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MASTER'S THESIS

**USER-CENTERED APPROACHES TO BUSINESS INTELLIGENCE
AND ANALYTICS SYSTEM DEVELOPMENT**

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AUTHORSHIP STATEMENT

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LIST OF ABBREVIATIONS

sl. – Slovene

3NF – (sl. Tretja normalna forma) Third Normal Form

AI – (sl. Umetna inteligenca) Artificial Intelligence

BI – (sl. Poslovna inteligenca) Business Intelligence

BI&A – (sl. Poslovna inteligenca in analitika) Business Intelligence and Analytics

CIF – (sl. Korporativna informacijska tovarna) Corporate Information Factory

CRM – (sl. Management odnosov z odjemalci) Customer Relationship Management

EDW – (sl. Centralno podatkovno skladišče) Enterprise Data Warehouse

ERP – (sl. Celovita programska rešitev) Enterprise Resource Planning

ETL – (sl. Pridobivanje, preoblikovanje, nalaganje) Extract, Transform, Load

HCL – (sl. Interakcija človek-računalnik) Human-Computer Interaction

IT – (sl. Informacijska tehnologija) Information Technology

1 INTRODUCTION

Due to the ever-growing amounts of data in the last few years, new and improved technologies have to be created in order to serve the needs of the growing base of users as well. As access to the internet, 67.5% of the worldwide population (Petrosyan, Nov. 2024) is still increasing, a more diverse user base needs to be considered when creating the appropriate technologies. Hence, user-centered approaches need to be in the forefront of the development process in order to make sure to satisfy the varying needs of users. These approaches can be applied to the development lifecycle of new systems to improve efficiency and effectiveness of the system.

Bernard Marr wrote in Forbes: “Over the last two years alone 90 percent of the data in the world was generated” (2018). This acceleration of data creation is due to the growth of Internet of Things (IoT) and big data. Consequently, any person who is in contact with data for their job is encountered with data overload. This means that people need to spend a lot more time trying to differentiate and choose what is relevant and irrelevant data for the specific task, especially decision-makers who depend on information (Ackoff, 1967).

This challenge calls for the need of business-intelligent systems, also known as Business Intelligence and Analytics (BI&A) systems, which are useful for gathering, processing, and analyzing data. Integrating user-centered approaches into the development of BI&A systems ensures these tools are intuitive, accessible, and capable of meeting the diverse needs of their users, enhancing their overall effectiveness and adoption.

Despite the need for user-centered approaches in BI&A system development, there is a serious gap in practical research and scientific literature currently present on the topic. There is extensive research on both topics, but only individually. It is easy to find scientific literature on different user-centered approaches and on BI&A system development methodologies. On the other hand, when these two are combined, one can see a lack in literature where the two topics intersect. Studies on BI&A adoption highlight the importance of user acceptance and involvement in successful implementation, yet do not fully explore structured methodologies for integrating user-centered design principles (Bano & Zowghi, 2015). This thesis aims to bridge this gap by further exploring how user-centered approaches can be applied to improve BI&A system development, enhancing system usability, adoption, and efficiency.

The purpose of this thesis is to create a BI&A development lifecycle that can be integrated with user-centered approaches and refine it through interviews. This involves the application of user-centered approaches in order to reach the purpose. Therefore, this thesis is very significant in today’s environment of increased importance and power of the users. This master’s thesis is putting forth benefits to any company willing to introduce a new BI&A system or improve their current one, with the main focus being the user.

There are several goals in order to reach the purpose of this thesis. The first goal is to analyze the BI&A system development activities more in depth so as to have a better understanding of what each step of the process means and find the most appropriate one where user-centered approaches can be implemented rationally. The second goal is to present and describe three different user-centered approaches that have potential to improve the system development process. And for the third goal, in order to verify my proposed solution for advancement of the process, I have conducted three interviews with experts in the BI&A system development field and gathered their input on the need for user-centered approaches in BI&A system development steps. After the analysis of their professional opinions, the final findings are extracted.

Research questions:

Question 1: Can user-centered approaches be used to improve effectiveness of Business Intelligence and Analytics system development?

Question 2: Which development activity will be most affected by the usage of user-centered approaches within the development lifecycle?

For the purpose of this master's thesis, a design science research methodology is used in order to verify the proposed scientific contributions, initially created by Simon Herbert in his 1969 book called *The Sciences of the Artificial*. This kind of methodology focuses on qualitative research so as to deliver more descriptive results. It is mainly used in Informatics and Computer Sciences for the analysis of the design process of a certain artifact, where the expected contributions come from the improvement of the design processes. The design science research methodology emphasizes the importance of building and evaluating the proposed artifacts several times in order to achieve the most relevant results.

This thesis starts with an introduction, followed by a literature review. In the second chapter, three methodologies to BI&A development are explained in more detail, as well as the BI&A development lifecycle which presents the core of the research for this thesis. And the third chapter includes explanations of three of the most popular user-centered approaches. In chapter 4, I explain the research methodology and give more context about the interviews and how they were executed. Chapter 5 represents the initial artifact where user-centered approaches are added to the BI&A development. Furthermore, chapter 6 is a thorough explanation of the results and findings of the interviews. And chapter 7 describes the concluding artifact, considering the feedback from the interviews, and contains a discussion section. And lastly, the paper closes with the conclusion.

2 BUSINESS INTELLIGENCE & ANALYTICS SYSTEMS

Business Intelligence and Analytics (BI&A) systems have become indispensable tools for organizations in today's data-driven world. As businesses generate and collect vast amounts of data, BI&A systems enable the transformation of raw data into actionable insights, driving

informed decision-making and strategic planning. These systems not only help organizations remain competitive by identifying trends and opportunities, but also improve operational efficiency through data visualization, predictive analytics, and real-time reporting. In a rapidly changing market environment, the adoption of BI&A systems is no longer a luxury, but a necessity for sustainable growth and innovation.

2.1 Definition of BI&A System

BI&A systems are able to extract relevant data and convert it into actionable information that is useful for the particular purpose at hand. Business Intelligence and Analytics can be characterized as encompassing methods, principles, technologies, practices, etc. employed to analyze vital business data (Côte-Real et al., 2014).

Business Intelligent (BI) systems are used interchangeably with BI&A systems in this thesis paper. A lot of the literature that I researched also used both versions while talking about the same thing. Therefore, I believe that it is a fair assumption to make that both terms can be used for the exact same thing.

Through the usage of BI&A systems, enterprises gain a deeper comprehension of their business and market, and decision-makers reduce the time needed to define the necessary data. In addition, BI&A empowers decision-makers to focus on the actual decision-making process while receiving support through better data understanding. Hence, steering to more data-led and thorough decisions being made that can help companies gain a competitive edge. Studies indicate that decision-making guided by data demonstrates higher decision quality compared to decisions based on intuition (Kowalczyk & Buxmann, 2015).

Nevertheless, BI&A systems require a large initial investment, both in time and money, because it is a big change in the current status quo. Implementing BI&A systems brings with it a set of challenges and obstacles that every organization must be aware of before taking on this endeavor, as these are critical for the future success of such an implementation.

Taking on a project of implementing a BI&A system includes a shift in mindset and way of working; it requires an organizational and cultural change. To unlock the advantages offered by BI&A and generate value, organizations require their employees to embrace and adeptly utilize these technological capabilities (Sharma et al., 2014). Therefore, this process can be seen as part of a change management undertaking, since it is imperative to manage people and their expectations carefully when it comes to implementing new technology. Effective change management steps, including communication, training, and fostering a culture of adaptability, are crucial to ensuring a smooth transition and maximizing the benefits of the new BI&A system within the organization (Shaik, 2020).

Additionally, the lack of a direct impact of perception of improved performance in correlation with the usage intention of the new BI&A system may be attributed to the

inherent difficulty of distinguishing the indirect benefits of BI&A use from the effects of other factors (Jaklič et al., 2018). This can pose an obstacle if employees do not see any, or enough, benefits in their performance through the usage of the new BI&A system, which leads to employees' decreased motivation to adopt the new system. However, the reality is that BI&A does have a positive impact on performance through the generation of valuable information and knowledge for decision-making (Hedgebeth, 2007), once it is accepted and adopted in everyday tasks of employees. The issue is that it is hard to differentiate its return on investment from other possible factors. Additionally, the positive results might not be immediately visible, which can lead to the wrong impression as though there are no benefits. This is exactly why change management is coupled with the implementation of new technology, in order to keep employees informed on the expectations of the future advantages and benefits of the change.

Another obstacle is the readiness and willingness of employees to change and adapt to the new technology. Due to this, it is really important to understand what factors affect the employees' and users' willingness to adopt and use the new technological system, as this knowledge can inform effective change management strategies. Jaklič et al. (2018) have shown that factors such as result demonstrability (the clarity of the system's benefits) and social influence (the impact of peers and organizational norms) significantly shape users' intentions to utilize a BI&A system. By identifying and addressing these factors, organizations can better manage the change process and enhance user acceptance.

In light of this discovery, it can be seen that motivation for usage does not come only intrinsically within the person who is utilizing the system. Instead, it is more important that employees are able to see a positive impact on their results. As previously indicated, where there is a perception that an individual's performance is not directly influenced by this transformation, it is necessary to analyze this factor at the organizational level. Business Intelligence systems, as Hedgebeth (2007) explains, empower organizations to align data with strategic goals and enhance the visibility of results at an enterprise level. Therefore, if the implementation of BI&A supports the better display of results of an organization, instead of focusing solely on the individual level, employees are more inclined to embrace the change.

Furthermore, the study underscores the pivotal role of social influence in shaping employees' intentions to adopt the new system (Jaklič et al., 2018). The active support of management and stakeholders is essential for fostering greater willingness among employees to integrate this novel approach into their daily routines and tasks. Equally crucial is the need for managers and influential figures to set an example during this transitional period, ensuring a seamless shift in practices.

Having said all of the above, it is evident that BI&A systems are quite complex to implement. There has been a plethora of research and discussions on this topic, as BI&A is becoming a widely used and necessary technology. The basis for developing a BI&A system is data

itself, meaning it all starts with data and builds up from there in order to create the system. The way the data is stored and processed is of huge importance, and it also varies based on the different needs of the users for the systems. Ranjan (2009) points out that one of the key success factors for a BI&A system includes aggregating data from the different operational systems into one centralized data warehouse in order to optimize decision-making. Different data modeling methodologies have been developed to achieve this, each offering distinct approaches to data integration, storage, and processing, depending on organizational goals and technical requirements.

2.2 Methodologies to BI&A System Development

When developing a BI&A system, it is crucial to consider different profiles of users expected to interact with it. This necessity leads to various approaches to designing and implementing such systems, each with distinct methodologies for structuring data and integrating it into the BI&A ecosystem. A methodology defines the structured framework and set of principles guiding the design, development, and implementation of a BI&A system, ensuring that data is efficiently organized, maintained, and utilized to meet business objectives. The connection between data modeling methodologies, warehousing processes, and the actual BI&A system is fundamental, as the methodology chosen influences how data is stored, accessed, and analyzed. The methodologies discussed in the following chapters are primarily centered on data architecture, ultimately shaping the BI&A system itself.

Based on my research, among the most commonly used methodologies are Inmon's Corporate Information Factory (CIF) Model, Kimball's Lifecycle Approach, and Linstedt's Data Vault Model. These three data modeling methodologies represent different approaches: Inmon's top-down approach, which prioritizes enterprise-wide consistency and centralized data warehousing; Kimball's bottom-up approach, which focuses on rapid business value through incremental data marts; and Linstedt's hybrid approach, which integrates flexibility, scalability, and historical tracking. These methodologies were developed in an era when system design was more deterministic, often placing less emphasis on user-centric considerations (Venter & Goede, 2015). Each of the aforementioned methodologies and approaches are explored in more detail in Chapter 2.2 and its subchapters.

Table 1 provides a structured comparison of the three BI data models mentioned above - highlighting their key characteristics, advantages, and trade-offs. It serves as a concise reference to help organizations determine the most suitable methodology based on factors such as approach, implementation speed, scalability, flexibility, and adaptability. This thesis paper focuses on how the various approaches affect the development of the BI system.

Table 1: Comparison of different aspects of BI&A development methodologies

Aspect	Inmon's Corporate Information Factory (CIF)	Kimball's Lifecycle Approach	Linstedt's Data Vault Model
Development Approach	Top-down	Bottom-up	Hybrid
Speed of Implementation	Slow (Requires upfront design & data consolidation)	Fast (Focuses on quick wins for business units)	Moderate (Adapts to needs, scalable for growth)
Scalability	High, but requires careful planning upfront	Moderate, can be challenging when integrating marts	Very High, designed for large & evolving data
Flexibility & Adaptability	Low (Rigid due to predefined enterprise-wide structure)	High (Can adapt to changing business needs)	Very High (Handles frequent schema changes easily)
User Involvement	Low during development (Users involved after deployment)	High (Business users engaged in early phases)	Moderate-High (Designed to integrate ongoing feedback)
Best for...	Large enterprises with long-term strategic BI goals	Mid-sized businesses or projects needing quick results	Companies with large and evolving datasets
Challenges	High upfront costs, complex to maintain, requires long-term commitment	Risk of data silos, possible integration challenges later	Complex modeling, requires skilled developers

Source: own work

Each of these traditional BI development methodologies has its strengths and considerations. The choice between them often depends on factors such as the organization's specific needs and goals, the complexity of the business environment, and the desired level of data centralization or decentralization, with research highlighting that the success of a BI&A system is heavily influenced by how well it aligns with the organization's strategic goals and

addresses business complexities (Watson, 2009). The ultimate objective is to create a robust BI&A system that supports informed decision-making and enhances organizational performance.

2.2.1 Inmon's Corporate Information Factory (CIF) Model

One of the earliest and most renowned methodologies to data modeling and BI system development is Inmon's Corporate Information Factory (CIF) conceived in the 1990s. This methodology consists of a data architecture framework designed to provide an integrated and standardized approach to managing an organization's information assets (Inmon, 1998). Developed by Bill Inmon, a prominent figure in the field of data warehousing and often regarded as the "father of data warehousing", CIF emerged in response to the growing complexity and heterogeneity of corporate data environments.

The Corporate Information Factory model aims to establish a centralized repository of data for the entire company called the Enterprise Data Warehouse (EDW), that could serve as a single source of truth for decision-making processes (George & Jeyakumar, 2019). This methodology uses a top-down approach to develop a BI&A system which makes it a highly structured process. Inmon's motivation stemmed from the need for businesses to efficiently leverage their data assets to gain competitive advantage and drive strategic initiatives. Consequently, centralizing all data within a unified data warehouse enables an organization to attain scalability, security and readiness for unpredictable and changing future demands (Koutsoukis & Mitra, 2003).

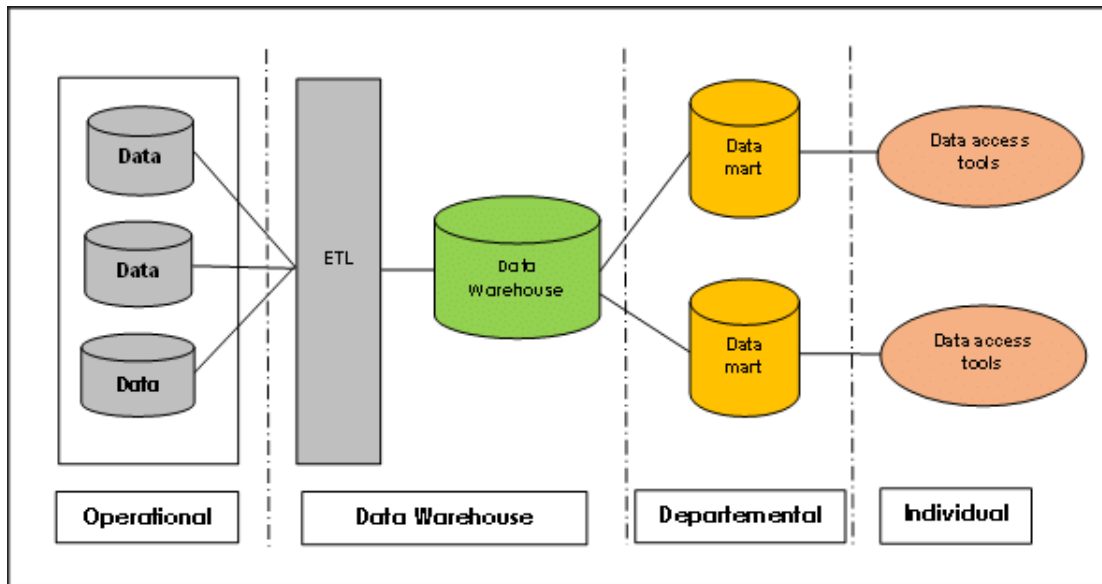
At the core of the CIF are several key principles, including the separation of operational and informational data, the use of a data warehouse as the central component for analytical purposes, and the establishment of standardized data integration processes. The architecture consists of various components such as operational data stores, data warehouses, data marts, and metadata repositories, each serving specific functions within the overall framework.

Figure 1 shows a visual representation of Inmon's model (ResearchGate, 2024). The CIF model follows a sequential, waterfall-like process that ensures robust data integration and standardization. The first step involves data acquisition and integration, where raw data from disparate operational systems is consolidated into a staging area for cleaning and transformation. ETL (Extract, Transform, Load) processes are employed to standardize data formats, eliminate inconsistencies, and ensure alignment with enterprise-wide data definitions (Koutsoukis & Mitra, 2003).

Following this, data warehousing is implemented using Third Normal Form (3NF) modeling, which prioritizes minimizing redundancy and maintaining data integrity (Ling et al., 1981). By structuring data in 3NF, CIF ensures a highly normalized environment that supports transactional consistency and historical tracking, making it well-suited for large-scale enterprise analytics. After the EDW is fully developed, data marts are created to serve

specific business functions, drawing from the EDW and maintaining consistency across different analytical outputs (George & Jeyakumar, 2019).

Figure 1: Inmon's Data Warehouse Architecture



Source: ResearchGate (2024)

However, this top-down approach also impacts the system's flexibility. While CIF offers high scalability due to its structured and standardized approach, enabling organizations to manage vast amounts of data efficiently, it lacks flexibility which is highlighted in Table 1: Comparison of different aspects of BI&A development methodologies. The rigid, waterfall-like development process demands extensive upfront planning and investment, making it difficult to accommodate rapid changes in business needs or incorporate new data sources without significant redesign efforts.

During the final step, once the data marts are established, business intelligence tools and reporting applications interact with the warehouse to generate insights for decision-making, relying on the integrity and consistency of the EDW for accurate and reliable reporting.

Overall, Inmon's Corporate Information Factory offers a comprehensive blueprint for organizations to effectively manage their data assets and derive actionable insights to drive business success. By structuring data in a centralized and methodical manner, CIF enhances long-term scalability, allowing organizations to accommodate growing data volumes and evolving analytical requirements without major architectural overhaul. Through its emphasis on integration, standardization, and accessibility, CIF continues to be a foundational framework in the realm of data architecture and management.

Nonetheless, George and Jeyakuma (2019) acknowledge that the CIF methodology can be resource-intensive, requiring significant upfront planning, investment, and technical expertise. This methodology involves developing a comprehensive Enterprise Data

Warehouse (EDW) before any usable outputs like reports or dashboards are delivered, which can result in long implementation timelines and delayed value realization for the organization. On top of this, user involvement is minimal in this first step, which is also the longest phase.

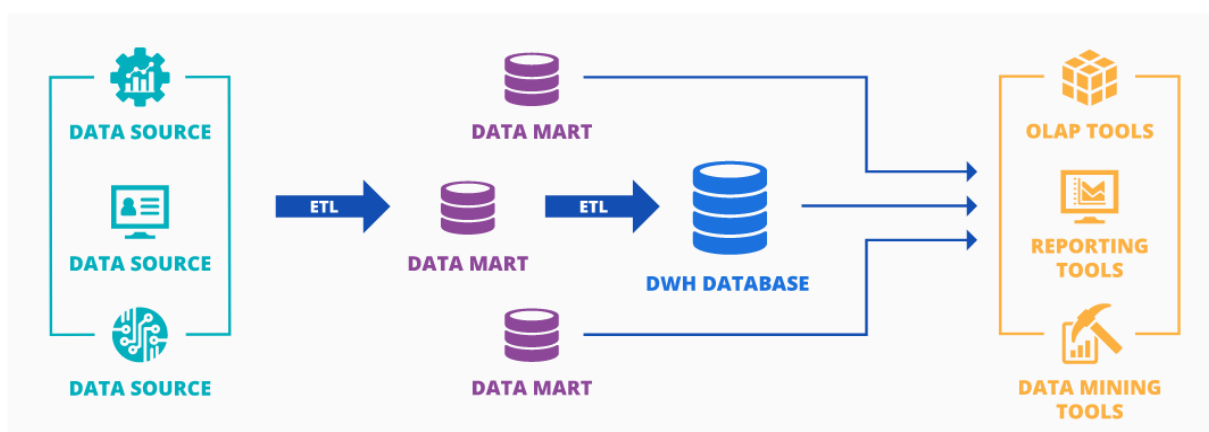
Furthermore, the high initial cost of infrastructure, design, and data integration can pose a challenge for smaller organizations or those with limited budgets (George & Jeyakumar, 2019). The complexity of ensuring enterprise-wide data consistency also increases the likelihood of implementation risks, such as scope creep or misalignment with evolving business needs during the lengthy development phase. These challenges stem from the top-down approach inherent in the CIF methodology, where each phase must be completed sequentially before moving on to the next. This rigid structure limits flexibility and makes it difficult to incorporate evolving business requirements mid-process, leading to prolonged development cycles and potential misalignment with rapidly changing organizational needs.

2.2.2 The Kimball Lifecycle Approach

The second most popular methodology to data modeling and warehousing is the Kimball Lifecycle Approach. It was developed in the 1990s by Ralph Kimball and presented in the book *The Data Warehouse Lifecycle Toolkit: Expert Methods for Designing, Developing, and Deploying Data Warehouses* (Kimball et al., 1998). The book describes the Kimball Lifecycle methodology which is focused on the technical aspects of data modeling and developing a data warehouse. The need for this came from the increased amounts of data being generated by businesses and the demand for analytical insights to inform decision-making. The creation of data repositories with Kimball's Lifecycle methodology to data modeling is structured around a bottom-up approach that emphasizes user needs, business objectives, and rapid deployment to ensure tangible business value early in the development process (Kimball et al., 1998).

A notable difference between the Kimball Lifecycle methodology compared to the Corporate Information Factory by Inmon is the approach employed in developing the data warehouse. CIF uses a top-down approach, while Kimball focuses on the bottom-up approach where it delivers business value incrementally. In the CIF model data marts are created from the Enterprise Data Warehouse. Whereas the Kimball Lifecycle methodology begins with the specific data marts, catering to specific business functions, and later forms the data warehouse as displayed in Figure 2 (Obsidian, 2024). The bottom-up approach allows for a more agile and business-driven implementation, enabling organizations to respond dynamically to evolving analytical needs.

Figure 2: Kimball's Methodology to Building a Data Warehouse



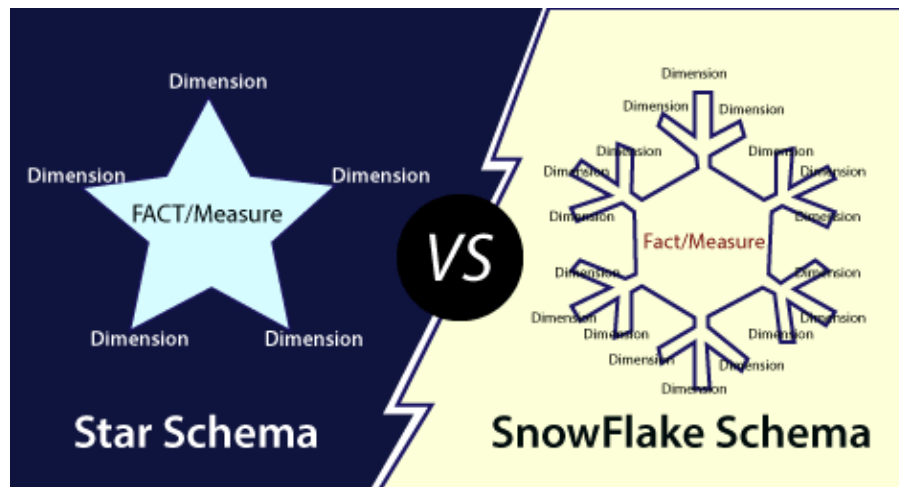
Source: Obsidian (2024)

The Kimball Lifecycle methodology begins with a thorough process of gathering and understanding the business requirements. This involves engaging with stakeholders from various departments and levels of the organization to identify the key business objectives, data needs, and reporting requirements (George & Jeyakumar, 2019). By collaborating with stakeholders, the project team can ensure that the data warehouse and BI solutions are designed to address the specific needs and challenges of the organization.

The second step in this process is the modeling step. Dimensional modeling is a foundational aspect of Kimball's methodology, essential for designing an effective data warehouse schema. This methodology involves structuring the data warehouse using star or snowflake schemas, which consist of fact tables containing measurable data and dimension tables containing descriptive attributes. For instance, in a retail environment, the fact table may contain sales transaction data, while dimension tables may include product, customer, and time dimensions. Dimensional modeling simplifies data retrieval and analysis, making it easier for users to derive insights from the data. Unlike Inmon's centralized data warehouse, which enforces strict normalization (3NF) to maintain data consistency, Kimball's dimensional modelling prioritizes usability and query efficiency by structuring data in a way that is easily accessible to business users. This makes the bottom-up approach particularly effective for reporting and analytics-driven organizations.

In Figure 3, the left is a star schema where fact tables are at the center, directly connected to dimension tables, forming a star-like structure. In contrast, to the right of the star schema is the snowflake schema which normalizes dimension tables into multiple levels, creating a hierarchical structure (Javatpoint, 2024). Both these schemas can be used in Kimball's methodology.

Figure 3: Kimball's approach: star vs. snowflake schema in data warehouse data modeling



Source: Javatpoint (2024)

When deciding whether to use a star or snowflake schema in this approach, several factors should be considered. Star schemas are often favored for their simplicity and ease of use, as they feature a centralized fact table directly connected to dimension tables in a star-like structure. This design simplifies query performance and navigation, making it suitable for scenarios where fast query response times are essential, such as in operational reporting or ad-hoc analysis (Golfarelli & Rizzi, 2009).

On the other hand, snowflake schemas offer better data integrity and storage efficiency by normalizing dimension tables into multiple levels, reducing redundancy and improving maintainability (Ponniah, 2010). Snowflake schemas are typically preferred in complex data models with hierarchical relationships between dimensions or when data needs to be shared across multiple fact tables. Ultimately, the choice between star and snowflake schemas depends on the specific requirements of the BI&A solution, including the complexity of the data model, performance considerations, and the preferences of end-users.

Once the modeling part is concluded, it is time to start working with the data. Data staging is a very crucial step, arguably the most important step involving the extraction, transformation, and loading (ETL) of data from source systems into the data warehouse. Similarly to Inmon's approach, during this process, data is cleansed, transformed, and standardized to ensure consistency and accuracy for analysis. For example, data from multiple software systems such as CRM (Customer Relationship Management), ERP (Enterprise Resource Planning), and sales systems may be extracted, transformed into a common format, and loaded into the data warehouse. Data staging lays the foundation for reliable and comprehensive reporting and analysis in the BI&A solution (Salim et al., 2020).

In the next step, after deploying the data warehouse, BI&A applications and reporting tools are developed based on the dimensional model established in the second phase of the

process. These applications enable users to access, analyze, and visualize the data stored in the data warehouse (Salim et al., 2020). For instance, dashboards, reports, and ad-hoc query tools may be developed to provide users with insights into key business metrics and trends. The BI&A applications are designed to be intuitive and user-friendly, allowing users to interact with the data effectively to support decision-making.

Once the BI&A tools are developed and deployed to end-users, the last step includes a maintenance process in order to keep the data and tools current and relevant. Adequate funding for dedicated maintenance resources must be ensured beyond the initial construction phase to sustain the warehouse effectively. These maintenance activities are essential for realizing a return on the initial investment and ensuring adaptability to arising business requirements. Hence, management commitment from the beginning of the BI&A undertaking is crucial for long-term sustainability, necessitating clear communication of these needs to stakeholders.

A distinguishing characteristic of Kimball's methodology is its high level of user involvement throughout the project lifecycle which is noted down in Table 1. Since data marts are designed incrementally, business users are continuously engaged in validating models, testing queries, and refining reporting capabilities. This participatory methodology fosters better alignment between IT and business needs, enhancing user adoption and satisfaction (George & Jeyakumar, 2019).

Additionally, the bottom-up approach enables faster implementation compared to Inmon's CIF. Organizations can deploy data marts incrementally, delivering usable insights much earlier in the project cycle. This contrasts with CIF's lengthy initial development phase, where the Enterprise Data Warehouse must be fully built before providing analytical outputs.

Furthermore, Kimball's methodology provides greater flexibility compared to the rigid structure of CIF. The iterative nature of development allows organizations to adapt the warehouse design as new business needs emerge, incorporating new data sources and adjusting schemas without requiring a full-scale redesign. However, scalability can be a challenge, particularly when multiple decentralized data marts need to be integrated into a cohesive enterprise-wide system. Without careful planning, the methodology risks creating data silos and inconsistencies, making enterprise-wide data governance more complex.

Despite its advantages, the Kimball Lifecycle Approach faces several challenges and criticisms which can be found in Table 1: Comparison of different aspects of BI&A development methodologies. One primary concern is the potential for high initial complexity and effort, particularly during the dimensional modeling phase. While the methodology's emphasis on star and snowflake schemas simplifies reporting and querying for end-users, the design process can become cumbersome when dealing with intricate and shifting business requirements or diverse data sources (Golfarelli & Rizzi, 2009). Additionally, the iterative nature of Kimball's methodology may result in fragmented or inconsistent data

marts if not carefully managed. This fragmentation can pose challenges to achieving an enterprise-wide view of data, undermining the system's effectiveness in delivering unified analytics (Salim et al., 2020).

Another notable limitation is the lack of scalability for handling modern big data requirements. As organizations increasingly deal with massive, unstructured datasets, the reliance on traditional dimensional models like star and snowflake schemas can become a limitation (Ponniah, 2010). Furthermore, the Kimball methodology assumes a relatively stable set of business requirements, which may not align with the rapid evolution of data needs in dynamic industries. This rigidity can hinder adaptability and necessitate frequent redesigns to accommodate changing business landscapes (Hedgebeth, 2007). While the methodology remains effective for small- to medium-scale data warehousing projects, these limitations highlight the need to consider alternative methodologies, such as the Data Vault Model, for more flexible and scalable solutions.

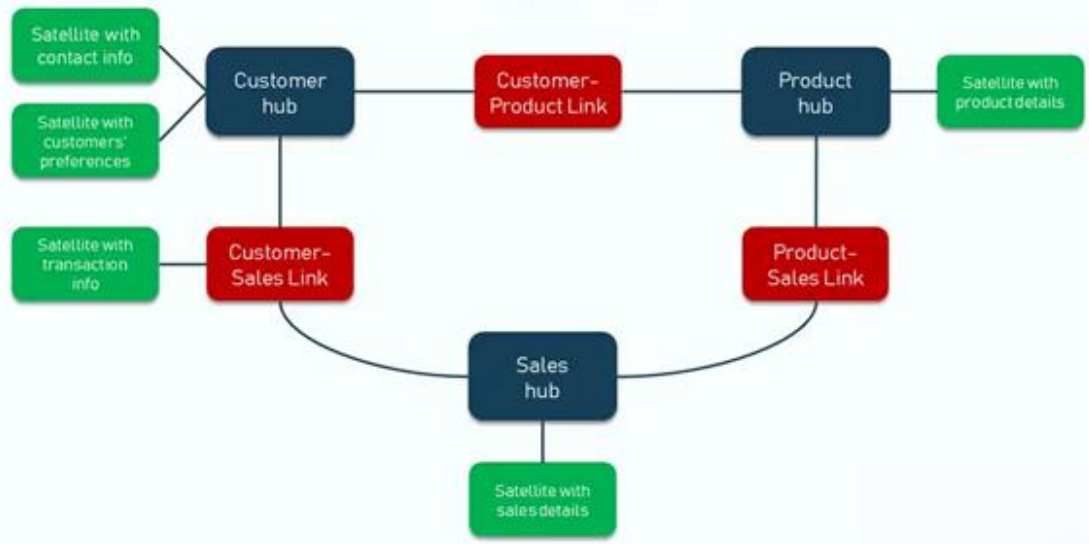
2.2.3 Linstedt's Data Vault Model

The most recent methodology which is gaining traction was developed by Dan Linstedt in the early 2000s. The Data Vault Model is a data modeling methodology designed for flexibility, scalability, and agility in data warehouse design. It is particularly well-suited for complex and rapidly changing business environments with large-scale data integration challenges. Linstedt (2001) defines the Data Vault as "a detail-oriented, historical tracking and uniquely linked set of normalized tables that support one or more functional areas of business". Linstedt's Model uses a hybrid approach to BI&A system development which was devised in response to the increasingly complex data ecosystems prevalent in businesses, providing a structured yet adaptable framework that accommodates heterogeneous data sources while ensuring flexibility, scalability, and auditability. Unlike traditional data warehouse models that prioritize either centralization or business-driven design, the Data Vault Model balances these aspects, enabling organizations to integrate new data sources with minimal reengineering while preserving historical data integrity.

The Data Vault Model introduces a unique architectural model built upon three primary components: Hubs, Links, and Satellites. Hubs serve as the foundational entities representing business concepts or entities, such as customers, products, or transactions. These hubs encapsulate raw, unaltered data related to each business concept, ensuring the integrity of business keys (Yessad & Labiod, 2016). Links establish connections between hubs, capturing relationships and associations between different business entities. This intermediary layer provides a clearer understanding of the data landscape by structuring complex relationships, which supports scalability and adaptability in data environments (Graziano, 2012). Satellites augment hubs and links with descriptive attributes, timestamps, and other metadata. By storing historical data and contextual details, satellites enrich the

model with comprehensive insights, enabling organizations to maintain auditability and adapt to evolving business requirements (Yessad & Labiod, 2016).

Figure 4: Data Vault Model



Source: Altexsoft (2024)

Figure 4 shows a visual representation of the synergy between these components that form the backbone of the Data Vault Model (Altexsoft, 2024). Hubs (dark navy-blue color) encapsulate raw data at its most granular level, preserving its integrity and ensuring minimal transformation. Links (red color) establish relationships between hubs, facilitating the representation of complex interdependencies within the data. Satellites (green color) complement hubs and links by enriching them with contextual information, historical data, and metadata. Having such a modular differentiation between the different kinds of data available within an organization makes this model more receptive to changes, thereby enhancing the model's analytical capabilities and potential for scalability.

The general steps of the process of developing a data warehouse with a Data Vault Model are very similar to the Kimball Lifecycle approach process. However, there are some crucial differences in the implementation that are worth mentioning. Both similarities and differences are explained in further details in the following paragraphs below.

Like in the Kimball Lifecycle methodology, the Data Vault Model begins with an in-depth analysis of business requirements. This phase involves identifying key business objectives, data sources, and user needs. During this phase, businesses define the core entities (Hubs), their relationships (Links), and the descriptive attributes (Satellites) that form the Data Vault's structure (Gribova, 2022). This first step ensures the model aligns with organizational goals and supports seamless data integration.

The second step - modeling and design - translates the identified requirements into the Data Vault schema. Logically, this step is the one that differentiates Linstedt's model from the other mentioned methodologies. The modular nature of this design facilitates the incremental addition of new data sources without requiring significant restructuring, making the model highly adaptable to evolving business needs (Giebler et al., 2019).

The next step involves extracting data from various operational systems, transforming it into a format compatible with the Data Vault structure, and loading it into the respective Hubs, Links, and Satellites. This methodology's ETL process is distinct from traditional methodologies because it prioritizes data integrity and historical tracking, ensuring that raw, unaltered data remains available for future analysis and auditing (Linstedt & Olschimke, 2016). This phase is necessary for all data warehouses because it is a phase of processing and loading data. The only difference is in the way it is done, based on the data model used for the data warehouse.

The final step involves deploying the Data Vault Model and continuously optimizing its performance. This step involves users and applications interacting with the warehouse to derive insights and make informed decisions. Thus, monitoring and addressing changes in data requirements or business objectives due to these direct interactions. Since this methodology inherently supports auditability and scalability, ongoing maintenance ensures that data structures remain aligned with changing business needs and it remains relevant and effective (Hultgren, 2012).

Some defining features of the hybrid approach used to create a Data Vault Model are emphasized in Table 1 and these are its exceptional flexibility and scalability. The separation of business keys, relationships, and descriptive attributes allows organizations to adapt their data architecture incrementally without disrupting existing systems. Additionally, its schema evolution model makes it particularly effective for handling frequent changes in business requirements with minimal reconfiguration, ensuring longevity and relevance in an ever-evolving data landscape. Scalability is another key advantage, as the model efficiently supports high volumes of data without performance degradation. These two characteristics make it highly suitable for industries dealing with high volumes of expanding datasets or those operating in dynamic industries such as finance, healthcare, and e-commerce.

The Data Vault Model enables faster speed of implementation compared to traditional data warehousing methodologies used by Inmon and Kimball, particularly due to its modular design. Organizations can implement and expand their Data Vault incrementally, ensuring that business users receive value quickly. However, the model's technical complexity may slow down initial implementation phases as it requires specialized expertise. User involvement in the Data Vault Model is generally lower compared to Kimball's methodology, as its structure is more abstract and technical. While business users contribute significantly during the initial requirement gathering and validation steps, much of the modeling and structuring is handled by data architects and engineers.

Despite its many advantages, the Data Vault Model presents some notable challenges. One significant issue is the increased complexity in data retrieval. The model's architecture, which involves multiple layers of hubs, links, and satellites, often requires complex joins to reconstruct business information. This complexity can impact query performance and necessitate optimization techniques for efficient data retrieval (Van Deek, 2025).

Another challenge is the proliferation of tables. This methodology frequently results in a larger number of tables compared to traditional data warehouse designs, increasing maintenance efforts and storage requirements. Moreover, due to its modular nature, the Data Vault Model requires more sophisticated ETL processes and governance strategies to ensure consistency across the entire data warehouse. Without proper oversight, organizations may face data quality issues or difficulties in maintaining data lineage. Hence, given its intricate structure, it demands specialized training and expertise, potentially posing challenges for organizations with limited technical resources (Morris, 2020).

2.3 Steps of the BI&A System Development Lifecycle

In order to find an appropriate fit between user-centered approaches and BI&A system development, one must comprehensively analyze the BI&A system development cycle and each of its activities. The specific user-centered approaches used in this thesis paper are explained in the next chapter. Additionally, it is very crucial to also consider the aforementioned methodologies when thinking of ways to adapt an existing process. Hence, in this section I am defining the appropriate BI&A development steps and elaborating on the most relevant methodology for the BI&A system.

Many authors describe different, yet fairly similar, activities of BI&A system development. For example, Olszak and Ziemba (2007) defined two main stages of the development process, they are creation and consumption. I am focusing on the creation stage as it is concerned with how the system is actually developed. On the other hand, the consumption stage talks about the way the BI&A system can be used after deployment. Olszak and Ziemba (2007) define the creation stage with several activities: understanding the BI undertaking, preparing relevant data, choosing appropriate BI tools, designing and implementing BI systems, and continuous updates.

Similarly, in the book *Business intelligence roadmap: The complete project lifecycle for decision-support applications* (Moss & Atre, 2011), the authors defined six activities for the development of a BI&A system. The process begins with the justification stage where the business case is analyzed in order to understand the required responsibilities to be carried out. Then comes the planning phase. Next phase is business analysis where the main focus is on data analysis. After this, the BI&A system is being designed, and later it is actually constructed. Lastly, the new system is deployed or implemented and evaluated in the respective context.

Having in consideration the extensive literature research done as well as comparing the two examples mentioned above, I am defining the most important activities that often overlap in different sources that are needed for the development of a BI&A system as:

- understanding of the appropriate current situation (as-is analysis),
- what is the aim? - business requirements gathering (to-be analysis),
- designing and modeling the system,
- construction and testing of the system,
- deployment and
- constant evaluation and updates.

These activities should be done in a cyclical manner.

This thesis paper takes into consideration these activities/steps as the BI&A system development lifecycle, which are presented in Figure 5.

Figure 5: BI&A system development lifecycle



Source: own work, based on SDLC

To ensure that the system is both efficient and user inclusive, it is essential to adopt an approach that naturally aligns with these steps while also integrating user involvement throughout the process. Given this, I have chosen not to use Inmon's top-down and Lindstedt's hybrid approaches due to their lower user involvement. Thus, the Kimball bottom-up approach is the most suitable one for the BI&A development lifecycle of this

thesis paper, as it prioritizes incremental development, adaptability, and direct engagement with end-users during system creation.

The Kimball Lifecycle follows a bottom-up approach, meaning that instead of designing a large-scale enterprise-wide system from the start, development focuses on building smaller, business-specific data marts that are directly aligned with user needs. This methodology ensures that user feedback is continuously incorporated, reducing the risk of misalignment between the system's design and practical business requirements. Kimball's methodology is particularly valuable in BI&A system development, as it enables organizations to prioritize high-impact areas first, refine data structures based on actual use cases, and enhance system usability through iterative improvements.

By aligning the BI&A development process with the Kimball methodology, it can be seen that user involvement should be deeply embedded at multiple stages. During the as-is analysis, business users and stakeholders provide input regarding existing inefficiencies and limitations. In the to-be analysis, the bottom-up approach allows teams to define specific, user-driven business requirements rather than imposing a rigid, pre-defined structure. During the design and modeling phase, data marts are structured around business processes that users actively interact with, making the system more intuitive. Finally, during deployment and evaluation, the iterative nature of Kimball's methodology ensures that updates and refinements are based on real user feedback, leading to a more responsive and adaptive BI&A system. This methodology serves as a basis of adding specific user-centered approaches and developing the initial artifact for this research paper.

3 USER-CENTERED APPROACHES

User-centered approaches to design represent a paradigm shift in the field of design, emphasizing the pivotal role of end-users in shaping the form and functionality of products and systems. This methodological framework prioritizes a deep understanding of user needs, preferences, and behaviors throughout the design process, ensuring that the outcome aligns seamlessly with the user's expectations. By fostering an empathetic connection between designers and end-users, user-centered design not only enhances the usability and accessibility of products but also promotes a more inclusive and satisfying user experience. User-centered approaches wield a transformative impact in crafting solutions that resonate with the diverse and dynamic needs of the user base. Even though these kinds of approaches have been around for about 70 years, they are relevant and prevalent now more than ever.

3.1 Human-Centered Design

Human-centered approaches to design gained significant traction in the latter half of the 20th century. Several factors contributed to this shift in design focus. One main factor initiating this change is the growth in technological advancements and the rise of the human-computer

interaction (HCI) field. As the usage of technological devices increased and became a more common occurrence, researchers emphasized the crucial role of humans/users in this process. Some other factors which helped this shift include changing market dynamics, and a cultural shift towards customizations and individualized experiences. Collectively, they propelled the widespread adoption of human-centered approaches.

In this chapter, for the sake of clarity, I would like to stress that in the elaboration of the human-centered design, the words users and humans are used interchangeably. As the users are humans, and the humans who use the system/product are users, I believe it should be quite straightforward.

I would also like to stress that user-centered design and human-centered design share common principles but differ in scope. User-centered design focuses on understanding end-users' needs, preferences, and behaviors to create products that align with their expectations, ensuring usability and task efficiency. In contrast, human-centered design extends this framework by considering broader human factors such as emotional responses, cultural contexts, and social impacts. Emerging alongside advances in human-computer interaction (HCI), human-centered design reflects a holistic approach that views users as multifaceted individuals with diverse needs. It emphasizes a deeper, empathetic connection, aiming to create inclusive, meaningful solutions that resonate with the complexities of human experience. Therefore, human-centered design is a specific type of user-centered approach.

One important milestone in the development of such design is the work of Don Norman, who is considered the father of the human-centered approach to design. Don Norman's book *The Design of Everyday Things* published in 2013, emphasized the importance of involving the humans, in the design process by explaining the impact of design on the user's experience. His book also outlined the basic principles of a good design, where humans were at the forefront of the process. This book paved the way for further developments and advancements in this field.

Jakob Nielsen, a usability expert, also contributed to the field through his research and publications on usability engineering. His main contributions are the usability heuristics, which are general rules for evaluating the user interfaces, and usability testing approaches, which gave structure to the testing process where users test while using the software (Nielsen, 1994). This yields practical quantitative and qualitative feedback on the design.

Putting Don Norman's principles and Jakob Nielsen's usability frameworks together creates a strong foundation for design, with users becoming the main focus of the process. Emphasizing the needs of users while also providing clear guidelines for integrating them into the design process has transformed how products are developed. By combining a deeper understanding of user behavior with structured usability evaluations, these approaches have shifted design from being technology-driven to being user-focused. This change has ensured that user feedback is not just collected but becomes a critical part of designing more effective

and satisfying products. Therefore, leading to the consolidation of human-centered design as a mainstream approach in various industries, mainly in the context of software and interface design.

Since then, human-centered approaches have evolved and expanded, becoming integral to other fields not just software and product design, such as service design, architecture, medicine and other areas where understanding and meeting user needs are critical (Lin et al., 2011; Gökoğlu, 2021; Vannelli et al., 2024).

There are several well-known human-centered design tools, which are meant to help designers leverage the user's point of view and opinions in the design process. Some of the more popular ones include prototyping, interviews, focus groups, observation, and usability testing. Ghazali and Ariffin (2014) have divided the design process into three phases: analysis, design, and evaluation. For each phase, they analyzed which tools were used in the healthcare environment and concluded that interviews are most common for the first phase, prototyping for the second phase, and usability testing for the last phase.

On top of this, there is another level of differentiation of user focus within this approach. There is a distinguishable difference between the amounts of involvement of users in the design process. Based on Sanders and Stappers (2008) four levels of involvement exist, including: designers representing users, designers consulting users, users participating in design, and users as designers. Complementary to this, Wallisch et al. (2019) differentiates between three levels, and those are: consultative, representative, and consensus design. Each one of these levels of involvement are associated with a certain type of user involvement activities that help establish the design process.

In the first level according to Sanders and Stappers (2008), designers use assumptions and existing research to simulate user needs without direct input from the users. The designers consulting users correlates to the consultative design, where users are only used as a subject that is meant to be studied and understood - a source of information. In this level of involvement, I believe that the main activities would involve surveys, observations, personas and user scenarios. In the representative design model, similarly to users participating in design, one can find activities such as prototyping, usability testing, etc. This means that only a sample of the target audience, or the user base, is asked for feedback on the design of the product at a certain moment. While in the last level of both models, users are continuously involved throughout the whole process, which would involve all the aforementioned activities.

I would suggest striving for the highest level of involvement, as the information exchange between designers and users needs to be continuous and cyclical to make sure that all information is current and still relevant to the design process. This is most crucial when it is a longer process as requirements can change throughout time. In addition, while users are kept in the loop during the whole process, they will feel more connected to the end result,

which can also increase the chance of satisfaction and acceptance once the final product/service is deployed.

Despite earning a lot of credits for the creation, evolution, and implementation of these approaches, Don Norman (2005) emphasizes the need for continuous criticism of the current principles. As human-centered design is becoming generally used and accepted, discussions and criticism have died down which could make it outdated to the current real-world context. He advises not to get too comfortable within the generally accepted rules and to continue pushing the boundaries to innovate and improve the existing design rules.

In this nature, he proposed the idea of an activity-centered design approach (Norman, 2005). This means that designers focus on completely understanding the activity, and designing with a focus on it, instead of users. Usability and understanding have improved in general since the user-centered approaches have been introduced, but products are still very complex.

From the start, designers need to ensure that the underlying idea of the product and how it should be used is comprehensible. This involves understanding the tasks and activities for which the new product will be used. As Don Norman (2005) wrote, "Understand the activity and the device is understandable." This highlights the importance of activity-centered design, as a clear grasp of the intended activities helps frame the problem that the product aims to solve. Additionally, several activities may be covered by one product, reinforcing the need to focus on activities as part of the initial design phase. However, I believe this represents only the starting phase of the design process, with subsequent steps involving direct user participation.

Once designers define the activities and areas to be considered in the product, it is crucial to engage with users to ensure they understand how the product supports their tasks. This interaction verifies that the product's features align with user expectations and clarifies potential gaps in understanding. While focusing on activities is essential for establishing the product's foundation, higher-level details, such as user interfaces and interaction points, require direct user feedback. Prototyping and testing with the target audience help validate design intentions and ensure usability.

Activity-centered and human-centered design approaches should complement each other rather than function in isolation. For products with broad, global use cases, starting with a focus on activities ensures the core goals of the design are clear and widely applicable. However, user feedback remains indispensable for confirming that these goals are achieved as intended. Conversely, in niche markets, human-centered design should take precedence from the outset to tailor the product to specific user needs and expectations. Balancing these perspectives ensures designs are both practical and meaningful for diverse audiences.

If the designer focuses only on understanding and designing with the activity in the forefront, then it is up to the user to decipher how the product should be used for that activity. It could

be manageable in some situations. But it can also be frustrating and very time-consuming for users if it is not so clear or straightforward. The difference in perspectives of the product and its features arises from the difference in knowledge and experience of designers and users, and even developers. Something that is obvious to a senior designer could be perceived differently by new users who are still adapting to the technological change which is being implemented through the new product.

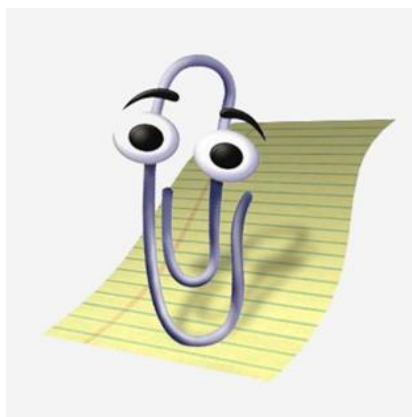
Examples of failed designs highlight the critical importance of such human-centered approaches. One such example is The Apple Newton PDA in 1993, see Figure 6. This product failed largely due to poor usability, particularly its inaccurate handwriting recognition system (Schroeder, 2017). It seems that this product was released far too early compared to market and user readiness. Similarly, Microsoft's Clippy assistant in 1997, displayed in Figure 7, is infamous for its intrusive nature, which irritated rather than assisted users (Duo Security, 2017). These examples underscore the significance of iterative design and user feedback in avoiding such failures.

Figure 6: Apple Newton PDA



Source: Museum of Failure (2024)

Figure 7: Microsoft Clippy



Source: Geekwire (2024)

Nevertheless, as Don Norman (2005) pointed out, it is not always perfect on the human-centered design side. And one should strive to think critically and look for further things that still need to be made better in order to improve the human-centered design process. There are several shortcomings when it comes to these approaches of design.

Catering to an international and diverse user base poses a formidable challenge to using human-centered design. When envisioning a product for universal use, the complexity of accommodating diverse perspectives of humans becomes apparent. This complexity arises from cultural, social, and contextual differences that influence how users perceive and interact with designs. The question that arises is: how does one consider the multitude of views and perspectives that users from various backgrounds and cultures bring to the table? The dilemma comes about from the trade-off between a broad approach that encompasses the preferences and needs of all users and the risk of diluting the focus of key user feedback by attempting to please everyone.

Finding the right balance between including everyone and being too specific is really important. If the design focuses on many diverse user groups, it might miss detailed, yet important needs of some others. On the other hand, if it concentrates on only a few types of users, it could leave out important ideas from the rest of the user base. So, the challenge is to find a middle point that recognizes different users and tries to optimize the design of the product while involving the diverse user base.

Furthermore, on top of the previous challenge, when incorporating diverse user types in prototyping and testing, a potential challenge in terms of design cohesion is introduced. Feedback that is too diverse can lead to conflicting priorities, making it harder for designers to craft a unified product vision (Hussain et al., 2012). If the feedback received by users is too diverse, it introduces complexity which may impede designers in effectively addressing the diverse wishes and demands of users, resulting in user dissatisfaction. Consequently, a new obstacle emerges: what quantity of varied user opinions and feedback is deemed necessary, and at what point does it become excessive? To mitigate potential adverse effects, maintaining clear communication and transparency with users becomes imperative.

Another challenge concerning human-centered design principles is prioritizing immediate user preferences that can pose long-term challenges for a product, accelerating its obsolescence. Overemphasis on short-term needs risks neglecting the adaptability and scalability required for future-proofing designs. As products evolve, users often uncover novel features and unexpected uses, requiring designs to remain flexible and relevant (Norman & Verganti, 2014). In order to ensure sustained relevance, it is essential to strike a balance between addressing current user needs and anticipating future developments, thereby fostering a product that evolves in tandem with user expectations and technological advancements.

Listening too closely to users can sometimes make a design unnecessarily complex. As Norman (2005) emphasizes, “Yes, listen to customers, but don’t always do what they say.” Therefore, it is essential to have a knowledgeable leader who understands the product, market trends and the specific user problems it aims to solve. Such a leader can properly evaluate user feedback, discerning which requests or complaints will truly enhance the product and knowing when to set aside suggestions that may not lead to meaningful improvements. This balance ensures that user input is effectively integrated while avoiding unnecessary complications in the design process.

3.2 Design Thinking Approach

“Individuals are encouraged to fail often to succeed sooner through trial and error: innovations do not arise from incremental tweaks” (Serrat, 2017). This quote has inspired the next user-centered approach which has this concept as the focal point of the whole process.

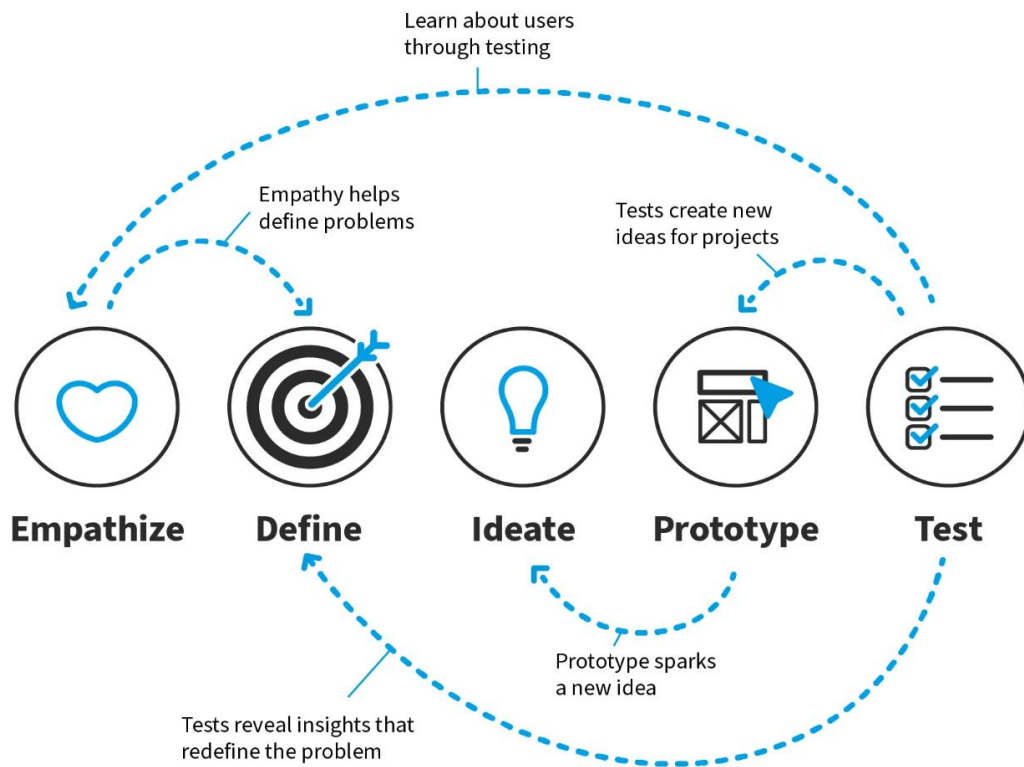
The design thinking approach to system development represents a user-centered methodology that emphasizes iterative problem-solving and a deep understanding of end-user needs. It follows structured phases: empathizing, defining the problem, ideating, prototyping, and testing. These steps are repeated as needed until the final result aligns with user expectations (Brown, 2009). Unlike the traditional waterfall process, where each step is completed sequentially, design thinking allows for flexibility. Teams can revisit earlier phases—such as redefining the problem—when new insights emerge during prototyping or testing, avoiding the inefficiencies of starting from scratch (Liedtka, 2015).

At its core, design thinking fosters collaboration and ongoing feedback from users throughout the process. This continuous involvement ensures that the solutions developed remain relevant and aligned with user needs. By leveraging user insights early and iteratively refining ideas, design thinking creates systems that are not only functional but also resonate deeply with the user experience. This approach has proven particularly effective in adapting to evolving user requirements and creating more satisfying outcomes (Carlgren et al., 2016).

Collaboration among multidisciplinary teams is another hallmark of design thinking. Encouraging diverse perspectives sparks creativity and innovation, allowing for the generation of more robust solutions. By combining iterative refinement with user-focused principles, design thinking addresses both immediate and long-term user concerns, resulting in systems that enhance effectiveness and satisfaction while remaining adaptable to future challenges (Brown, 2009; Carlgren et al., 2016).

Figure 8 is a visual representation of the design thinking approach, where the dynamic, iterative part is emphasized by drawing dotted lines from different phases to show how different parts of the process can be connected without having to follow the structure sequentially from start to end each time (Interaction Design Foundation, 2024).

Figure 8: Design Thinking: A Non-Linear Process



Source: Interaction Design Foundation (2024)

The design thinking process officially commences with empathizing, a crucial phase where designers immerse themselves in the users' world to gain profound insights into their needs, challenges, and perspectives (Interaction Design Foundation, n.d.). Through methods such as interviews, observations, and empathy maps, designers cultivate a deep understanding that forms the foundation for the subsequent stages. Another very valuable tool in this step is the creation of personas. These personas represent archetypal users, embodying their characteristics, needs, and motivations, which help to empathize with and understand the diverse user base.

Moving to the defining phase, the focus shifts to synthesizing gathered information to distill the core problem. This step involves sifting through diverse data, identifying patterns, and articulating a well-defined problem statement. It sets the stage for a targeted approach to problem-solving, ensuring that subsequent efforts are aligned with the specific challenges at hand (Bender-Salazar, 2023). During this phase, personas help distill the collected information into a clear problem statement. By referencing these personas, designers can articulate the specific challenges and requirements of different user segments. In essence, personas play a crucial role in humanizing the design process and maintaining a user-centric focus throughout various stages of design thinking (Salminen et al., 2022).

Ideation follows, unleashing a burst of creative energy to generate a variety of potential solutions. In this phase, it is important to consult diverse people, not strictly designers, in order to utilize the differences that each person brings to the table. Multidisciplinary teams engage in brainstorming sessions, sketching, and other collaborative techniques to explore diverse possibilities for the end product (Interaction Design Foundation, n.d.). The goal is to foster a fertile ground for innovation, encouraging novel concepts that can later be refined and tested. The key in this step is open-mindedness and acceptance of every idea.

The prototyping phase takes selected ideas and transforms them into tangible, visual representations. This step involves creating low-fidelity prototypes that allow for quick and iterative user testing (Interaction Design Foundation, n.d.). By materializing concepts in a tangible form as early as possible, designers gain valuable insights that inform further refinements and improvements. This step supports the quote in the beginning of the chapter, where creating low-fidelity prototypes maximizes the potential of future success through trial and error, through also utilizing the design process and user involvement.

The final step, testing, involves putting the prototypes into action and collecting real-world user feedback. This feedback loop is integral to the design thinking process, as it provides concrete insights into the effectiveness and user experience of the proposed solutions.

In the event of shortcomings in the proposed product, as revealed through the generated prototype and feedback received during testing, the design team possesses the flexibility to revisit any stage of the process. If the received feedback indicates a critical feature omission, resulting in a necessary reevaluation, the team may return to the initial stages of empathizing or redefine the problem to address any fundamental oversights. On the other hand, if user feedback confirms that the product fulfills their needs but requires refinement in interface aesthetics, the team is likely to directly revisit the ideation or prototyping stages, guided by users' feedback. This iterative cycle ensures continuous refinement and adaptation, aligning the final product with the ever-evolving needs and expectations of the end-users.

Nonetheless, like every methodology, design thinking is not without its disadvantages and criticism. One of the most common criticisms of this approach is its ambiguity and lack of structure within each stage (Carlgren et al., 2016). While design thinking is often described as a mindset or a flexible method to approach problem-solving, critics argue that this fluidity can make it difficult to replicate or measure success consistently. This lack of standardization often creates challenges when organizations attempt to implement design thinking across diverse contexts, especially within traditional structures that prioritize linear, process-driven approaches.

Another significant challenge arises from cognitive biases, such as overconfidence or anchoring, which can hinder the effectiveness of design thinking. Liedtka (2015) highlights that while iterative techniques like prototyping and feedback loops are designed to reduce these biases, their success depends heavily on how well organizations understand and use

them. Many teams face difficulties in interpreting user feedback and adapting their processes due to limited experience or time constraints. Without proper training and an environment that fosters experimentation, these biases can undermine the very user-centered outcomes that design thinking seeks to achieve.

Furthermore, scaling design thinking across larger organizations presents additional obstacles. Carlgren et al. (2016) emphasize that while small teams may benefit from the collaborative and innovative nature of design thinking, integrating its principles at an organizational level often requires substantial cultural and managerial shifts. Resistance to change and skepticism about its perceived lack of rigor can impede adoption, especially in settings that value tangible, immediate results. Despite these challenges, organizations that commit to addressing these barriers and cultivating a culture of collaboration and flexibility are more likely to harness the full potential of design thinking.

3.3 Agile Methodology - Scrum Framework

3.3.1 Agile Methodology

Agile methodology is a project management and software development approach that prioritizes flexibility, collaboration, and customer satisfaction. It emerged as a response to traditional, rigid project management methodologies that struggled to adapt to changing requirements and evolving user needs. The Agile Manifesto, published in 2001 by a group of software developers, outlines the core principles of Agile methodology, emphasizing individuals and interactions, working solutions, and customer collaboration over processes and tools (Beck et al., 2001).

The Agile Manifesto is composed of 12 principles which are the guiding rules for agile development. One of these principles that stuck out to me concerning user involvement goes like this: Welcome changing requirements, even late in development (Agile Alliance, n.d.). Agile processes harness change for the customer's competitive advantage. This is crucial as it acknowledges the dynamic nature of user needs and market conditions. Embracing changes late in the development process allows for the incorporation of valuable feedback, ensuring that the final product aligns more closely with user expectations. This flexibility empowers organizations to adapt swiftly to evolving user requirements, providing a competitive advantage by delivering solutions that are not only responsive, but also more attuned to the rapidly changing demands of the user and the market.

In the context of software development, Agile methodology breaks down complex projects into smaller, manageable iterations called sprints. These sprints typically last two to four weeks, allowing for continuous reassessment and adjustment of project goals based on user feedback. The iterative nature of Agile encourages teams to be adaptable, responding quickly to changing requirements and incorporating user input throughout the development process.

One of the key contributions of Agile methodology to the literature is its emphasis on customer collaboration and responsiveness, which has been shown to significantly impact project success (Bano & Zowghi, 2015). By involving users throughout the development cycle, Agile methodology ensures that the end product aligns closely with user expectations and needs. This user-centered approach significantly enhances the overall quality and relevance of the final product but also fosters a deeper connection between users and the development team. Agile's iterative cycles, characterized by frequent delivery of functional components, provide users with tangible results and regular opportunities for feedback. This feedback loop helps developers to refine the product continuously and address user concerns early, improving overall satisfaction and usability. Such active involvement develops trust between users, developers, and designers, enhancing communication and fostering competitive advantages in dynamic markets.

While the Agile Manifesto garnered attention from the software development community, Agile methodology did not become an immediate hit in every sphere. Initially, there was skepticism and resistance to change, as traditional waterfall models were deeply ingrained in project management practices. The transition from traditional methods to Agile required a shift in mindset, organizational culture, and project management processes.

However, organizations began to witness the benefits of its iterative and collaborative approach, primarily in the sphere of software development. The emphasis on adaptability, customer satisfaction, and continuous improvement addressed many of the shortcomings of traditional methodologies (Nerur et al., 2005). As Agile success stories emerged, more teams and organizations started adopting Agile practices also outside of the software development realm, such as marketing, product management, and even non-technical business processes (Gustavsson, 2016).

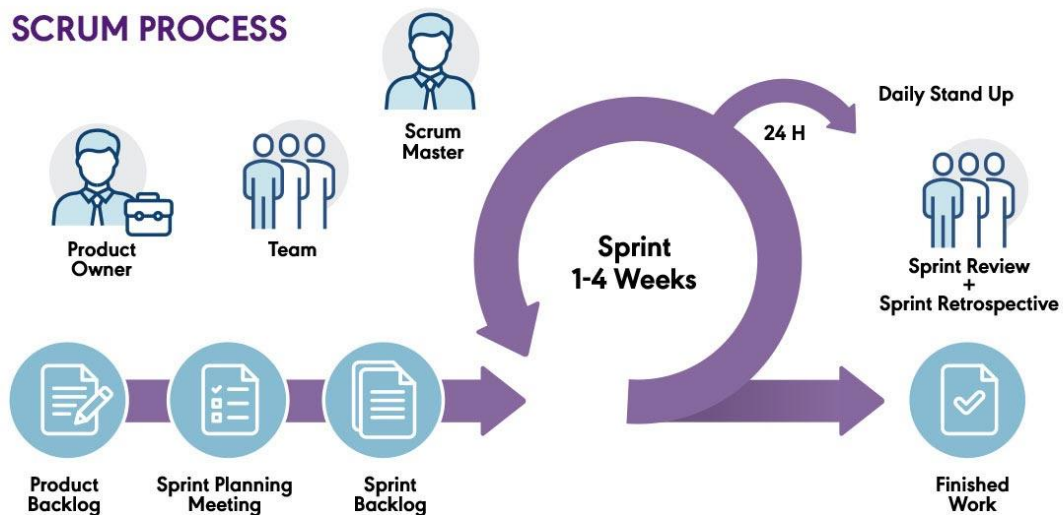
Mainly, the Agile methodology's popularity grew in the mid-2000s, with various frameworks and methodologies, such as Scrum, Kanban, and Extreme Programming (XP), aligning with Agile principles and gaining traction. Agile's success in the software development domain led to its adoption in other industries, where it addressed challenges such as slow delivery and inflexible planning systems, further solidifying its place as a transformative approach to project management (McKinsey & Company, 2021). By the late 2000s and early 2010s, Agile had become a mainstream methodology, with its principles being applied across diverse fields, from marketing to product management.

3.3.2 Scrum Framework

One of the most popular and widely-accepted agile methodologies is the Scrum framework. The Scrum framework is an Agile product development approach that prioritizes flexibility, collaboration, and iterative progress. Scrum is not a methodology, meaning it does not provide guidelines on how to create the product. It is a framework that recognizes the inherent lack of strict definition in the development process, emphasizing the establishment

of a broad deliverable definition and the contextual understanding of development (Schwaber, 1997). Additionally, Scrum enables teams to adapt to rapidly changing requirements through its iterative nature, making it highly effective for complex and dynamic environments (Kokol et al., 2021). It was formalized in the early 1990s by Jeff Sutherland, Ken Schwaber, and Mike Beedle and has since gained widespread acceptance and popularity in the software development community.

Figure 9: Scrum Process



Source: PM-Partners (2024)

Scrum operates on the principles of transparency and adaptation, aiming to deliver a potentially shippable product increment at the end of every iteration, known as a sprint. The framework is built upon defined roles, events, and artifacts, which contribute to its simplicity and effectiveness. Figure 9 represents the Scrum process which I am explaining below in more detail (PM-Partners, 2024).

Scrum defines three primary roles that form the foundation of its cross-functional team structure. At the center is the Scrum Master, who facilitates the Scrum process by ensuring adherence to its principles and removing obstacles that hinder the team's progress. The Scrum Master acts as a bridge between the development team and external stakeholders to ensure smooth communication and collaboration. The Product Owner plays a critical role in defining and prioritizing the product backlog - a dynamic list of potential product features - ensuring the team works on tasks that align with the project's objectives. Finally, the Development Team, composed of self-organizing professionals, is responsible for delivering product increments, collaborating to turn backlog items into functional deliverables. These roles are fundamental to the effective implementation of Scrum in practice (Masood et al., 2021).

Scrum also incorporates structured events to ensure transparency, alignment, and continuous improvement. Each sprint begins with Sprint Planning, where the team collaboratively defines the work to be completed during the sprint. Daily Standups provide an opportunity for team synchronization, allowing members to discuss progress, identify challenges, and adjust plans as needed. At the end of the sprint, the Sprint Review offers a platform for demonstrating completed work to stakeholders and collecting feedback for further refinement. Lastly, the Sprint Retrospective encourages the team to reflect on the sprint process, identifying areas for improvement to enhance efficiency and collaboration in subsequent iterations. These events form the backbone of Scrum's iterative and transparent approach (Ramin et al., 2020).

What makes the Scrum framework stand out is its ability to foster collaboration, adaptability, and a focus on delivering customer value as fast as possible and consistently. By breaking down complex projects into short, time-boxed sprints and encouraging frequent communication and feedback loops, Scrum enables teams to respond quickly to changing requirements of users and the market. This iterative and user-centric approach aligns well with the fast-paced and dynamic nature of the software development industry, allowing teams to deliver high-quality products that better meet user needs. It is a very effective strategy to gain a competitive advantage.

Furthermore, the Scrum framework provides a clear structure while allowing for flexibility, making it adaptable to various industries and types of projects beyond software development. Its success in enhancing team productivity, delivering customer value, and improving project outcomes has made Scrum a go-to framework for organizations seeking an Agile methodology that combines structure with adaptability.

Despite some initial skepticism, Agile methodology's significance lies in its ability to improve project outcomes by fostering collaboration, adaptability, and continuous improvement. It has added a dynamic dimension to project management literature, challenging traditional waterfall models and promoting a more responsive and user-centric approach. As organizations across various industries increasingly recognize the value of user feedback and rapid adaptation, Agile has become a cornerstone in modern software development and project management practices. Its widespread adoption is a testament to its effectiveness in delivering high-quality products that meet the evolving needs of users in a rapidly changing technological landscape.

3.3.3 My Experience with Scrum Framework

The Scrum framework is prevalent in the company where I work. The company is a managed services provider; thus, it is important to be on top of market trends and strive to innovate and differentiate. Agile principles can help managed services providers by fostering adaptability and responsiveness to client needs, enabling iterative improvements and rapid resolution of issues to deliver consistently high-quality services. They have been working

with agile principles for quite a long time before I joined. By the time I joined the team, all of the Scrum roles and events were already established. For example, my manager is the Scrum Master. He is the one who communicates with the rest of the business the most and bridges the communication gap between stakeholders and our team. I am part of the Development Team. We work in one-month sprint increments. At the start of each month, we are assigned stories (tasks) to develop, and during the month, we often communicate with the requesters of these stories to clarify requirements or seek feedback. This collaboration helps build a strong relationship with the requester/user, keeping them informed of progress and ensuring their voice is reflected in the final output.

Nevertheless, before these stories can be part of a sprint, they need to go through the refinement and prioritization process. For this, instead of one Product Owner, we have a small team of three colleagues who work as Product Owners. They have weekly meetings in order to look through all of the user stories (requested tasks), and speak to the appropriate stakeholders and make a strategic decision on the priority of each story.

Once the stories are prioritized, they go through the refinement process according to priority. In our company, refinement sessions are organized based on the process which the story is related to. In these sessions, the Scrum Master, requester of the story, and one or two colleagues from our Development Team are present to define requirements and acceptance criteria for the story. After this, the story is ready to be put in a sprint. In our team, the Scrum Master is the one who defines the sprint for us; he chooses how many stories can be developed that month based on resource availability.

On top of this typical Scrum way of working with user stories and sprints, we also follow the Scrum events. We have daily meetings where each colleague from the Development Team shares what they are working on and whether they need help from someone else. We also have Sprint Reviews where we share what was developed by each teammate. However, in these meetings we do not involve other stakeholders. We have a different system of monitoring the response of stakeholders and requesters to our development work, and this is through a ticketing system. Once we see a ticket that is connected to a story that we developed, we gather with the team and discuss how to proceed with the received feedback. Sometimes we have to apply fixes, other times the feedback might be out of scope, so we need to ask for a new story. Since our team works on maintaining the ticketing system of the company, it makes sense to use this feedback mechanism which is already widespread throughout the company.

The last type of Scrum event is the Sprint Retrospective. This is one that we struggle to consistently implement in our working processes. We have put more emphasis on it in the last few months, but it is still something we are getting used to as it is a change in the way we work. However, I personally recognize the benefits of having these meetings regularly, as they can help improve the way the sprints are organized and implemented. Additionally,

it is meant to also review the satisfaction of the team members, which is very important in order to keep the team spirit and self-driving work ethic high within the team.

3.3.4 Challenges of the Scrum Framework

Despite all of the positive remarks about the Scrum framework, there are still some challenges and criticism for this approach. Schwaber K. (1997) acknowledges that while Scrum provides significant advantages in adaptability and user satisfaction, it requires a shift in organizational culture. Successful implementation depends on team collaboration, stakeholder involvement, and a willingness to embrace change. The paper outlines case studies demonstrating Scrum's effectiveness in delivering high-quality software in dynamic environments.

Scrum, while widely adopted, faces criticism regarding its risk management processes. A study by Pilliang et al. (2022) highlights that the repetitive nature of risk analysis in Scrum can become burdensome for stakeholders, potentially leading to disengagement and oversight of critical risks. The authors suggest that without a streamlined approach, the continuous demand for risk assessment may detract from the team's focus on development tasks, thereby affecting overall productivity and project outcomes.

Additionally, the flexibility inherent in Scrum can lead to inconsistent practices across teams. Hron and Obwegeser (2022) conducted a systematic review revealing that adaptations of Scrum in various settings often result in deviations from its core principles. Such modifications, while intended to fit specific project needs, can dilute the effectiveness of the framework and lead to challenges in maintaining process integrity and achieving desired outcomes.

4 RESEARCH METHODOLOGY

4.1 Research Purpose

The purpose of this thesis paper is to create a BI&A development lifecycle that can be integrated with user-centered approaches and refine it through interviews. This involves the application of user-centered approaches in order to reach the purpose. Therefore, this thesis is very significant in today's environment of increased importance and power of the users. Moreover, Business Intelligence and Analytics systems are becoming necessary for prosperous functioning of companies due to the high generation of data, leading to the need to make data-led decisions. This thesis puts forth benefits to any company willing to introduce a new BI&A system or improve their current one, with the main focus being the user.

There are several goals in order to reach the purpose of this thesis. The first goal is to analyze the steps of the BI&A development process in order to have a better understanding of what each step means and find the most appropriate one where user-centered approaches can be implemented rationally. The second goal is to present and describe three different user-centered approaches that have potential to improve the system development process. Subsequently, I have conducted three interviews with experts in the BI&A system development field and analyzed their input in order to verify my proposed solution for improvement of the BI development process, which is my third goal. After the analysis of their professional opinions, the final findings can be extracted.

4.2 Research Design

For the purpose of this master's thesis, a design science research methodology is used in order to verify the proposed scientific contributions, initially created by Herbert Simon in his 1969 book called *The Sciences of the Artificial*. This kind of methodology focuses on qualitative research so as to deliver more descriptive results. It is mainly used in Informatics and Computer Sciences for the analysis of the design process of a certain artifact, where the expected contributions come from the improvement of the design processes. This leads to an increased knowledge of the specific artifact at hand, as well as significant increases in the artifact's efficiency and effectiveness.

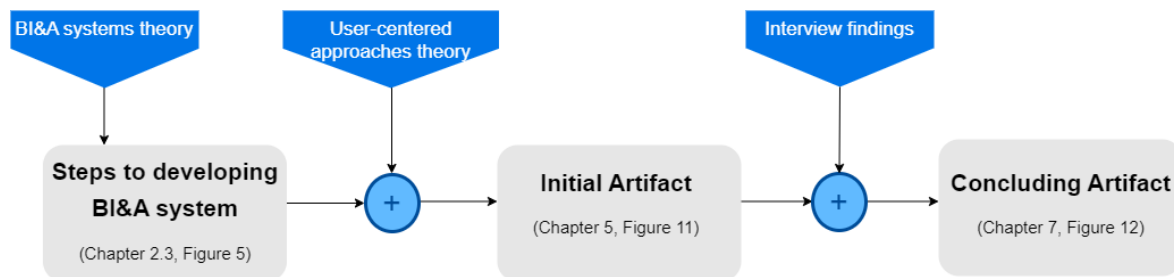
The design science research methodology emphasizes the importance of building and evaluating the proposed artifacts several times in order to achieve the most relevant results. This indicates the need for practical field research. The design cycle proposed by Takeda et al. (1990) explains the steps needed to be taken. A very important step is to start with the problem in mind, knowing what the issues are and what needs to be solved. The next step is to develop an artifact. One evaluates the artifact and based on the outcome starts from the beginning again with the awareness of a problem. As previously mentioned, design science research is an iterative process, hence these steps are repeated until the developed artifact produces a solution for the problems. Having this in mind, an artifact was created based on available research and theories of the current development process of BI&A systems. The artifact went through several iterations of analysis and evaluation based on the literature review, leading up to the initial artifact, which was then evaluated through 3 semi-structured interviews. They were performed with professional BI&A system developers, with several years of experience and in-depth expertise of the subject matter. Their opinions were taken into consideration for the final iteration of the design cycle, which led to the development of the concluding artifact of the development process of BI&A systems.

At the early stages of my research, in addition to my own literature review, I used a generative AI tool as a supplementary instrument to help identify relevant academic literature on Business Intelligence and Analytics (BI&A) systems and user-centered approaches. Specifically, I asked the AI tool to suggest key scientific papers, summarize

their main findings, and provide links to the original sources for verification. This helped broaden the scope of my literature review and pinpoint potential gaps that my study aims to address. However, since AI-generated content has its limitations, I carefully evaluated all suggested papers to ensure they were credible, relevant, and aligned with my research purpose. I also cross-checked its recommendations with peer-reviewed sources from Elsevier, Science Direct, Google Scholar, and other digital libraries.

Figure 10 visually represents the research design and each of the stages of the creation and evaluation of the artifact. The initial artifact was created through an in-depth investigation of BI system development, informed by existing literature and established methodologies. After finalizing the initial BI system development process (presented on Figure 5 in Chapter 2.3), I progressed to the second cycle of artifact development by incorporating user-centered approaches. Following this cycle, I continued my literature review, which allowed me to further evaluate and enhance my artifact by more effectively applying user-centered principles to specific steps in the development process. Upon completing my desk research and final evaluation of the artifact (presented on Figure 11 in Chapter 5), it was prepared for presentation to BI experts for additional assessment and critical feedback regarding the implementation of user-centered approaches. The interview findings are the evaluation of the initial artifact, which lead to the concluding artifact (presented on Figure 12 in Chapter 7) and answers to my research questions.

Figure 10: Process of creating and evaluating of the artifact



Source: own work

The following step was to define a preliminary structure and guide for the interviews. I began by identifying key themes relevant to the research questions, ensuring they addressed gaps in existing literature and practical challenges faced by organizations. Each question was crafted to be open-ended, encouraging in-depth exploration during the semi-structured interviews. The goal was to discuss each of the three implementations of user-centered approaches that I proposed in order to evaluate which one would impact the system development effectiveness most. This approach ensures that the questions are aligned with my research purpose and goals and facilitate meaningful data collection for analysis.

Research Questions:

Question 1: Can user-centered approaches be used to improve effectiveness of Business Intelligence and Analytics system development?

Question 2: Which development activity will be most affected by the usage of user-centered approaches within the development lifecycle?

4.3 Research Instrument

The research instrument used to answer my research questions is semi-structured interviews. The questions created for the interviews are explained below. The full list of questions can be found in Appendix 3. The questions were developed based on each of the BI development steps mentioned in Chapter 2.3, specifically in Figure 5: Steps to developing BI&A system. The goal is to go through the questions per each step of the BI development lifecycle and get a complete picture for each step from the point of view of an experienced developer. They were created in a way to encourage a discussion about the implementation of user-centered approaches in the BI development cycle, including advantages and disadvantages. This helps evaluate each integrated step and helps answer the research questions. The explanations of the interview questions below are grouped based on the theme or research question they are referring to.

The first question (see Appendix 3) focuses on examining my propositions/artifact and discussing whether this is the correct user-centered approach for that part of the BI development process. The second question is more directly addressing the impact of efficiency on the development process. The following few questions were meant to indirectly help with the evaluation of the efficiency of the user-centered approach by means of discussing the time needed to implement the approach and integrate the users within those steps of the process. Question five also asks about ways to motivate users and make sure they stay engaged throughout the process. The sixth question is meant to get a different perspective on the efficiency of the approach by asking for any experience with disadvantages of its implementation and ways to overcome them.

Question seven is meant to open up the discussion about the user-centered approaches in general and see what situations have BI experts faced already with such approaches, the lessons learned from it, and any problems with it. The next, eighth, question is meant as a follow up, in case the interviewee cannot think of any concrete example, to guide them through a similar thought process about a fictional scenario instead of a specific personal example.

The ninth question gives the opportunity to the interviewee to add any user-centered approach in other locations within the BI development process. With this I am being mindful that through their hands-on experience there might be something that I could have evaluated as lesser importance than it actually is. Hence, giving the chance for them to add their own perspective and own enhancement to the artifact itself. And the last question is directly

asking for which user-centered approach they believe would increase the efficiency of the development process, from my propositions and also their own additions, if any.

4.4 Research Implementation

The next step was to find suitable people to evaluate my artifact. Through referrals, I contacted five people who currently work in the BI field. However, not everyone who I initially spoke to fit my criteria. From the five initial candidates, I eliminated one who had only 3 years of experience. I was looking for someone with more than five years of experience of working in this field in order to ensure that they have encountered different projects, and situations that we can discuss on the topic.

Another important part of the elimination process with the initial candidates was the mention of working with or having some contact or interaction with users. I included this part so as to have interviewees who have had some experience with user-focus on projects. This is important because it will help interviewees to evaluate and discuss my artifact when they have their own examples to draw from and explain their point of view. In this phase, I eliminated one more person who said he was not the one to have much contact with users; others in his team did this part.

In the end, I had three interviewees with experience in BI and collaborating with users with whom I could discuss my artifact in more depth.

Each interviewee was contacted via email with a short description of the topic and content that would be discussed so as to give them the opportunity to prepare. The three different types of user-centered approaches were presented to them in the same email to make sure that everything is clear. The aforementioned description and explanation of the topics that were sent to the interviewees is added in Appendix 4. All of the interviews were done online, through Zoom due to geographical distances. I will not be mentioning the interviewees' names; they will be referred to as interviewee A, B, and C.

The first interview was conducted with interviewee A on August 6th, 2024 and lasted 51 minutes. She is a BI developer working at Crazy Labs Limited, which is a leading mobile game development company renowned for creating engaging and innovative gaming experiences (Pitchbook, n.d.). She has prior experience in BI in different countries. On a daily basis she works with loads of data - analyzing data from the customers and finding ways to improve the products that they provide. On top of this, using the data to determine advantages and disadvantages of the product is part of her daily tasks too. In order to analyze the data and reach well-informed decisions from it, she is using a variety of BI tools.

The second interviewee, interviewee B, was scheduled for August 15th, 2024. The interview lasted approximately 63 minutes. He works as a BI developer for Open Line BV, which specializes in providing innovative IT solutions and services, focusing on optimizing digital

infrastructure and enhancing business performance for its clients. Some of the daily tasks include getting data from different systems, transforming it and putting it into models. He also added a semantic layer on top of the data to ensure better user-friendliness for some users who might not be very technical.

The last interview was conducted on August 27th, 2024 with interviewee C, with a duration of 48 minutes. She has been in the BI industry for approximately 20 years. In the current role of BI developer, she has been 4 years. Yet considering her vast experiences in this industry, I deemed her qualified for these interviews. She works in Connected Data Group BV, which focuses on providing advanced data solutions and analytics services that empower organizations to harness their data for better decision-making and strategic insights. Some of her responsibilities include developing and setting up data architecture and BI platforms.

Table 2 summarizes the date of each interview and its length, as well as mentioning the company of the corresponding interviewee and the industry in which it operates.

Table 2: Data about interviews

	Interview date	Interview duration	Company	Industry
Interviewee A	6th August, 2024	51 min	Crazy Labs Limited	Gaming
Interviewee B	15th August, 2024	63 min	Open Line BV	IT services
Interviewee C	27th August, 2024	48 min	Connected Data Group BV	IT services

Source: own work

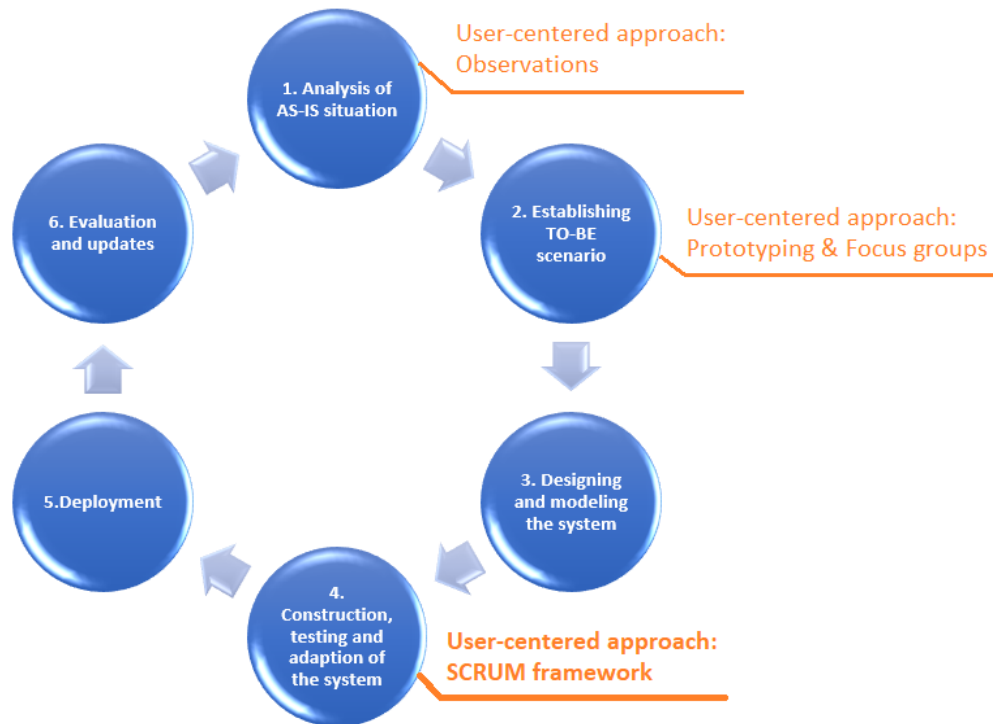
5 INITIAL ARTIFACT: IMPLEMENTATION OF USER-CENTERED APPROACHES TO BI&A SYSTEM DEVELOPMENT

The initial artifact was developed through a thorough exploration of BI system development methodologies and existing literature. The primary steps of the BI&A system development lifecycle are discussed in Chapter 2.3., where it is explained how the activities of the cycle are derived.

This laid the foundation for the subsequent implementation of user-centered approaches to BI&A system development in the second phase of my research. Through my comprehensive literature review, I further supported the evaluation and refinement of the artifact, allowing

for a more targeted application of user-centered approaches at various stages of the BI development lifecycle. After concluding my literary research and evaluation, the initial artifact was prepared for presentation to BI experts to obtain additional insights and feedback on the implementation of these user-centered strategies through interviews. The artifact is shown in Figure 11.

Figure 11: Implementation of user-centered approaches to BI&A system lifecycle (Initial Artifact)



Source: own work

Based on the literature review, I have come to an answer to my first research question, which is: Can user-centered approaches be used to improve effectiveness of Business Intelligence and Analytics system development? From Figure 11 above, and the subsequent explanation of each of the steps with the integrated user-centered approaches below, I confidently believe that user-centered approaches can improve the effectiveness of the BI&A system development process.

The first step in BI system development involves an in-depth analysis of the current ('as-is') situation within the organization and its external environment. Internally, this includes a clear understanding of the company's mission, vision, and current BI tools or systems, alongside identifying any gaps or limitations these systems present in meeting the organization's goals. Externally, an analysis of industry trends, competitor strategies, and emerging technology highlights the opportunities and threats in the market. In this step, I propose to use the user-centered approach of observations of stakeholders' interactions and engagement.

This is supported by Sanders and Stappers (2008) where they define the different levels of user involvement in the human-centered design. Observations are part of the designer consulting users level where users are viewed as a source of information which helps to start on the right track with the development process. I believe that this is crucial in the beginning steps of the development process as it allows developers to understand user needs and pain points directly, aligning system development with practical, user-centered insights from the start.

Establishing a ‘to-be’ scenario entails defining the ultimate objective of the BI system with a clear end goal, setting the foundation for focused, goal-oriented development. This stage requires gathering detailed requirements, such as identifying the types and volumes of data, as well as deciding on the BI tools that best support these needs. This stage encourages user engagement and iteration of some development steps which is supported by design thinking. I suggest using the methods of prototyping and focus groups. Like Serrat (2017) pointed out, it is important to try to succeed faster through trial and error because this is the way to develop something relevant and unique.

Through prototyping and focus groups, developers engage with users to refine data requirements and gather insights on the data model, system architecture, and process structures, ensuring that the new system will meet both functional and practical needs. This approach helps to practically confirm whether designers and developers are on the correct path. Moreover, this direct interaction with users helps to build and maintain a closer relationship with the users, which can help in future development activities.

The third step focuses on creating visual representations of the data model and designing the BI system's architecture to enhance user comprehension and alignment with business goals. Unlike earlier phases where user involvement is central, Kimball's bottom-up approach does not place heavy emphasis on direct user input during this step. Instead, this phase is more technical in nature, where data architects and BI developers focus on structuring data marts based on predefined business processes. The goal in this step is to ensure efficiency, scalability, and logical data organization rather than frequent iterations with users. This is why I have not added any specific user-centered approach to this step.

During construction, the BI system is developed according to established design guidelines from the previous step. In this step I am adding an agile, user-centered approach like Scrum to facilitate continuous improvement and adaptation. Agile methodologies, particularly Scrum, emphasize iterative cycles of development, frequent feedback loops, and close collaboration between developers and end users (Schwaber, 1997). This ensures that the system evolves in direct response to user needs rather than following a rigid, predefined structure that may not fully align with shifting business realities.

Both technical and functional testing are conducted in this step, involving selected users to verify system performance and functionality. Feedback gathered during testing enables

developers to make necessary adjustments, aligning the system more closely with user needs and improving system stability, usability, and relevance to the business context before final deployment.

With this, I have reached an answer to my second research question, which is: Which activity will be most affected by the usage of user-centered approaches within the development lifecycle? By using the Scrum framework in this step, I believe that user involvement is optimized to utilize continuous communication and improvements, ensuring the final system effectively addresses real-world challenges (Beck et al., 2001). Therefore, I believe that integrating a user-centered approach to this activity of developing, testing and adapting will have the highest impact on the efficiency of the BI&A development system.

Deployment involves rolling out the BI system across the organization, beginning with workshops and training sessions tailored for employees and other stakeholders who might be involved. Training sessions ensure that users can effectively navigate and leverage the system's tools and data insights, fostering organizational alignment with the new system. For external users, if applicable, similar training is conducted to facilitate smooth adoption, leading to a complete and efficient deployment that integrates the BI system into daily workflows. In my opinion, this step does not need any additional user-centered approach as it already involves users through training and workshops.

And lastly, evaluation and continuous improvement form a cyclical process that supports the system's adaptability to evolving business needs or technological advancements. By regularly assessing the system's performance and relevancy, the organization can identify specific areas needing updates rather than reconstructing the entire system. Staying attuned to industry shifts and emerging technology allows the organization to maintain a competitive edge, enabling proactive adjustments that keep the BI system relevant, efficient, and aligned with strategic objectives. At this stage, user involvement is less crucial as improvements are primarily driven by performance metrics, system analytics, and technological advancements rather than direct user feedback.

6 INTERVIEW FINDINGS

6.1 Findings on Steps of BI&A System Development Lifecycle

This chapter presents insights gathered from the interviews with experienced BI developers, aimed at addressing the research questions on user-centered approaches in BI system development. Each interviewee shared their perspectives on which development activities benefit most from user-centered methods, they mentioned potential drawbacks of some approaches, as well as suggested improvements to the initial process design. Their responses highlight the value of incorporating user-driven practices to enhance alignment with user needs and improve overall system effectiveness.

As I presented my initially proposed development process, each of the interviewees was encouraged to challenge the proposed user-centered approaches and add their own improvements where deemed necessary. Interviewee A did not have anything to add to the existing steps, while both Interviewee B and Interviewee C offered suggestions to enhance the BI system development process further. Drawing on their practical experience, they proposed adding specific user-centered approaches to Step 3, which they believe would strengthen the alignment between user expectations and the system's design. These additions reflect their understanding that involving users early in the design phase can deepen insights into user needs and improve the quality of the final product.

Table 3: Interviewees' evaluation of integrated user-centered approaches to BI&A development

	My proposal	Interviewee A	Interviewee B	Interviewee C
Step 1. AS-IS analysis	Observations	Focus groups	<u>Observations</u> + questions	<u>Observations</u>
Step 2. TO-BE scenario	Prototyping + focus groups	Prototyping	<u>Focus group</u>	<u>Focus group</u>
Step 3. Designing and modeling	-	-	Prototyping	Modeling workshop
Step 4. Construct, test, adapt	<u>Scrum</u>	<u>Scrum</u>	<u>Scrum</u>	<u>Scrum</u>

Source: own work

Table 3 compares my initial proposal (column two) for the steps in the development lifecycle most impacted by the implementation of user-centered approaches, along with the specific approaches suggested. The final three columns detail the choices made by each interviewee for these steps, including the additional user-centered approach proposed by Interviewees B and C in Step 3. Since the last two steps from the development process do not have a specific user-centered approach, they are not included in Table 3. The italicized and underlined entries in the table highlight the approaches with the highest consensus among the BI experts for each step. This comparison informs the refined and finalized development process (concluding artifact), incorporating their valuable experiences and feedback. The concluding artifact will be further broken down by each step in Chapter 7.

Interviewee A expressed support for the proposed user-centered approaches in general, emphasizing their importance in creating effective BI systems. For Step 1, she endorsed the use of focus groups, where stakeholders collaboratively discuss their experiences,

challenges, and expectations. This method was highlighted as a way to gather diverse perspectives and establish a clear understanding of the current situation, setting a strong foundation for the development process. She emphasized that she thinks it will be more effective to use focus groups in this step, instead of solely depending on just observations.

For Step 2, she agreed on prototyping, stressing its value in aligning the system with user expectations. She continued to explain that prototyping allows developers to refine the product iteratively, ensuring it meets user needs, especially since, as she noted, “Very rarely we create products for someone very similar to us.” Due to this, she also stated this step would bring the highest impact to the final BI&A system if it properly focuses on the actual user needs, not the perceived ones. By giving a prototype to the user to interact with, one disregards any assumptions about the user, and the focus is moved directly to the user feedback from the interactions with the prototype.

Finally, for Step 4, she supported the use of the Scrum framework, agreeing that it facilitates fast, iterative development while keeping users actively engaged throughout the development and testing process. Nevertheless, she mentioned that agility’s importance can vary across industries; in some sectors, such as gaming and applications, the user interactions have a much greater impact on success than strict adherence to agile practices.

To illustrate their approach, Interviewee A explained that in her work with apps and gaming products, they regularly analyze user feedback, often by reviewing user comments on platforms like Play Store. This feedback helped identify what users find valuable and which issues most affect their experience, allowing for rapid adjustments that improve both user satisfaction and profitability. In a recent example, the team added a new feature to a core game, which not only boosted user retention but also increased profitability. As she put it, “The main goal is profit, but it needs to be done through user retention.” This example highlighted the belief that user-centered design is key to successful BI development, as it leads to outcomes that benefit both the user and the business.

Interviewee B also agreed with the general initial artifact and each of the steps that would be impacted by user integration. He noted that Step 1 is crucial for understanding the current system, suggesting that asking stakeholders “why is it the way it is now” helps set the right foundation. For this step, he does agree with the approach of observations, he would just incorporate some questions to it as well.

Stakeholders are not always aware of what they need, they usually focus on the solution but not the actual question they have. Hence, interviewee B suggested doing focus groups in the second step, where one can sit down with stakeholders and unpack. In Step 2, he highlighted the importance of extended focus groups for defining requirements and aligning the system with user needs. He also mentioned that this is the most crucial step in the BI development process which can bring the highest impact. This is why it is important to understand the

stakeholders in this step and make sure they are thoroughly involved in defining the TO-BE scenario for the system.

Interviewee B suggested incorporating prototyping as an additional user-centered approach in Step 3, instead of Step 2. He argued that prototyping at this stage allows users to visualize and interact with initial design concepts, making it easier to gather meaningful feedback on the system's functionality and user interface. According to Interviewee B, providing users with tangible representations of the design enables them to identify any potential mismatches between the proposed system and their actual needs. This early feedback is invaluable for refining the design before moving to more resource-intensive development steps.

For Step 4, Interviewee B supported using the Scrum framework to enable rapid development and deployment while maintaining active user involvement.

Interviewee C acknowledged the use of observations in the first step, as this can help uncover some hidden inefficiencies by analyzing users in their natural work environment, providing a clearer picture of their current challenges.

On top of that, Interviewee C recommended conducting focus groups for Step 2, as they enable collaborative discussions and capture diverse perspectives to refine system requirements, ensuring alignment with user needs and having "the end goal well defined, in order to guide users as well as designers and developers." Additionally, she was confident that this step will be most affected by user involvement. She echoed this through an explanation that if this step is done correctly, everything after it is easier.

Similar to Interviewee B, Interviewee C proposed adding a user-centered approach to Step 3. However, she suggested using modeling workshops where developers and users would collaboratively create the conceptual model of the system. She explained that a modeling workshop would involve working directly with users to outline the system's primary components, relationships, and workflows. By developing the conceptual model together, users can provide real-time input on how they envision the system's structure and functions, helping developers create a design that closely reflects user expectations. Interviewee C argued that this collaborative process clarifies misunderstandings early on and fosters a shared understanding between developers and users, which can prevent major issues in later development stages.

Interviewee C agreed that integrating a Scrum approach in Step 4 would be very useful due to the iterative nature of it. Nevertheless, she confirmed her previous statement about Step 2 being most important and most affected by user involvement by saying that this is a small step if Step 2 before it was done properly.

The proposed additions to Step 3 by Interviewees B and C highlight their shared belief that user-centered approaches should extend beyond initial requirement gathering to involve users more actively in design and modeling. Their suggestions underscore the importance of

iterative, hands-on collaboration throughout the development cycle, particularly in shaping the system's foundational design elements. This recommendation shows that engaging users directly in the modeling and designing phases can improve the effectiveness of BI system development by ensuring that the design framework aligns well with user needs and expectations. The propositions from Interviewees B and C were further considered during their respective interviews and questions were adjusted accordingly to include this as well.

6.2 Other Findings on Research Questions

In response to when results begin to emerge, all three interviewees noted varying timelines based on the industry and approach used. Interviewee A highlighted that in the gaming industry, results are visible within 3-4 days due to the high volume of daily user engagement, allowing for quick analysis of behavioral changes. In BI systems, however, results may take longer due to different user interaction patterns and scale. Similarly, Interviewee B emphasized that user-centered approaches impact data quality immediately, and the first contact with users is crucial for establishing an effective relationship and understanding their needs. He stressed the importance of “sitting down and putting yourself in their shoes and thinking together about these things. It's not about trust, it's about understanding”. Interviewee C pointed out that prototyping provides immediate feedback on system functionality and user requirements, but organizational delays, such as coordination with technical teams, can slow down the process. These insights collectively emphasize that while some results can be immediate, industry context and organizational structure play a significant role in the timeline.

Regarding how users are prepared, each interviewee emphasized different methods to ensure effective user engagement. Interviewee A discussed using A/B testing with control and test groups to evaluate feature impacts before full implementation, along with tutorials for additional guidance. She emphasized that BI processes often involve workshops and meetings to train users, though ideally, dashboards should be intuitive enough to eliminate the need for extensive training. Interviewee B highlighted the importance of tailoring preparation to the solution's complexity, suggesting that training is necessary if users are unfamiliar with the system. He stressed the need for critical evaluation of user input, as users might not always fully understand their own needs. Interviewee C described a process involving interviews and discussions in the early stages, allowing for open conversation and thorough understanding. She also mentioned workshops in Step 3 to collaboratively develop the conceptual model. These approaches ensure users are well-prepared and actively involved throughout the development process.

In regard to motivation to participate in the development process, interviewee A explained that users are often motivated internally because the system directly affects their experience, such as in gaming contexts where product designers need data for reports. This shared goal fosters engagement, as users feel their input improves the product and benefits them. She

added that, “involving users helps them feel part of the community, which can increase their willingness to spend money”. However, challenges can arise when users demand data too quickly, leading to inaccurate predictions. For example, a seemingly minor change, like altering the smile of a Barbie character, led to significant backlash and retention issues when users perceived it negatively. These insights highlight the importance of involving QA and gathering feedback from multiple user channels, such as Facebook or Reddit, to address potential issues proactively.

For Interviewee B, keeping users engaged requires creativity and an understanding of their perspective. He suggested making the process enjoyable by avoiding overly technical details and presenting concepts visually, such as using dummy data to build excitement. “We are visual beings,” he noted, emphasizing the importance of clear and engaging communication. Consistent updates, such as weekly progress reports, help sustain user energy and interest throughout the development lifecycle. Additionally, understanding the stakeholders and tailoring communication to them is critical—using metaphors and relatable examples ensures users grasp the objectives and feel included. Asking for opinions regularly also reinforces user involvement and encourages meaningful contributions.

Interviewee C acknowledged that motivating users can be challenging, especially when they don’t directly benefit from the system, such as data providers who don’t use the reports themselves. She stressed the importance of building relationships from the beginning, as involving stakeholders early creates a foundation for collaboration. Over time, dividing participants into smaller, more focused groups helps streamline feedback while maintaining communication with all stakeholders. In cases where external data providers are involved, interviewee C suggested highlighting the benefits of their contributions by showing how the system adds value to the organization as a whole. Clear communication of the vision is also critical, ensuring that all parties understand how their input fits into the broader objectives. Additionally, she noted that management must take an active role in facilitating alignment and addressing political complexities, as their involvement ensures all contributors are engaged and motivated.

Understanding the potential disadvantages of implementing user-centered approaches in the BI system development process is crucial for identifying proactive strategies to address these challenges. Anticipating issues allows teams to minimize disruptions, adapt methods to fit specific contexts, and create solutions that enhance both the development process and its outcomes. This approach ensures that even when difficulties arise, they can be effectively navigated to achieve optimal results. Each of the interviewees was asked for their experiences and concrete examples and lessons learned from such situations they have come across.

In Interviewee A’s previous experience in the telecom industry, user-centered approaches were not always necessary, as dashboards were created primarily for servers rather than end users. These dashboards, designed to track data accuracy and support quick analysis,

prioritized functionality over aesthetics since they were intended for internal use rather than user engagement. This demonstrates that while user-centered approaches are valuable, they may not always align with the system's purpose or the target audience and industry.

Interviewee A also discussed the disadvantages of specific user-centered approaches. For instance, Agile methodologies may struggle with features that require longer development cycles, as frequent changes every two weeks, for example, can hinder progress for more complex projects. Additionally, the other two approaches face challenges when users are uncertain about their needs, often wanting a mix of nice-to-have and must-have features. As she explained, “Everyone wants everything always, [but designers] have to decide and compromise on this.” Furthermore, conflicting goals between user enjoyment and business objectives, such as with voluntary versus non-voluntary ads, can create tension. “The goal is not the same for the user (enjoyability) versus colleagues (profit),” she noted, highlighting the importance of finding a balance that satisfies both perspectives.

Moreover, Interviewee B highlighted several disadvantages of implementing user-centered approaches, particularly when dealing with user expectations and data quality. Users often focus too much on the end result, which can introduce a sense of ego, while neglecting the foundational importance of data quality—an issue that becomes more pronounced when systems maintained by different teams are involved. Regarding Scrum, he noted that while it ensures that processes stay on track and work as planned, it can sometimes feel cumbersome, such as when feedback is delayed due to users' availability. He shared an example where users requested something highly specific that could not be achieved with the available data. In such cases, it is critical to explain why the request cannot be met and offer an alternative solution to address their underlying needs, maintaining trust and collaboration in the process.

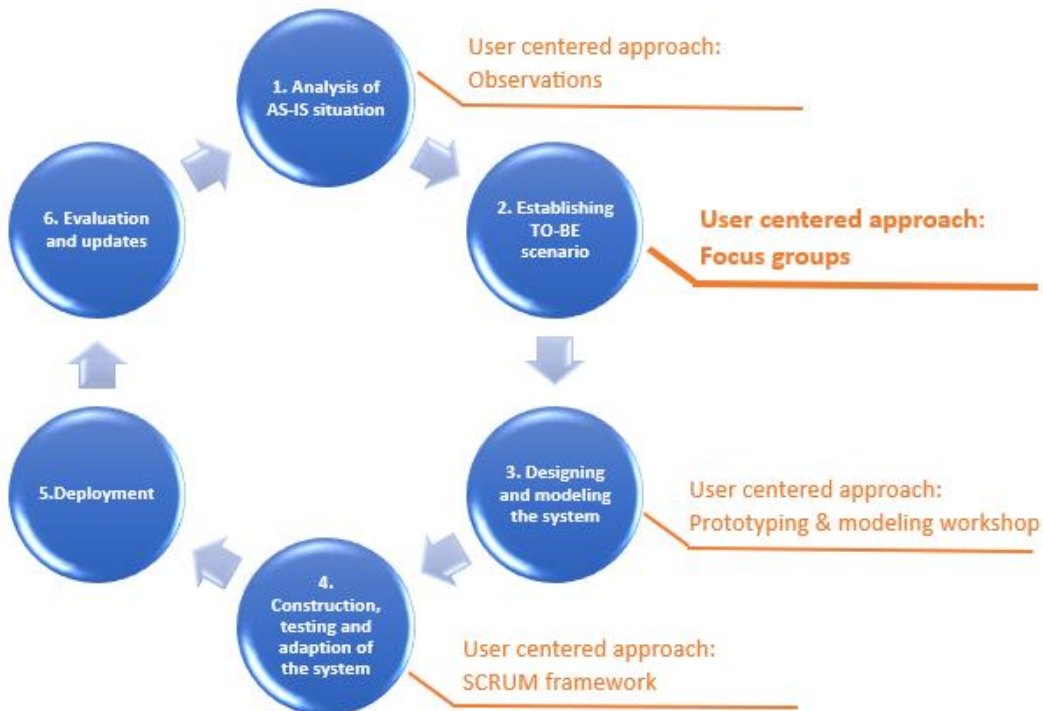
Finally, Interviewee C also pointed out several disadvantages, emphasizing challenges related to user engagement and communication. She noted that users can sometimes become less responsive, causing projects to lose momentum, especially when user priorities shift. This issue can resurface unpredictably, creating delays. Additionally, relying on a single or very few users can lead to bottlenecks, making it crucial to involve a slightly larger user group to reduce dependency on specific individuals. Effective communication is another concern, as it is essential for one person to take the lead in managing communication and coordination throughout the process. From a technical perspective, she highlighted instances where the necessary data exists but cannot be accessed, causing further obstacles. While Scrum generally works well, she observed that discussions can sometimes become overly lengthy, diverting time away from actual development progress.

7 THE CONCLUDING ARTIFACT AND ITS DISCUSSION

The concluding artifact integrates insights from user-centered approaches and interviews with experts, ensuring a practical and adaptive framework for BI&A system development. Each step emphasizes tailored methods – ranging from observations to focus groups and workshops – that align with both user needs and organizational goals. By addressing challenges identified during the interviews, this refined BI development process fosters continuous feedback, enhances user engagement, and promotes the creation of an intuitive and effective BI system.

Based on the analysis of the interviewee's responses, I was able to confirm my answer to research question 1: Can user-centered approaches be used to improve effectiveness of Business Intelligence and Analytics system development? All of the interviewees agree that user-centered approaches can improve the effectiveness of such system development. This is in line with the suggestion from George and Jeyakumar (2019) for early user engagement, as stakeholders can interact with some prototypes tailored to their business areas, leading to more immediate insights and iterative improvements. In addition, Bano and Zowghi (2015) have identified that user collaboration and responsiveness are significant contributors to project success. This consensus is further supported by the discussion below, which highlights how these approaches improve BI&A system effectiveness by ensuring closer alignment with user needs and expectations.

Figure 12: Implementation of user-centered approaches to BI&A system lifecycle (Concluding Artifact)



Source: own work

As a result of the interviews, Figure 11 in Chapter 5 is adapted into Figure 12 to display the concluding artifact where the specific user-centered approaches are slightly changed. Notably, Step 3 has an additional user-centered approach related to it, enhancing its impact on the system's design. The significance of which activity would be impacted the most is shifted to Step 2 (marked in bold) instead of Step 4, as all the interviewees unanimously agreed on its importance in the development process. These modifications reflect the realignment of the framework based on expert insights and are explained in detail below.

The first step, AS-IS analysis, focuses on understanding the current state of the system. Observations remain the primary user-centered approach here, supported by most interviewees. This method involves watching users in their natural environment to uncover hidden inefficiencies and gain a clear understanding of their challenges. This user-centered approach is crucial because several of the interviewees mentioned that users are not always conscious of their needs/expectations. Thus, it can help by providing valuable information about the actual needs/expectations of the users and operational bottlenecks, even if they are not aware of them. In addition, Interviewee B suggested complementing observations with targeted questions to better capture user perspectives. This can help dive deeper into a specific scenario and these discussions allow stakeholders to collaboratively unpack their experiences and establish a robust foundation for the subsequent stages. Sanders and Stappers (2008) supported this as well and they defined different levels of user involvement in the human-centered design.

For the next step, focus groups are used to collaboratively define the desired future state of the system, ensuring all stakeholders share a common vision for the future of the BI system. Clear requirements and expectations are established, guiding the development process toward a user-aligned outcome. Two out of three of the interviewees agreed on the value of focus groups in this step of the development process, emphasizing its role in capturing diverse perspectives and aligning requirements with user needs. The consensus around focus groups reflects their effectiveness in facilitating open dialogue and ensuring that the TO-BE scenario is grounded in practical user insights. Moreover, they all agree that this step in the development process would be most affected by adding a user-centered approach.

A key finding from this study was that the second step of the BI&A development lifecycle – establishing to-be scenario - is impacted the most from user-centered approaches, specifically, work with focus groups. This directly answers research question 2, which investigates which activity of the BI&A development lifecycle is most impacted by user involvement. Initially, based on the literature review, I theorized that Step 4 - construction, testing, and adapting - would be the most affected by user-centered approaches. However, expert insights contradicted this assumption, instead emphasizing the significance of Step 2. This is because Step 2 directly influences how well the system aligns with user needs. Since this step defines the core functionalities of the BI system in the beginning phases, integrating user-centered approaches here has the highest potential to improve overall system

effectiveness. As one interviewee noted, if this step is executed correctly with user integration, the rest of the development process flows much more smoothly.

Step 3 saw significant enhancements based on interview feedback. This step involves creating the system's design and key components based on gathered insights from earlier stages. It is important to ensure that both the architecture and the data visualization elements meet user expectations for usability and relevance. Initially, I underestimated the role of user-centered approaches in this step, assuming that its highly technical focus limited the potential for direct user involvement. However, Interviewees B and C highlighted ways to bridge this gap and they recommended adding prototyping and modeling workshops. Prototyping, suggested by Interviewee B, allows users to interact with early design concepts and provide tangible feedback, helping to identify mismatches between the design and user expectations. Interviewee C proposed modeling workshops, where developers and users collaboratively create the system's conceptual model. This collaborative and direct process fosters real-time input and ensures that the design closely reflects user needs. It also shows that regardless of the level of technical focus, it is important to find ways to still include users in the development process in a way that would help minimize the technical knowledge gap. In this case, that is achieved through direct interaction and visualizations. Both suggestions emphasize the importance of active user involvement in shaping the system's foundational elements.

The Scrum framework remains the preferred approach for Step 4, with unanimous support from all interviewees. This agile methodology facilitates iterative development and continuous user engagement, ensuring that the system evolves in response to user feedback. Agile methodologies, particularly Scrum, emphasize close collaboration between developers and end users (Schwaber, 1997). Agility's importance may vary by industry, but it is particularly valuable in environments where user interactions significantly impact success. In such contexts, for example the gaming industry, rapid iterations based on user feedback can lead to improvements in user retention and overall system effectiveness. The Scrum framework plays a crucial role in maintaining active user involvement, aligning development efforts with user needs through continuous feedback and adaptive processes.

Step 5 is the most technical step, it involves launching the system for end-users, ensuring it is fully functional and ready for practical use. A well-planned deployment phase minimizes disruptions and maximizes user acceptance. While no additional user-centered approaches were specifically proposed for this step, the deployment phase benefits from the groundwork laid in earlier stages to ensure a smoother rollout. The iterative feedback collected during design and construction ensures that the final product is aligned with user expectations, facilitating a successful deployment process. Regular user engagement throughout the development lifecycle minimizes the risk of last-minute adjustments and enhances user acceptance during deployment.

The sixth step, evaluation and updates, ensures that the BI&A system remains adaptive to changing business requirements and technological advancements. Unlike earlier stages that heavily rely on direct user feedback, this phase is primarily guided by performance metrics, system analytics, and emerging industry trends. Interviewees emphasized that while user feedback remains valuable, long-term system optimization is often driven by data accuracy, processing efficiency, and integration with evolving business needs. Regular system assessments help organizations identify targeted updates rather than undergoing costly, large-scale system overhauls. Additionally, industry context plays a crucial role in shaping evaluation cycles—companies operating in highly dynamic sectors may require more frequent adjustments, whereas organizations in stable industries can afford longer evaluation intervals. By staying proactive and aligning improvements with both business strategy and technological innovations, companies can ensure their BI&A systems remain relevant, effective, and competitive over time.

While the outlined user-centered approaches significantly enhance BI&A system development, their effectiveness is influenced by external factors beyond the development process itself. Key contextual elements, such as industry norms and organizational structure, shape how these methods can be implemented in practice. Additionally, the intended purpose of the BI&A system determines the extent to which user-centered design should be prioritized. The following insights from the interview findings further illustrate how these factors impact the integration of user-centered approaches.

Industry context and organizational structure play a significant role in the timeline of the project. The interviewees highlighted that different industries and organizational setups influence how quickly a BI&A system can be developed and implemented, and how user integration influences this. This is also supported by Jaklič et al. (2018) who have highlighted the importance of considering organizational setup and culture and user needs during the integration of BI&A systems. For instance, organizations with rigid hierarchies and lengthy approval processes may face delays in integrating user-centered approaches, as multiple layers of decision-making slow down iterative improvements. On the other hand, industries with fast-moving, data-driven cultures—such as technology or finance—may adopt user-centered methods more seamlessly due to their agile work environments. This suggests that while user-centered approaches can improve BI system effectiveness, their implementation must be adapted to fit the operational dynamics of a given organization.

Another key consideration is that user-centered approaches must be balanced with the system's primary purpose and target audience. One interviewee noted that dashboards developed for internal use were primarily focused on data accuracy and rapid analysis rather than user engagement or aesthetic design. This highlights that in some cases, prioritizing usability over visual appeal is necessary, particularly in industries where efficiency and precision outweigh the need for intuitive user experience. While user-centered design principles typically emphasize ease of use, certain BI&A applications—such as highly technical internal dashboards—may require a more function-driven approach. This

underscores the importance of context-aware design, where the level of user involvement is tailored to the system's intended function and user group.

8 CONCLUSION

This thesis explored ways to create and improve the Business Intelligence and Analytics (BI&A) system development lifecycle in order to enhance its efficiency and usability. Through a literature review analysis of the BI&A development lifecycle, the identification of suitable user-centered approaches, and expert interviews, this study successfully achieved its goals.

A major contribution of this thesis is the creation of an artifact which is a refined BI&A development process that integrates user-centered approaches at key development steps. This artifact represents a structured process that aligns BI system development with user needs, ensuring that user engagement is both meaningful and effective. The proposed process was validated through expert interviews, confirming its practical relevance and applicability across different industries. By embedding user-centered methodologies into the BI&A lifecycle, this framework provides companies with a systematic approach to enhancing system usability and effectiveness.

The interview findings confirm that user-centered approaches contribute to more effective BI&A systems, addressing the first research question and filling the identified gap in the literature. Moreover, through interviews with experienced BI developers, I have identified that the second step in the BI&A development process, establishing to-be scenario, can be most impacted by integrating user-centered approaches. By including users in establishing a to-be scenario and defining requirements (Step 2), it highly increases the effectiveness of the BI system development lifecycle because it results in a more accurate alignment of system features with business needs from the start of the process. The interview findings also established other key steps in the development process where user-centered approaches can be used to increase effectiveness. Step one, analysis of as-is situation, utilizes the observations approach. Step three, which is designing and modeling the system has two approaches: prototyping and modeling workshops. And step four – construction, testing and adaptation of the system – is the last step where a user-centered approach was added, and this is the Scrum framework.

This thesis makes both practical and theoretical contributions to the field of BI&A system development. From a practical standpoint, the research provides a structured approach for integrating user-centered methodologies into BI&A development processes. It highlights specific steps where user involvement is most beneficial, ensuring that business intelligence tools align with actual user needs. This insight is valuable for organizations looking to enhance user adoption and efficiency. The study also serves as a guideline for companies aiming to bridge the gap between technical development and user expectations, leading to improved system usability and business performance.

On a theoretical level, this research contributes to academic discussion by addressing a gap in existing literature - the intersection of BI&A development and user-centered approaches. While both areas are extensively studied independently, this study provides a framework for their integration, offering new perspectives on how system development methodologies can evolve to incorporate user-centered approaches. This theoretical contribution not only strengthens knowledge in the field but also lays the foundation for future studies to build upon and refine user-centered BI&A methodologies.

This study also revealed that the impact of user involvement varies across industries. For example, in the gaming industry, rapid user feedback loops directly enhance user retention and overall system effectiveness. In contrast, sectors such as healthcare and finance, where data accuracy and security are paramount, require a balance between system functionality and user-friendliness. Industry-specific factors also influence the speed at which a BI&A system can be developed and implemented, as well as the extent to which user integration is feasible.

Despite the benefits of user-centered BI&A development, several challenges were identified. Conflicting user goals, project slowdowns, and data accessibility issues emerged as potential barriers. Organizations must carefully balance user involvement with project timelines and technical feasibility to ensure that user-centered approaches enhance, rather than hinder, system development. Additionally, excessive user involvement can lead to continuous requests for new functionalities, delaying progress and complicating system usability. Users may also struggle to clearly articulate their needs, resulting in misaligned requirements that require costly revisions later in the process. To address these issues, organizations must implement structured approaches to user participation, ensuring that feedback is effectively gathered and integrated without disrupting the overall development flow.

While this study provides valuable insights, it is not without limitations. The research relied on a qualitative methodology with a limited number of expert interviews, which may not fully capture the diversity of perspectives across all industries. Future research could expand on this by incorporating a larger sample of experts or conducting quantitative analyses to measure the tangible effects of user-centered approaches on BI&A system performance. Additionally, comparative studies could evaluate the effectiveness of user-centered focus across different industries, identifying patterns in how user involvement impacts BI&A system development. Case studies on companies that have successfully implemented user-centered BI&A systems could also provide practical insights into best practices and common challenges, further refining the integration of user involvement in BI&A development.

I am a technical developer by profession, my expertise primarily lie in system design and implementation rather than direct user interaction and requirement definition. Future studies conducted by researchers with different professional backgrounds, or those incorporating multidisciplinary perspectives, could help mitigate some biases and provide a more holistic view of user-centered BI&A development.

In conclusion, this thesis highlights the importance of integrating user-centered approaches into BI&A system development, particularly in the establishing to-be scenario step. Organizations seeking to implement or improve BI&A systems should prioritize early user involvement to enhance system efficiency, effectiveness, and adoption. As data-driven decision-making continues to evolve, further research on industry-specific adaptations of user-centered design in BI&A systems will be crucial in shaping the next generation of intelligent business tools. By continuously refining user-centered approaches, organizations can ensure that BI&A systems not only keep pace with technological advancements but also drive meaningful, user-driven innovation in an increasingly complex digital landscape.

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APPENDICES

Appendix 1: Povzetek (Abstract in Slovene language)

POVZETEK

Razvoj sistemov poslovne inteligence in analitike (angl. Business Intelligence and Analytics, BI&A) je ključnega pomena za organizacije, ki želijo izkoristiti odločanje na podlagi podatkov in pridobiti konkurenčno prednost. Medtem ko se je na uporabnika osredotočeno načrtovanje izkazalo za učinkovit pristop pri razvoju programske opreme, njegova neposredna integracija v razvoj sistema BI&A ostaja premalo raziskana. Trenutna literatura obsežno pokriva metodologije BI&A in opisuje korake razvoja sistema BI&A; vendar sem po skrbnem premisleku ustvarila razvojni cikel, ki najbolj ustreza potrebam magistrskega dela. Na uporabnika osredotočeni pristopi so temeljito obravnavani tudi v literaturi, neodvisno od procesov BI&A. Tako ostaja v raziskavah glede njihovega presečišča velika vrzel.

Ker podjetja dajejo večji poudarek uporabi podatkov in uporabniški izkušnji, postaja vključevanje na uporabnika osredotočenih pristopov v razvoj sistema BI&A ne samo koristno, ampak nujno. Z zagotavljanjem, da so končni uporabniki aktivno vključeni v razvojni proces, lahko podjetja ustvarijo bolj intuitivne in funkcionalne sisteme BI&A, ki so v skladu s potrebami uporabnikov. Magistrsko delo raziskuje vlogo na uporabnika osredotočenih pristopov pri izboljšanju razvojnega procesa in učinkovitosti sistemov BI&A, kar na koncu prispeva k njihovi širši uporabi in dolgoročnemu uspehu.

Z uporabo raziskovalne metodologije znanosti o oblikovanju je predlagan začetni artefakt na podlagi celovitega pregleda literature in nato izpopolnjen s polstrukturiranimi intervjuji s strokovnjaki s področja BI&A. Ta začetni artefakt je oblikovan kot strukturirana kombinacija razvojnih procesov sistema BI&A in pristopov, osredotočenih na uporabnika. Skozi razprave s strokovnjaki je bil začetni artefakt podvržen ponavljajočim se izboljšavam, ki so vodile do končnega artefakta, ki opredeljuje pristope, osredotočene na uporabnika, za posamezne korake razvojnega procesa. Prvi korak, analiza stanja kot-je, uporablja pristop opazovanj. Drugi korak razvojnega procesa – vzpostavitev bodočega scenarija – je opredeljen kot tisti, na katerega najbolj vpliva vpletenost uporabnikov. Ugotovitve kažejo, da uporaba pristopa, osredotočenega na uporabnika, med tem korakom povzroči natančnejšo uskladitev funkcij sistema s poslovnimi potrebami od začetka procesa. Natančneje, fokusne skupine se kažejo kot najučinkovitejša metoda za vzpostavitev prihodnjega scenarija, saj omogočajo neposredno sodelovanje, kolektivne povratne informacije in dinamične razprave med deležniki. Tretji korak, ki je načrtovanje in modeliranje sistema, ima dva na uporabnika osredotočena pristopa: izdelava prototipov in delavnice modeliranja. In četrti korak, izgradnja, testiranje in prilagoditev sistema, je zadnji korak, kjer je predlagan pristop, osredotočen na uporabnika, in to je ogrodje Scrum.

Ta raziskava prispeva tako teoretično kot praktično s premostitvijo vrzeli med pristopi, osredotočenimi na uporabnika, in razvojem sistema BI&A ter ponuja nov pogled na to, kako je mogoče te domene integrirati. Zaključni artefakt zagotavlja strukturiran pristop za

vključitev vključevanja uporabnikov v ključne razvojne korake, kar zagotavlja, da sistemi BI&A niso le učinkovitejši, temveč tudi širše sprejeti.

Prihodnje raziskave bi lahko potrdile ta okvir s študijami primerov o podjetjih, ki so uspešno implementirale sisteme BI&A, z uporabo pristopa, osredotočenega na uporabnika, prav tako bi lahko zagotovile praktične vpogled v najboljše prakse in izzive, s čimer bi dodatno izboljšale integracijo vključevanja uporabnikov v razvoj BI&A. Poleg tega bi lahko primerjalne študije ovrednotile učinkovitost osredotočenosti na uporabnika v različnih panogah, pri čemer bi identificirale vzorce, kako vpletenost uporabnikov vpliva na razvoj sistema BI&A.

KLJUČNE BESEDE: Poslovna inteligenca in analitika (BI&A), pristopi, osredotočeni na uporabnika, metodologije za razvoj sistemov, raziskave znanosti o dizajnu, agilna metodologija, oblikovalsko razmišljanje, oblikovanje, osredotočeno na človeka.

Appendix 2: Abstract in English language

ABSTRACT

The development of Business Intelligence and Analytics (BI&A) systems is critical for organizations aiming to leverage data-driven decision-making and gain a competitive edge in an increasingly evolving marketplace. While user-centered design has proven to be an effective approach in software development, its direct integration into BI&A system development remains underexplored. Current literature extensively covers BI&A methodologies and outlines BI&A system development steps; but after careful consideration, I created a development lifecycle that best fits the needs of this thesis. User-centered approaches are also thoroughly discussed in literature, independently of BI&A processes. Thus, a significant gap persists in research regarding their intersection.

As businesses place greater emphasis on data utilization and user experience, integrating user-centered approaches into BI&A system development is becoming not just beneficial but necessary. By ensuring that end users are actively involved in the development process, companies can create more intuitive and functional BI&A systems that align with user needs. This thesis investigates the role of user-centered approaches in enhancing the development process and efficiency of BI&A systems, ultimately contributing to their broader adoption and long-term success.

Using a design science research methodology, an initial artifact is proposed based on a comprehensive literature review and subsequently refined through semi-structured interviews with BI&A experts. This initial artifact serves as a structured combination of BI&A system development processes and user-centered approaches. Through discussions with experts, the initial artifact underwent iterative refinement leading to the concluding artifact that defines the user-centered approaches per step of the development process. Step one, analysis of as-is situation, utilizes the observations approach. The second step of the development process – establishing to-be scenario – is defined as the most significantly influenced by user involvement. Findings suggest that employing a user-centered approach during this step results in a more accurate alignment of system features with business needs from the start of the process. Specifically, focus groups emerge as the most effective method for establishing a to-be scenario, as they facilitate direct engagement, collective feedback, and dynamic discussions among stakeholders. Step three, which is designing and modeling the system has two approaches: prototyping and modeling workshops. And step four, construction, testing and adaptation of the system, is the last step where a user-centered approach was added, and this is the Scrum framework.

This research contributes both theoretically and practically by bridging the gap between user-centered approaches and BI&A system development, offering a novel perspective on how these domains can be integrated. The concluding artifact provides a structured approach for embedding user involvement at key development steps, ensuring that BI&A systems are not only more effective but also more widely adopted.

Future research could validate this framework through case studies on companies that have successfully implemented user-centered BI&A systems could also provide practical insights

into best practices and common challenges, further refining the integration of user involvement in BI&A development. Additionally, comparative studies could evaluate the effectiveness of user-centered focus across different industries, identifying patterns in how user involvement impacts BI&A system development.

KEY WORDS: Business Intelligence and Analytics (BI&A), user-centered approaches, system development methodologies, design science research, Agile methodology, design thinking, human-centered design.

Appendix 3: Interview questions

Let's go through all of the parts where I have proposed to add some kind of user centered approach and evaluate the potential significance/impact of each change.

1. Discuss the kind of approach used: do you agree? Which approach would you have chosen in this step of the process?
2. How does it affect the efficiency of the development process?
3. When did you start seeing results by the implementation of this approach? If no experience, when would you expect to see results?
4. How were the users prepared to be integrated in this process? - trainings/meetings/workshops
5. How were the users motivated to participate? How much did they engage throughout the process?
6. Follow up: What could be the disadvantages and how could they be overcome?
7. Can you think of any concrete examples in using this user-centered approach? What were the lessons learned from this example? If any problems, how did you solve the problem?
8. If no examples, what do you think could be a potential problem with the implementation of this user centered approach?
 - Step 1. Understand the stakeholders and their involvement → observations from Human-centered
 - Step 2. Requirement gathering (types of data, amount of data, usage of data) → prototyping from design thinking
 - **Step 4. Construction, testing and adaption of the system (whole step) → agile methodology (scrum way of working)**
9. Do you have own ideas & thoughts to add to this process, is there something more important or with higher impact? (a different place where to add a user-centered approach in the development process)

10. From the proposed changes (mine and yours), which one do you believe would have the highest impact on the end result (=increase efficiency of the BI&A system which will be developed)?

– Why do you expect this?

If I need to follow up to clarify something when analyzing answers, can I contact you again shortly?

Appendix 4: Introduction for interviews

This research is part of the Master's thesis with the topic "USER-CENTERED APPROACHES TO BUSINESS INTELLIGENCE AND ANALYTICS SYSTEM DEVELOPMENT" at the Business Informatics program at the School of Economics and Business, University of Ljubljana, Slovenia. During the first step of theoretical research, different user-centered approaches and Business Intelligence and Analytics (BI&A) systems have been reviewed in the existing scientific literature. From the gained theoretical knowledge, I created a BI&A system development process with proposed user-centered approaches as being part of the process. The second step is conducting practical research through semi-structured interviews with 3-5 experts from the field. In this interview, I would like to ask you, based on your experience and lessons learned, to comment and discuss with me the possibility of using user-centered approaches in the BI&A system development process that I have proposed. I am envisaging a duration of 45-60 min for this interview discussion. After I finish all of the interviews with experts/practitioners from the field, I will adapt and finalize my proposed process.

Users are becoming more and more powerful. Therefore, in order to have satisfied users, it is very useful and important to make sure that they are part of the creation/development process. Some of the more popular user-centered methods include **human centric design, design thinking and agile methodology** (using the Scrum framework more precisely).

- Human centric design is one of the first user-centered approaches that was developed. It prioritizes the needs, preferences, and experiences of end-users throughout the development process.
- Design thinking involves a deep understanding of user needs through empathy, iterative prototyping, and testing in a cyclical manner.
- Agile methodology emphasizes collaboration, user feedback, and small, incremental changes, allowing teams to quickly adapt to changes and deliver relevant value for users continuously throughout the development lifecycle.

The goal of this interview is to gain insights through your experience of working with such systems on how you believe they might be improved **by including users in the development process**.

Thank you for agreeing to participate in this interview. If you express interest, I can provide you with the final result of my research.

If you wish, your identity will remain anonymous and I will only describe your company and your position. However, if you agree, I can also use your name in my paper when annotating the interviews and using your answers to draw conclusions.

Once again, thank you for your inputs in this interview.