits of gamification to create more effective and enjoyable user interfaces.

7.4 Future work

Looking ahead, there are distinct areas where the prototype could be further refined and enhanced with additional time and resources. Prioritizing these aspects would not only improve the prototype but also provide a richer foundation for understanding user interactions and preferences:

1. Further improvements in usability of the prototype: Continue refining the user interface to enhance ease of use and reduce learning curves, ensuring that new users can quickly adapt and proficient users can operate more efficiently.
2. Customization and user settings: Develop more advanced customization options to allow users to tailor the dashboard to their personal preferences and workflow needs, which could include adjustable themes, layout configurations, and data display options.
3. Advanced gamification mechanics: Expand on the initial gamification elements by incorporating additional features suggested during user testing, such as achievement unlocks or more complex point systems that reward user proficiency, accuracy, or consistency over time.
4. Quantitative user feedback: Supplement qualitative insights with quantitative data by implementing analytics to track user interactions, conducting A/B

testing to compare feature effectiveness, and distributing surveys for direct feedback. This structured approach will help in quantifying user satisfaction, pinpointing usability issues, and prioritizing future developments based on empirical data.

5. Accessibility improvements: Ensure that all aspects of the dashboard, including gamification elements, are fully accessible to users with disabilities. This may involve conforming to WCAG guidelines, providing alternative ways to interact with gamified features or enabling the users to use archived versions of the prototype for increased consistency and familiarity.

The insightful suggestions from user testers, who proposed a variety of specific features for inclusion, significantly influence these future directions. Their detailed recommendations underscore the practicality and relevance of potential enhancements. Notably, the majority of these suggested additions have already been identified as feasible within the capabilities of Power Apps, indicating that existing tools can be further leveraged for implementation.

Table 7.1: Guidelines for dashboard design identified during the course of the thesis project

Guideline	**Description**
Clarity and simplicity	Design with clarity to make complex information understandable at a glance.
Consistency	Ensure uniformity across the dashboard to facilitate user familiarity and ease of use.
Flexibility	Allow customization to meet the diverse needs of different user groups.
Interactivity	Engage users with interactive elements that encourage exploration and interaction.
Understanding pervasive needs	Address common user needs to ensure the dashboard provides relevant and useful information.
Accessibility	Make the dashboard accessible to all users, including those with disabilities.
Giving feedback to users	Provide immediate feedback to help users understand the impact of their actions.
Data transparency	Offer clear information about the data's origins and methodologies to build trust.
Contextual user support	Include context-sensitive help features that provide guidance when needed.
Gathering feedback from users	Actively collect and utilize user feedback to improve the dashboard.
Use of Power Apps	Leverage Power Apps to quickly develop and iterate on dashboard features.
Integrating Artificial Intelligence	Incorporate AI to automate tasks and offer predictive insights.
Strategic integration of gamification	Evaluate and implement gamification appropriately to boost user engagement.

8

Conclusion

In this thesis, I delved into the complexities of dashboard development with a focus on the innovative integration of gamification. My research addressed the question:

> " In what ways can the integration of design thinking and game design principles be leveraged to enhance the functionality, user engagement, and accessibility of corporate dashboards? "

I thoroughly examined the integration of gamification into dashboard design to enhance functionality and boost user engagement. The findings established a solid foundation, demonstrating that introducing game design elements significantly increased both user engagement and satisfaction. Users reported not only greater enjoyment but also a heightened ease of use, making data interactions more intuitive and gratifying.

From these findings, I proposed a series of best practice guidelines designed to assist developers in seamlessly integrating gamification into dashboards. These guidelines emphasize the need to align gamification strategies with user goals and the specific requirements of the dashboard environment. They advocate for a balance between the motivational incentives of gamification and the practical demands of data presentation, ensuring that gamification supports rather than hinders the decision-making process. By following these guidelines, developers can create dashboards that are more engaging and effective, optimizing the motivational advantages of gamification while focusing sharply on data usability and enhancing user experience.

The following guidelines can be applied to gamification of a corporate dashboard:

- Clarity and simplicity: Ensure that all gamification elements are straightforward and easily understood to avoid overwhelming users and to enhance the user experience.
- Consistency: Maintain a uniform design and functional approach across all gamified elements to foster a cohesive user experience and make the learning curve easier for all users.
- Flexibility: Adapt gamification strategies to fit the unique needs and preferences of different user groups, allowing customization and scalability according to departmental or individual requirements.
- Interactivity: Design interactive gamification elements that encourage active

participation and continuous engagement from users.

- Understanding pervasive needs: Develop gamification elements that address common challenges and goals across the organization to ensure wide applicability and relevance.
- Accessibility: Ensure that gamification components are accessible to all employees, including those with disabilities, to foster an inclusive environment.
- Giving feedback to users: Implement instant feedback mechanisms through gamification to acknowledge user actions, provide encouragement, and guide next steps.
- Providing comprehensive information: Use gamification to educate users about the dashboard's functionalities and the data it displays, enhancing their understanding and ability to use the dashboard effectively.
- Gathering feedback from users before deployment: Collect user input on the gamification features during the development phase to tailor the dashboard to meet actual user needs and preferences.
- Gathering feedback from users after deployment: Continuously collect and analyze user feedback post-launch to refine and adjust the gamification elements for better alignment with user expectations and organizational objectives.
- Use of Power Apps: Leverage platforms like Power Apps to build and integrate gamification features quickly and efficiently, taking advantage of their customization capabilities and seamless integration with existing systems.
- Strategic integration of gamification: Evaluate the appropriateness of different types of gamification for various dashboard functions, ensuring that each gamified element adds value and aligns with business objectives.

Furthermore, I identified the following gamification elements as having potential use in corporate dashboards:

- Leaderboards: Encourage competition and motivation by ranking users based on their performance metrics.
- Points systems: Assign points for completing tasks or achieving goals.
- Achievement badges: Award badges for significant milestones or accomplishments to visually represent and reward users' achievements.
- Progress bars: Visually indicate progress towards goals, helping users feel a sense of accomplishment as they see their progress.
- Challenges: Implement challenges or mini-quests where completing data-related tasks rewards users with points, badges, or other incentives.
- Feedback loops: Provide immediate feedback on actions, which is crucial for engaging and teaching users through a reward system.

- Interactive tutorials: Use game-like tutorials that engage users in learning how to navigate and use the dashboard effectively.
- Leveling up: Implement a system where users can 'level up' by completing tasks, gaining more complex functionalities and responsibilities as they progress.
- Real-life rewards: Link dashboard achievements to real-world incentives like gift cards, extra vacation days, or public recognition, providing tangible rewards for engagement and performance.

Acknowledging the limitations of the scope and methodology, this thesis suggests that further research should explore a wider array of corporate environments and larger datasets to validate and expand upon these findings. Future studies could also explore the impacts of more complex gamification strategies on different user demographics.

In conclusion, the potential integration of design thinking and gamification into dashboard development offers promising avenues for enhancing user engagement and functionality. The guidelines and insights presented serve as a foundation for future exploration and development, aiming to better understand how gamification can be effectively utilized in corporate dashboard design.

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A

Appendix: Interview preparation

A.1 Data collection and privacy disclosure

- **Introduction:** Thank you for agreeing to participate in this interview. This section provides an overview of data collection and privacy practices for this research.
- **Purpose:** Information gathered during this interview is exclusively for academic purposes, contributing to a Master's thesis at the University of Gothenburg.
- **Privacy and Anonymity:**
  - Any personally identifiable information will be removed or anonymized in the final documents.
  - Participant's job title and company name may be disclosed, with permission, to add context to the insights gathered.
  - Responses are recorded for accuracy but transcribed to protect identity, except for agreed-upon details.
- **Data Security:**
  - Assurance of secure data storage.
  - Voice recordings will be deleted post-verification of transcript accuracy, and transcripts disposed of after research completion.
  - Quotes used in the thesis will be anonymized.
- **Participant Rights:**
  - Full right to withdraw from the interview at any stage.
  - Option to clarify, amend, or retract responses post-interview is available.
- **Further Information:** Participants are encouraged to ask questions or seek more information about these procedures.

A.2 Key interview categories and example questions

1. Background and Experience

- Can you describe your background and experience in dashboard development?
- How do you stay updated with the latest trends in dashboard design and user experience?

2. Design Process

- Could you walk me through the steps you take from conceptualizing to the final deployment of a dashboard?
- How do you incorporate user feedback into your dashboard design process?
- How do you collaborate with other departments or stakeholders during the dashboard design and development process?

3. Challenges

- What are the most significant challenges you face in creating dashboards that are both functional and engaging for users?
- How do you address the challenge of designing for diverse user groups with varying levels of data literacy?

4. User Engagement and Feedback

- How do you measure user engagement and satisfaction with the dashboards you develop?
- Can you share an experience where user feedback led to a significant change in a dashboard's design or functionality?

5. Introduction to Gamification

- Are you familiar with the concept of gamification?
- When you hear 'gamification,' do you think it could be applied to dashboard design?

6. Exploring Familiarity with Concepts

- Are there any applications or games that inspire your dashboard designs?

7. New Technologies

- How do you evaluate and integrate new technologies or data sources into your dashboards? Can you give an example of a technology you've recently incorporated?
- What future trends do you foresee in dashboard design, particularly regarding user experience and engagement?
- How do you plan to incorporate these trends into your future projects?

B

Appendix: Sketches in prototyping

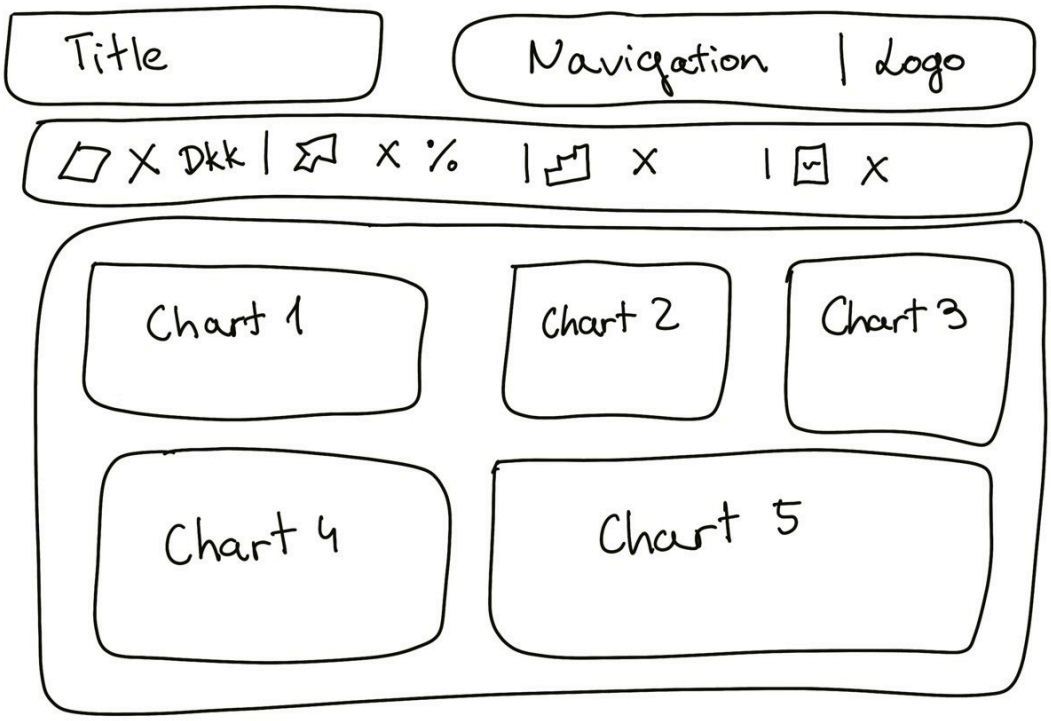

Figure B.1: Sketch of a typical dashboard layout

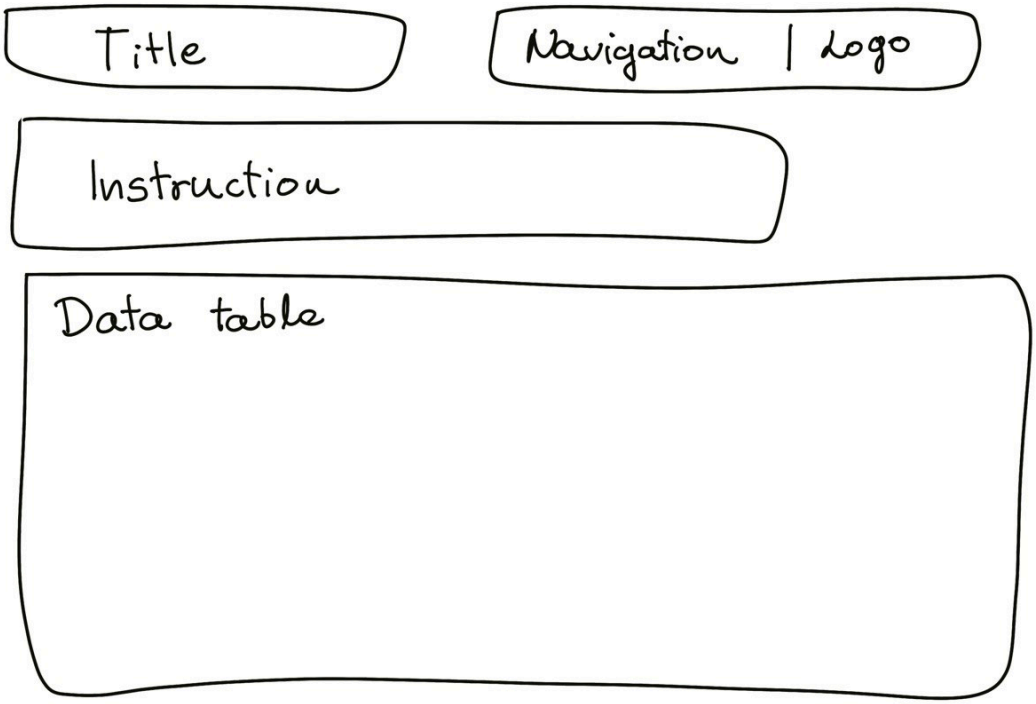

Figure B.2: Sketch of a typical dashboard layout

C

Appendix: Interview transcriptions

C.1 Ethical disclosure

Please note that all interviews included in this appendix have been anonymized to protect the privacy and confidentiality of the participants. Identifiable information has been removed or altered, and any references to specific individuals, departments or business-related figures have been generalized or changed. These transcriptions are provided for transparency and to support the findings discussed in the thesis. All participants provided informed consent for their interviews to be used in this manner, as well as agreed to disclose their company name and generalized title in the workplace.

C.2 Interview 1

Interviewer: Could you please give me a little bit of a description of your background and your experience with Dashboard Development?

Interviewee 1: So, I will just give a bit of an introduction of who I am and what I am doing now. I had a bachelor's and master's degree in computer science and engineering, and I started my internship here in Novo Nordisk a year ago. So, I have been working as an intern for a year, mainly developing the dashboard in Tableau, and now I have been transferred into a full-time employee, continuing on working on developing the dashboard for my stakeholders based on their requirements and also communicating across the sites and I am sitting in the *Department name*, the centralized function that coordinates towards the global production sites.

Interviewer: Could you walk me through the steps that you would take from having an idea of a dashboard to deployment of the dashboard?

Interviewee 1: So, the ideas are mainly coming from the inputs from my stakeholders. So, before we start, internally in our team we have a kind of a scheme to kick off the project. So basically, we have something called a solution refinement where we are in communicating with the stakeholders to align on their expectations, what they want to see on our dashboard, and we evaluate, we identify the problem they have, what kind of data they want to see and then we evaluate the complexity

of that and then finally we align on the timeline and on the deliverables. I would say the most time-consuming part is identifying the problem instead of the visualization. But basically, the idea of this visualization is coming from me, but of course, we are in a very agile way of communicating as well as developing. So, I am always doing my first draft of my idea on the dashboard and then I ask feedback quite often from my stakeholders to see if they agree with that but for the visualization part my principle is to keep the data brief and show the most critical part on the 1 pager, I do not want to have people lose their focus on my dashboard. So, what I am doing is that first of all we have the template for the dashboard, the header thing, the logo and whatever. So, we have a very good compliance on that. And then for the customized part of developing the visualization, I would say I would always have the first hook up on the data that is the most important part. For example, I am doing some analysis on the Batch Change overtime for the production line performance. So, I would always show the average number of the BCO time for those lines based on the filters so that is the first part of my design that I always wanted the user to see the most important number at the first glance and then I will try to add as much more detail as possible in the tool tip, while if they are like too much information, I will try to avoid putting too much on the on the dashboard and then I would instead, I will put it in the tool tip like as the next level of detail.

Interviewer: You were saying that you have a template for the dashboard design. Is this something that everybody in your team uses?

Interviewee 1: Yes, that is, that is the that is agreed in our team that we will develop based on the template. So that is mainly the header, we have the style of the font, the size, the color palette and also the info icon. Also, the separate line and the logo of Novo. That is basically it. But mainly for the most part we can develop based on the yeah, our preference.

Interviewer: Right. I think, yeah, that is quite nice because it would be easier for the users to get accustomed to the dashboards.

Interviewee 1: Yes, exactly.

Interviewer: What challenges do you think there are while making the dashboard both functional and good-looking, as in being engaging for the users as well?

Interviewee 1: I will say for me, I will always prioritize the functional part instead of it looking good. So of course I have my style on the design, on the color, but first of all, the precise, the accurate number is the most important. And I would say the story, the data can tell is more important than how they look visually. I mean right, but always I mean it is always depending on the feedback that I have from, from communicating with the stakeholders. On the visualization part I mean, as long as we agree on the data that is accurate and is exactly what could add value to the decision making or bring some insights. Then the next step is agreed on the visual and for the visual I would say most of the time the stakeholders do not care that much but I would try to propose how they want to visualize it, either a bar chart or a graph, or the targets showing as a number or as a line, but I always have to emphasize again what the story the data can bring and the value that the data can

add is the most important.

Interviewer: And do you also use a lot of captions, for example, adding a lot of words to the dashboards, not only the data, or do you try not to do that and just let the data speak for itself?

Interviewee 1: Personally, I would prefer to let the data speak because I will always assume that whoever my users of my dashboard will always have the background of understanding what this dashboard is trying to tell us. So as long as they have the background of that, what they care about is mainly the numbers, the data but of course as a supplementary I would add some very brief text to kind of separate them. For example, we have some kinds of similar KPIs. I mean, the definition could be similar but there can be a small difference. Then I would try to use some kind of color coding or division lines to separate them or some assistance text on that, to navigate the user to not to get lost or mix them together.

Interviewer: Are you familiar with the term gamification?

Interviewee 1: No, I am not.

Interviewer: For example, that would be adding some game design elements to something that is not a game, like Duolingo does to engage its users. Do you think it could be an option to engage the users?

Interviewee 1: Yes, I am not familiar with this term, but I have heard of it. It is quite an interesting part to be added to the user experience. I mean, it could really dependant on the task itself. So, for example, if we are creating a dashboard to report to the management, what is the most important is to show the correct number to provide the transparency of the data in the in the one pager. I don't expect that the management will spend time on the engaged with the dashboard. But I think the same goes to the line of business. So, for example, I do not expect the line of business, as in, operators or line managers to spend time on playing around with the user interface, what they need to do is to just to input the data or read the data very efficiently, I would say because the time is so valuable in these cases. But I would say if you were doing it for training purposes or when you are on boarding some new employees or you are doing some training, it would be super nice engage them like in a game. I just remembered that when I had to so some trainings, the ones that were the most interesting were the ones where I felt engaged as if I was in a game. The others was so much text with no engagement it was not so interesting.

Interviewer: What do you think about the future trends in dashboard design? How do you think that they will evolve over time and have you been incorporating some new technologies or thinking about some new technologies to add to your dashboards in the future?

Interviewee 1: This is a super good question. My first thought is AI, like the copilot which helps us do visualization for the dashboards But I would have to say that the data quality is more important than, at least in my role and in my functional area, it is more important than the visualization. So definitely in the future maybe

we can have a Copilot to help us on the tableau to do a bunch of the calculations or the design on the dashboard and in the data quality, how we are showing the proper data, and how to properly analyze, how we decide to use this part of data to show the insights, this is more important than the visualization I would say. These tools could help improve the efficiency there, but our prioritization is always to make sure that the data quality is good and trustful.

Interviewer: Do you consider the accessibility of your dashboards as well when designing your dashboards? So, for example, for people with color blindness, or do you think about the styles of the text. And have you ever put your dashboards through one of those websites that evaluates the accessibility of your dashboards?

Interviewee 1: I have to recognize that I do not. I have not really thought of this part when developing dashboards. For example, I have developed a dashboard that consolidates twenty or something different KPIs then we are color coding the KPI like a small dot based on whether the performance meets the target right. So we have either green or red to indicate the status of the KPI. So that is mainly coming from the requirements put forward by the stakeholders, so we are all assuming that whoever is looking at this dashboard can see if its either red or green, but it is a very good point that could it will be worth to invest some time on investigating how many users have issue when reading the dashboard. But apart from that, like I mentioned at the beginning that I tried to add as much detail as possible in the tool tip. So regardless the color I would like to show more information of the status. So, I will always include what is the number of the budget, or the target and what is the number for the current status. So, in that regard I think that could possibly cover people who are color blind, but for the for the size, font or style, I will say it is very depending on the dashboard itself. We have the size of the dashboard, and we have so much information already so we cannot put, for example, the header too large to lose of detail in the data.

Interviewer: Thank you so much for the interview.

C.3 Interview 2

Interviewer: So, I would like to ask you to introduce yourself a bit and give me some background about your experience with dashboard development in general.

Interviewee 2: Sure, I can start by saying I joined Novo Nordisk and this position as BI Analyst in November 22. So that's a bit more than a year ago. I didn't have any academic background in this area. I had some experience in my previous student job position where I was working a bit with dashboards for reporting purposes, but I would say that this is my first experience actually working with building dashboards. In terms of organization I'm sitting in *Department name*. So, we are a bit of this sort of central unit which is designed to report and guide strategy, setting directionals and following up on and reporting with the production sites. So that's also why I'm unfocused, mostly on production data. The dashboards that we make look into production on a weekly basis, and we focus on extrapolation the sample data into lead time.

Interviewer: Would you say that the stakeholder groups for your dashboard users are pretty small?

Interviewee 2: It's actually quite broad, I would say. The main stakeholder group is within my department, the capacity teams, they are sort of the central validators that are talking with the production site and with the management. So that's one group and they are the main stakeholders. Then the 2 main stakeholders I am supporting are the manufacturing site, if there are any business requests that should be displayed on our dashboards. Then the third one is actually supply chain analytics because we do not own the data, so it is production data that is coming from supply chain analytics. So, whenever we have some data requests or some data errors, they reach out to us for help. And then there are also the end users who can be pretty much anywhere in the organization and are also using it for reporting, they take the information and do screenshots and put it into their slides for their own reporting purposes. So, I would say it's quite broad. The number, both the number stakeholders and also the groups.

Interviewer: I can definitely see that then and maybe do you have any challenges when considering the different levels of data literacy between the end users of the dashboards? So, for example, there are some end users that would like to see extremely advanced and detailed data, but some of them would not exactly understand it and need some more support.

Interviewee 2: I would say that data literacy varies across the stakeholders. Well, first of all, this is my personal opinion since I don't directly interact with the end users, the team that I interact most outside of my own team, is another team in my department and I think for them the data literacy is quite high because two of them are also former more Business Intelligence people, so they experience and understand it better, and then some of them, I think they are still quite good at understanding what are the data challenges and we are also in close dialogue we have in weekly meetings with them. So then they are also a bit more aware of these data challenges. The ones that I see have more questions regarding the data are at the senior management levels. My perception is that their data literacy is lower, and this impacts their understanding of the dashboard data, but I don't know if it's a general rule, it is more some of the observations that I had. Overall, it really varies.

Interviewer: Who would be interacting with the end users? Is there a mailbox that you have for them, or would there be special people who would be interacting with them when they have questions?

Interviewee 2: We do have a mailbox for my entire BI team, but because in our BI team we are focusing on I, think five or six different areas, and we are split by each person into this area, so it's normally it is me that people are asking but I do not think I have had many questions about the existing dashboards, I think it is more when it is something new which we have not had them much, so we are having the dashboards that they have been in use for a couple of years and they have gotten used to what to expect and information is quite clear. But I have seen this that, whenever there is something new because I am also slowly transitioning or working

with the environmental area and there is a new dashboard and then people come with questions to try to understand the dashboard. So, it is more about whether there's something new that this is one of the questions and end users directly to me.

Interviewer: Could you walk me a bit through the steps that you would take from having an idea for a dashboard to actually publishing the dashboard?

Interviewee 2: Yep, I can actually give you a quite recent example because I have been working on a new dashboard since last month and to be fair, the way that we are doing, it is actually more coming from the main stakeholders, is it based on their need for the dashboard. So, it is more, I would say, a top - bottom approach, but they have the need and then they know they want to see, for example, this KPI that they want to see visually, we track it in production on a weekly basis but now they wanted to track it on a monthly basis. So, the data was already available even with some of the graphs. So, they actually in this case they had quite a clear idea of what they wanted they want to see, for example, the KPI metrics on the top, they want to see the development of the actual numbers versus the targets, they wanted to see a quarterly view and then also wanted to see it is split by different production sites. So, in this case they had the actual clear, the overview of what they wanted to do and then two other views which we also had them in in other dashboards. It's more that they wanted to have consolidated all into one dashboard. So that would be like one use case. Then an average case that, in our team, we started doing like half a year ago is the so-called solution refinement sessions. So, it is more about taking a design thinking approach. This is more for the cases when there is maybe something vague for the end user, so the stakeholders do not know exactly what they want to do. So, in this case we are having this framework where first we are focusing on what is the problem, we are trying to understand the problem. Here we are asking a couple of questions. Like, what is actually the problem? This is to understand if a digital solution is something that will help solve their problem. Then we are going into the solution mode or trying to think how we can then solve this problem in the best way. So that is also something that we do. This is a need that we have seen because oftentimes people jump into solution mode and then end up developing a dashboard that is not really used after that and of course, it is time and effort that is put into developing it. So that is why we started doing this solution refinement, and we are definitely seeing good results because it is a deeper understanding then you also make sure that you are working on the right problem. I would say I think it's been like a lot of value. These are the usual two kinds of use cases that I can think of.

Interviewer: That is really interesting to me as well since I was also examining about using design thinking in particular for the dashboard development. It seems that it has been working quite well for you. How do you exactly measure the satisfaction of the stakeholders and for how long do you measure it after publishing? Do you look at the analytics or do you ask the stakeholders directly?

Interviewee 2: That is a good question. We do have these user statistics; it was one of my colleagues that built a dashboard where we can see all of our team dashboards and we can see the initials and who's been using it. So, we have the data in terms of

number of users. That is one thing we are doing but if it is being used or not, again because we are building something on the request of our stakeholders and in my area, the dashboards, they are being used in different reporting for us with different frequencies, so can be weekly or it can be monthly. And then if it's something is not being used, it is mostly because, they are not interested in tracking a certain KPI and we kind of get it signaled from, in this case, the stakeholder saying lets actually archive this one because we were not using it. Secondly, in our team, we have also been working over the last year on maturing our processes a bit and because we are having more than enough frameworks. So right now we are working on it and I think in the next month we are having this so-called Auditing week where we are actually going to look at our Business Intelligence solutions and their Alteryx flows and for some of our Tableau dashboards, we will check in terms of the number of users and see what is actually being used, what needs to be changed to better correspond to our standards and then, most likely, if something that is not being used it is just going to go into the archive folder. Does this answer your question?

Interviewer: Yes, it does. It is always kind of difficult to assess whether a dashboard is really bringing business value or not. So, the maintenance of the dashboard might not be worth it in the end if it is not being used enough. I also wanted to ask you if you are familiar with the term gamification?

Interviewee 2: Yes.

Interviewer: Can you see any parts of dashboard development or any ways in which gamification could be used in a dashboard?

Interviewee 2: I think it is definitely interesting and to my best knowledge I have not really been seeing it applied. At least in the dashboards that I am maintaining or that I am seeing. Just to make sure that we're speaking about the same thing and aligning on it, could you, could you what is the definition that you have?

Interviewer: Right. So, it would be just applying any kind of game design principles or ideas from game design to a more serious environment. For example, maybe you are familiar with Duolingo, so that would be for example a good example of that, as in, we take language learning and apply to that some forms of game.

Interviewee 2: Ok, so we track everything production against the targets and usually we signal them in red or green if it is above or below the target and here it is more again, it is more for reporting purposes. Then if you are below the target, then they discuss in the meeting what actions to take upon that. So at this level, I do not see it relevant, maybe something more operational on the operational floor? Even so, I think I am having a hard time to think applicability in this area.

Interviewer: What about, for example, for educational purposes, do you think maybe a tutorial with gamification applied could be useful for like people who are just joining have sometimes a hard time actually using the data. Do you think that would be potentially a use or maybe with this type of dashboard it would also not be very applicable?

Interviewee 2: I mean, in my mind, gamification and where I see it applicable is if

you want to incentivize something or change, a certain behavior and not having the people to go into a certain direction. So, let's say you want to achieve that production target, but again there are multiple factors that come into play. For learning purposes, it could be maybe that when giving the information or the instruction of all the certain dashboards you would have some sort of guided experience of how to use and where the data is. I have actually started looking into this one, how to build on top of the dashboard, I think it is this sort of pop up that you the page and then you can hide it and then hide it and maybe in there, there could be some gamification involved but I think that it is definitely also like some food for thought for me as well. And if you have any examples that you have seen across Novo with this one, I would also be really interested in seeing that.

Interviewer: Of course. For now, I have only started with the interviews and I will be conducting still more so maybe when I have the results, I could share them with you as well. What you have been saying about like the interactive tutorials, that is also a very good example of how it could be applied potentially. So I will definitely take that idea as well.

Interviewee 2: It is not something that I have done before but yes I think it is a good idea.

Interviewer: Right, of course. But it is something that I am also investigating how it can be done. Now just talking in general about new technologies. What kind of trends do you see in dashboard design nowadays or what kind of new tools or new ways of designing?

Interviewee 2: In general, with Business Intelligence, it is the fact that you give the people power to take ideas into with visualization and tracking the data because you give sort of this very easy way to build a dashboards, so everybody can build a dashboard because it is more of a plug and play and the same in Tableau and but in terms of trends I would say that AI is like the whole topic right now, for example, with Tableau, I know that there is some AI, but then the data would be hosted on their server which could not be the case for us because we do not allow to have that data flow of communication with our servers. So, I think there was still a bit of a long way to go there. I think to be honest, it is also a question that I am having myself because at least the dashboards that I am doing here they are more for reporting purposes and to have this data-driven decision making, but it's more reporting and I would like to see how and what other applicabilities besides reporting there are as in, using for analysis, so I think it is also a question I am having for myself because at least the dashboards that I am doing here they are more for reporting purposes and to have this data-driven decision making, but it's more reporting and I would like to see how and what other applicabilities besides reporting there are as in, using for analysis, so I think it is also a question I am having for myself.

Interviewer: Right. So also what can you do with that data after you report it? And how can you use it later on in the process?

Interviewee 2: Yes, like what use cases are for, for dashboards, you know, besides

reporting and analysis and so on.

Interviewer: I think that is also interesting, for sure. Thank you so much for the interview!

C.4 Interview 3

Interviewer: Can could tell me a bit about yourself and what is your experience with dashboard development in general?

Interviewee 3: I started in Novo Nordisk 2 years ago. I was a student assistant in supply chain analytics in *Department name*. At that time, I learned how to use Tableau as a first tool, and it was the first very first time that I started build dashboards and I got to know these types of tools. And then I also wrote my thesis with the current department. They hired me at the end of December 2022. So, I have been with this department for a year and one month and currently I also work on a lot with the user interface, but mainly because I am developing some apps so there is a lot of user interface involved. As power BI and now back to Tableau Dashboard for some other projects, so from the overall over experience I understood that Simplicity is the key. You must keep in mind that you cover a wide and different range of users. So you must put yourself at a user perspective most of the time, you have to think of yourself as a user that is maybe 25 years old, maybe 60 years old and then you have to remind yourself that they already different, you know from each other, how they can interpret the dashboard, how they can see how they can use it. A dashboard has to be, I would say, clear, and must capture the main essence of the message that you want to show or cover the purposes of what you want to visualize. Therefore, the title and then graphs have to be simple and clear, so this means not too many features or colors or elements, focus on showing the right information. For example, in Novo Nordisk, we have theme colors which are very good to be used because users are familiar with that and then also those colors are also very efficient in a dashboard, however, you should keep in mind not to overuse them otherwise it might be confusing. Finally, I believe that it is quite important to have an information section, it can be a tool tip or can be tab when you can explain the purposes of the dashboard, its sources, some calculations, basically the overall purpose of the dashboard. It is also important to keep this section concise because users do not usually want to read much text. You can also make these tool tips and pop us in important results to further explain it just in case.

Interviewer: Do you use a tool tip, do you use it like in the fields themselves or do you use it somewhere outside in the visual?

Interviewee 3: In the files. For example, if you have a graph with bars which shows the CO2 emissions, there is an area on the X axis and another on the Y axis. Then if you over on a specific area you would understand how much emissions each area has contributed per year. Yes, you can see it visually but if you want a deeper dive, you can quickly just over and then the tooltip shows the information. Especially because many users want to be able to find information efficiently and quickly, so a tooltip always helps, especially at the management level.

Interviewer: Right. What do you think about the data literacy of users because you were saying that it is very important to consider things like the age of the person who is using the dashboard. So, what do you think about how some people would like to have a lot of information and some people would like to only have the basic information?

Interviewee 3: Yeah, but that is why feedback is so useful. I always make two versions and then I am open to feedback and make the changes that make sense. Also, this is another good use for an information tooltip or tab why creating also Info tab is good.

Interviewer: Could you please walk me through the steps that you would take from like coming up with an idea of the dashboard to deploying the dashboard. How would that be? How would you collaborate with the stakeholders as well? And how would the process look like?

Interviewee 3: So, first of all, there is a stakeholder meeting. Where they ask you if you can develop this specific dashboard. It is important to understand what the data is about and why do they need to create a dashboard to visualize it? Because maybe before creating dashboard you need to work behind with the data, maybe through Alteryx you must do some calculations to make things easier to visualize, because yes, the dashboard can give you the feature to make calculations, but sometimes it is basic and not so flexible. In this case you might need to create the Tableau server publisher data. Regardless, understanding and having an overview of what the data is about rather than going direct to the technical perspective is very important. So, once your data is clean and then you know what they want to see, you should still have frequent meetings so that you can get their feedback quite often so that you do not create something that either halfway or not what they are looking for or need. Listening to users to are going to be using the dashboard is very important. I will say biweekly meetings are the best schedule. You should look for feedback that is not only technical, as in, how they want to visualize the data but also ask about the colors and the style.

Interviewer: Do you think that in Novo Nordisk most of the dashboards follow the same style and have those information pages or do you think that there are differences throughout different departments?

Interviewee 3: I would say not always but it also depends on the complexity of the data and how the dashboard has to be structured based on the data. Sometimes no extra tooltips are needed but other times, the data might be so complicated that it can be then the user might find itself looking at so many tooltips. In these cases, it is better to keep the dashboard simple and add in the info tab a link to an email or SharePoint where the information can be better explained. Also, the dashboard can always be improved. The more they use it, the more feedback you receive. Only once it is quiet and nobody says anything, then it is a perfect dashboard. But once you publish it, of course it can be 1-2 months where people start using it and then they have their own opinion. Of course, you have to always be open to any feedback because it is very valuable, but you should also filter through them and do not consider them if It is back not in the scope of the dashboard. Always go back to

the scope of the dashboard to create a good user interface or the possibility of the dashboard. So that is also a good reminder.

Interviewer: Yeah, right. If you are receiving a lot of feedback, it's also about prioritization of that feedback because that can be contradictory as well.

Interviewee 3: Yes, and also you have to know because you are the one who build the dashboard and then if you have already succeeded the main purpose of the dashboard that the others' feedback might be just details, you know and you always have to see if you make additional changes, then it might be too much, and with there is too much main information then it is misleading and you just lost the purpose of the dashboard.

Interviewer: Are you familiar with the term gamification? Could you see any use for it in dashboard design?

Interviewee 3: Maybe, I'm not sure. I am maybe not that interested in it at the moment but I guess this is part of innovation and using new technologies and so on. So there would be some elements that are like a game whether we try to make them like this or not.

Interviewer: So what do you think about the integration of new technologies in dashboards or new trends in dashboard design? Have you used power apps or some other new technologies?

Interviewee 3: I developed a tool in my model driven app but I incorporated the dashboard in the app and I think it's good if you know the tools, if you know how they work. If they fit perfectly, and if you think that in the app you can contain or group all the information you need, then just do it so it is not scattered in different SharePoints and then everything just centralized and then that is also very good because we are in a huge company that is growing and growing, and then we need to keep things as centralized as possible, especially talking with dashboards, data or different power apps. If have the possibility to keep it in the same place, then we can just integrate different tools, which is also very nice. Power Apps and Power BI for example work perfectly.

Interviewer: Could you let me know how you integrated the dashboard inside the Power Apps app?

Interviewee 3: Last year I built a monitoring app where different projects were ranked based on energy saved. The energy savings were listed and then the data centralized in the database were then used in power Bi and then I start building, you know, a graph where you can see summaries of all the project, how many giga joules of energy and water savings and then I grouped it by the status of the project. Then you visualize it and then you can publish it in the power BI server and then you to into the app, you can add the dashboard through the power BI server. So, you can create a new section and you can have only the dashboard and on the side they have the list of the project and there you can see how much energy and water has been saved.

Interviewer: Right. Yep. Yeah, that's super interesting to me as well, because I'm

also exploring Power Apps right now a little bit for my project. So yeah, thank you so much for the interview.

C.5 Interview 4

Interviewer: Can you tell me about your background and your experience with dashboard development in general?

Interviewee 4: My expertise lies in Business Intelligence. I have 10 plus years of working experience out of which 8 of them are in Business Intelligence development. I have worked with various tools like Qliksense, PowerBI, Alteryx and so on. That has been my main expertise for eight years or so, I have also worked with various dashboards. In Novo Nordisk, I have been here for three years, and I belong to the analysis and execution team which is dashboard building services for all locations of Novo Nordisk. I also led the visualization strategy in another company.

Interviewer: What does the process look like in terms of collaboration with multiple stakeholders when you are developing dashboards?

Interviewee 4: The first step is to try to understand what they are looking for, and what I mean by this is to understand the business questions at hand, what answers do they need/what from this dashboard, so talk to your users to better understand this. The second is to see what tools they are used to already, this is to understand habits. Habitual, habitual UI design is also a thing, because then they will find it convenient to adapt to the new tool, right? If something looks similar, or if something looks like OK, this is convenient. This is similar to what we used to do. So, something like that makes it easier to have them adopt the new tool easily, right? So, these are the kind of things that you should do in the first step initially and then with the different users, it is a bit different, most of the time it helps to have a mockup because then you give them an idea of this is what I can offer, this is what I think would be beneficial for you. What suggestions do you have, or do you think this would be useful? So that would be the second step getting that and then you start to build a report and you have frequent touch points with them so that then so you know that you are going on the right track, right? One thing I have noticed is that a big thing is all of these tools they do offer a wide range of visuals, when I say visuals, I mean a bar chart of flow chart and so on but usually users generally do not appreciate really complicated ones, like you have something called a box plot, a distribution chart. While it could be nice to see it, but people find it very hard to understand and especially if you have users like in Novo Nordisk, you have the sales representatives using the dashboard, they are trying to understand something, they are on the go and do not have time to sit and analyze what the visual means, right? So by keeping it simple, I think it is super smart to keep it simple because it leads to them trying to reach out to your tool. Keeping it simple is the ultimate objective. Answering the business questions while only using that part of the data right, you can build a lot of stuff and you can make it really crowded. Do not do that, we follow a less is more concept in developing dashboards and lessons, more concept is super. So it is a good way because then you know exactly what

business questions are there and what you will need to answer it. And then the users do not have to look through the report or pages of the report just to find what they're looking for, and the third thing would be to sort of make it convenient in terms of where to find certain things. I tend to sometimes add even something like a download button they could right click on the visual and go and get it, but it is about making it convenient for them, right? The whole reason why you have the dashboard is so that they are not scrambling through excels and trying to get stuff from there, it is for convenience's sake and. So, we try to make it as convenient as possible. This, I mean it cannot have every small feature, but how much ever we can we try to make it convenient for them and of course it should follow a storyline. The whole dashboard in in should tie up together somehow, it cannot be very unrelated.

Interviewer: What would the challenges that you face when creating dashboards that are both simple but also convey all of the information that needs to be conveyed? Do you use informational tooltips?

Interviewee 4: Absolutely yes. Some kind of description is also needed in some of the pages, right, so usually if there is a need, then we provide a sort of glossary sheet at the end and we link each page to it, so that then they can just by the click of a button go there and check what it is. So, we either do that or if it is a small enough note then we just put it under the visual as to what they need to do. If there is something like they need to enter information to see something then we would say that enter this information to get your result or something like that. So yeah, definitely description is a thing, but do not overcrowd it. We do not ever write paragraphs of stuff. We write 1 liner that explain precisely what is there. So yeah, that is the thing. And also, if there's a link that they need to visit or if there is a connected tool they need to visit, then we try to put in links into our dashboard to serve as sort of a one stop shop. For what they are looking for, right? Yeah. So, we try to make it again and goes back to convenience instead of them coming out of the tool and then going somewhere else. We try to enable or embed links into the dashboard so that they can have access through the dashboard itself. Because one of the big things that we face is sometimes the users are like, oh, no but I have to come out and go to this and that. But yeah, I mean, some things cannot be avoided especially when we have external solutions for certain things, so here we utilize weblinks so that it is easier for them to navigate. User adoption is a very key topic, right? Whatever you build, if it's not used, then there's no point. It means that we do as much to try and promote it, promote whatever however we can right the user adoption however we can we try to promote it, and these are just the small things that do that.

Interviewer: What trends have you noticed in the visual design that is shown to users, how has ti changed over the past few years?

Interviewee 4: I think people, especially those who initially thought it was all about excel right, and people were very used to seeing things in a tabular form, it slowly then adapted to bar charts and then line charts and then combo charts. But now people are ready to have a mixed view of things, right? It is not just pivots, it is just straight table. But people are ready to see, or they are more accustomed

to seeing that this kind of a question is best answered or viewed as this visual. If it is comparative, or if it is percent of whole right, like we use the pie chart or so on and we use a combination of these. It is never just tabular or just bar charts or just, you know, line charts. So, we use a combination of these. And I think all of the users are also growing into that kind of mindset where I will need to quickly then see this visual and realize this is how it is depicted right? And This is why we also keep it simple, because if we then use very complicated. Then objects are lost, and they will not be used. And we've seen that people will not use it when you make it too complicated. This another thing that also helps is easy indicators in your data, right? The reason why we have color is to easily identify something right, some anomaly or something like that, and we call this the three second rule wherein within 3 seconds the user will get to know what is happening, right, whether we have indicators we have color indicators or we have like the warning symbol or just you know in red, green, yellow. These are the kind of sort of indicators that show them within 3 seconds that OK mainly we are doing good or yeah we are not going doing good in this that, so this also helps I think so I think the users now having used so many reports over the years and are also accustomed to sort of reading these kinds of visual indicators, reading or adapting to the different combination of visuals that we have right and also the like small features, I think they are getting accustomed to using these things.

Interviewer: Do you think that maybe the data literacy of the users in general is improving nowadays?

Interviewee 4: Absolutely, yes. I agree that data literacy is increasing thanks to us having these kind of reports right that are easy that are easy to understand and also when we have descriptive fields. We put it in as much as possible so that then they understand it relative to what they are looking for, right? Like channel comparison or these kinds of things. So that that when we do provide these things you there are users, there are users who come back saying oh, but can you also give me these numbers based on this field or based on what is happening in this sort of data set, right? And then we go to the back end and search which column it would be and so on and provide it. So, I think they are aware that these things are possible. So, they then ask, it is all about asking and then for us it is all about figuring out if it is feasible or not, right? So definitely, yeah, I think they are growing and that is good.

Interviewer: Are you familiar with the term gamification?

Interviewee 4: I am, yes, in terms of enhancing engagement sometimes we think of it like a game. I'm not sure right now about specific examples that could be gamification because it is very broad.

Interviewer: What do you think about the future trends, so things that are coming up now and the new technologies, are you familiar with powerapps or power automate?

Interviewee 4: Exactly. So I think those things are going to be very useful in the future because also at the moment I think a lot of use cases are also based upon the

fact that it is not just from database to reports, but they also are looking for features now to enter data in reports and capture them as data, right. And this could be some sort of data that you need to collect from the reps on the go or you know some descriptive fields that only the people on the field can provide at a certain point, right? So then you need it to be in runtime. So, the moment they enter it then they need to be seeing it somewhere, right? And validating it so these are the kind of use cases that are coming up. And I think the new features that are there, I think it is possible through power automate and Qlicksense it is possible through the right back function. So, I think this kind of these kind of trends are going to increase where they are trying to make it a two ways sort of thing, right, not just receiving data but also giving data into the system directly through the dashboard, right? Again, going to the starting point of the data collection and giving it there. So, these kinds of things are what I am seeing, a rising trend for, right? So yeah. And also, things like connecting it to other systems like the case where you can capture an insight and then send it to your colleague just through teams or things like that right where you are not waiting for a big presentation to be made or put it into APP and only then show that this is oh, but yeah, todays sales increase that much and so on. So, you can just pick the inside and send it as a message and also e-mail based triggers which tell you that today this for this insight this is the value and so on, right. So these kinds of things are I I see a rising trend for these kinds of convenient again convenient options.

Interviewer: Or maybe there could be for example a notification whenever you go in it shows you how much it has changed from last time you visited.

Interviewee 4: Absolutely like an alert system or so on, right. So, these kinds of things where in your mixing Business Intelligence and AI, let's say is becoming a rising trend.

Interviewer: Yes, super interesting too and this could also be an element of gamification. We will see what other uses there are for it.

Interviewee 4: Yes, we will never know until we get the requirement and we try to then make it possible, right? So yeah, true.

Interviewer: Thank you so much for the interview.

C.6 Interview 5

Interviewer: What is your background in dashboard development and experience?

Interviewee 5: I have been working with Dashboarding software for about 10 years now, and really, I started kind of on accident. I was working in an office and one of the BI people got sick, and so they needed me to help them. And at that point, 10 years ago, and this is still common in some offices, they would use dashboard software, but they do not really realize that they can use it for dashboards. They use it for creating graphs and stuff like that, like doing complicated calculations, but not creating interactive things. So, when I first started using Dashboarding software, that was basically how I used it was just creating fancy graphs, but not

really understanding the capabilities. Then I went to grad school and kind of got more into dashboarding and I worked in an office where they had transformed what used to be pdf file all the statistics about the school which used to be like 50 pages, and they made it into a series of dashboards. So that was cool that they took that initiative to sort of make it completely digital and completely open to the public. Versus a pdf where it was just a lot harder for that to be accessible so that was something that they did was they had all the student statistics, like how many students, what was the race, ethnicity breakdown. What were their outcomes, what were they doing. And so really to give an idea of the picture of the school. So, I created some dashboards with them, and I also oversaw the updating dashboards. And I think that, you know, it was an intimate environment. So, like everyone kind of knew each other and we knew what other people wanted. And it was very easy access and people were very open. So, the development process was very casual and it was also academic, so the timelines were not so strict, and then I continued working in higher Education and kind of worked in various offices somewhere. They had dashboards online, but people still were very resistant. They wanted the pdfs and stuff like that. They were like, can you print this as a pdf? So still dealing with a lot of that. Like old habits die hard and I think also another problem was that when we developed the dashboards, we did not really consult people as much as we should have and done that change management and then I went to an office where we did not make dashboards at all. And then I came here, and we are very much like a dashboard driven environment. A lot of the tools are self-service, which is nice. I think that this is one of the first places I have worked where we have really empowered people to use the data on their own, and I think that that is really cool. So here I am now. I feel like , it is a business environment, so things are expected to be very fast and simple and easy. So, I think that the expectations are higher and so you kind of must be a bit more efficient when you create those dashboards, right?

Interviewer: So, you have had experiences with people on different data literacy levels?

Interviewee 5: Yes, absolutely. Everything from like 65-year-old board member who does not know how to open a dashboard to people who you know, basically this is second nature to them.

Interviewer: How do you stay updated on the latest trends in dashboard design?

Interviewee 5:

I feel like the different types of software's, have different types of communities. So, I used to use Tableau a lot and a lot of the tutorials and news and stuff came in the form of blogs and websites and now I feel that for PowerBI, lot of it is like videos and it is kind of interesting. There is something kind of different about it. People just like to have that interactive element even in the way that they present their knowledge sharing. So that is one way is just following some people online also like looking at other people's dashboards and what they are doing trying to be very aware of what the people on my team are doing and what practices they use. There is also power hour where it is like twice a month, an IT consultant and other

people get together and they talk about sort of the newest happenings or things to keep aware of. So those are some of the ways that I keep in touch with the latest happenings.

Interviewer: What would you say are the biggest challenges in making this work that you encountered? And how they differ from the challenges in your past experiences?

Interviewee 5: One of the challenges that comes to mind is that when you make dashboards, you are very aware of all the features and how they work and it becomes second nature to you, but you forget what it was like when you were just starting and you are like, where are the filters? What does this do? So yeah, like you forget what it is like to be a beginner and I think that that is one of the greatest challenges is that, you know, you have people that are deep into it and have been doing it for a long time and then you have people who maybe have never used PowerBi before, so the setup to them is completely foreign. Another is sort of understanding what the pervasive needs are, so you might have an instance where someone needs something, but it is only for a short period of time. It is only for a certain project and maybe an analysis is what they need on a dashboard and so you might create a dashboard. They might use it like 50 times in the first few months and then it never gets visited again. I think that that in my mind is a failure. If you create something and no one uses it, yes, then it is you just wasted your time, right?

Interviewer: So how would you approach this issue?

Interviewee 5: I would talk to the stakeholders and understand exactly what they need. It is kind of like a process that I learned overtime and refined, but to understand sort of the process and what sort of stakeholder is looking at long term and kind of like meeting them where they are at, like you might not necessarily want to just do a dashboard right away. You might want to work on an analysis with them and sort of like build that trust like, yes, you know what they are doing. You know what they are dealing with, what their motivations are, what questions they are trying to answer, and then sort of I've seen them like doing this analysis every three months is like a lot of work. Why don't I just do a lot of work right now and then not have to do any work later? So, I think that making sure that there is that sort of trust that they know that you know what they are doing and that you know what they need. And you are not sort of like trying to be a bit too much like top down when it might not necessarily work.

Interviewer: How do you incorporate stakeholder feedback in your process during the process of development?

Interviewee 5: One is probably to get more feedback than less. Sometimes you know you think, oh, I just need to get the feedback of this one stakeholder. But then, like no, there are like 100 people who are going to use this, and you need to understand the perspectives of all those different types of people and how they use it because they might approach it differently. Their like sort of business process might be totally different.

Interviewer: Would it be possible to get the feedback of so many stakeholders?

Interviewee 5: Yes, it comes down to prioritization and try to find one person who would represent each group.

Interviewer: What trends can you see in dashboard development nowadays and maybe new software's that are being used?

Interviewee 5: I think one thing that I have noticed is that integration with different things like integration with a database was as good as it gets, it was like yes, we did it. But now there is integration with POWERAPPS and so you are connecting with a lot of different types of software, and you are allowing for different levels of communication. So, I think you know the features where you can write back, or have it live connected to forms or various other sort of data sources, I think is one of the newer developments that I have noticed. Kind of like including the dashboard and in various parts of the workflow so I think thinking more holistically about what the work is that people want to accomplish versus we are going to create this tool that has data and people can consult it when they need it. But it kind of like always lives over there. So, I think, you know, there is more of a holistic view now, right? And I guess it will be also more personalized with PowerApps.

Interviewer: Are you familiar with the term gamification in general?

Interviewee 5: I yes. There were actually some people that. because I worked in higher Ed, there were people who would try to gamify education. So that was sort of a thing that people explored kind of like that movie Ender's Game. It is where they have the game of military actions. So, it is a dark example, but it turns out it is very effective for getting people to do things and learn things that they otherwise would not want to. I have also heard a little bit about, like, the psychology of video games where you sort of give people puzzles to solve and when they figure it out, it is like a reward system they like, get, like a dopamine hit.

Interviewer: Do you think that dashboards could also be like a puzzle in this situation.

Interviewee 5: I think that is a really interesting idea. I think that the idea is sort of like discovery, right, like you are discovering things through the data and that makes it more engaging versus like people know something and they want the answer and they are like: OK, here it is. Try not to fall asleep here.

Interviewer: What in particular elements of gamification could just say being applied to dashboards for example? Like a point system for example.

Interviewee 5: That is a really interesting question, I do not really know how you could make it gamified, but one thing that came to mind that was with that power BI basic training having it as a game would be much more interesting and would for sure be a really good way to help people learn. I cannot think of any way to apply it to sort of just regular everyday activity, but I think for learning and adaptation it's a really good idea. I believe that some dashboards would maybe not be applicable for gamification at all. For example, if they are for like management or just more serious kind of dashboards or just for reporting purposes for example, but maybe when it comes to like dashboards that are available to a wide wider

audience, it could be possible to add like interactive tutorials for example, yeah. Or something like notifications for personalized tools for a specific type of user. So, I think those could be maybe examples of that. One thing that kind of comes to mind now is simulation dashboard could be very engaging. So, like we have the external benchmark dashboard and I think that is nice although I think it is a little difficult for people to use. But if there is a way to sort of like fiddle things to sort of like figure out how to meet your goal. Like how can I change this so that I produce such cost savings or something and then you know, if it was like you got the goal or whatever and then it would give you a prompt saying: you just generated cost savings! So something like that I think on the super interactive dashboards, where you are changing different parameters I think that could be a good thing.

Interviewer: What do you think about having a notification with the track record of what people have done throughout the dashboard?

Interviewee 5: I think that that would be nice, especially because not only could that be a way of motivating people but also they could always go back and where they were and what they have done, I think it would be a great quality of life change. You know, sort of way to say like you are looking at X data and this is sort of the takeaway and I do not know maybe if that is something where we have like AI addins or something or if we have some special programming, but I could see that being useful. One thing that I think people are working on and we talked a lot about during our off site is these chat bots that you can kind of talk to and they like will explain where do you find this? What does this mean? In very easy to understand language, I do not know if it necessarily gamifies anything but yeah, I think it enhances the experience.

Interviewer: Do you think it would be possible to gamify learning while the users are using the dashboards?

Interviewee 5: I think that that would be like something that would be more engaging, and it would meet that need to educate people. You can have a leaderboard you can have, for example, like a progress bar. There are different things to think about here. It could replace the long powerpoints that no one pays attention to and they are easily forgettable so we get multiple questions about complex topics like for example, savings methodology, so if the user could get a tutorial or an explanation while in the dashboard I feel like that could save us many emails.

Interviewer: Thank you so much for the interview.

C.7 Interview 6

Interviewer: I would like to start by asking you about your background in dashboard development and your experience in general.

Interviewee 6: Yes, so I did my studies at *University name*, I graduated in 2020. From a masters, that is, I think now it's called *Programme name*, but back then it was called *Programme name*, but essentially it was just basically teaching us how to use BI tools or yeah, data analytics tools to support sales and marketing function.

So that's where I kind of learned about BI and then eventually I was working for *Company name* for the project, for the *Project name* project, so they are the one that kind of created the whole system, so I was working there as a student assistant in BI and then when I graduated I moved on to *Company name* Company where I was working as a data intelligence specialist, so very much BI specialist in the marketing department for about a year and nine months before I moved over to Novo Nordisk as a business intelligence analyst or consultant. **Interviewer:** Have you made dashboards in your studies as well?

Interviewee 6: We have not, I would say we trained into using, you know the BI tools at the time it was Tableau for me and that is the way I used mine. It was for my master thesis. So I wrote it about sing a rejsekort transaction information to do some station design optimization when it comes to the rejsekort equipment, so I had to kind of create visuals so it was I was not doing dashboards when I was studying. It is only when I started working full time that I started designing dashboards

Interviewer: You have mentioned using Tableau in your studies for your thesis and now what tools are you using to design dashboards?

Interviewee 6: Now I have moved over to PowerBI.

Interviewer: Could you guide me through the process of what do you do when you are conceptualizing a dashboard until the deployment of the dashboard.

Interviewee 6: It depends because I am an internal consultant, meaning that it depends on the team that I am working for because some have project managers. So, in that case they do all the user requirements. So, I come in at the moment where they already gather all the requirements so I do not have any access to the end user because the PM is the is the middleman basically and then I am conveyed all the requirements or like you know what they are expecting and then I have to do a mockup of what they are expecting, which then the PM takes back to the end users. They make some adjustment, return it to me. And then I work on the actual product. The first part is that we agree on the layout, the second part is designing the dashboard. So, in the mockup I only show the layout with dummy data and once the mockup is approved, I actually design the dashboard, which could be done at the same as the testing. Other times I create all the measures and I hand in the dashboard for testing and get back feedback if the numbers are wrong or something else is wrong. Then I prepare it for launch and after that it is the maintenance and hyper care of the dashboard which is usually very back and forth. But if I am doing the whole process by myself without the PM I would ask if they an inspiration, from an already existing dashboard, so the layout, the features and then I would try to understand their real need and gather as many requirements as possible. After that is basically the same process as before. Some teams are very involved with the design other not so much. Also it the design itself varies a lot from team to team, for example, the finance team they already have quite standard design so there is not much room for being creative here since their design have already been proved to work and their users are used to navigate through those designs. Only when there is no previous dashboard you can have more freedom to create and have your own style. However, in these cases the end user also has more freedom to give a lot

feedback which can be good but also bad if its too random or too much. When it reaches that point I usually say ok lets stop here otherwise we will not be moving forward, and then I take the time to try and collect my thoughts and try to find the best compromise.

Interviewer: How do you prioritize consistency with other dashboards or reports that a team already has? Who gives you that feedback?

Interviewee 6: It is usually the PMs who give me that feedback. Again, if I am designing for the finance team, I am even given a template and then I must work up to make sure that the data is in there correctly. In other teams, although there is no template and there is interested in previous dashboards then I try to make sure that I do it as similar as possible and any other compromises I deal with the PM.

Interviewer: How do you monitor the feedback after you deploy the dashboard? Is it your responsibility to maintain it?

Interviewee 6: Usually, the user testing part is when you have that kind of space to do any modifications and once it is signed off it is signed off. If anything, major comes as a change request, which would go into a backlog depending on priority and we have a specific time to agree to do it or not to do it.

Interviewer: What would you say are the biggest challenges in making the dashboards?

Interviewee 6: I think the challenge is mostly at the on the data level and it is it's the speed. So basically it is the measures that you are trying to do, or whatever you are trying to have the dashboard do, what calculation are you trying to have it do. If it is too heavy, too big calculations then they affect the speed of the dashboard, so that affects the performance of it and then it is not up to standard, so we have that standard that we want to stay under 10 seconds for any dashboard when they are opening or operating. If you are above that, then your dashboard is not up to performance and so those are the challenges sometimes because, especially in finance, they usually use 2 or more heavy measures that are then slowing down the performance and because I am using a template it is also hard for me to have the freedom and try to change it how I think it would make it faster or more efficient/optimized.

Interviewer: Would you say that you are used to working with end users with high levels of data literacy?

Interviewee 6: Yes. It is very high, again especially in finance, because they already use Excel and they are used to crunching numbers every day, so they know exactly what numbers should be like.

Interviewer: What trends do you see nowadays in dashboard development or any new technologies that are being used?

Interviewee 6: Well, I mean, power BI is constantly evolving. So, we constantly have new kinds of new specifications, new features, because before I would say, you know, you have, we, we had the possibility to kind of like get a visual from you know,

the visual store and now PowerBI is really trying to kind of incorporate new things within the software itself. So we do not have to use that many external provider. And now a Copilot is out. I have not tried yet to use it in in pair with PowerBI, but that is also coming something that we can now, you know, just like kind of automatically ask copilot something like: What is the best visual fo this set of data. So, I think that more AI applications will be possible in the future.

Interviewer: Are you familiar with the term gamification?

Interviewee 6: Uhh, so maybe you could let me know?

Interviewer: Right, so it would be applying some game elements to a non-game environment, such as dashboards. For example, are you familiar with Duolingo? So there are some challenges, achievement, and so on.

Interviewee 6: Yes, I know now. Hmm, I haven't really thought about it much though. I think challenges, sure, you could have a challenge, but what would that add for you? Maybe if it was like a global dashboard so a lot of users and so on. If the stakeholder would like it.

Interviewer: Maybe for example it adds to the educational value and motivation for the users.

Interviewee 6: Yeah, it could. I guess it can be a better experience when you have something to interact with, as I said if there are a lot of users it could be difficult to get feedback from them or teach them so maybe they can personalize it themselves and choose whether they have a tutorial or not and so on.

Interviewer: Thank you so much for the interview

C.8 Interview 7

Interviewer: I would coulike to start by asking you about your background and experience with dashboard development in general.

Interviewee 7: I joined Novo Nordisk last year, April. So I am about to complete a year in Novo Nordisk. So here I joined *Department name*. So basically I work on dashboards related to HQ and IO wherever the finance related dashboards are prepared. So, we handle the sales dashboard, profitability dashboards and HQ related monthly MMR reports are there, Monthly management reports, so those are frequently reviewed on a monthly basis. So mainly I'm working on power Bi raw tool as a front end and in back end, I use Alteryx and different kind of data extraction tools to repair the data and I did some part automate things also to make the front-end work. So these are my roles here and previously the complete number of years of experiences are on the 5.5 in mainly in developing the Tableau dashboards and before that I worked on Microsoft Access. So now powerBI is has taken the major stage on the data visualization tools. So yeah, so the market is now focusing on Power BI and Tableau kind of tools. So, this is my experience.

Interviewer: How does your process of the dashboard development look from the conceptualization of the dashboard to deployment of the dashboard?

Interviewee 7: At the initial level we have the project managers who take the major role in conceptualizing the structure. So, it involves discussion between the users. For example if you focus on IO, there are set of sample users they take or people who are interested to who will or who may use those dashboard. The project manager from our team interacts with them. What are the data they want to see and what are the things they want to analyze monthly basis, What are the repeated analysis they do. So they interact and 1st the interaction with the user starts. If they want to see something basic so related to the numbers, like if they want to see the sales, see the numbers. So, it starts with the sales value. But how do you want to see the sales value in a different manner. So mainly they will have some KPIs. So, the KPIs they already would have been defined. If it is not defined, they then definition of KPI start there. But normally already the KPIs are there like what is the growth compared to the budget? This is a KPI and how much we have achieved this much and how much is that month on month growth. So, these are some of the KPIs first discussed which to be placed on the top. So, the values are first, the KPI is different, so it stays on the top. So, then the analysis comes. So now you know the number, but you want to know how this number arrived or where I should work on. So, you need the details of the next level of data. So, then the drill down starts from there. So basically, you are showing the most important things as a KPI on the top. Then once you see the numbers, whether it is positive or negative, then you want to know why it is positive or why it is negative. You want to answer the next question of that, so you want to break down and go inside that. So how this is how the data flows, especially in data visualization. So, you need to support with if they have some more questions why it is positive, why it is negative and where it is positive where it is negative. If it is sales we have where it went well, in which country it has went well in which product it went well in the last minute. So, you need to answer those questions. So that's how the next level of things starts to help them with the analysis. So, we also have a standard structure of where to place the slicers, where to place the KPI cards. So, these are the things.

Interviewer: What is the frequent feedback that you get from users?

Interviewee 7: So once we give the dashboard we get a lot of feedback immediately and while getting the feedback based on the IT goes to the backlog first to the we have this DevOps systems so it goes to the backlog, it means it is added to the list of tasks we need to do and we take on the based on the priority. So immediately giving the dashboard we get a lot of feedback and we fix it immediately if there is a serious thing, like if this if something is work not working for those things are fixed first, If the numbers are wrong those are fixed first. If there is a likely small features are requested, then we do it immediately. Otherwise, it goes to the backlog. If it is something like a new page is completely new, page is needed or new dimension or new analysis is needed. New cards is needed. New KPI cards are needed. Then it goes to a backlog and then we add it later. Maybe we give them a timeline based on the time we have or the activities we have, and we give them a timeline and we add it. So that is how we take this continuous development process.

Interviewer: How do you deal with different levels of data literacy of the end users?

Interviewee 7: There are, as you said, right there are different data literacy people are there. So, we try to make things very standard, we keep it simple and standard so that most of our dashboards will look in a similar fashion even if we have a sales dashboard. Also, it looks very similar to this. The structure will be the slicers will be on the top and the next level will be on the next. So the users are basically understand the business but not the dashboard, how it works. So we give an initial level of training of how this works, how interaction works. Like if they click this, this changes. So, this kind of the give them a manual or interaction. We made a video. Before launching a dashboard so everyone is suggested to see that video. So I think here the information page is there. So, we give a about the tool. So about this tool we have a detailed page here so they can see the demo video, training session, introduction slides, everything is available, them for them to understand how this works. We have this for all dashboard because that is a basic thing. We have a lot of users and people move between the departments. So not everyone used Power BI. Some departments use Tableau, some use click. So, we need to make them understand the interface first. So, some tabs will be available here in power B some tabs will be will not be there in Tableau, it will be on the top maybe. So, we make we will try to make the things standard inside power BA, whatever the dashboard we developed for example it looks it, it will look very similar. The visuals will look different, but the structure on the top will look similar. Even the colors, everything we have, CDA guidelines, corporate guidelines, so the structure color, everything is maintained. So normally whenever users use the dashboard, they use through the system, so only the landscape mode is best for that. So, we understood those things and now all the dashboards which we make are only in the landscape except one which is used for printing purposes. So, we have printing sized pages are there in that particular one otherwise everything is made on the landscape mode right now. So these are the few changes we made to make the user easily understand or easily own the dashboard if they feel very looks like. If it is very advanced and they may not use it. So, if we make them too familiar with this so they will start using it, they will feel it is easier to use that that technology's not far away for them.

Interviewer: What new trends or new technologies that are being used in dashboards do you think will start to be used?

Interviewee 7: Nowadays, the things are moving towards AI, so people want to see the comments directly, like if this is showing like this instead of this if they want to click the there is an option which is going to be enabled. So, copilot is going to come inside and if they click give insights. Now I think it may not work properly. If you click insights, it can generate insights like the obesity care is doing well compared to diabetes, GLP one or other others. So, like that they can generate comments automatically for the users. So, users no need to deep dive for a quick analysis. So already the dashboards are made for very quick analysis so that they jump into the decision making easier. So, the KPI cards are placed on the top so that they can make easy decisions. So now instead of analyzing these numbers, they need to see RIA. So, Ria is slightly above the budget one. So instead of analyzing this and seeing OK it is 11.9 percent compared to the previous year and 226,000,000 more

than the budgeted one, it will if they click on the copilot, it automatically generates the comments for them based on the data.

Interviewer: Are you familiar with the concept of gamification, and if so, how do you think it might relate to dashboard development?

Interviewee 7:

I'm maybe a little familiar with the concept. It's about using games in work context, and like for work? But for dashboards, I think there could be some small elements added, but nothing too much. And yes, I also have seen some game elements in like training materials so I guess it could be possible like that. Of course, it is more important that any of these ideas would need to be tested and we would see how users actually react to these elements because we would want to make sure that these features make the dashboard more useful not just more complicated. The aim is to add value, make the dashboard not just a tool they have to use, but something they want to interact with all without losing sight of its purpose which is being a business tool.

Interviewer: Thank you for the interview.

D

Appendix: User testing plan

D.1 User Testing Plan for ZeroError Tracker

D.1.1 Objective

To evaluate the user experience of the ZeroError Tracker, focusing on engagement, usability, and the effectiveness of gamification elements in encouraging error reporting and resolution activities.

D.1.2 Participants

- Users currently working in a corporate setting, who have some level of experience with corporate dashboards
- A mix of users low, medium and high interest in games to assess the appeal and effectiveness of gamification across different user groups

D.1.3 Data collection and privacy disclosure

For information regarding the data collection methods and privacy disclosures provided to participants during the user testing phase, please refer to Appendix A. This appendix includes the same procedures that were applied to the interview participants.

D.1.4 Tasks for Users

D.1.4.1 Task 1: Log In and Explore the Main Dashboard

- **Objective:** To assess initial impressions and understandability of the main dashboards layout and presented metrics.
- **Actions:** Log in to the ZeroError Tracker and explore the main dashboard screen. Participants are asked to verbally describe their first impressions and what information they can gather from the dashboard.

D.1.4.2 Task 2: Report an Error

- **Objective:** To evaluate the usability of the error reporting feature and the intuitiveness of the points system.
- **Actions:** Navigate to the "Add new error" screen, report a new error by filling in the required fields, and submit. Note the notification appearing after submission.

D.1.4.3 Task 3: Use the Error Detail Screen

- **Objective:** To assess the functionality and user experience of searching and viewing detailed error information.
- **Actions:** Use the search functionality on the Error detail screen to find a specific error. View details and note if the points to earn are clearly indicated.

D.1.4.4 Task 4: Interact with Gamification Features

- **Objective:** To measure engagement with the gamification elements (points, achievements, leaderboard).
- **Actions:** View the leaderboard, check the user profile for points earned and badges/achievements.

D.1.5 Questions for Users

D.1.5.1 Usability and Interface

- How easy was it to navigate through the different screens of the ZeroError Tracker?
- Were you able to easily understand the information presented on the main dashboard?

D.1.5.2 Engagement and Gamification

- Did the points system motivate you to report or resolve errors? Why or why not?
- How do you feel about the leaderboard and achievements? Did they add to your engagement with the app?

D.1.5.3 Effectiveness

- Do you think the ZeroError Tracker would help improve error reporting and resolution activities in your workplace?
- Was the information provided on the Error detail screen sufficient for understanding and acting upon errors?

D.1.5.4 Suggestions for Improvement

- What features or functionalities would you add to or change about the ZeroError Tracker to enhance your experience?

D.1.5.5 Overall Satisfaction

- Overall, how satisfied are you with the ZeroError Tracker based on this testing session?
- Would you recommend any changes to make the prototype more user-friendly or engaging?

This user testing plan aims to collect detailed feedback on the ZeroError Trackers design, usability, and the effectiveness of its gamification elements, guiding further improvements to enhance user experience and engagement.