A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: AN APPRECIATIVE INQUIRY STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT

by

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DEDICATION

This product of labour is dedicated to God, through whom all things are possible.

To my dear father and mother, Ostenwald and Christie, who have continuously encouraged me along the way.

To my dear mother-in-law, Karien, who have cheered me on to persevere.

To my loving husband, Jurie, and my dearest son, Juwald, who have sacrificed much precious family time supporting me to complete the research.

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- My language editor, David Swanepoel for his meticulous document care and attention to detail; and

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2015 Design Lead, Standard Bank, Big & Small Business Banking (Johannesburg).

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2014 Usability evaluation for business intelligence applications: a user support perspective. Article published in SACJ (South African Computing Journal), Vol 53, No 1, 2014. (http://sacj.cs.uct.ac.za/index.php/sacj/article/view/198)

LIST OF ACADEMIC OUTPUTS BASED ON THIS RESEARCH

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- Jooste, C., Van Biljon, J.A., & Botha, A. (2018). A Conceptual Framework Representing the User Experience for Business Intelligence front-ends. Paper presented at the *International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD). 2018, Durban, South Africa.* DOI: 10.1109/ICABCD.2018.8465464

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DECLARATION

I declare that **A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: AN APPRECIATIVE INQUIRY STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I, further, declare that I submitted the thesis to originality checking software. The result summary is attached. I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: AN APPRECIATIVE INQUIRY STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT

ABSTRACT

In South Africa and globally, companies focusing on business optimisation and continuous improvement have embraced business intelligence for the purpose of decision-making as data are becoming more readily available. Companies recognise the need for, and importance of, user experience when interacting with the dashboards to assist users with decision-making and to enable users to take timely evidence-based actions. It is no longer sufficient only to support users in achieving their goals by employing basic usability principles; digital products need to provide an overall positive user experience to be considered successful. Numerous frameworks have been developed for the user experience of digital systems. However, with the literature emphasizing the importance of context, those user experience frameworks cannot be transferred to business intelligence. This dearth of evidence-based business intelligence specific user experience frameworks comprises the rationale for this study.

The research methodology is comprised of mixed methods as this methodological paradigm aligns best with the pragmatist and appreciative inquiry research approach. The research design framework draws on the Affordance Theory, Logic Model and Agile software development approaches. The context of the study is that of software development in an agile environment in South Africa. The theoretical research contribution comprises of the validated conceptual literature-based framework for the user experience of business intelligence dashboards and the compilation and use of an original research design framework that was utilised to guide the research. This research study also has value for industry in that it has produced a novel validated practitioners' framework that can be used in practice to identify user experience shortcomings and highlight opportunities for improvement.

Keywords (in alphabetical order):

Affordance theory, agile software development, appreciative inquiry, business intelligence dashboards, logic model, mixed methods, user experience, product design.

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LIST OF ABBREVIATIONS

• AI	Appreciative Inquiry
• BI	Business Intelligence
• BIS	Business Intelligence Systems
• CIO	Chief Information Officer
• CL_UXF_1.1	Conceptual Literature-based UX Framework 1.1
• CL_UXF_1.2	Conceptual Literature-based UX Framework 1.2
• CAP_UXF_BID_1.1	Conceptual Appreciative Practitioners' User Experience Framework for Business Intelligence Dashboards
• CPMS	Corporate Performance Management Systems
• CRM	Customer Relationship Management
• CSE	Computer Self-Efficacy
• DSS	Decision Support Systems
• DW	Data Warehouse
• EDP	Enterprise Development Planning
• EIS	Executive Information Systems
• ERP	Enterprise Resource Planning
• ES	Enterprise Systems
• ETL	Extract, Transform, Load
• GSS	Group Support Systems
• HCI	Human-Computer Interaction
• HCD	Human-Centred Design
• HE	Heuristic Evaluation
• ID	Interaction Design
• IDSS	Intelligent Decision Support Systems
• IS	Information Systems
• IEC	International Electro-technical Commission
• ISO	International Standards Organisation
• IT	Information Technology
• JED	Just Enough Design
• KMDSS	Knowledge Management-Based DSS

- KPI Key Performance Indicators
- LMS Learning Management System
- MIS Management Information Systems
- MM Mixed Methods
- MVP Minimum Viable Product
- NSS Negotiation Support Systems
- PDSS Personal Decision Support Systems
- PEOU Perceived Ease of Use
- PSSUQ Post-Study System Usability Questionnaire
- QA Quality Assurance
- QUIS Questionnaire for User Interface Satisfaction
- RP Research Problem
- SLR Systematic Literature Review
- SUMI System Usability Measurement Inventory
- SUS System Usability Scale
- UE Usability Engineering
- UE Usability Evaluation
- UEQ User Experience Questionnaire
- UI User Interface
- UP Usability Problem
- US User Satisfaction
- UX User Experience
- VAP_UXF_BID_1.1 Validated Appreciative Practitioners' User Experience Framework for Business Intelligence Dashboards 1.1
- VAPO_UXF_BID_1.1 Validated Appreciative Practice-Oriented User Experience Framework for Business Intelligence Dashboards 1.1

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Chapter 1

Introduction

This chapter serves as a point of departure from whence the research journey can be followed from commencement to completion. To support this, the following aspects have been included, background to the research, the problem statement, the objectives for the study, how the study was undertaken, the rationale for the study, the contribution of the research to the field of study and, finally, an overview of the structure of the research thesis.

1.1 Background and context

Little research has been published on the user experience (UX) of the front-end of business intelligence (BI) applications. Although literature has proposed a number of different UX frameworks specific to diverse concepts (Gegner, Runonen, & Keinonen, 2011; Hokkanen, Xu, & Väänänen, 2016; Irshad, Rohaya, & Rambli, 2016; Law, Hassenzahl, Karapanos, Obrist, & Roto, 2015), discussed in Section 3.3, none of these UX frameworks (see Table 3.2) were specific to BI front-end applications (at the time of the study). Research has confirmed that context is critical to the performance of interactive systems (Dourish, 2004; Sato & Douros, 2004).

Computing has become increasingly ubiquitous in the past three decades and has entirely changed the contexts in which people use computers (Bødker, 2006). UX is, therefore, being exposed to several diverse contexts. Research indicates that the experience goal needs to be appropriate for the target context of use (Kaasinen *et al*., 2015). With context being shown in the literature to have much importance, the lack of it, or the need for a UX framework specific to front-end BI dashboard, was confirmed.

BI brought many previously undiscovered opportunities to companies wanting to optimise and improve their business (Jooste, Van Biljon, & Mentz, 2013). Opportunities derived from data and analysis in different organisations have brought about a significant interest in BI and analytics, enabling users to make appropriately-timed business decisions (Chen, Chiang, & Storey, 2012).

BI solutions can assist an organisation to gain many benefits (Gibson, Arnott, & Jagielska, 2004), such as more and better information (Mihai, 2014), better decision-making capabilities, improved support of strategic goals, integrated information (Watson, 2009) and improved organisational performance (Wieder, Ossimitz, & Chamoni, 2012). The benefits provided by the correct implementation of a BI solution are notoriously difficult to quantify and measure. Some benefits, such as the cost savings from local data mart consolidation, are easy to measure (with a local impact). Other benefits, such as the revenue gained from enabling the accomplishment of strategic business objectives, are more difficult to quantify and measure but have a global impact (Gibson, Arnott, & Jagielska, 2004). Improving organisational performance is especially relevant when tough economic times demand instant and well-informed decisions (Knoesen & Seymour, 2015).

Good UX can be considered a competitive upper hand for the company and can amplify value to users (Hokkanen *et al*., 2016). UX design is key to creating successful ubiquitous computing devices and environments (Kuniavsky, 2008). The exclusive measurement of useful and usable products is no longer sufficient for product success (Schulze & Krömker, 2010). Business success is increasingly becoming dependent on an organisation's ability to provide a pleasant UX (Hildén, Väätäjä, Roto, & Uusitalo, 2016). For products to succeed in their various contexts of use, it is no longer sufficient to support users in achieving their goals by employing good usability. It is also imperative that products provide enjoyment and user engagement (Fronemann & Peissner, 2014).

Interactive dashboards have become a popular technique to aid users in BI analysis and data discovery. However, the usability of BI tools has not fully matured to a level where novice users can utilise its features efficiently and effectively without assistance from IT experts (Smuts, Scholtz, & Calitz, 2015). Smuts *et al*. (2015) also confirmed that limited research had been conducted regarding usability criteria specific to BI tools that support novice users. Their proposed guidelines for designing and evaluating information visualisation tools indicate a need for particular context-relevant BI tools. For the purpose of this study, the term context is defined, as per Dey (2001), as "any information that can be used to characterise the situation of an entity, where an entity can be a place, a person or an object relevant to the interaction between a user and an application" (Dey, 2001:5). In the setting of Human-Computer Interaction, the user experience encompasses every aspect pertaining to the interaction between an object or a person within a specific context of use. This suggests that the context also plays a role in the experience (Obrist, 2010; Wigelius & Väätäjä, 2009).

While numerous frameworks have been developed for UX in the past 20 years, there is still a need for research that bridges the gap between theory and UX design and evaluation (Law *et al*., 2015). This identified gap is being narrowed with research being done to bridge the gap between UX theory and practice (Geiser, 2020; Goethe *et al*., 2019). There is also a need for representations and understandings of UX that are precise (Kaye *et al.*, 2011). The literature points toward a lack of theoretical underpinning for UX frameworks. Smuts *et al.* (2015) identified the need for a usability framework specific to BI. This is relevant as BI tools presenting data and information are used by people to gain knowledge (Todd, 2017). Research points out that users need to understand the source of the data, with BI *black box* solutions having a negative connotation (Parenteau *et al*., 2016).

There are various definitions of BI and UX; these are explained more in Chapter 2. The basic definition of terms follows next to present critical concepts pivotal to the study.

1.2 Definition of terms

The following terms are defined, based on their use in this study. The key definitions of terms below are sorted alphabetically and not in the order of appearance in the research or according to relevance or importance.

Affordance theory maintains that the world is perceived not only in terms of object shapes and spatial relationships but also in terms of the possibilities of objects for action (affordances) (Gibson, 1966).

Agile software development is defined as described within the Agile Software Development Manifesto published by software practitioners and consultants in 2001 (Beck, Grenning, *et al*., 2001; Cockburn & Highsmith, 2001). It is the way of developing software in an incremental manner that values individuals and interactions over processes and tools, producing working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change over following a plan.

Appreciative inquiry is a philosophy that explores and investigates what works in a specific context. The inquiry discovers data that are analysed for shared themes. The participants in the research articulate the themes and dreams of ‘what could be and what will be’ in a specific domain

(Cooperrider & Whitney, 2015). The essence of the discovery keeps the best of the past by discovering what it is and stretching it into future possibilities. Appreciative inquiry aims to determine the 'best' of 'what is', identifying and building on past achievements, existing strengths, and opportunities of 'what could be'. Appreciative inquiry is broken down into four phases, viz. discover, dream, design and develop (Cooperrider & Whitney, 2015).

Business intelligence is defined as the integration, aggregation and multidimensional analysis of data originating from various information resources, where meaningful information can be delivered at the right time, at the right location, and in the suitable form to facilitate improved decision-making for individuals or larger units (Bose, 2009; Mola, Rossignoli, Carugati, & Giangreco, 2020; Negash & Gray, 2008; Olszak & Ziemba, 2007; Wang & Wang, 2008; Yeoh & Popovič, 2016).

Business intelligence dashboards are defined as information management tools that display organisational information on a single screen, using data visualisations, allowing users quick at-a-glance insight into current performance. Data visualisations primarily include business analytics metrics and key performance indicators (KPIs) (Hansoti, 2010; Joshi, Masurkar, Tawde, & Gharat, 2017).

Development, as defined from an organisational point of view, is a domain, also called 'technology' in some organisations, and is the area of a business that performs the actual building of the software, including back-end and front-end development.

Human-computer interaction is defined as a multidisciplinary field focussing on the interaction between humans and systems; it is interested in the point of contact between the application and end-user (Preece, Rogers, & Sharpe, 2002). Human-computer interaction, abbreviated as HCI, is concerned mainly with designing interfaces, evaluating interfaces, and implementing interactive systems for people to use. In summary, it is a field that focuses on interactive systems and their use (Dix, Finlay, Abowd, & Beale, 2004).

The ***logic model*** is defined as the flow of processes to produce desired results; the logic model illustrates the connection between components and guides the development of a system (Wong *et al.,* 2010*)*.

Mixed method is defined as research that involves the collection, analysis and interpretation of both quantitative and qualitative data in a single study (Creswell, 2014; Leech & Onwuegbuzie, 2010).

Product, as defined from an *organisational* point of view, is a domain group of relating products or services. There are usually several identifiable product domains with corresponding organisational units, each in charge of its own product domain (Züllighoven, 2005).

Product, as defined from a *software development* point of view, is a part of the applications domain, which has the potential to be analysed and modelled and can be built independently of other product domains (Züllighoven, 2005).

Usability is an objective quality defined as the effectiveness, efficiency, and satisfaction with which users of an application can achieve specific goals (International Organization for Standardization, 1998).

User experience (UX) is a subjective quality; it is defined as an individual's responses and perceptions resulting from the use and anticipated use of a product, service or system (International Organization for Standardization, 2019).

1.3 Research problem

Several theoretical frameworks have been developed in UX research since the turn of the century (Law *et al*., 2015). Many of these frameworks have specific areas of focus within UX. For example, a framework with a focus on pragmatic attributes and hedonic attributes (Law *et al*., 2015), a framework with a focus on temporality within UX (Karapanos, Zimmerman, Forlizzi, & Martens, 2010), frameworks with a focus on UX evaluation (Lindblom & Alenljung, 2020; Zarour & Alharbi, 2017), frameworks that focus on the UX of early product versions (Cheng, 2016; Hokkanen *et al*., 2016), a framework that concentrates on strategic UX work (Liikkanen, 2016), frameworks that focus on UX within academic environments (De Kock, van Biljon, & Botha, 2016), UX within organisations (Hildén *et al*., 2016) and frameworks on UX in practice (Goethe *et al*., 2019; Kuutti, 2010; Law *et al*., 2015; MacDonald, Sosebee, & Srp, 2021; Obrist *et al*., 2012).

The lack of existing UX frameworks specific to BI dashboards pointed to a gap in the literature. A gap in the literature is insufficient to motivate the need for research (Chatterjee & Davison, 2021) but this also pointed to a lack of support for UX design practitioners in the field of BI dashboards and, therefore, provided the rationale for this study. Thus, this study has produced a conceptual UX framework specific to BI dashboards based on the literature review conducted during the study (Jooste, Van Biljon, & Botha, 2018). In response to this conceptual framework, more research has been published confirming the framework's structure and elements (Eriksson & Ferwerda, 2019).

From the literature reviewed in Chapter 3, it is shown that context influences the use and design of interfaces (Feng, 2017); having a context-specific framework would enable transferability and applicability of validated elements required for the use and the design of digital user interfaces. For the purpose of this study, applicability is defined, as per Wang, Moss and Hiller (2006), as the *extent* to which something could be implemented in another setting, and transferability as the extent to which the *measured effectiveness* of something could be achieved in another setting.

The research problem (RP) identified is that, currently, there is no validated framework representing UX for the front-end of BI dashboards. The need for a validated UX framework specific to BI dashboards was confirmed by Eriksson *et al*. (2019).

1.4 Research questions

Research problem: there is a lack of UX frameworks specific to the development or use of BI dashboards.

The research question has been constructed to address this gap and the need identified in the literature. The primary research question is, therefore, formulated as:

Primary research question: What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?

Note that the word 'best' is specifically chosen as it is an appreciative inquiry term used throughout the study. This term is employed throughout the appreciative inquiry practitioner interviews to attain their view of what they subjectively consider to be required for the 'best' UX of BI dashboard interfaces. Appreciative inquiry and the term 'best' will be further discussed in Section 4.2.2.

Further to the primary research question, three secondary research questions (SRQ) aim to address the research question; those are:

- SRQ1: What are the essential elements that influence a UX framework for BI dashboards based on literature reviewed?
- SRQ2: What are the practitioners' perspectives on the elements that influence the best UX of BI dashboards?
- SRQ3: What elements are essential to a validated UX framework for BI dashboards?

1.5 Research objectives

Table 1.1 outlines the research questions based on the research problem identified; the table also presents the research objectives, data capturing strategies, and the corresponding research outcomes.

Table 1.1 Research questions, objectives, data capturing strategies and outcomes.

Research question	Research question description	Objectives	Data capturing strategy	Outcomes
Secondary Research Question 1	What are the essential elements that influence a UX framework for BI dashboards based on literature reviewed?	To identify the essential elements that influence the UX of BI dashboards through a systematic literature review.	Systematic literature review.	A conceptual framework with the elements that influence the UX of BI dashboards.
Secondary Research Question 2	What are the practitioners' perspectives on the elements that influence the UX of BI dashboards?	To identify the practitioners' perspective on the elements that influence the UX of BI dashboards through interview questions guided by the theoretical framework.	Interviews to capture practitioners' perspective on the elements that influence the UX of BI dashboards.	A practitioner's view of the elements that influence UX of BI dashboards.

Secondary Research Question 3	What elements are essential to a validated UX framework for BI dashboards.	To identify the elements essential to a validated UX framework for BI dashboards.	Validation of the elements that emerged from the practitioners' interviews based on survey and focus group.	A verified framework consisting of elements that influence the UX of BI dashboards.
Primary Research Question	What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?	To identify the essential elements required for the best UX of BI dashboards within an agile development environment.	Synthesis of frameworks produced during this research study.	To produce a practice-oriented framework comprising of the essential elements required for the best UX of BI dashboards within an agile development environment.

1.6 Research paradigm, philosophy, and theoretical perspective

Guba and Lincoln (Guba & Lincoln, 1994) describe a paradigm's nature as basic belief systems based on ontological, epistemological and methodological assumptions that guide research action or an investigation. According to Khaldi (2017), a paradigm assists a researcher in organising the design of the research, data collection and interpreting process. Simply described, a paradigm is an overarching philosophical framework of the way in which scientific knowledge is produced (Brink, Van der Walt, & Van Rensburg, 2006).

1.6.1 Research paradigm and philosophy

Guba and Lincoln maintain that researchers should be clear about what paradigm informs and guides their research approach (Guba & Lincoln, 1994). The term paradigm was first used by Thomas Kuhn in 1970 (Kivunja & Kuyini, 2017) when it was used to discuss generalisations, values and beliefs that a community or specialists share concerning the nature of knowledge and reality (Kaushik & Walsh, 2019). The research paradigm fits the researcher's ontological beliefs about the nature of reality, that which is (Creswell, 1998). Denzin and Lincoln (2011) define paradigms as human constructions, providing a view of where the researcher is coming from to build meaning into data. Paradigms are, thus, important because they provide beliefs and influence what should be studied, how it should be studied, and how the results of the study should be interpreted (Kivunja & Kuyini, 2017).

Brink *et al*. (2006) refer to research philosophy as a worldview, or *Welt Anschauung*, representing, amongst other things, the researcher's assumptions, values and beliefs about themselves, the environment, the nature of reality, knowledge, and methods for obtaining knowledge. From the literature, the term *worldview* is widely used as an alternative word used for paradigm (Creswell & Plano Clark, 2011; Lincoln, 1990). The researcher's personal view of what constitutes acceptable knowledge, and the process by which this is developed, shapes the research philosophy (Saunders & Tosey, 2013). The research philosophy also directs the method of data gathering and how the data are interpreted (Burns & Grove, 2005).

A paradigm is, thus, a philosophical and theoretical perspective of a specific scientific school or discipline, within which theories, laws, generalisations and the studies performed in support of them are formulated (Merriam-Webster, n.d.). For the purpose of this study, the term *paradigm* is used to refer to philosophical assumptions or to the basic set of beliefs that provide guidance to actions and define the worldview of the researcher (Saunders, Lewis, & Thornhill, 2019).

Because of the nature of the research topic and the context of the study being specific to the practical creation and use of information systems interfaces, a *pragmatist* philosophical standpoint was adopted in the research. Pragmatism is a philosophical view that a theory or concept should be evaluated with regard to how it works and its consequences as the standard for action and thought (Houghton, Hunter, & Meskell, 2012).

Pragmatism was considered an appropriate choice of philosophy because it has roots in the 'realist' tradition, which is concerned with the notion that reality is multilateral, complex, multi-faceted and shaped by experience (Houghton *et al*., 2012). Pragmatism supports the theory that our worldview is constructed based on our perception of it. Pragmatic researchers argue that there is no best approach to developing knowledge and no reason to assume that qualitative and quantitative methods are incompatible (Plano Clark & Creswell, 2008). Pragmatism provides methods of research that are seen to be most appropriate for studying the phenomenon at hand. It allows for the combination of methods that, in conjunction with one another, shed light on: 1) the actual behaviour of participants; 2) the beliefs that stand behind those behaviours; and 3) the consequences that are likely to follow from different behaviours (Kivunja & Kuyini, 2017).

Pragmatists recognise that there are many ways of interpreting the world and undertaking research. No single point of view can ever give the entire picture and that there may be multiple realities (Saunders *et al*., 2019). The research paradigm and philosophy are discussed further in Section 4.2.

1.6.2 Theoretical perspective

A study's theoretical perspective is based on models and theories that are purposely selected and integrated to form a theoretical framework (Abend & Rappoport, 2013). According to Frodeman, Klein, and Pacheco (2017), the thinking about, and the understanding of, research problems from an interdisciplinary perspective assists researchers not to relying only on theories in a particular discipline. The use of interdisciplinary perspectives is presented as an enlightening and effective way to be fully engaged in the research. A theoretical framework forms the structure that can hold and support a research study (Abend & Rappoport, 2013). This study utilises a combination of (1) the **logic model**, (2) **affordance theory**, (3) **the agile model** and (4) **appreciative inquiry** as a theoretical research design framework.

The logic model will be used to understand how things work (purpose, context, inputs, activities, outputs, effects). A Logic Model portrays the flow of processes to produce desired organisational or programme results, illustrates the connection between components, and gives guidance in developing a system (Wong *et al*., 2010). The logic model has links with a pragmatic approach in that it is concerned with things that work in practice (Jones *et al*., 2020; Wyatt Knowlton & Phillips, 2013).

Affordance theory will be used to understand how practitioners perceive things. Cornwell, O'Brien, Silverman, and Toth (2003) considered roles such as agent, environment, perception, causality, information, and context to understand the concept of affordance more effectively. The affordance theory states that the world is perceived not only in terms of object shapes and spatial relationships but also in terms of object possibilities for action, also called affordances (Gibson, 1966). Gibson, as the father of the affordance theory, believed that perception drives action. This concept of affordance was introduced to the Human-computer Interaction (HCI) community in 1988 by Donald Norman in the book titled 'The Psychology of Everyday Things'. Since then, it has become a familiar term in design. Kaptelinin (2014) focused on affordances and design and maintained that good designs, such as the Holmes Stereoscope, are intuitive.

The **Agile model** will be used to understand how software products are designed and built-in practice following agile software development practices (individuals and interactions, working software, customer collaboration, responding to change). Agile is known to increase business value and is recognised by delivering working, tested, deployable software on an incremental basis (Beck & Fowler, 2001). According to the Agile model, challenges in modern realities include:

1) Modern economy – it is difficult to predict how computer-based systems will evolve;
2) Market conditions change rapidly - end-user needs evolve, competitive threats emerge without warning;
3) In many software development project situations, requirements will not be clear before the project begins; and
4) Change is expensive - agile can reduce the cost of change.

Incorporating the Agile model into the theoretical framework could assist the agility and adaptiveness of the theoretical framework mitigating it from becoming obsolete, or irrelevant, owing to technological advances in the future.

Appreciative inquiry will be used as a philosophical approach to guide the research. Appreciative inquiry is known for its inspirational approach and it focuses on what 'works' and is possible instead of the customary stage of identifying the problem (Reed, 2006). Appreciative inquiry seeks to engage stakeholders in self-determined change. It also encourages practitioners to move beyond traditional problem-centred methods (Ashford & Patkar, 2001). Appreciative inquiry aims to ascertain the best of 'what is', identifying and building on past achievements, existing strengths, and the possibilities of 'what could be'. Appreciative inquiry can be understood in four phases: discover; dream; design; and develop (Wall, Russell, & Moore, 2017; Whitney & Trosten-Bloom, 2011).

The appreciative inquiry approach emphasises the importance of focusing on the workplace setting and understanding its context. This approach aligns with the pragmatic approach as described by (Crotty, 1998) and it would be appropriate for guiding this study with a focus on the real-world context of UX framework use in the workplace, as there is a similarity link between appreciative inquiry and pragmatism, with pragmatism being used to measure knowledge by what 'works' (Cutchin & Dickie, 2012). The theoretical research design framework constructed from appreciative inquiry, the logic model, the Agile model, and the affordance theory is presented in Section 4.3.

1.7 Research design

The research design employed a mixed method approach, utilising qualitative and quantitative data to optimise data collection, using complementary data collection methods (Creswell, 1998). Refer to Figure 1.1 for a simplified depiction of the research design.

A systematic literature review was undertaken to review the literature on the topic of the research problem thoroughly to identify whether the problem has been addressed sufficiently. This research phase set out to answer the research question: *What are the essential elements that influence a UX framework for BI dashboards based on literature reviewed?* The systematic literature review produced a novel conceptual framework that answered this question, and which encompassed the frameworks inspected during the systematic literature review. Figure 1.1 depicts a simplified view of the research design.

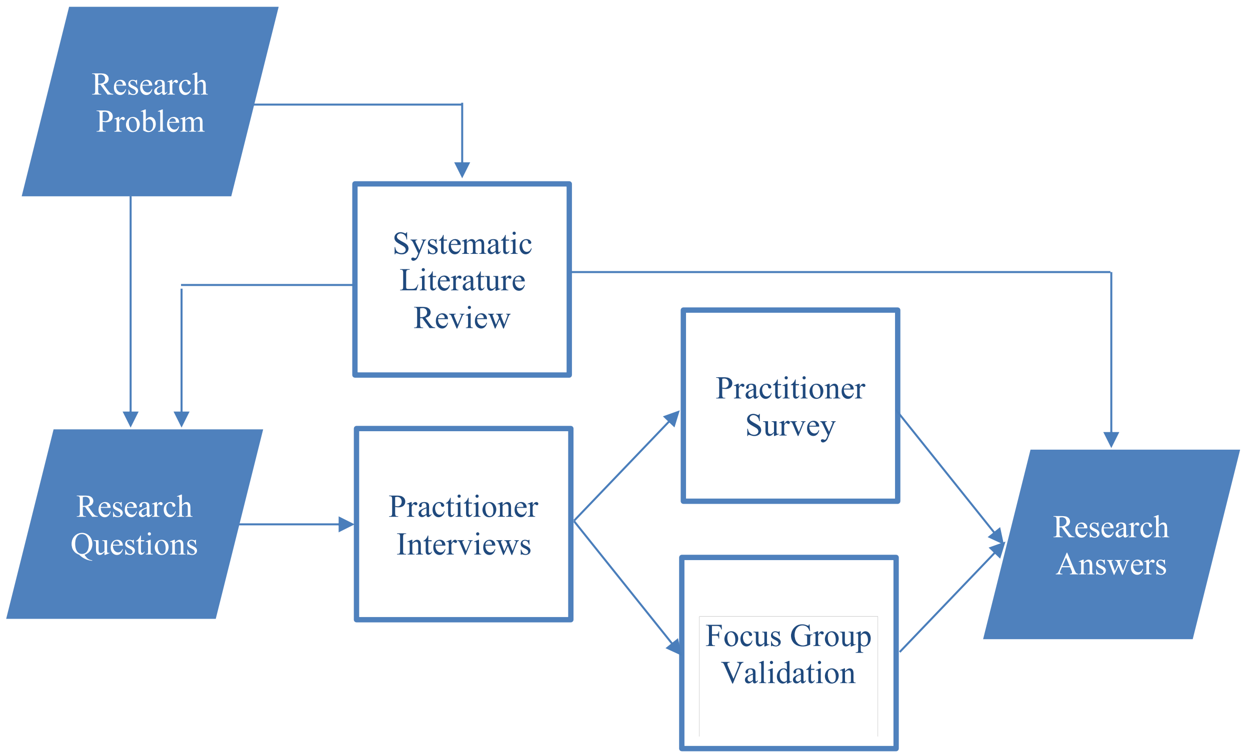

Figure 1.1 Simplified research design.

Following the SLR, practitioners were interviewed to collect primary data to answer the question: *What are the practitioners' perspectives on the elements essential for the best UX of BI dashboards?* This question was addressed by analysing the data collected from the practitioner interviews and producing a practitioner's UX framework on what is required for the best UX of BI dashboards. A sequential explorative mixed method, which prioritised the collection of qualitative data utilizing interviews prior to the collection of the quantitative data via a survey, was utilised. Thereafter the practitioner-based UX framework was validated by a larger audience of practitioners to produce a validated UX framework answering the research question: *What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?*

The practitioner UX framework was then validated by practitioners in a focus group session to produce an updated, validated UX framework for BI dashboards. The research design and methodology are discussed in Chapter 4.

1.8 Scope and limitations

The scope of the research was limited to the development of software within an agile software development environment. Initially, the research was focused only on the interface elements required for the best UX of BI dashboards, but, owing to the data collected during the interviews, it became very evident that the participants considered other non-interface related elements as being just as essential to ensure the best UX for BI dashboards. The researcher then decided to widen the scope to include what she considered critical based on the participant interviews for a more complete picture of the problem space.

The limitations of the research included the number of survey participants meeting the qualifying criteria (that contributed to the quantitative data), owing to the specialist nature of the topic and way of working in practice (in the software development environment). The research study took place during the Covid pandemic and had to adapt during strict Covid lockdown periods in 2020, where mobility was limited and interaction between research participants and the researcher was mostly remote. This extended the duration of the study. Limitations are further discussed in Section 7.3.

1.9 Ethical clearance

Ethical clearance was obtained for the study in 2018 for a period of five years until the year 2023. Ethical clearance was awarded by the Research and Ethics Committee of the University of South Africa (UNISA) College of Science, Engineering and Technology (CSET). The ethical clearance certificate is included in this document in Appendix K: Ethical Clearance (Ref number 035/CJ/2018/CSET_SOC). Ethical considerations in the research are discussed in Section 4.6.

During all stages of the research, these ethical principles were followed. This was done by upholding voluntary participation in the study with participants having the right to withdraw from the research at any time, by obtaining permission from participants and receiving informed consent to participate, by ensuring that no harm came to the participants, by protecting participants' anonymity and confidentiality and by avoiding misleading the participants (Babbie, 2016). The researcher also adhered to the participants' right to self-determination (Barrow, Brannan, & Khandhar, 2020).

1.10 Significance and rationale

Academically contributing theoretically, the study has produced the following artefacts:

- An original conceptual UX framework for BI dashboards, Conceptual Literature-based UX Framework 1.1 (CL_UXF_1.1) for BI dashboards was published in 2018 based on the systematic literature review conducted.

- An expanded conceptual UX framework for BI dashboards, Conceptual Literature-based UX Framework 1.2 (CL_UXF_1.2) updated with the inclusion of three additional elements in response to literature published confirming the CL_UXF_1.1.

- an original contemporary Theoretical Research Design Framework (TRDF_AAAL_1.1) employing appreciative inquiry as a philosophically supported technique. The framework was developed as part of the research design, making use of existing theoretical approaches (such as appreciative Inquiry, affordance theory, Agile model, and logic model) to guide the execution of the research.

In practice, contributing for practitioners in the industry, the study has produced:

- An original Conceptual Appreciative Practitioner based UX Framework for BI Dashboards (CAP_UXF_BID_1.1) based on interviews conducted with practitioners.

- An original Validated Appreciative Practitioner based UX Framework for BI Dashboards, (VAP_UXF_BID_1.1) based on survey of a larger sample of practitioners validating a subset of the CAP_UXF_BID_1.1.

- An original Validated Appreciative Practice Oriented UX Framework for BI Dashboards (VAPO_UXF_BID_1.1) from the synthesis of the frameworks produced during the study, discussed in Section 6.6.

Additionally, the document was submitted to Turnitin to assess its originality. The document's originality report can be viewed in Appendix L.

1.11 Overview of the structure of the thesis

The document comprises of seven chapters. Chapter 1 serves as an introduction to the research, Chapter 2 provides domain orientation to the research and expands on the definition of terms, Chapter 3 provides a theoretical foundation to the research, Chapter 4 presents the philosophical viewpoint, research design and methodology followed, Chapter 5 presents the data analysis, Chapter 6 presents the research results and, lastly, Chapter 7 concludes the research. Supplementary Sections have been placed under Appendices A-L. Appendix J provides a visual overview of the thesis layout as well as the layout of the individual chapters. Table 1.2 provides an overview of the thesis per chapter, giving the chapter's objective and relevance.

Table 1.2 Thesis chapter overview.

Chapter	Objective	Relevance
1 Introduction	Introduction to the research. Provide an overview of the study.	Positioning the research within the current disciplinary field.
2 Domain orientation	Provide the novice reader with an orientation to the domain. Linking the research to existing disciplinary concepts.	Included for orientation. A subject matter expert could skip the second chapter and fast track progress through the document should domain orientation not be required or relevant.
3 Theoretical foundation	Present SLR. Present a compilation of conceptual literature-based UX framework for BI dashboards in an agile software development environment.	The need for a UX framework specific to BI dashboards was investigated. The need for a UX framework specific to BI dashboards was confirmed by literature.
4 Philosophical viewpoint & research design	Present the researcher's philosophical viewpoint and approach to the research. Present the overall research design, the methodology followed, why it was chosen, what it comprised of, who was involved, how and when it was conducted.	The gap between theory and practice will be addressed through a pragmatic research approach. The gap between theory and practice will be addressed through collecting data from practitioners in the field.
5 Data analysis	**Qualitative data analysis**	
	Present the analysis of the data collected from the practitioner interviews. Present the practitioners UX framework for BI dashboards.	The need for a UX framework specific to BI dashboards as experienced by Agile Practitioners was addressed.
	Quantitative data analysis	
	Present the descriptive statistics and item analysis performed on the data collected from the practitioner survey. Present the principal component analysis and exploratory factor analysis performed on the data collected from the practitioner survey.	The need to validate and ensure rigour is applied in search for a UX framework specific to BI dashboards as experienced by Agile. Practitioners who will add value to practitioners in practice were addressed.
6 Results & findings	Present the validated practitioners with UX frameworks for BI dashboards.	The need for a UX framework specific to BI dashboards was addressed to expand academic knowledge on the topic of UX for BI dashboards. The practice of Agile in software development is a current reality; the UX framework will enable practitioners to know what is required for the best UX of BI dashboards in practice.
7 Conclusion	Conclude the research to the reader.	Provide an overview of the study to the reader.

Chapter 2 follows next, providing domain orientation to the research.

Chapter 2

Domain Orientation

The purpose of this chapter is to provide domain orientation especially for the novice reader, connecting the research to existing disciplinary concepts. The key concepts relevant to the problem domain are business intelligence, user experience, usability, product design and agile software development.

2.1 Business intelligence (BI)

BI enables organisations to leverage vast amounts of data and assemble them into a decision support mechanism that provides competitive advantage (Božič & Dimovski, 2019). The term 'business intelligence' was first used by Hans Peter Luhn (an IBM researcher) in 1958, when he published a work called *a Business Intelligence System*.

Luhn's definition and view of BI, the different components, and the flow of data, were instrumental in allowing us to what we know BI to be these days. Luhn introduced concepts such as a *single version of the truth* and the motivation to provide *better data* (speaking to data quality) (Alasiri & Salameh, 2020). Luhn's view of data flow (input, process, and output) is also aligned with the Logic model as used in this study (Section 4.3.4).

The term 'business intelligence' was documented to be used in the *Cyclopaedia of Commercial and Business Anecdotes* by Richard Millar Devens (1865). The term was used to describe how Sir Henry Furnese gained profit from receiving and acting upon timely information about his environment sooner than his competitors could become aware of the information (Devens, 1865).

The ability to collect and react appropriately, ideally proactively, based on the information retrieved is central to BI. Up to this day the concept of information presented to the user at the right time to make an informed decision is still a fundamental part of BI (Azeroual & Theel, 2018).

BI includes applications and processes that allow data to be consolidated, stored, retrieved, and analysed as part of an organisation's decision-making process (Côrte-Real, Oliveira, & Ruivo, 2017; Wixom, Watson, & Werner, 2011). These dramatic improvements in data collection, storage, and processing capabilities have created new opportunities in recent years (Brynjolfsson & McElheran, 2019). In recent years, BI applications have emerged as the top spending priority for CIOs (Chee *et al.*, 2009). Executives have realised that data are amongst their most valuable assets (Chee, *et al* 2009). Data driven decision-making can have a considerable effect on the nature and performance of an organisation (Brynjolfsson & McElheran, 2019).

BI spans a wide area of application and software products, and, as can be seen from the definitions, BI can vary in terms of functionality, sophistication, and complexity (Rouhani, Ashrafi, Ravasan, & Afshar, 2016; Wieder & Ossimitz, 2015).

BI can also be viewed from different perspectives: *firstly*, as an all-encompassing architecture of technologies and methodologies utilised to support business decision-making (systems view); and *secondly* as the user-facing application top layer where user interaction takes place (user interface perspective) (Cupoli, Devlin, Ng, & Petschulat, 2013).

Definitions aligned to the *systems view* speak to the different components and functionality of BI. BI systems can be defined as a collection of data analysis tools that organisations use to make efficient and informed decisions through the correlation and analysis of business-related information (Božič & Dimovski, 2019). A complete BI solution is a collection of tools and related technologies, applications and processes that work together towards particular organisational objectives (Wieder & Ossimitz, 2015). A complete BI solution is made possible through the BI components that enable data collection (extract, transform, load – ETL), data storage in data warehouses, data marts, and/or other operational data stores, and for data transformation and analysis (Baars & Kemper, 2008; Choy *et al.*, 2004).

With an increasing demand for 'at a glance' decision-making, in addition, user facing BI tools provide multidimensional data analysis, reporting and query tools to generate valuable information (Chee *et al*., 2009; Choy *et al*., 2004; Ereth & Baars, 2020; Vural, Sengül, Davis, & Gü, 2008). Moss and Hoberman (2004) share this perspective, stating that BI is all the processes, technologies and the tools required to change data into information, and information into knowledge, and knowledge into plans that drive profitable business action. Elbashir, Sutton, Arnold, and Collier

(2021) support this systems view presenting BI systems as integrated support for management control.

Gangadharan and Swamy (2004) defined BI as the output of in-depth analysis of granular business data, including database and application technologies. As well as analysis practices, it encompasses knowledge management, enterprise resource planning, decision support systems and data mining. The definition reiterates that BI collects and enables the effective use of information to improve business success; it also shifts the focus from the internal systems workings of BI to the end result which is the output generated and the user interface perspective.

From a user interface view, the top layer (also called the front-end) analysis tools enable decision-making, forecasting, document management, knowledge management, information visualisation and dashboarding (Chen *et al*., 2012). BI can also be utilised as a performance management framework that help companies set their goals, such as KPIs, to analyse performance against those goals and track their progress, gain insight, take action, and, importantly, measure success (Golfarelli, Mantovani, Ravaldi, & Rizzi, 2014; March & Hevner, 2007). Dashboards provide summary data from BI data sources and systems. Dashboards normally have visual indicators that can be read and interpreted at a glance. Interface components that provide visual signals can be in the form of gauges, traffic lights, speedometers, or other visualisation of information. The components are often colour coded to provide alerts or indicate a particular status (Microsoft, 2009).

The views and definitions presented in Section 2.1 are of importance considering their relevance to the research. They highlight that BI comprises more than the extraction, transforming and loading of databases, but that it is also about the use of the software and tools to assist decision-making to allow for tracking of information that pertains to organisational objectives or key performance indicators (KPIs) and to take action based on the information provided.

For the purpose of this study, BI is defined as the collection, integration, aggregation, storage, preparation, and processing of data from various information resources for analysis. It also includes the ability of the system to produce and present meaningful information at the right time and in the right form to assist management or other individuals within the organisation with improved decision-making ability (Azeroual & Theel, 2018; Olszak & Mach-Król, 2018).

2.2 Information systems (IS)

Bonczek, Holsapple and Whinston (2014) maintain that we could currently be living in what will be referred to in subsequent years as ‘the information age’. They base this assumption on the volume and complexity of information that is readily available and processed by individuals and organisations which has grown enormously. Simon (1977) suggested at that stage in history that we were approaching the initial stages of a third information revolution characterised by technological innovations in information processing, drastic growth groups and organisations in size, number and complexity and human-machine information processing systems. More recent the literature points back to past industrial revolutions, identifiable through these technological advancements, but it also points forwards to the 4th Industrial Revolution (4IR) where the focus is on the quality of life regardless of inequalities across the globe (De Oliveira & Oliveira, 2019).

Information researchers acknowledge that, in the current business environment, IS are one of the most important components. Not only do IS enable companies to pursue opportunities through harnessing the collection, processing, distribution, and sharing of data in an integrated a timely manner (Almazán, Tovar, & Quintero, 2017), but, additionally, they also play vital roles within organisations by supporting business processes and operations, supporting decision-making by employees and managers of an organisation and by supporting the strategies of organisations to gain a competitive advantage (Goyal, 2014).

IS do not only connect data with data and data with people, but they also connect people with people, assisting in bridging geographical spaces, allowing employees of an organisation to be more efficient, which, in turn, also positively impacts processes, administration, and management of information. This allows for improved productivity and enhances the competitiveness of organisations (Abbasi, Sarker, & Chiang, 2016).

The distribution of technology to remote locations has allowed the growth of flexibility in identifying and managing changes. The distribution of technology to remote locations has also revealed that there are significant costs involved in such infrastructure and that the success of businesses depends largely on the IS (Zachman, 2010).

2.3 Decision support systems (DSS)

Management especially benefits from the integrated information generated by BI for their planning and decision-making. Various specialised approaches have resulted from IS, such as management information systems (MIS), decision support systems (DSS), enterprise systems (ES), executive information systems (EIS) (Azeroual & Theel, 2018) and BI. Previously information had to be gathered and collated for executives and management (EIS) providing information for the purposes of decision-making; those dashboards, however, had to be manually updated as they were not connected to the original data sources. Those decision support systems required constant and significant manual input from individuals and departments, and this caused them to be unsustainable (Lamont, 2007). A BI system is a form of decision support system that enables organisations to realise business value (Wixom, Watson, Reynolds, & Hoffer, 2017). See Table 2.1 for an adapted overview of DSS.

BI forms part of enterprise-focussed decision support systems, and it encompasses the retrieval and analysis of data from a data warehouse to produce information using preselected reporting software, query tools, and analysis tools (Nelson & Wright, 2005).

Table 2.1 Decision support systems (DSS) adapted from (Sawaragi, Inoue, & Nakayama, 2012).

DSS Field	Description
Personal decision support systems (PDSS)	Small-scale systems, usually produced for one manager, or a small number of independent managers, to support a specific decision or task.
Group support systems (GSS)	The combination of communication and decision support system technologies used to enable groups of people to work together effectively.
Negotiation support systems (NSS)	The primary focus of this system is the group work negotiated between opposing parties.
Intelligent decision support systems (IDSS)	These systems allow for the application of artificial intelligence techniques to enable decision support.
Data warehousing (DW)	Systems providing large-scale data infrastructure for decision support.
Knowledge management-based decision support systems (KMDSS)	Systems that support decision-making through the storage, retrieval, transfer, and application of knowledge.

Enterprise system (ES)	Large scale enterprise software that supports information flows, business processes, data analytics and reporting, types of which are enterprise resources planning (ERP) systems, enterprise planning systems and customer relationship management (CRM) systems.
Enterprise focused decision support systems including executive information systems (EIS)	BI and corporate performance management systems.

The presentation of information to the user in the *user-facing interface layer* is of interest to the study. As this is the point of interaction between the user and the system, we will now consider *dashboards*.

2.4 Dashboards

The top layers of the BI architectural stack, being reporting, analytics, and dashboards, are distinguishable from the rest of business-intelligence (Cebotarean & Maiorescu, 2011).

A dashboard is a type of graphical user interface which allows for an at-a-glance view of key information specific to a particular business objective or process (Presthus & Canales, 2015). The 'dashboard' is often displayed on a web page or app which is connected to a database that updates the report to ensure the dashboard is automatically updated (Sluijter & Otten, 2017). As an example, a supply chain dashboard may display numbers and percentages related to order efficiency, such as the number of orders placed, or the number of orders delivered on time and in full. Similarly, a logistics dashboard may show data related to the number of issue requisitions per location per period or the availability of critical parts for a specific machine or area of the operations (Golfarelli *et al*., 2014).

Information systems brought increased availability of data that prompted BI analysts and other decision-makers to make sense of the information and knowledge, and this led to data visualisation (Negash & Gray, 2008).

Visualisation is the process of representing data by graphical images. Data allowed for the representation of abstract objects, like, for example, profit, sales, or cost. With abstract data, visual analogues are created. Visualisation of data these days has advanced beyond commonly known graphs (Hehman & Xie, 2021; Qin, Luo, Tang, & Li, 2020). Data visualisation is used to create advanced dashboards in which large amounts of information are presented on-screen (Liermann & Li, 2021).

The automotive industry also focuses on improving the use of automobile dashboards to present information to the driver (Stevens, Bossauer, Jakobi, & Pakusch, 2017) and provide an improved experience to passengers (Hildebrand & Sheller, 2018) with dashboard demands increasing to inform the driver more effectively by making use of technological and societal advances (Stevens *et al*., 2017). Visualisation allows business analysts and other stakeholders to use their natural spatial/visual abilities to identify structural patterns to determine where further exploration should be done or where action should be taken. Visualisation technologies are utilised in domains such as HR, finance, supply chain, marketing, manufacturing, training, and organisational modelling and many other (Presthus & Canales, 2015).

Visual indicators used these days on dashboards can be in the form of gauges, traffic lights, speedometers, or other graphical representations. Often these indicators make use of colours, such as red, yellow, or green, to communicate status or alerts (Microsoft, 2009). A key criterion for a data visualisation component to be considered a dashboard is that it should be connected to a data source that updates the dashboard on a regular basis. Dashboards extract directly from different databases and/or data warehouses and are interactive (Microsoft, 2009, IBM, 2012). The dashboard technology is robust, enabling users to drill down into interesting or task specific information and allowing the user to query the information presented, and, in doing so, providing the company with valuable information to gain a competitive advantage (Chen *et al*., 2012).

Joshi *et al*. (2017) maintained that a waterfall software development approach is the most suitable systems development life cycle approach, while Schmitt and Hörner (2021), Navarro, Pérez, and Ruiz (2016) and Leau, Loo, Tham, and Tan (2012) promote Agile. *This study has explored Agile software development as an opportunistic alternative to waterfall BI dashboard creation*.

In summary, BI enables the extraction of information from data and provides visualised information to support decision making. The visualisations provide for an overview of complex data sets. The overview of data allows for the consumption of complex data constructs. The visual representation and structure of the data allow for the identification of patterns, trends, anomalies, and relationships in the data.

2.5 Human-computer interaction (HCI)

Human-computer interaction (HCI) is a multidisciplinary field paying attention to the interaction between humans and systems, the point of contact between the application and end user (Preece *et al*., 1994). Interactive and dynamic communication (interaction) between systems and users is facilitated by computer hardware and through software interfaces. It is important to notice that there is a focus on the way the system and the user influence each other throughout this interaction (Hsiao & Chou, 2008).

A brief history of the term is provided for the purpose of orientation and context. The term *human-computer interface*, first appeared in a paper on *the ergonomics of a computer* by Shackel (1959). Licklider (1960) then published a paper on 'Man–Computer Symbiosis' which presented man living together with the computer. In 1969 the first human-computer interface conference was held and the first journal, 'The International Journal of Man-Machine Studies' was published. Booth (1989) published 'An Introduction to Human-computer Interaction'; this was really the beginning of the discipline of Human-Computer Interaction (Booth, 1989).

Human-computer interaction is a discipline concerned with the design of interfaces, the evaluation of interfaces, and the implementation of interactive systems for people to use. It is also a discipline concerned with the study of major phenomena surrounding the interactive systems and its use (Dix *et al*., 2004). Many years ago, Booth (1989) had already noticed the interest in human-computer interaction within not only academia, but also industry and government and he maintained that human-computer interaction is important both in research and commercial terms.

In addition to the definitions produced by academia, standards for human-computer interaction have been documented under the auspices of the International Organisation for Standardisation (ISO) and the International Electro-technical Commission (IEC). Human-computer interaction standards have been continuously updated since they were released about 30 years ago (in 1992). A main function of the standards is to force consistent application, and this has been attempted by the ISO/IEC standards for interface components.

Human-computer interaction differs from interaction design and human-centred design in scope, with human-computer design having a narrower focus than interaction design, focussing mainly on the design, evaluation and implementation of interactive systems for use by humans (Rogers, Sharp, & Preece, 2012). Human-centred design is a design focussed subset of human-computer interaction, focussed on design (International Organization for Standardization, 2019).

The ISO 9241-210:2019 formulates **human-centred design** as a specific approach to *interactive systems development* that endeavours to make systems *usable* and *useful* (the term useful was not mentioned in the 1999 definition but was well included in the updated standard of 2010). This is accomplished by paying attention to users of systems, their needs, and their requirements, through the application of human factors or ergonomics, applying usability knowledge and techniques. This all-encompassing tactic improves efficiency and effectiveness, human well-being, user satisfaction, accessibility and sustainability; and it also counteracts possible adverse effects of use on human health, safety and performance (International Organization for Standardization, 2010, 2019).

2.6 Usability

Usability is one of the main concepts that have emerged from the field of human-computer interaction (Dix *et al*., 2004; Gulliksen, Boivie, & Göransson, 2006; Rogers *et al*., 2012).

One of the first definitions of usability saw usability as a principal concept comprising key areas such as memorability, efficiency, learnability, errors, and satisfaction (Nielsen, 1994). More definitions of usability followed, such as the total effort required to learn, operate, and use software or hardware (Jones, 1997), the degree to which the design of a particular user interface considers the physiology and psychology of the users, and also the extent to which the interface makes using the system effective, efficient and satisfying (Gebus & Leivisk, 2009; Gulliksen *et al*., 2006). This definition is aligned to the definition of usability as per the ISO 9241-11, presented further on in Section 2.6.

Rogers *et al.* (2012) define usability as the learnability, effectiveness of use and measure of enjoyment of an interactive product according to the user. Rogers *et al.* (2012) divide the concept of usability into measurable goals of learnability, efficiency, effectiveness, memorability, utility, and safety. Considering the literature (Schrepp, Hinderks, & Thomaschewski, 2017) on the evaluation of UX (considered in Section 2.7.2) there appears to be an intersection of the experience elements proposed and the initial usability elements advocated by Rogers *et al.* (2012).

Other proponents, like Hsiao and Chou (2008), argued that usability refers to the clarity of communication via the user interface; the extent that a user and system can communicate clearly without misunderstanding through the interface. Their definition supports the viewpoint of Preece *et al*. (2002), that maintains that proper interaction design should allow products to support the way people naturally communicate and interact in their everyday lives. The seminal text of Preece, *et al*. (2002) sums up usability as being aimed at allowing products to support people through natural interaction in their everyday lives.

Usability is defined in ISO 9241-11 (1998) as 'the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction *in a specified context of use*' (International Organization for Standardization, 1998). In a subsequent release of the ISO 9241-11 the definition had been adjusted to focus on an interaction goal; usability was defined as the effectiveness, efficiency, and satisfaction *with which users of an application are able to achieve specific goals* (International Organization for Standardization, 2018).

This definition has become even more results oriented in ISO 9241-11:2018 where usability is defined as the *outcome of interacting* with a system, product or service. There is also a clear differentiation that usability is not considered to be a characteristic of a product, even though specific characteristics of a product can contribute to the usability of a product in a particular context of use. As stated in Section 1.2 for the purpose of this study ***usability*** is viewed as an objective quality, and is defined as the effectiveness, efficiency, and satisfaction with which users of an application are able to achieve specific goals (International Organization for Standardization, 1998).

In addition to *usability,* the ISO has also provided related standards of importance to this topic that are worth mentioning. Table 2.2 provides an overview of the related ISO definitions with recent updates.

Table 2.2 ISO codes and definitions of usability.

ISO Code	**Goal**	**Definition**
ISO 9241-11 (1998)	Guidance on usability	Usability: the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.

ISO 9241-11 (2018)	Guidance on usability	Usability: the outcome of interacting with a system, product or service.
ISO/IEC 9126 (1991)	Software product evaluation - quality characteristics and guidelines for their use.	Usability: a set of attributes that bear on the effort needed for use and on the individual assessment of such use by a stated or implied set of users.
ISO/IEC 9126 was replaced with ISO/IEC 25010 (2011)	Systems and software Quality Requirements and Evaluation (SQuaRE)	Usability: the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.
ISO/IEC 25010 (2017)	Systems and software Quality Requirements and Evaluation (SQuaRE)	Usability: the degree to which an IT service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.
ISO/IEC FDIS 9126-1: (2000) was also replaced with ISO/IEC25010 (2011/7)	Software engineering - product quality - part 1.	Usability: the capability of the software product to be understood, learned, used and be attractive to the user when used under specified conditions.

The ISO/IEC 9126-1 describes six categories of software quality that should be considered during product development; those are usability, functionality, reliability, efficiency, maintainability, and portability (ISO/IEC 9126-1, 2020). Note the explicit use of the words ‘when used under specified conditions’, which are similar to ‘context of use’ in ISO 9241-11. The reference to *context* was added to the definition to position it so that a product in itself does not have intrinsic usability but can have the potential to be used in a particular way in a particular context (Bevan, 2001). Usability as a concept, has developed to include usability inspection methods, frameworks, validation through evaluation and measurement of performance which has been covered at length (Jang & Yun, 2020; Weichbroth, 2019).

As usability is a foundational and integral part of user experience, it will be discussed in the follow sections by further considering the principal elements that comprise usability, as well as how usability can be measured. These aspects are important in this study, which has a pragmatic world view, and which is interested in what works in practice.

2.6.1 Usability elements

The primary elements of usability are effectiveness, efficiency, satisfaction, safety, utility, ease of learning (learnability) and the ease with which something can be remembered (memorability) (Nielsen, 1994; Rogers *et al*., 2012). The central qualities of usability will now be further defined:

- *Effectiveness* can be considered to be the extent to which a system or person can realise its/his/her goals and objectives. It also pertains to the completeness and accuracy (how well?) by which users can achieve the particular goals in specified contexts (Dix *et al*., 2004; Y. Rogers *et al*., 2012).

- *Efficiency* considers the user's productivity when using the interface; ease of learning and ease of use are underlying design heuristics. Efficiency pertains to time spent on a task, resources required to complete something or the utilisation of something (Bevan, 2001; Preece *et al*., 2002).

- *Satisfaction* is defined by the ISO 9241-11:2018 as how much the user's physical, cognitive and emotional responses (as a result of system, product or service use) measure up to the user's expectations and needs (International Organization for Standardization, 2018). Satisfaction also plays a part in the user's decision to engage with the interface in the future (Gunesekera, Bao, & Kibelloh, 2019).

- *Safety of a system* refers to be the protection of the user from undesirable situations and dangerous conditions. It can be defined as the extent to which an interface allows users to perform a task or interact free from unacceptable risk of human, data, equipment or environmental losses or accidents (Bretschneider-Hagemes, Korfmacher & Von Rymon Lipinski, 2018; Rogers *et al.*, 2012).

- *Utility* pertains to functionality of the intended design. It determines whether the user's need has been met in terms of what the user wants it to do. It is important that a product is both easy to use and does what the users want. Similarly, it is also important to consider that, if a product can do what you want but it is very cumbersome to use, the usage of the product will also be affected (Nielsen, 1994; Rogers *et al.*, 2012).

- *Learnability* (ease of learning) points to how easy it is for a user to learn to use a product or service. When considering the System Usability Scale (SUS) used to measure learnability we can see that two parts of learning are measured, firstly *how quickly* a user can learn to use a system and, secondly, *how much* needs to be learnt to be able to use a system (Brooke, 2020; Gebus & Leivisk, 2009; Norman, 2013).

- *Memorability* (ease with which something can be remembered) can be defined as the quality of something being easy to remember or worth remembering. Memorability is how easily users can return to a system after a period of not using the system and resume proficiency (Nielsen, 1994; Sukmasetya, Setiawan, & Arumi, 2020).

In summary, understanding the central qualities of usability allow for the use of these qualities as criteria to evaluate the usability of a product or service (Bevan *et al.*, 2016; Nielsen, 1994; Rogers *et al.*, 2012). It is necessary to break up usability in terms of its elements of effectiveness, efficiency, and satisfaction to quantify, measure and verify the use.

2.6.2 Usability evaluation

Usability is evaluated and measured by utilising specific metrics that can be observed and can be quantified in terms of the interaction of a user with a system (Tullis & Albert, 2008). The goal of usability measurement is to assess the usability of a system to enable the incorporation of feedback back into the SDLC to improve the usability of a system (Foltz *et al.*, 2008).

Various techniques can be employed for the purpose of usability evaluation, such as interviews, focus groups, questionnaires, direct observation in the field, direct observation in a controlled environment, and indirect observation (Preece *et al.*, 2002). Several tools have been developed and employed to evaluate usability, such as the SUS (System Usability Scale) developed by Brooke, SUMI (System Usability Measurement Inventory) developed by the Human Factors Research Group (HFRG) at the University College Cork, and PSSUQ (a Post-Study System Usability Questionnaire) developed by IBM (Assila, Oliveira, & Ezzedine, 2016). However, usability alone is no longer sufficient when designing software (Law *et al.*, 2008) and, therefore, the concept of UX needs to be explored.

2.7 User experience (UX)

The success of a product cannot be achieved these days by supporting users to accomplish their goals through incorporating good usability (Fronemann & Peissner, 2014). Hildén *et al*., (2016) state that a flawlessly working system is no longer enough; organisations also must ensure that a delightful experience is provided to users. UX focusses on non-functional elements of interactions, concentrating on the user enjoyment and sensation.

This aligns to the direction in industry to consider the holistic user experience and not only usability of a product (Fronemann & Peissner, 2014; Roto, Lee, Mattelmäki, & Zimmerman, 2018; Schulze & Krömker, 2010). Arguments have also previously been raised from the human-computer interaction community that usability as a single framework for user-system relationships is not sufficient to react to change in products, product-service software systems (Law, Van Schaik, & Roto, 2014). This viewpoint, that the concept of usability is insufficient for user-system interactions, has produced various UX frameworks by academia (De Kock *et al*., 2016; Desmet & Hekkert, 2007; Karapanos *et al*., 2010; Law *et al*., 2015). These experience-specific frameworks have allowed for an improved comprehension of the phenomena called experience from both an experiential as well as a pragmatic point of view.

The interest in the field of UX in both academia and industry points to the fact that practitioners and HCI researchers alike have acknowledged the limitations of traditional usability and recognised that products need to be both usable and pleasurable as a well-functioning system is not sufficient anymore (Jordan, 2000; Norman, 2004).

User experience will now be considered to allow for an understanding of the importance of UX, the background of UX and where it fits into this research.

Looking back at the knowledge about the topic and the diverse viewpoints of the field from a group discussion to find a shared definition on what UX really was, revealed that the topic has come a long way. Previously statements about UX, including the following (Law *et al*., 2008:2397), were made, such as “UX is an emergent field without a formal body of knowledge”, “UX is a term that is elusive to grasp”, “UX is a momentary feeling a user has while interacting with a system”, “UX is an attitude towards a system”, “UX is an emotional bonding with a system”, “we cannot design user experience, but we can design for user experience”, “Usability is subsumed by UX”, "expectations determine user experience", "UX is a value". Next, current definitions will be considered and then we will look at ways UX is measured and how the body of knowledge is moving closer to a more widely explored landscape of user experience.

According to Hildén *et al*. (2016), the field of UX is concerned with the studying of, designing for, and evaluation of the experiences that people have as a result of system use. Research in the field of user experience has increased in recent years and a number of user experience evaluation methods has seen the light of day. Additionally, there are products that demonstrate 'pure UX' by focusing on, and fulfilling, a specific user need (Fronemann & Peissner, 2014). Where usability focuses on improving human performance, UX, on the other hand, focuses on improving the user satisfaction through achieving hedonic and pragmatic goals (Petrie & Bevan, 2009).

From the development of the UX Manifesto, the UX principle, policy and plan have emerged and have formed the Pillars of the UX Manifesto, see Figure 2.1 (Law, Vermeeren, Hassenzahl, & Blythe, 2007). UX has also been defined by the ISO 9241-210 and includes user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO 9241-210, 2019). When this ISO definition (usability) is compared to the ISO definition of user experience the difference is in focus and scope, of task performance (for usability) and overall pleasure (for the user experience) (Bevan, 1995). The ISO definition of UX forms part of the standard on the ergonomics of human-system interaction. From the ISO definition, UX is all encompassing, including all the emotions, preferences, beliefs, perceptions, psychological responses, physical responses, behaviours, and accomplishments of a user that occur before use, during use and after use. Three principal aspects are elevated by the ISO definition of UX to influence the user experience; these are the system being used, the user and the context of use, and they are aligned to definitions from the literature (De Kock *et al*., 2016; Law *et al*., 2008).

The Nielsen Norman Group defines 'user experience' as all aspects that pertain to the end-user's interaction with a company, the company's services and the company's products (Norman & Nielsen, 2021).

According to Sutcliffe and Hart (2017), UX is the users' judgement of the quality of a product as a result of interacting with the product as well as the product qualities that allow for effective and pleasurable use. Similarly De Kock *et al*. (2016) define UX as a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service. UX includes all the user's emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours, and accomplishments that occur before, during and after use. UX is a consequence of brand image, presentation, functionality, system performance, interactive behaviour and assistive capabilities of the interactive system, the user's internal and physical state resulting from prior experience, attitudes, skills and personality, and the context of use. UX can be broken down into elements that are user-related, system-related and context-related.

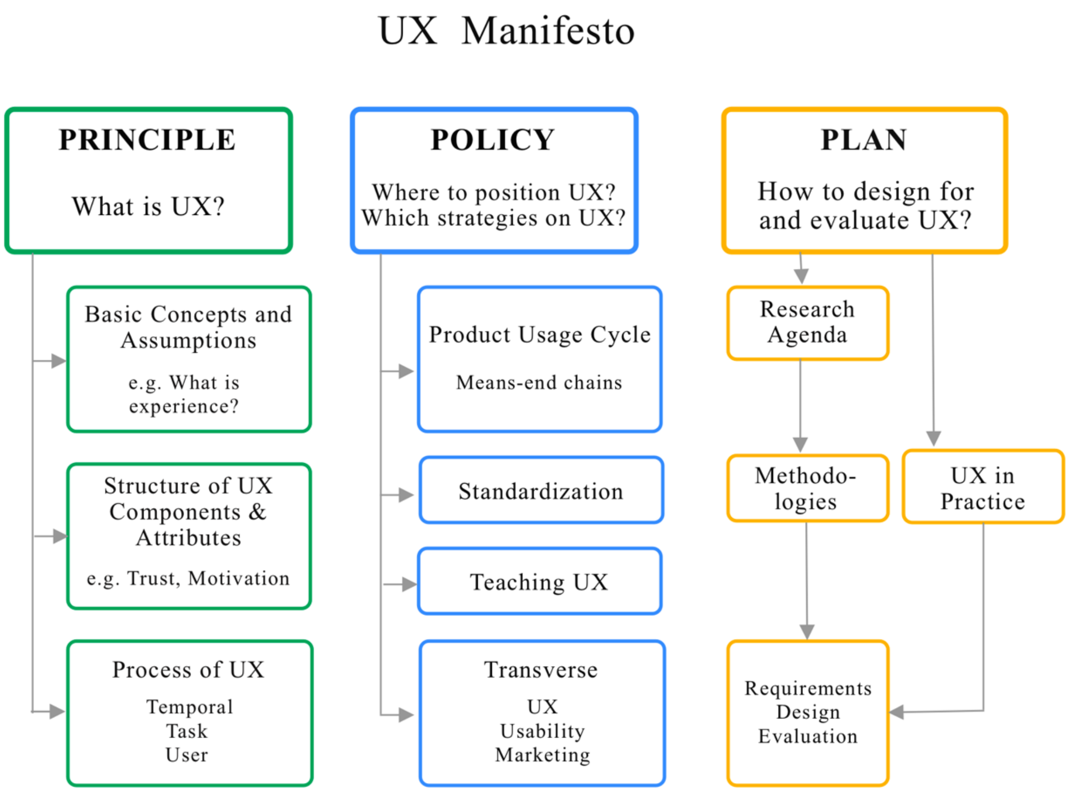

Figure 2.1 Pillars of the UX Manifesto.

Kuniavsky (2010) presents UX as the combined perceptions of users while they interact with a product or service. Similar to usability, the perceptions that Kuniavsky (2010) includes are effectiveness (how bad or well was something done), efficiency (how slow or fast, or cheap or expensive something is), emotional satisfaction (how does the user feel about the overall outcome) and, in addition to those, the quality of the relationship that was established with the product or service provider (considering the expectations that are set for subsequent interactions). De Kock *et al*. (2016) also generalises the concept of UX and states that user experience describes how persons feel about a product; it also describes the pleasure and satisfaction associated when using or interacting with something.

Zaharias and Mehlenbacher (2012) presented user experience as a dynamic process that involves both the traditional concepts of usability and accessibility within Human Computer Interaction (HCI) as well as the hedonic and affective design qualities formulated by Hassenzahl and Tractinsky (2006). Hassenzahl (2008) positions UX as a person's perceptions and reactions that result from either the use, or the anticipated use, of a product, system, or service. This definition aligns closely with the Nielsen Norman Group of UX. Hekkert (2006) considers the importance of time in the definition and maintains that UX is a time specific, momentary, primarily evaluative feeling (either good or bad) while the user is interacting with a product or service. Shedroff (2001) presents the term as all aspects of the experience (specific or general) that a customer, user or audience member encounters with a product, service, or event. He also emphasises that the experience includes more than mere functionality and flow, but also the comprehension formed through use of all senses.

According to the internet giant Google, user experience encompasses every interaction that people have on a website, mobile site, app, online properties, or services. They operationalise their definition saying that creating a good user experience means focusing on the user wherever he/she might be. They also state that the overarching goal of a good user experience is to help users to do what they want to do when interacting with a system or organisation (Pinto, 2018).

UX has become increasingly important as a product quality in conjunction with providing opportunities for user engagement and enjoyment (Fronemann & Peissner, 2014). UX design has also started to attract more management attention as it has been consistently associated with financial success and increased innovativeness according to business leaders (Brown, 2008; Koskinen, Karvonen, & Tokkonen, 2013). A study conducted presented the opinion that a user interface designed well could potentially increase a website's conversion rate by up to a 200%, and a better UX design could yield conversion rates up to 400% (Gualtieri, 2009).

The literature points to the importance of enjoyable UX to ensure business success (Fronemann & Peissner, 2014). This, in turn, focuses the attention on the ability of an organisation to activate the entire organisation to improve the UX through its daily work (Hildén *et al*., 2016). Liikkanen (2016) maintains that a strategic UX initiative is required for practical UX to succeed and to achieve a new level of UX requires strategic thinking in large organisations. Traditional industrial companies are forced to develop their own capabilities to be able to meet internal demands in the software domain. Several suggestions have been made from the literature on how to make UX part of companies (Macdonald, 2019).

It is important to have UX experts that lead the adoption and understanding in the organisation; indeed, the entire organisation needs to be bought into UX to move towards a competitive advantage (Hildén *et al*., 2016). Throughout disciplines there has been a drive to establish UX teams in-house as organisations are realising the value of creating their own internal UX departments (Macdonald, 2019). In-house UX teams allow organisations to produce product experiences that are more consistent, and, which, in turn, improve user satisfaction (Alves, Valente, & Nunes, 2014). Organisations should consider changing their focus from a problem-driven approach to an experience-driven design approach to be able to ensure the best experiences possible (Hildén *et al*., 2016).

2.7.1 UX elements

As mentioned in the definition of UX above, there are proponents that maintain that UX comprises mainly three elements, viz. the user, the system, and the context of use (Hassenzahl & Tractinsky, 2006).

De Kock *et al*. (2016) elaborates on this by describing these elements as follows:

- the *user* comprising of the expectations, predispositions, needs, motivations, etc.;
- the *system* as comprising of the hedonic qualities, the pragmatic qualities, the usability, functionality, etc.; and
- the *context* as encompassing the organisation, technical environment, or physical environment.

User experience elements can also be divided under concepts of hedonic quality (Hassenzahl, 2003) or user satisfaction (based on the ISO 9241-11). Another perspective is that product design encapsulates three levels of information processing (as experienced by the users): a visceral (or intuitive) level; a behavioural level; and a reflective level.

This indicates that usability elements, do not cover all the aspects relevant to the user for the best experience (Norman, 2004). An example of contextual user experience elements are as per Figure

2.2 which represents the elements of user experience for a mobile augmented reality context (Irshad *et al*., 2016) .

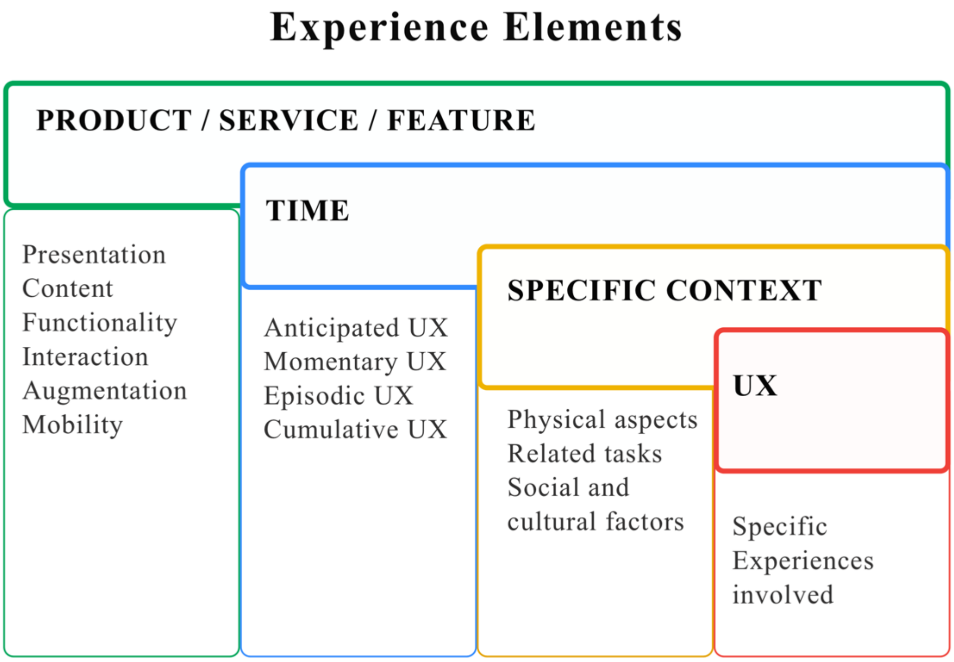

Figure 2.2 Elements of UX for a mobile augmented reality context (Irshad *et al.*, 2016).

2.7.2 UX evaluation

There are several ways to evaluate the user experience depending on the goal of the evaluation and the resources available, such as time, access to users and systems. As user experience is subjective and based on a collection of the user's past experiences, expectations and context, methods such as heuristic evaluations have not been considered in depth for the evaluation of UX (ISO 9241:10, 2010). Law *et al*. (2014) still expressed uncertainty with regard to understanding whether UX constructs are measurable.

Questionnaires have been commonly used as tools for the assessment of usability. Questionnaires allow for efficient quantitative measurement of a specific screen or product feature. These quantitative questionnaires are usually used in conjunction with other quality assessment methods to evaluate the UX and enable an interpretation of results (Laugwitz, Held, & Schrepp, 2008). A number of user experience questionnaires have been developed (Schrepp *et al*., 2017).

One such questionnaire is the User Needs Questionnaire (UNeeQ). The user experience exploration concept was developed by Fronemann and Peissner (2014), and it is based on the user experience concept testing approach by Sproll, Peissner, and Sturm (2010). It consists of a User Needs Questionnaire (UNeeQ) which is based on the UXcellence Framework. It evaluates the user experience of a product by measuring the accomplishment of the ten basic needs, which are security, self-expression, keeping it meaningful, relatedness, popularity, competition, physical health, competence, influence, and stimulation. The overall user experience is also measured. Results point to the UX Concept Exploration being valid, robust, and serving the purpose as a UX-based innovation method (Fronemann & Peissner, 2014).

Another user experience questionnaire that was developed is the User Experience Questionnaire (UEQ). It evaluates the interface attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. It is a simple and efficient tool to enhance the results from expert evaluations or usability testing. The questionnaire proved that user experience considerations (which involved how the user feels about the interface) and the usability considerations were equally important for the end user. The UEQ was easy to use, reliable and a valid measure for user experience, to be used in conjunction with complementary data from subjective methods with quality ratings (Laugwitz *et al*., 2008).

The UEQ was then later further developed to include more subcategories for each of the six main categories mentioned above, ending with 26 categories in total on a continuous scale with extreme values at each end that are tested. Where the research participant has to select *towards* a particular concept or *away* from a particular concept, for example asking how a user experiences a website, it is either ‘annoying’ or ‘enjoying’ (Schrepp *et al*., 2017).

Google’s HEART framework is a tool to evaluate the quality of user experience (Rodden, Hutchinson, & Fu, 2010). The HEART framework guides the right choice of user experience metrics for a product. The HEART framework measures user happiness, engagement, adoption, retention, and task success. The tool is robust enough to facilitate the identification of meaningful metrics that could be practically implemented and that optimise the business for an organisation (Rodden *et al*., 2010).

The literature uses combinations of interviews and surveys to collect data to evaluate and measure UX constructs (Law *et al*., 2014; Procci, Singer, Levy, & Bowers, 2012). Data capturing strategies, such as surveys and interviews, can be distinguished from tools (like questionnaires, eye tracking and keyboard logging) that are used to collect data from respondents. Measurement can be employed to check whether a new release of a product version improves the user experience, or whether the new release impacts business metrics such as, for example, customer conversions. To evaluate user experience, we need to determine what constitutes user experience and what should be measured to be able to determine at a minimum the improvement or a deterioration in UX. In summary, the use of questionnaires as a tool is cheap and highly efficient for the quantitative measurement of a specific quality of a product (Schrepp *et al.*, 2017).

2.8 Product design

Product design is included in the domain orientation as it is relevant to the study in that it forms part of the agile software development life cycle. Product design is defined as the task of designing a software product for an organisation while keeping the user's needs as well as the business objectives in mind (Interaction Design Foundation, 2020). The goal of product designers is to improve the user experience by identifying user problems, solving these user problems, implementing solutions and thereby unlocking and delivering customer value and enabling a sustainable customer base (Duc & Abrahamsson, 2016).

Product design is aimed at creating products that go beyond usability and experience and are not just delightful to use but are also designed to perform well from a business growth perspective. Product design includes product goals, high-level summaries or 6–12-month forecasts of product offerings and features on product roadmaps and driving the delivery of successful products. Product design can be described as a wider field than user experience, which is, in turn, a wider field than usability. Product designers keep an eye on the potential impact of design decisions; they are subject matter experts with rich domain knowledge and they are also very much aligned to organisational objectives (Interaction Design Foundation, 2020).

According to Stoica, Ghilic-Micu, Mircea, and Uscatu (2016), software development models assist in the improvement of the quality of software, and software development models also improve the overall development process. Software development models are different methodologies or processes that have been chosen to develop a piece of software according to its objectives and purpose. Many different types of software development life-cycle models exist; each model having been developed with specific objectives in mind. The Software Development Life Cycle (SDLC) is a process that describes the activities performed during each stage of the software development process (see Figure 2.3).

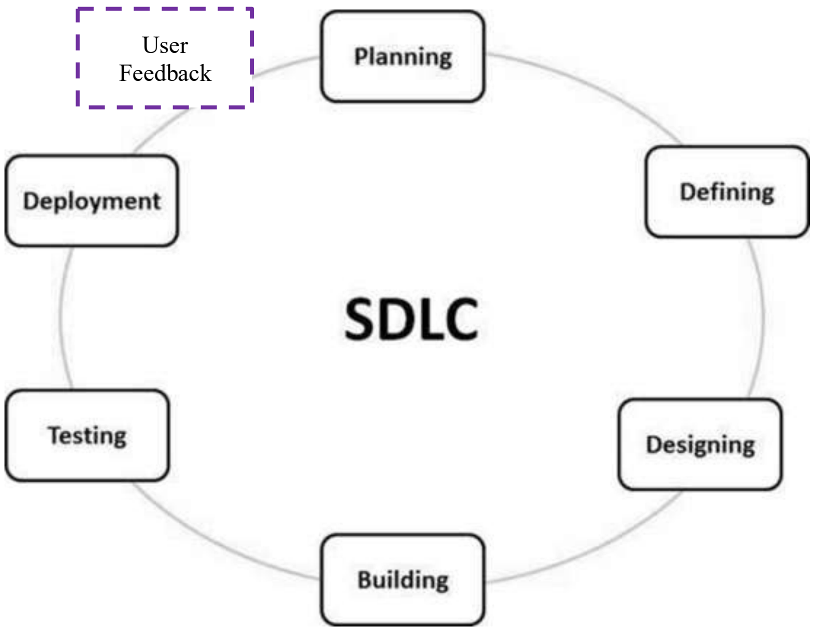

Figure 2.3 Typical stages of the software development life cycle (SDLC) adapted from Stoica *et al.* (2016) by adding 'user feedback'.

2.9 Agile software development

Agile software development is an iterative approach to software development, following incremental development cycles during which the development of the software follows a recurring iterative pattern to release software to gain feedback which is used to improve solutions and subsequent releases (Szalvay, 2004). Agile software development differs from traditional software development. Historically software was developed by completing one step or part before continuing to the next part of the project or development. Another important difference is that the software is delivered to the users only when the development has gone through all the steps and all the steps have been completed (Geiser, 2020; Szalvay, 2004).

Agile development is employed to enable the improvement of the user experience at quick turnaround speeds (Gothelf, 2013; Liikkanen, Kilpiö, Svan, & Hiltunen, 2014; Nguyen & Dupuis, 2019). It is different from the serial development of software done in the past where user testing occurred only towards the end or after the completion of the development of the software in that users are involved in testing the product as early as possible once a minimal viable product (MVP) is ready (Cheng, 2016). An MVP encapsulates the basic product features that meet the users' needs or requirements (Lenarduzzi & Taibi, 2016).

The Agile Manifesto (Beck, *et al*., 2001) is a proponent of the following :

- it values individuals and interactions over processes and tools;
- it focusses on working software over comprehensive documentation;
- it values customer collaboration over contract negotiation; and
- it promotes responding to change over following a plan.

Key agile principles (Leau *et al*., 2012) are: (1) The involvement of customers at an early stage; (2) Following an iterative development process; (3) Self-organizing teams; (4) Adaptation to change.

Cheng (2016) maintains that this iterative and experimental way of developing software has influenced and altered methods used to develop user-centred products. This way of thinking and focussing on the user is grounded in the beliefs of lean production approaches and design thinking (Holweg, 2007). The concept of *agile software development* will be discussed further in Section 4.3.2 when the Agile model is considered as it holds contextual importance in the research and has been included in the theoretical framework of the study.

2.10 Chapter summary

The purpose of Chapter 2 has been to provide the reader with information about research domain concepts to allow for an informed understanding of these key concepts.

Now that these terms have been introduced, the theoretical foundation to the research will be offered in Chapter 3.

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Chapter 3

Theoretical Foundation

Chapter 3 continues from the introduction presented in Chapter 1 and the domain orientation provided in Chapter 2. This chapter concentrates on the systematic literature review conducted during the study. The chapter has been compiled with the following objectives:

- To present the systematic literature review that was undertaken during this study. For this purpose, the strategy of the literature review and the process followed is described in Section 3.2. This strategy and process are outlined to explain how the final literature publications that formed the basis of the literature review were selected and also the basis of the literature-based conceptual framework that was developed.

- To present an analysis of the systematic literature that was undertaken. As described in Section 3.3, this includes the inspection of the frameworks that formed part of the systematic literature review, focusing on the research goals of each piece, the methods employed and, importantly, the elements identified by each of these frameworks.

- To present the identification of the need for UX frameworks for BI dashboards based on the literature review in Section 3.4.

- To present the ***conceptual literature-based UX framework*** **(CL_UXF_1.1)** that was developed as output and presented in Section 3.5, constituting the literature reviewed for BI dashboards.

Chapter 3 continues by defining a literature-based framework in Section 3.1. Section 3.2 presents the systematic review strategy and process. Section 3.3 presents the analysis of the UX frameworks selected through the systematic literature review. Section 3.4 highlights the need for UX frameworks for BI dashboards. Section 3.5 presents the CL_UXF_1.1 framework developed from the literature review for BI dashboards. The chapter is summarised in Section 3.6.

3.1 Literature-based framework

For the purpose of this study, a *framework* is considered, as per Reeves (2013), to be a way of packaging Human Computer Interaction (HCI) theory into dispersible and re-usable structure, so as to bring and keep subsequent design and application up to date.

During the systematic literature review, a number of user experience frameworks were reviewed. From the review it became apparent that, for each of these frameworks, there were different areas of focus and different goals and that the elements of the frameworks were at varying levels of abstraction (some were low level, granular elements, while other were higher level, grouped categories). After comparing the selected pieces of literature, the theoretical grounding, the different stages of development at which the research was aimed were identified, the research goals were considered more closely as were the framework elements of which these different frameworks were comprised.

The use of interactive dashboards has become a preferred technique for assisting users in data discovery and analysis. The usability of BI tools has, unfortunately, not been fully developed to a level at which novice users can utilise the features effectively and efficiently without the assistance from technical experts (Smuts *et al*., 2015). The literature confirms that limited research has been conducted on usability criteria specific to BI applications that support novice users (Smuts *et al*., 2015). Smuts *et al*. (2015) propose that usability guidelines be considered as criteria for the design and evaluation of information visualisation tools.

This also points to a need for specific context-relevant research into BI tools, and it highlights the need for a usability framework for BI. The output of the systematic literature study produced a literature-based conceptual framework that included usability elements which form an integral part of the wider user experience framework.

Subsequently, a conceptual framework, identifying the elements that influence the UX of BI dashboards. was developed from the systematic literature review, addressing the secondary research question (SRQ1), objectives and the outcome set out in Chapter 1, Section 1.5.

3.2 Literature review strategy and process

In academia it is critical to build new research on existing research and relate new research to existing knowledge (Snyder, 2019). With the substantial increase in and availability of information on the web, it is essential to employ strategies when selecting information to ensure the quality and relevance of the information. A systematic literature review was undertaken to identify the existence and occurrence of topic relevant literature.

A systematic literature review allows for the formulation of general statements about existing literature or an overarching conceptualisation (Baumeister & Leary, 1997). Systematic reviews aim to identify, critically evaluate and integrate findings of all relevant, high-quality individual studies addressing one or more research questions (Siddaway, 2014). It is important for a researcher to conduct a robust systematic review of the literature, allowing for the identification of the current literature, its limitations, quality and potential (Piper, 2013). A systematic literature review is also a methodological and rigorous review of research results (Weichbroth, 2020). Systematic reviews are characterised by being objective, systematic, transparent and replicable (Siddaway, 2014). In addition to potentially answering the research question, the information retrieved will give guidance with regard to the planning and suggestion of the value of novel research (Piper, 2013).

Research papers summarised in a literature review are referred to as *primary* studies, while the review itself is a *secondary* study. The accumulation of evidence through secondary studies can be very valuable in offering new insights or in identifying where an issue might be clarified by additional primary studies (Brereton *et al.*, 2007).

Not only is the aim of a systematic literature review to aggregate all existing evidence on a research question, but it is also intended to support the development of evidence-based guidelines for practitioners (Kitchenham *et al.*, 2009). Evidence-based research and practice was initially developed from research in the domain of medicine. Since then many other domains have adopted this approach, including social policy, economics, education, nursing and information systems (Kitchenham *et al.*, 2009). The end point of an evidence-based software engineering review is for practitioners to use the guidelines to provide appropriate software engineering solutions in a specific context (Brereton *et al.*, 2007). Reviews of existing research evidence have the prospect of informing both practice and scholarship (Briner, Denyer, & Rousseau, 2009).

For the purpose of this study, a systematic review is defined as: 'A review of clearly formulated questions that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the primary studies that are included in the review' (Siddaway, 2014).

It is important to construct a protocol for conducting a literature review since the protocol provides clear guidance for conducting a literature review (MSKTC, 2019). It is essential to develop the protocol before commencing with the literature review. To ensure that the process is clear and consistent throughout, it should include information considered to identify and screen relevant articles for the review, and it should also outline the review methods for the entire process (MSKTC, 2019).

A systematic literature review was undertaken as part of this study's research proposal in January 2017 to gain visibility of relevant literature available for consideration to be included and analysed in preparation for the study. The systematic literature review enabled a broad view of past research. The systematic literature review was updated in March 2019 to confirm that the research problem was still relevant to date. Revisiting the literature allowed for capturing the increase in the number of research articles published since the initial review (Table 3.1).

The strategy employed in this literature review comprised of constructing a review protocol which included the stages described by Siddaway (2014) as part of the method used for the systematic literature review. The literature review stages were used as guidelines to conduct the systematic review: stage 1 – Scoping; stage 2 – Planning; stage 3 – Identification (searching); stage 4 – Screening; and stage 5 – Eligibility and Quality. As the process progresses the number of records identified, screened, and selected as eligible move through a review funnel, leaving only the records of essential value to the research question. Figure 3.1 illustrates the reduction process with stages of how the number of records for each stage was filtered for suitable records.

3.2.1 Literature review Stage 1: Scoping

Stage 1 of the literature review involved the 'scoping' of the literature in order to establish what research has been done before and what might make a novel, important and interesting scientific contribution to the literature. The research area was scanned to account for other literature reviews that already exist, to assess the number of research studies that must be assessed, and to help formulate and clearly define the purpose, scope, and specific research question the review will address (Snyder, 2019).

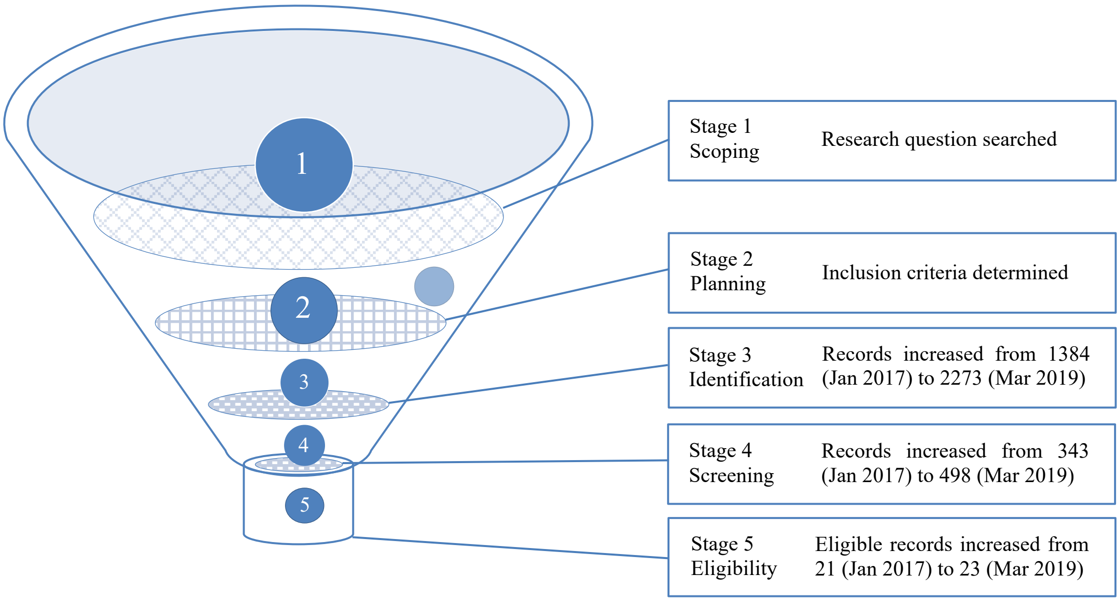

Figure 3.1 Systematic literature search (5 stage) process of filtering search results (updated March 2019).

During this stage of the study, the research question took shape and was formulated as: *What are the elements that influence the UX of BI dashboards?* The question was formulated to be clear, specific, and answerable, as recommended by Siddaway (2014). The research question was also formulated in such a way that it would focus on a narrow search area in the literature. The digital libraries (IEEE Explore, ACM, Scopus, and Springer) and search engine (Google Scholar) summarised in Table 3.1 were consulted to identify whether a previous systematic literature review of this research question had been conducted. The literature was searched for using the Google Scholar, digital libraries, and University of South Africa (UNISA) e-library search engines, and only the articles accessible from the UNISA e-library were used to ensure that peer-reviewed, quality publications were included in the study. These digital libraries were chosen as they contain comprehensive collections of practitioner and academic literature with full-text articles and bibliographic records.

3.2.2 Literature review Stage 2: Planning

Once no indication of a previous systematic review of the research question could be found, the research question was broken down into keywords as summarised in Table 3.1 to continue the search for literature on the topics relevant to the research question. The searches were done between 14 January 2017 to 28 January 2017, and again during March 2019, to check for new relevant literature. The keywords for the database searches were business intelligence, business analysis, big data, usability, visualisation, analysis, knowledge visualisation and UX. The following inclusion criteria were applied to the results returned by the database search:

1) Must be written in English; and
2) The title, abstract or keywords must mention at least two of the key words.

Table 3.1 Keyword search results across digital libraries.

BI	BA	BD	U	V	A	KV	UX	ACM Jan2017	ACM Mar2019	Google Scholar Jan2017	Google Scholar Mar2019	IEEE Explore Jan2017	IEEE Explore Mar2019	Scopus Jan2017	Scopus Mar2019
x		x						97	173	33700	32900	256	282	228	271
x		x	x					2	3	1890	4710	2	2	3	5
x		x			x	x		1	3	312	110	1	2	6	16
x					x			213	339	25700	60400	279	627	2960	1136
x			x		x			3	6	4200	8800	4	8	5	12
	x	x	x					1	3	581	1600	1	5	0	1
	x	x						104	214	4490	13100	304	798	89	252
		x	x					46	75	13800	35600	113	282	157	453
x			x					52	66	13700	19700	82	108	64	92
	x		x					15	21	833	3210	11	25	3	7
		x		x				316	589	26900	74300	934	2373	997	2936
		x				x		87	144	230	590	128	331	3	6
x				x				234	288	18600	34400	262	430	246	424
x						x		79	92	265	387	61	99	3	5
	x					x		31	42	37	72	31	54	1	1
	x			x				98	141	3280	9000	160	306	27	64
x							x	1	6	n/a	12600	n/a	177	n/a	33
		x					x	2	46	n/a	27000	n/a	657	n/a	353
x					x		x	1	21	n/a		n/a		n/a	
Title search: 'BI' and 'U' Title								1	1	n/a		n/a		n/a	
Title search: 'BI' AND 'UX'								0	0	n/a		n/a	n/a	n/a	n/a

Table 3.1 Legend: BI - Business Intelligence, BA – Business Analysis, BD – Big Data, U – Usability, V – Visualisation, A – Analysis, KV – Knowledge Visualisation, UX – User Experience.

3.2.3 Literature review Stage 3 & 4: Identification and Screening

The different search combinations yielded varying search results from the different digital libraries (electronic databases) and the search engine. Boolean search operators were used to narrow the searches. To narrow the search down further, only the ACM literature was imported into an electronic citation manager Mendeley, as the ACM literature was of sufficient academic quality compared to the other search engine results. The ACM Digital Library is the full-text collection of all articles published by the ACM in its articles, magazines, and conference proceedings. The search results were reduced to the ACM articles as the ACM Digital Library is a comprehensive collection of records representing the fields of computing and information technology.

3.2.4 Literature review Stage 5: Eligibility and Quality

During the eligibility stage of the literature review, the remaining results were read through quickly to confirm that the *content* of the literature publications was relevant to the proposed study. During this process, there were further eliminations, and the results were further reduced to 197. Thereafter the remaining records were further investigated for quality. This was done through identifying whether the literature publication qualified for inclusion by complying with the inclusion criteria that needed to be present in the literature publication.

The inclusion criteria were the mention or discussion of theory, methods, research questions and the research findings. During this stage, the UX elements and topics relevant to the research in the various literature publications were collected and inserted as column headings to the results spreadsheet, and the re-occurrence of elements was marked and mapped to the column headings to be able to identify how often similar UX elements and other topics relevant to the research were mentioned by the different literary publications. At that stage of the process, it was noted that some of the literature reviewed discussed similar concepts but used synonyms, which then led to a decision to group the 66 topics identified in the literature results.

The grouping of the relevant research results topics was accomplished through a card sorting exercise conducted by three people to group topics written on cards to see how these topics could be grouped and whether the topics were understood in a similar way by the three people. The aim was purposefully to focus on relevant topics to produce a more meaningful set of literature references to take forward into the following stages of the research process.

3.2.5 Element extraction and marking process

The stepwise process that was followed in the element extraction and marking will now be explained. Firstly, a table was created with the literature publications as rows. The framework elements were then added as table column headings. Secondly, each literary publication that was selected as eligible was reviewed for framework elements. Thirdly, the elements from the first literary publication were added to a table to start the creation of the columns. Fourthly, these elements were marked for the corresponding row of literary publications as ‘present’ in the literary publication. Then that process was repeated until all the literary publications had been reviewed for their framework elements, and all new elements had been added to the table as columns. The literary publications reviewed were dated between 2007 and 2017. A total of 21 frameworks were compared based on their use of supporting theory, the description of methodology employed, their qualitative/quantitative/or mixed method nature, the limitations mentioned, and their elements presented for the framework. Refer to Appendix A for the matrix compiled from the literature review process.

3.3 Literature analysis

The process of inspecting and analysing the qualifying publications allowed for the emergence of research themes present in the literary publications, Table 3.2 (chronologically ordered).

The literary publications were inspected to identify the research goal of each of the publications. From the qualifying literature that was considered, the most common goals for creating UX relevant frameworks are (from most to least): the identification of specific UX elements for a specific purpose; UX in practice; user accessibility; UX within organisations; Minimum Viable Product (MVP) improvement; and design innovation. Sub-themes that emerged are: context relevant frameworks; using UX towards improved product development; UX design improvement; relativity of time in the UX; and building trust through the UX.

From the qualifying articles reviewed, eleven (11) literary publications mentioned the theoretical basis for the framework that they developed. Theories employed in the selected literature publications were: human–computer interaction theory; network theory; activity theory; domain action theory; means–end theory; affect theory; and appraisal theory.

Table 3.2 Qualifying literature publications research goals and emerging themes.

Reference	Title	Literature contribution	Research goal	Theme
Shin, Im, Oh, & Kim (2017)	Design for experience innovation: understanding user experience in new product development.	A framework for experiential networks and experience innovation based on the network concept.	To understand the relation between users and products in a complicated usage context.	Users/Product (context)
Cheng (2016)	The Mobile App Usability Inspection (MAUi) Framework as a Guide for Minimal Viable Product (MVP) Testing in Lean Development Cycle.	The Mobile App Usability Inspection (MAUi) Framework as a Guide for Minimal Viable Product (MVP) Testing in Lean Development Cycle.	To improve the quality of a minimum viable product (MVP) in a lean development cycle.	MVP (context)
De Kock *et al.* (2016)	User Experience of Academic Staff in the Use of a Learning Management System (LMS) Tool.	A framework of the factors that influence the user experience of the academic when using an LMS	To identify factors that will influence the user experience for an online learning management system.	UX elements (context)
Hildén *et al.* (2016)	Participatory Development of User Experience Design Guidelines for a B2B Company.	Participatory development of user experience guidelines for B2B company.	To support the change in the internal organisational culture towards UX.	UX within the organisation (context)
Hokkanen *et al.* (2016)	Focusing on User Experience and Business Models in Start-ups: Investigation of Two-dimensional Value Creation.	Minimum viable user experience framework (MVUX).	To identify and structure the UX elements that are essential when building early product versions.	MVP
Irshad *et al.* (2016)	Multi-layered Mobile Augmented Reality Framework for Positive User Experience.	Multi-layered mobile augmented reality for positive UX.	To devise a framework that highlights augmented reality design elements (product features) significant for the UX.	UX elements
Liikkanen (2016)	UX Strategy as a Kick-starter for Design Transformation in an Engineering Company.	UX strategy framework.	To inform UX researchers of the need for strategic UX work as an enabler of practical UX	UX in practice
Law et al. (2015)	Tracing Links between UX Frameworks and Design Practices: Dual Carriageway.	Theoretical UX frameworks and design practices.	To understand how abstract UX frameworks inform concrete design practices.	UX practice
Kaasinen *et al.* (2015)	Defining user experience goals to guide the design of industrial systems.	A framework that includes five approaches to defining UX goals.	To identify what kinds of approaches there are for defining UX goals.	UX goals
Fronemann & Peissner (2014)	User Experience Concept Exploration – User Needs as a Source for Innovation.	Conceptual UX framework of causes and effects of a positive UX.	To aid user-driven innovation through User Experience Concept Exploration.	Design Innovation

Savioja & Norros (2013)	Systems usability framework for evaluating tools in safety-critical work.	Systems usability framework for evaluating tools in safety-critical work.	To understand the consolidated work practices and the user experience it creates.	UX in practice
Schifferstein, Kleinsmann, & Jepma (2012)	Towards a conceptual framework for experience-driven innovation.	Towards a conceptual framework for experience-driven innovation.	Tools supporting an innovative design process.	Design innovation
Gegner et al. (2011)	Oscillating Between Extremes: A Framework for Mapping Differing Views on User eXperience.	A framework for mapping differing views on user experience.	To investigate the understanding of UX across different units within the organisation.	UX within the organisation (context)
Schulze & Krömker (2010)	A Framework to Measure User Experience of Interactive Online Products.	A framework to measure UX of interactive online products.	To identify and measure influencing factors of user experience of interactive online products.	UX elements
Wäljas, Segerståhl, Väänänen-Vainio-Mattila, & Oinas-Kukkonen (2010)	Cross-Platform Service User Experience: A Field Study and an Initial Framework.	Cross-platform service user experience: a field study and an initial framework.	To investigate the key elements of user experience associated with cross-platform interactions.	UX elements (context)
Karapanos *et al.* (2010)	Measuring the dynamics of remembered experience over time.	An initial framework for UX over time.	To present an alternative methodological approach for studying how users' experiences with inter- active products develop over time.	Concept of time in UX
Akhter, Buzzi, Buzzi, & Leporini (2009)	Conceptual Framework: How to Engineer Online Trust for Disabled Users.	Conceptual Framework for how to Engineer Online Trust for Disabled Users.	To propose some guidelines to extend the design of usability conceptual frameworks in order to promote trust in e-commerce websites for people with visual disabilities.	Accessibility (context)
Baguma & Lubega (2008)	A Web Design Framework for Improved Accessibility for People with Disabilities (WDFAD).	A web design framework for improved accessibility for people with disabilities (WDFAD).	To present web accessibility design requirements into a developer-oriented format.	Accessibility (context)
Velasco, Denev, Stegemann, & Mohamad (2008)	A Web Compliance Engineering framework to support the development of accessible Rich Internet Applications.	A web compliance engineering framework to support the development of accessible rich internet applications.	To present a web compliance framework developed to support both users and application developers to create accessible content for rich internet applications.	Accessibility (context)

Desmet & Hekkert (2007)	Framework of Product Experience.	Framework of product experience.	To develop a general framework of product experience that provides a structure that facilitates comparisons between experiential concepts.	Design innovation
Beauregard & Corriveau (2007)	User Experience Quality: A Conceptual Framework for Goal Setting and Measurement.	User Experience Quality: A Conceptual Framework for Goal Setting and Measurement.	To develop a framework for conceptualizing extended elements of UX in order to communicate with UX stakeholders and advance goal setting and measurement within applied settings.	Design innovation

The qualifying literature was also reviewed to identify at which stages of the software developmental process the research was aimed. Fourteen articles were aimed at the software development process parts *before* software deployment; those are planning, defining, designing, building, and testing.

Three articles were aimed at stages of the SDLC process *after* the software had been deployed to the user where feedback was collected and fed back into the planning part of the process. Four literary publications focussed on the process both before deployment and after software had been deployed to the user.

The data collection method employed in the articles was also considered. From the literary publications selected, eight publications did not mention the data collection method employed during the study, seven publications mentioned that qualitative methods had been used to collect data during the research and six literary publications described making use of a mixed method to collect data. The data collection methods provided insight into how previous researchers had decided to collect data and they influenced how data was collected during this study which utilised a mixed method to collect data.

3.4 Need for UX frameworks for BI dashboards

A number of literature-based UX frameworks have been developed by research practitioners in the past 20 years (De Kock *et al*., 2016; Desmet & Hekkert, 2007; Hildén *et al*., 2016; Karapanos *et al.*, 2010; Law *et al*., 2014; Obrist *et al*., 2012). Law, *et al.* (2014) maintain that these frameworks have improved an understanding of the phenomena related to what is empirically called ‘experience’.

Although numerous UX frameworks have been proposed by various authors, such as Shin, Im, Oh, and Kim (2017), Hokkanen *et al*. (2016), Irshad *et al*. (2016), Law *et al*. (2015), Gegner *et al*. (2011), (Hassenzahl, 2005), McCarthy and Wright, (2004), none of them was specific to the interface of BI applications.

The UX frameworks that were reviewed comprised of different UX elements, on different levels of abstraction. The elements were synthesised to include all the elements from the different UX frameworks. While each of the UX frameworks analysed and listed in Table 3.2 has its own specific emphasis, for example visual aesthetics (Lavie & Tractinsky, 2004) or temporality (Karapanos *et al*., 2010), these frameworks have a number of resemblances in common: they focus on advancing the practice of interaction design; they take an experiential perspective; and repeatedly share the same psychological constructs (Law *et al*., 2014).

The literature review confirmed that a UX framework specific to BI did not exist at the time (July 2017). Jooste, Van Biljon and Botha (2018) highlighted the need for a UX framework specific to BI dashboards and presented a UX framework that could be beneficial to the design and development of BI software. Eriksson and Ferwerda (2019) confirmed the need for a UX framework for BI and extended the 2018 framework by Jooste, Van Biljon and Botha (2018).

This points to the importance of the BI UX topic in the face of the dearth of research and the relevance for BI practice.

3.5 Conceptual literature-based UX framework

The qualifying literary publications each proposed a set of elements required for the specific research objective (refer to Table 3.2). Although the frameworks considered had different research goals, different areas of focus and framework elements being at different levels of abstraction (some were groupings of elements) all the elements were within the bigger domain of user experience and software development.

The combined set of elements from the qualifying pieces of literature produced a total set of two hundred and twenty-three (223) elements. This set was then refined into a master set of one hundred and seventy-three (173) elements from the qualifying literature. The elements were then sorted into similar concepts to group them, and they were synthesised to produce a synthesised set of elements. This synthesised set of elements (with elements on different levels of abstraction) is presented as a conceptual literature-based UX framework and attached as Appendix B.

The *Conceptual (literature-based) UX Framework (*CL_UXF_1.1*) for BI dashboards* that emerged from the systematic literature review had nine (9) principal categories with elements in each of these categories (see Table 3.3). The categories were: (1) UX Strategy; (2) UX Goals; (3)

UX Tools; (4) UX Design; (5) UX Designer; (6) Technology (also called Development); (7) Product; (8) Product-user interaction; and (9) User. The list of categories with their expanded elements is presented in Table 3.3.

Table 3.3 Conceptual UX framework for BI Front-ends (CL_UXF_1.1).

Category	Elements
UX Strategy	• Brand, UX mission, UX philosophy, principles, accessibility strategy, measuring achievement of UX goals, data and analytics, UX KPIs, design/development processes, UCD process, HR – UX roles/competencies, HR training, change management and communication strategy.
UX Goals	• Reason for product existence, technical possibilities and constraints, empathy, brand alignment, scientific understanding of humans [theory], understanding design context, simple design, intuitive design, essential design – only what is needed.
UX Tools	• Processes available such as evaluation process, standardised questionnaires, such as SUS, style guide, user representations, interaction flows.
UX Designer	• Designer responsibilities, professionalism, approachability, selling design ideas.
UX Design	• Design presentation, design functionality, design interaction, design attractiveness, compositional layout, emotional considerations, sensual, designing of cross-contextual activities, service coherence, minimalistic design (corresponding goal), consistency.
Product	• Perceivable (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status). • Use (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise, diagnose and recover from errors, product use). • Features (meaningfulness, features, qualities, security) (new component: performance). • Support (pedagogical appropriateness, help and documentation) (new component: education/training). • Content (content, content fluency – right data, right time).
Development	• Possibilities (technical possibilities) • Challenges (technical challenges, technical constraints) • Support (technology support – context)

Product / User interaction	• Touch point (product interaction, product use, touch point orchestration) • Context (usage context – experience driven innovation, context-related tasks, context physical, spatio-temporal – effects of place and time of experience) • Experience (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario, temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability).
User	• Emotions (mood, concerns, attitude) • User traits (skills/abilities, specialty/expertise, personal, physical attributes, knowledge/experience, competence, physical health) • Motivators (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy) • Association (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal) • Perceptions (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content).

3.6 Chapter summary

In conclusion, this chapter has presented the systematic literature review that was conducted as part of the study.

The strategy and process followed during the systematic literature review was described (first chapter objective), to allow for an understanding of how the final literary publications were selected that formed the basis on which the **CL_UXF_1.1 framework** was developed.

The analysis of the filtered list of literature selected from the SLR was presented (second objective of the chapter), highlighting the research goals of each piece, methods employed and importantly the elements identified by each of these frameworks.

Thereafter, the novel conceptual framework *(*CL_UXF_1.1*)* (third objective of the chapter) which was produced from the synthesis of the frameworks inspected in the literature review was presented (see Appendix B).

Chapter 4 follows, where the research design and methodology will be discussed, including the novel theoretical ***research design framework*** that was developed during the study that guided the research.

Chapter 4

Research Design and Methodology

The literature review presented in Chapter 3, identified existing UX frameworks, and a novel framework, CL_UXF_1.1, was produced for BI dashboards (see Appendix B).

Chapter 4 is dedicated to the research design and methodology followed during the study. The chapter has been compiled with the following objectives:

- To present the research philosophy, the philosophy that shaped the approach to the research, and the choice of research methods that were selected (see Section 4.2).

- To present the compiled theoretical research design framework which provided theoretical grounding, structure, and guidance to the research (see Section 4.3).

- To describe the methodological choice in the study and the motivation for this choice (see Section 4.4).

- To describe the research process as it was broken down (see Section 4.5).

- To present the ethical research considerations taken in the study (see Section 4.6).

Chapter 4 continues by discussing the research design in Section 4.1. Section 4.2 presents the research philosophy and paradigm. Section 4.3 presents the research design framework. Section 4.4 presents the methodological choice. Section 4.5 presents the research process followed in the study. Section 4.6 presents the ethical research considerations and application in this study. The chapter is summarised in Section 4.7.

4.1 Research design

Research has been defined as the systematic process of collecting, analysing, and interpreting information (data) in order to increase our understanding of a phenomenon in which we are interested (Leedy & Ormrod, 2010). Goddard and Melville (2007) remark that, at the heart of research, you will find the discovery and the creation of knowledge. Goddard and Melville (2007) also continue to describe what they would call ‘good’ research, in that it is planned, organised and has a specific goal (Goddard & Melville, 2007). Research in the discipline of Information Systems is, according to Recker (2012), primarily concerned with the socio-technical systems made up of organisations and individuals that deliver information technology for business tasks.

To clarify the difference between the terms ‘research design’ and ‘research methodology’, the definitions of both these concepts will now be presented. Research design is defined by Durrheim (Terre Blanche, Durrheim, & Painter, 2006) as a strategic action framework that serves as a bridge between research questions and execution, or the implementation of the research strategy. Saunders and Tosey (2013) compare the research design to an onion and they create the analogy of the ‘research onion’ in which the research design comprises of outer layers of research philosophy, possible methodological choices, strategies, and the time horizon and, importantly, their inter-relationships. As such a research methodology has many dimensions, while research methods form a part of the research methodology.

A research methodology can also be framed as a way to solve a research problem systematically (Kothari, 2004). Methodologies help to ensure that the principal data collection techniques and analysis procedures used in the research undertaken are both appropriate and coherent. Research methodology is presented as the study of how we can gain knowledge of the world around us through the process of research (Denzin & Lincoln, 2011; Guba & Lincoln, 1994). A research methodology can also be a certain philosophical and ethical approach followed in order to develop knowledge; a theory of how research should take shape considering the nature of the subject it seeks to speak to (Hammell, 2006).

4.2 Research philosophy and paradigm

The term *research philosophy* refers to a system of beliefs and assumptions (Saunders *et al*., 2019). The philosophical assumptions or the basic set of beliefs that guide actions are defined by the worldview of the researcher (Lincoln, Lynham, & Guba, 2011). These assumptions inevitably shape how the researcher understands the research questions, the methods used and how the findings are interpreted (Crotty, 1998). The term *paradigm* is considered to be synonymous, and it is used interchangeably with the term *research philosophy.* Next the basic terms ontology and epistemology will be presented.

Ontology refers to our ideas of reality and how it is constituted (Fayolle, Kyro, & Ulijn, 2005; Žáček, 2017). The researcher‘s epistemological beliefs comprise what is possible for one to know, the relationship between the researcher and what is being researched (Creswell, 1998). Ontology seeks to describe the basic categories and relationships of existence to define entities and types of entities within its framework. In both computer science and information science, an ontology is a data model that represents a set of concepts within a domain and the relationships between those concepts. It is used to reason about the objects within that domain (Quek, 2005). These definitions concur with Zambon and Guizzardi, (2017) who maintain that ontology describes a particular area of interest (or a domain) in a formal way and that it defines the classes of objects that are in that area and the relationships that may exist between them.

Epistemology is concerned with how we can acquire knowledge about that reality (Fayolle *et al*., 2005). The word epistemology stems from the Greek words ‘episteme’ (knowledge) and ‘logos’ (theory). Epistemology is concerned with understanding the origin, nature and validity of knowledge; it seeks to provide knowledge about knowledge and that is why sometimes epistemology is referred to as a theory of knowledge (Roos & Von Krogh, 2016). Table 4.1 represents the research philosophy positions considered for the study. The table has been adapted from the work of Bunniss and Kelly (2010) to include pragmatism as a philosophical position.

Table 4.1 Comparison of five research philosophical positions adapted from Saunders, *et al.* (2019) and Bunniss and Kelly (2010).

	Positivism	**Interpretivism**	**Critical theory**	**Postmodernism**	**Pragmatism**
Ontology: What is the nature of reality?	Reality doesn't change. Real, independent. Universalism. Granular Ordered	Reality changes. Subjective. There is no one truth. Complex, rich socially constructed. Multiple meanings, interpretations, realities.	Reality objective, truth is opposed by competing groups. Layered (the actual, empirical and the real). External, independent.	Reality is formed by others. Nominal Complex. Socially constructed through power associations. Some meanings, interpretations.	Reality is found in environment, experienced through human experience. Complex, rich, external. 'Reality' is a practical consequence of ideas and actions.
Epistemology: What is the nature of knowledge?	Objective, generalisable theory constructed to accurately describe the world. Knowledge can be neutral or without value.	Knowledge is subjective. There are many different viewpoints of reality. There is no one 'correct' way of knowing.	Knowledge is co-constructed between people. Knowledge is mediated by power relationships and constantly under revision.	Knowledge and truth are decided by dominant ideologies. Concentrated on absences, silences and oppressed meanings, voices and interpretations.	Contextual practical meaning. Focus on problems, practices and relevance. Problem solving Informed future practice as contribution.
Methodology: What is the nature of the approach to research?	Discover what exists through prediction and control. Theory is established deductively. Scientific method used. Looks for causality, fundamental laws.	Focus on understanding. Uses inductive reasoning. Meaning is constructed through researching in the natural environment. Collect different interpretations.	Focus on emancipation. Research is used to envision how things could change for the better. Characterised by ongoing redefinition of problems and cooperative interaction.	Focus on ideology in the maintenance of economic and political power. The importance of power relationships, personalisation, and discourse in the 'construction' of truth and world views.	Focus on what works. Research used to uncover and understand what exist Research used to envision how things could change for the better.
Axiology: What is the role of values?	Value-free research. Researcher is detached, neutral and independent of what is researched Researcher maintains objective stance.	Value-bound research. Researchers are part of what is researched, subjective. Researcher interpretations key to contribution. Researcher reflexive.	Value-laden research. Researcher acknowledges bias. Researcher to minimise bias and errors. Researcher as objective as possible.	Value-constituted research. Power relationships between research and researcher. Research narratives repressed/silenced at the expense of others Researcher radically reflexive.	Value-driven research. Research started and continued by researcher's beliefs. Researcher reflexive.

What techniques can be used to gather this information?	Tends to use quantitative methods, often including statistical testing of hypotheses.	Tends to use qualitative methods.	May use both quantitative and qualitative methods. Iterative research design.	Deconstructive – reviewing texts and realities against themselves. In-depth investigations of anomalies, silences and absences. Range of data types, typically qualitative methods of analysis.	Following research problem and research question. Range of methods: mixed, qualitative, quantitative. Concentrating on practical solutions and outcomes.

The researcher utilised a reflective tool designed by Bristow and Saunders called HARP (Heightening Awareness of Research Philosophy) (Bristow & Saunders, 2014) to guide the thinking about the researcher's values and beliefs in relation to the research. The tool allowed the researcher to consider the potential fit between her own beliefs as per the HARP tool presented in Figure 4.1 and those of major philosophies in Table 4.1, showing the comparison of five major research philosophical positions as adapted from Saunders *et al*. (2019).

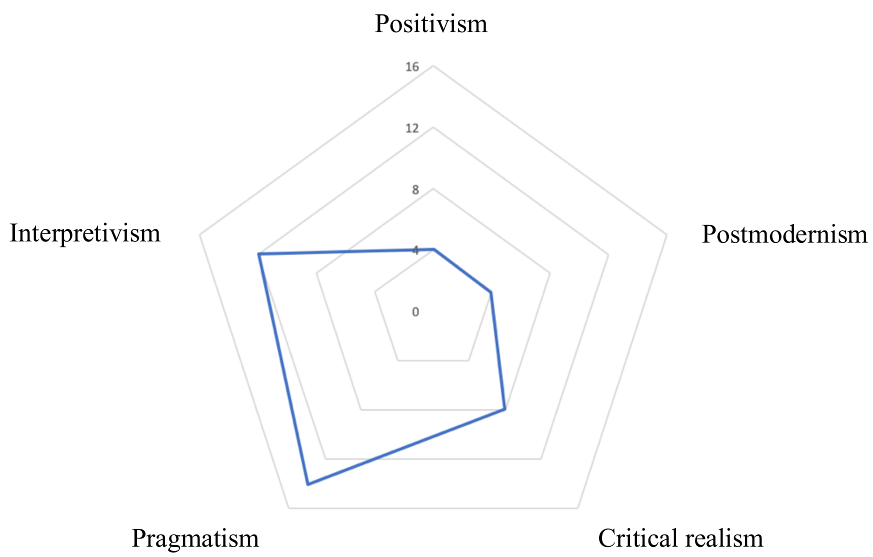

Figure 4.1 The utilisation of HARP allowed for reflection on the researcher's beliefs.

The results of the HARP indicated that there was the closest alignment of values and internal beliefs between the researcher and those beliefs of the pragmatic research philosophy which was selected to be followed in the study.

4.2.1 Pragmatic research philosophy

Pragmatism was introduced in Section 4.2 (see Table 4.1); this term will be discussed further owing to its relevance in the study. Maxcy (2003) maintains that pragmatism as a research paradigm is philosophically rooted in the historical contributions of pragmatism as a philosophy and, therefore, comprises of a plurality of methods. The word *pragmatism* originates from the Greek word 'pragma', which means action. The concept of action is central to pragmatism (Pansiri, 2005). In the same way, the world is also not static; it is in a constant state of change. The world is also changed through actions; action is the way to change existence (Goldkuhl, 2012; Morgan, 2014).

Pragmatist philosophy maintains that human actions cannot be detached from past experiences and internal beliefs that have developed from these past experiences. Action is, therefore, fundamentally connected to human thoughts. Consequently, actions are taken based on the potential consequences of the action, and the results of actions are used to predict the consequences of similar actions in the future (Kaushik & Walsh, 2019).

As indicated in Table 4.1, pragmatism is grounded in the environment and can be encountered only through human experience (Bunniss & Kelly, 2010; Morgan, 2014; Saunders *et al*., 2019). In terms of the mode of inquiry used, pragmatism is situated in between paradigm continuums (Kaushik & Walsh, 2019). Post-positivism usually maintains quantitative methods and deductive reasoning, whereas constructivism utilises qualitative approaches and inductive reasoning. Pragmatism combines the two poles and offers a flexible and more reflexive approach to research design (Morgan, 2014). Abductive reasoning is in many cases associated pragmatism that alternates between deduction and induction. In this way, the researcher is constantly part of the creation of data and theories (Goldkuhl, 2012). There is a link between the main concern of pragmatism and appreciative inquiry, and that is to measure knowledge by what works (Cutchin & Dickie, 2012). The appreciative inquiry approach emphasises the importance of focusing on the workplace setting and understanding its context, an approach described as far-reaching that fits a pragmatic approach (Crotty, 1998). This mode of inquiry utilised in this study, appreciative inquiry, will be discussed further in Section 4.2.2.

The study will be viewed from a *pragmatic approach* as pragmatics recognise that there are many ways of interpreting the world and undertaking research; that no single point of view can ever give the entire picture and that there may be multiple realities (Saunders, Lewis, & Thornhill, 2009).

4.2.2 Appreciative inquiry as underlying philosophical approach

The appreciative inquiry paradigm (frame) is applied as the underlying philosophical approach in this study. Appreciative inquiry is a way of seeing the world and is a way of orientating yourself in the world (Cooperrider, Whitney, & Stavros, 2008). Appreciative inquiry provides a paradigm changing approach to enable change at any level of a system of any nature (Watkins, Mohr, & Kelly, 2011). According to this appreciative inquiry *frame* that we look through, problems and solutions are not seen as separate things but rather as an all-encompassing whole that contains all our dreams about the future and the road towards what *can be* (Cooperrider & Fry, 2020). The researcher interprets this as *a positive design outlook* fitting to the context of the research problem.

Appreciative inquiry is used to describe both the appreciative inquiry paradigm as well as the methodology initiatives, which mean the specific steps used to bring positive change in a system (Hammond, 2013)

Appreciative inquiry is defined as *a cooperative search for the 'best' of what can be* (Cooperrider, Whitney, & Stavros, 2005). Appreciative inquiry does not fit into any particular ideology but is known for its inspirational approach and is focused on possibilities instead of the customary stage of identification of the problem (Reed, 2006). Many problem-focussed solution strategies are rooted in negativity, identifying and discovering what is wrong or not working. Appreciative inquiry encourages practitioners to move beyond traditional problem-centred methods (Ashford & Patkar, 2001).

Traditionally problems are identified and analysed, root causes unearthed, and solutions designed to remedy the problems and their origins. This problem-focussed culture creates a 'problem searcher mindset' which affects optimism and positive team dynamics, and which fosters a team and organisational culture of blame and fault-finding (Riopel, 2020). Appreciative inquiry facilitates a shift towards a strengths-based culture (Stratton-Berkessel, 2010). Cooperrider and Fry (2020) position this strength-based change as enabling research through a pragmatic application in the workplace based on circles of strength, the individual's elevation (harnessing the individual's strengths), the organisational integration (of stakeholders' strengths to determine strategic business application) and societal extension (of strengths into the surrounding environment and into society). Additionally, since the philosophical perspective of the study is pragmatic, it challenges 'taken for granted' ideas and is, therefore, a theory that is suited to appreciative inquiry's epistemological roots (Crotty 1998).

Appreciative inquiry seeks to engage stakeholders in self-determined change (Cooperrider *et al.*, 2005). It allows teams to look at what is already working well, and then to look beyond that to find opportunities of what could be even better. This shifts the attention from fear of failure to a drive towards success (Cooperrider *et al.*, 2005). Appreciative inquiry aims to ascertain the best of 'what is', identifying and building on past achievements, existing strengths, and possibilities of 'what could be' (Cooperrider *et al.*, 2005). Initially, appreciative inquiry utilised a four phased approach as created by Whitney and Trosten-Bloom (2011). These included: 1. discover; 2. dream; 3. design; and 4. destiny. Notably, appreciative inquiry prescribes the specific steps of discover, dream, design and deliver. During each of these phases the researcher focuses on the positives (Whitney & Trosten-Bloom, 2003). For the discovery phase, questions are considered, such as 'what is working currently' and 'what is the best', having an appreciated mindset during discovery. The dream phase constitutes asking questions such as 'what could be?' or 'what desired results can be envisioned?'. The design phase continues to ask questions such as 'what should the ideal be?' and is focussed on collaboration with others to construct the ideal. The destiny or sometimes also called the delivery phase is the final phase focused on sustaining the course (Whitney & Trosten-Bloom, 2003) and on constructing futures through action and innovation (Ludema, Manning, & Johnson, 2016). Figure 4.2 provides a visual representation of the 4 phases of appreciative inquiry.

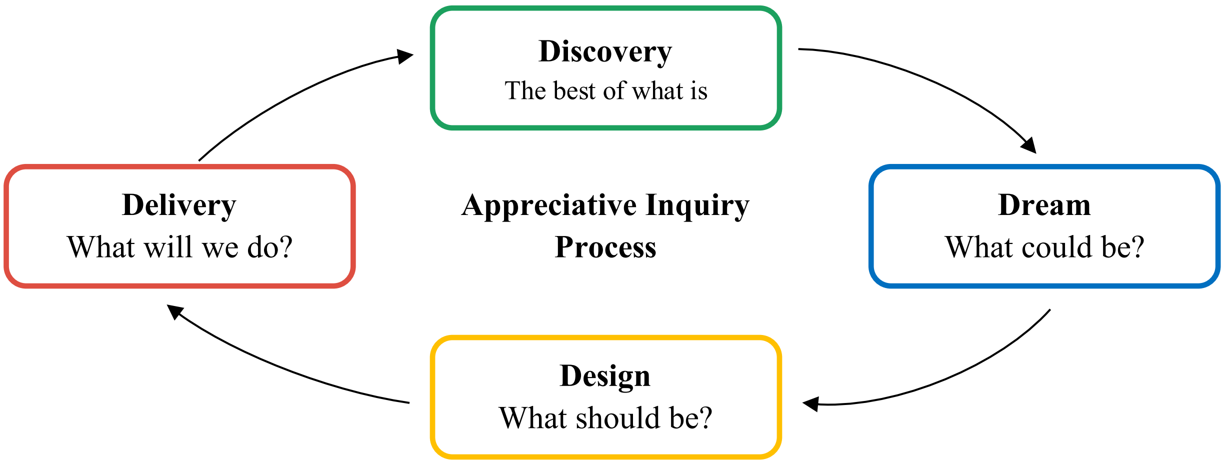

Figure 4.2 Phases in the 4D appreciative inquiry process (Cooperrider & Whitney, 2001).

This approach was refined by Buchanan (2014) to a (5) five-step phased process, which included an additional phase at the start of the iterative process, a 'definition' phase, used to focus and determine the topic of the inquiry, followed by the 'discovery', 'dream', and 'design' phases, and the last phase was changed from 'destiny' to 'delivery'. Notably, for the purpose of this study, the four steps of discover, dream, design and deliver were utilised.

Key truths about appreciative inquiry that will contribute to the novelty of the research relate to the approach of appreciative inquiry in the following ways: firstly, it's affirmative manner, focusing on possibilities and not problems; secondly it is inquiry-based, which indicates that there is a search for discovery and learning and an openness and willingness to learn more through question asking; and, thirdly, appreciative inquiry is a unique, spontaneous and improvisational approach, with the flexibility to change according to changing contexts and circumstances (Cooperrider & Whitney, 2005).

Appreciative inquiry has been utilised in domains such as leadership, technology, creativity, diversity, innovation, change, learning and collaboration (Stratton-Berkessel, 2010). This points to the suitability of its use as a paradigm in the context of this research which is focussed on user experience elements required for the best dashboard in a constantly changing development environment.

Ludema *et al.*, (2016) formulated six paradigm shifting question to allow for insight which would not have been achievable otherwise. The questions are:

1. What have led us/you to where you are today?
2. What has been our/your high point?
3. What do we/you value?
4. What is changing?
5. What's the best future we/you can imagine?
6. What will it take to get us/you there?

Appreciative inquiry requires collaboration sessions, where a large group meets about planning, designing or implementing that brings together a whole system of internal as well as external stakeholders in a focused way to work together on a task of a strategic nature, and, in particular, a task of creative value (Cooperrider, 2017).

To conclude, it is important to note that this link between real world application based on pragmatism and discovering and improving on *what works* from appreciate inquiry were considered appropriate for guiding this study. Employing the 4-stage process of discover, dream, design and deliver with a focus on the real-world context of the development and use of a UX framework specific to BI dashboard software within the workplace.

4.3 Theoretical research design framework (TRDF_AAAL_1.1)

A theoretical foundation, also called a theoretical research design framework, forms the structure that can contain and support the research design. Theoretical foundations are important because they become a lens through which the research problem and research questions are evaluated (Grant & Osanloo, 2014).

A theoretical framework is constructed from different concepts, the concepts' definitions, with reference to their academic origin, and the major theory that they represent in a specific study (Asher, 1984). Van der Waldt (2020) maintains that a thorough theoretical framework can assist in helping to organise the research, mapping out the research and becoming a blueprint for a study. He maintains that a study needs a sound theoretical framework to bring focus, to ensure the inclusion of relevant theory and to strengthen methodological arguments.

NOTE: It is important to note that authors use the term 'conceptual framework' interchangeably with 'theoretical framework' (Ravitch & Riggan, 2016; Rogers, 2016). However, in this study, these terms refer to different frameworks which are distinguished as follows:

- Chapter 3 presented the **Systematic Literature Review**, which produced a domain specific, novel, conceptual literature-based ***UX framework*** (CL_UXF_1.1) consisting of nine ***UX categories and their related elements***.

- Chapter 4 presents a ***Theoretical Research Design Framework*** (TRDF_AAAL_1.1***)*** that was developed as part of the research design, making use of existing models, approaches, and theory (such as appreciative inquiry, affordance theory, Agile model, and logic model*)* to guide *the* ***execution*** *of the research*.

To repeat, the CL_UXF_1.1 comprises of UX elements (output of the SLR process) speaking to *what* was produced by the systematic literature review. Whereas the TRDF_AAAL_1.1 provided research design guidance and directed the *how* the research would be conducted.

According to Ravitch and Riggan (2016), a theoretical framework provides stability to the research by:

- communicating the theoretical assumptions clearly upfront which allows the reader to consider them critically;
- connecting and bracing a researcher and a study to existing knowledge [the previous relevant research also helps to provide a support for the choice of research methods];
- Guiding the researcher to address the questions of 'why' and 'how' through the stating of the chosen theoretical assumptions as well as guiding the researcher to progress intellectually from merely re-accounting an occurrence that had been witnessed to the ability to generalise the different aspects of a phenomenon within a connected and supported collection of knowledge; and

- Identifying the boundaries to those generalisations, allowing the identification of key influencing variables for a specific phenomenon, emphasising the importance of how these key variables are unique to different contexts.

According to Frodeman *et al.* (2017), thinking about and understanding research problems from an interdisciplinary perspectives assists researchers not only to rely on theories in a particular discipline. This is presented as an enlightening and effective way to be fully engaged in the research.

Theoretical frameworks are constructed by choosing a topic of study within the researcher's area of specialisation or field of interest. Then, the researcher should choose a title focussed on the study. Key concepts should be separated in the topic, considering how these topics are potentially related. A literature review should then be conducted to identify related concepts. The theoretical framework is then generated, based on casual relationships (Van der Waldt, 2020).

A similar process was followed during this study where an area of interest was selected, which was User experience and BI front-end where users interact with the product. Then, a topic was formulated to describe the focus of the study, the title was formulated as 'A User Experience Framework for BI Dashboards: A Mixed Method Study within an Agile Software Development Environment'. Key concepts inherent in the topic that were selected were explored in the literature. The context of an agile software development and, specifically, the consideration of designing for change, led to the consideration and inclusion of the Agile Model, the concept of user experience and the use thereof in a dashboard context led to the consideration and inclusion of the Affordance Theory, and the overarching domain of information systems led to the consideration and inclusion of the Logic Theory. Figure 4.3 depicts the novel theoretical research design framework constructed from relevant theoretical approaches and models to support and guide the research. This is discussed in Section 4.3.1 – Section 4.3.4.

Each of the concepts (appreciative inquiry, affordance theory, Agile model and logic model) that make up the TRDF_AAAL_1.1 (see Figure 4.3) will be discussed further to clarify their unique contribution to the research design theoretical framework.

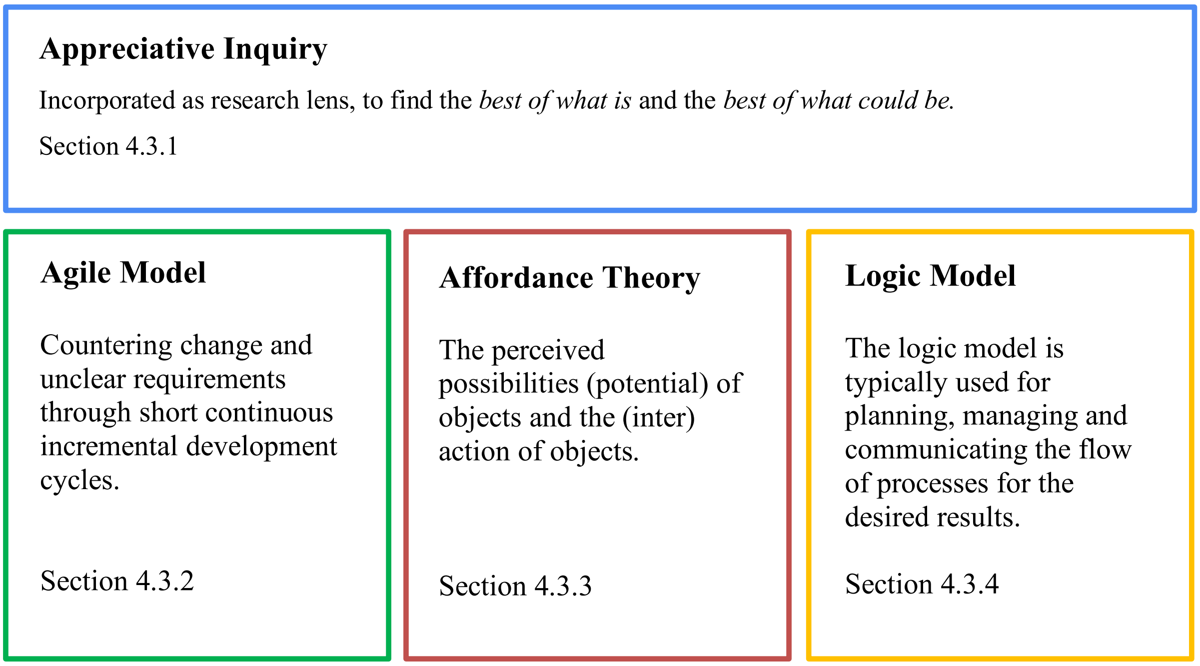

Figure 4.3 Theoretical research design framework (TRDF_AAAL_1.1) developed to provide structure and guidance to the research.

4.3.1 Appreciative inquiry

The appreciative inquiry approach allowed for an intentional pragmatic approach to discover *the best of what is to be found in practice* regarding the UX of BI dashboard interfaces and *the best of what could be* regarding the UX of BI dashboard interfaces in an agile software development environment. Appreciative inquiry was discussed in Section 4.2.2 as it forms part of the philosophical perspective and approach of the study.

The appreciative inquiry approach, therefore, shaped the way in which the interview questions were formulated, and questions were positioned through the lens of appreciative inquiry in an aim to find the best of what is and the best of what could be and these were presented in the interviews as: 'what is required *for the best…'*. The composition of the interview questions is discussed in more detail in Section 4.5.2.3 that presents the development of the qualitative research instrument.

This focus on *what works* is important to the study as it focusses the attention of the interview participant on what is working in his/her agile software development environment or on what he/she has experienced in the past that worked. This ties in with the pragmatic philosophical outlook of the research focussing on finding out *what works*.

The appreciative inquiry approach also allowed the interviewees to participate in the research whilst being in a positive frame of mind. This helped him/her to focus on the positive elements during the 'discovery' stage and also positioned them to look to what could be improved during the 'dream' phase and how that could possibly be done during the 'design' and 'delivery' phases. During the interview process it was also observed that the interviewees found the appreciative inquiry approach employed in the interviews refreshing, and they enjoyed participating from a positive contributor position.

4.3.2 Agile model

The Agile model was included in the theoretical framework of the study *to understand how software is built in practice* as the research is conducted within the context of an agile software development environment. Agile software development is an incremental and iterative software development process. During these incremental cycles, product requirements are refined as work is produced and validated; this is done through self-organizing, cross-functional collaborating teams, working together towards the creation and delivery of a solution (Singh, 2013)

Agile that is personified by the Agile Manifesto (which focuses on individuals and interactions, working software, customer collaboration, responding to change) is supported by the Twelve Principles of Agile Software development, a reaction from the software development community against the frustrations experienced in the software development industry during the 1990s (Eby, 2016). During that period of frustration, one of the most widely used software development models was the Waterfall model, which was characterised by slow, long, siloed periods of work with substantial delay between the point where the business requirements of a product were achieved and the actual delivery of technology that met the customers' needs. This led to project cancellations and even project failures (Abrahamsson, Salo, Ronkainen, & Warsta, 2017).

Different agile software development approaches have emerged in response to this start-to-finish way of software development, such as Scrum, Lean Development, Feature Driven

Development, Extreme Programming, Adaptive Software Development (ASD) and Crystal methods. These approaches view change from the viewpoint that mirrors our current unstable global economic environment (Highsmith, 2002). The Agile manifesto emerged to guide the development of software in an agile way by providing 12 principles to guide the way of working.

The 12 Principles of the Agile Manifesto (Beck *et al*., 2001) speak to:

1. Bring value to the customer through fast and continuous delivery of software.
2. Requirements that change are welcomed, even late in development. Utilising change for competitive advantage through agile processes.
3. Frequently delivering working software.
4. Collaboration between business and developers throughout the project on daily basis.
5. Motivated individuals are central to projects. Individuals should be provided with the environment and support they need and then trusted to do the job.
6. Communication is emphasised; face-to-face conversation is chosen as the most efficient and effective method of conveying information.
7. Working software is indicative of progress.
8. Agile software delivery promotes sustainable development.
9. Good design technical excellence improves agility.
10. The amount of work not done by simplifying is crucial.
11. Self-organizing teams produce the best requirements, architectures, and designs.
12. Reflection by the team on how to become more effective occurs at regular intervals, allowing the team to adjust its behaviour accordingly.

Agile is known to increase business value, and it is recognised by the delivery of working, tested, deployable software on an incremental basis (Beck & Fowler, 2001). According to the life cycle cost theory of Boehm, (1988), the cost of change increases as the software development lifecycle progresses. With this considered as being valid, the response has been not to determine how to prevent change early and along the project, but rather how to be able to handle change in a better way throughout the life cycle of the product.

As releases are made again and again the cost of change could be expected to climb over time. This is due mainly to the development area that grows and includes more things, such as code, documents, models, amongst other things. Stoica *et al.*, (2016) specifically mention that unfamiliarity of team members with specific artefacts will add to the learning curve and time taken to execute, organised, high quality artefacts will improve ease of change (Stoica *et al.*, 2016)

According to Waters (2020), the Agile model aims to address modern challenges like:

- Project failure [±70% of projects fail to meet their objectives in terms of time, cost, features. Project predictability is not catered for by traditional software delivery methods];
- Modern economy [economic uncertainty means having sufficient funding to finish a project];
- Constant and rapid change [market conditions change rapidly, technology changes quickly and new, disruptive technologies impact everything from development to product consumption];
- End user needs change [requirements change quickly; products should change according to the user expectations]; and
- Competitive threats that emerge without warning [to counter the speedy releases of software with good UX is more than a competitive advantage; it is critical to business survival].

In many software development situations, project requirements will not be perfectly clear before the project begins. In the domain of software development, change is expensive. Agile can reduce the cost of change by failing fast and learning from that (Butt & Jamal, 2017). Appreciative inquiry is seen as an invitation to the positive revolution in change (Cooperrider & Whitney, 2005). Constant change is having an impact on people, families and organisations and forcing people to find new ways of working and interacting in this new reality (Cooperrider *et al.*, 2008). This points to the continuous nature of change these days. Companies that have achieved ongoing success in the long run have learnt and accepted that change is a process, not an event (Whitney & Cooperrider, 1998).

In summary, the Agile Model allows for the countering of change and unclear requirements through short, continuous, incremental development cycles.

4.3.3 Affordance theory

Affordance theory will be used *to understand how things are perceived*. The affordance theory states that the world is perceived not only in terms of object shapes and spatial relationships, but also in terms of object possibilities for action (affordances). Affordance theory holds that *'perception drives action*' (Gibson, 1966). An affordance is the possibility of an action; this is derived from the relationship between an agent and the agent's environment (Gibson, 1979). This definition is built on the foundation of perceptual psychology and originates from the Ecological Approach to Visual Perception by Gibson (1979). This concept of affordance was introduced to the human-computer interaction (HCI) community by Donald Norman in the book entitled 'The Psychology of Everyday Things' (Norman, 1988). Kaptelinin's work focused on affordances and design and it maintains that good designs are intuitive, such as the Holmes Stereoscope (Kaptelinin & Nardi, 2012). Since then affordance has become a familiar term in design, extending beyond behavioural or cognitive psychology into digital interfaces (Kaptelinin & Nardi, 2012).

Affordance, as Gibson had originally described it, has over the years evolved into a broader definition where the ability to identify the potential for action has been translated into the discoverability of an action in a digital interface. Discoverability in the context of a digital interface is the ability for a user to identify actions through interface design and information communication (Borowska, 2015). Affordance theory also provides the foundational support for the incorporation of an analysis of IS and IT artefacts (Volkoff & Strong, 2013).

Nye and Silverman (2012) maintain that an affordance either exists or does not exist. They are of the viewpoint that the physical properties of something to indicate the possibility of something occurring is an extremely inclusive definition of affordances. According to them, an agent does not necessarily require to be aware of the action that can be afforded, for example the discovery (or affordance of opening) of a secret door.

A user's ability to discover intended interactable components and, specifically components intended for navigation within the digital, connects to digital wayfinding. Wayfinding (Raubal,

2008) allows the user to find his/her way and navigate purposefully in a digital domain. This allows for motivated, purposeful, and directed movement from one point to an intended destination that is not visible to the traveller. The key here is that it requires involvement from the user (digital way finder) and the (digital) environment (Raubal, 2008). The ability for a user to navigate an interface is important for the usability of the product (Fang & Holsapple, 2007).

According to Cornwell, O'Brien, Silverman, and Toth (2003), affordances cannot be similar for all agents (users). They maintain that every agent (user) would have a unique view (dependent on past experiences and leanings) of the objects in their surroundings. In other words, people form meanings from past interactions with places and things (Jordan, Raubal, Gartrell, & Egenhofer, 1999).

The researcher views affordance theory as being linked with the research topic at multiple levels of abstraction. Firstly, from an UX point of view, affordance is relevant as UX interface components are designed to communicate the possibility of interaction; secondly, affordance theory is also considered to be relevant to the research as the researcher views the ability to identify and act upon change as an affordance-like consideration that is connected to the agile theory through the common occurrence of a change of state that is important in both affordance theory (as the perceived possibility to move from one state to another) and the Agile model (where changing states is a constant occurrence in the agile process).

4.3.4 Logic model

The Logic model was used to *understand how things work* within an agile software development environment (purpose, context, inputs, activities, outputs, effects). The use of the logic model also provided a more focussed enquiry and guided better thinking in structuring the research (Wyatt Knowlton & Phillips, 2013).

A logic model is typically used for planning, managing and communicating the flow of processes to produce desired results on any level (project, programme or organisational). It allows for a visual illustration and allows for clarity about the sequence of, and the connection between, components and it provides guidance in the development of a system, for example, in the case of a performance management system (Wong *et al*., 2010).

Wyatt Knowlton and Phillips (2013) point out that logic models aim to provide structure. They provide a partial solution for improved planning, adaption, and decisions. They also remark that logic models can promote effectiveness. The logic model's ability to adapt is similar to that of the Agile model, encouraging practitioners to fail fast and learn, adapt and, from feedback, sort out (Bridge, 2021).

McNamara (2021) describes the logic model as a high-level visual representation of the flow of processes producing desired results as output. The logic model is more substantial than merely a picture; it also encompasses all the processes, theories and scientific evidences behind it, usually containing inputs, processes, outputs and outcomes of a process (Frechtling, 2007).

These parts of the logic model can be described as follows:

- Inputs are materials, money, people, equipment, information, ideas, time, etc, anything that is used as part of a process to produce desired results. Inputs can also be external influences or forces within the organisation (Seidman, 2017).

- Processes can be activities or methods that are put together to produce the desired results; they can range from rudimentary paper-based processes to sophisticated scientific processes. Typically, logic models are not usually aiming to mass produce recurring processes to produce a desired result (W. K. Kellogg Foundation, 2004).

- Outputs are the actual tangible results of the process. Outputs are normally quantifiable and are sometimes misunderstood to measure the success of a process. Consequently, for output to be an indicator of the process's success, the output should be directly associated with the desired benefits which should be achieved (Frechtling, 2007).

- Outcomes can be thought of as the impact of an ongoing result of the process. Outcomes are normally grouped under learning outcomes, skills outcomes and outcomes impacting conditions (Strycker, 2016).

4.3.4.1 Application of the logic model

The Logic model allowed for thinking about the process of the research as a whole and allowed one to view the separate parts of the research as processes that are linked, where *input, process and output or outcome* took shape as the research was planned.

The logic model also focussed the research and guided the consideration of the intended goal of each of the research processes; in other words, the intended output necessary in the larger research process was mapped out and linked to the overarching output of the entire study and the intended outcome of research. These processes are also presented in Table 4.2 for the aid clarity.

Table 4.2 Inputs, processes and outputs of the research according to the Logic Model.

Research Phase	Description	Input	Process	Output
Phase I	Systematic literature review process	Literature: Input A	Review process: Process A	Curated list of qualifying literature: Output A
Phase I	Compilation of conceptual framework	Curated literature: Output A = Input B	Literature analysis and synthesis: Process B	Conceptual literature-based UX framework (CL_UXF_1.1): Output B
Phase I	Compilation of theoretical framework	Theories and models: Input C	Selection of theories and models: Process C	Theoretical framework: Output C
Phase II	Compilation of qualitative instrument	Theoretical framework: Output C = Input D	Creation of qualitative instrument: Process D	Qualitative instrument: Output D
Phase II	Conducting interviews	Qualitative instrument: Output D = Input E	Conducting of interviews: Process E	Data collected from interviews: Output E
Phase II	Qualitative data analysis	Qualitative data: Output E = Input F	Analysis of qualitative data: Process F	Framework from Practitioners view: Output F
Phase III	Compilation of quantitative instrument	Key themes from practitioners' views: Output F = Input G	Compilation of quantitative instrument: Process G	Quantitative instrument: Output G
Phase III	Conducting survey	Quantitative instrument: Output G = Input H	Conducting of survey: Process H	Data collected from survey: Output H
Phase III	Quantitative data statistical analysis	Quantitative data: Output H = Input I	Factor Analysis of survey data: Process I	Dataset from factor analysis: Output I
Phase III	Interpreting factor analysis	Dataset from factor analysis: Output I = Input J	Interpretation of dataset from factor analysis:	Validation framework from statistical analysis:

			Process J	Output J
Phase III	Validation of data	Conceptual literature-based framework (CL_UXF_1.1): Output B = Input K Conceptual practitioners' framework (CAP_UXF_BID_1.1) Output F = Input L Validated framework (VAP__UXF_1.1): Output J = Input M Validated framework (VAPO_UXF_BID_1.1): Output K = Input N	Validation of data from different sources: Process K	Validated practitioners' framework for UX of BI dashboards in an agile environment: Output L

4.3.4.2 Application of the logic model – Phase I

Phase I of the research consisted of the following inputs, processes, and outputs:

i. The systematic literature review process exhibited, and was aligned to, the structure of the logic model where the literature that was candidate literature was seen as *input A* into the systematic literature review process. The literature screening, filtering, and selection were seen as the *process A* part of the review, and the selected, qualifying literature produced the curated *output A* of the literature review. This output then served as the *input B* into the compilation of the conceptual framework.

ii. *Input B* was identified as the literature that met the criteria for selection. Process B consisted of the analysis and synthesis of the selected literature. Output B was identified as the Conceptual UX Framework for BI dashboards that included major categories with their representative elements.

iii. The consideration of theories and models that would be relevant to the research and would assist in the execution of the research served as Input C, while the relevant and suitable theories and models which were inspected and selected to form a novel theoretical framework were considered to be Process C. The Theoretical Framework that served as input into subsequent phases of the research was Output C. This framework provided structure and perspective on the research. The Theoretical

Framework also informed the research design and provided guidance on the subsequent execution of the research and, hence, is perceived as, and considered to be, an overarching input into the execution of the research.

4.3.4.3 Application of the logic model – Phase II

Phase II consisted of the following inputs, processes, and outputs:

i. The theoretical framework produced in Phase I (Output C) was utilised as Input D which informed the interview approach and the process followed in the compilation and composition of the interview questions (Process D) when the qualitative research instrument was developed (Output D).

ii. The qualitative instrument, Output D, was then utilised as Input E which was used to facilitate the interview process (Process E) in which participants were interviewed according to the instrument developed (Input E). The interviews allowed for data to be collected from the interview participants (Output E).

iii. The data collected from the interviews that were held were Input F; the analysis of the qualitative data was then considered to be Process F. This produced a novel practitioners' view (Output F) on what is required for the best UX for BI dashboards in an agile software environment.

4.3.4.4 Application of the logic model – Phase III

Phase III consisted of the following inputs, processes, and outputs:

i. The key categories from the novel framework that was produced based on the practitioners' view were then used as input G to compile a quantitative research instrument to validate these views from the practitioner interviews. This process (process G) produced the quantitative instrument, the survey questionnaire, Output G of the research.

ii. The quantitative instrument was used as input H to conduct the survey, Process H of the study to collect data from the survey which was labelled as Output H.

iii. The data collected from the survey was then used as input I to perform statistical factor analysis on the dataset, process I, to produce an analysed set of elements, output I.

iv. This dataset with the factor analysis applied, Input J, was then used to interpret the factor analysis, Process J, to produce a validated practitioners' framework, Output J.

v. During the different parts of the research study, output was generated from the collection of data from different sources, such as:

   a. the conceptual literature-based UX framework (CL_UXF_1.1), considered to be Input K;
   b. the novel framework based on the practitioners' views (from interviews) (CAP_UXF_BID_1.1), considered to be Input L;
   c. the validated practitioners' view (from survey) (VAP_UXF_BID_1.1), considered to be Input M; and
   d. the validated practitioners' view (from focus group) (VAPO_UXF_BID_1.1), considered to be Input N.

These pieces of output were then finally triangulated (Process K) through comparing results from the interviews, survey, and focus group, to produce a validated practitioners' view of what is required for the best UX for BI dashboards within an agile software development environment (Output K) as the final output.

Figure 4.4 represents a high-level view of the research process viewed through the lens of the Logic Model, showing the input, process, and output from one phase to the next and the major research inputs (research problem, research design,), research processes (methodology followed, data analysis) and research output (frameworks produced by study).

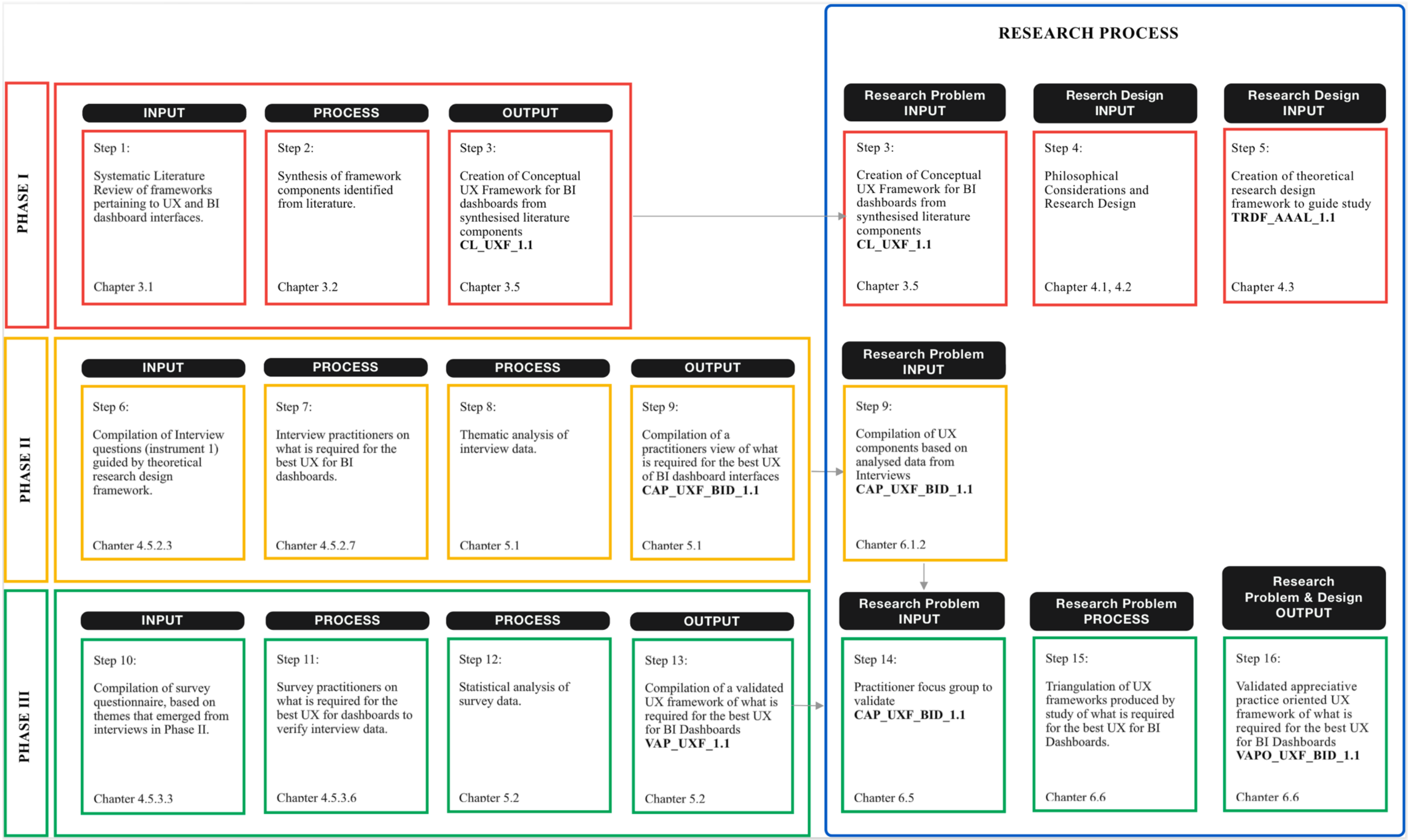

Figure 4.4 High-level process of research through lens of Logic Model.

4.3.4.5 Theoretical research design framework (TRDF_AAAL_1.1) summary

In summary, the theoretical structure that was created to guide the research is based on the principles of the affordance theory, the logic model, and the Agile model; together these form a theoretical framework and foundation for the study. For the purpose of clarity, in this study the theoretical structure created to support and guide the study will be referred to as the ***Theoretical Research Design Framework*** *(*TRDF_AAAL_1.1***)***, see Figure 4.3. Next, the methodological choice will be discussed in Section 4.4.

4.4 Methodological choice

The research methodology utilised in the research study is mixed methods. Mixed methods incorporates both qualitative and quantitative data. The combination of these data types provide the best understanding of a research problem (Khaldi, 2017).

Combining the two types of data means you benefit from both the detailed, contextualized insights of qualitative data and the generalizable, externally valid, insights of quantitative data. The strengths of one type of data often mitigate the weaknesses of the other.

Mixed methods were used in this study to allow for the combining of both qualitative and quantitative data, qualitative to collect detailed and context specific data from the participants' point of view as well quantitative to collect more responses to allow for generalisation, thereby giving a voice to the participants who are practitioners in the domain of the research as the research context is that of an agile software development environment. Mixed methods also ensure that the research and the findings produced by the study are grounded in the participants' practical experience (Guetterman & Creswell, 2015).

Accordingly, the research design allowed for the collection, analysis, and integration of both qualitative and quantitative data (Plano Clark & Creswell, 2008). Mixed Methods also allowed the research design to be informed by a pragmatist philosophical worldview (Creswell, 2014).

There are various different mixed method designs to choose from when conducting mixed methods research that guide the design of the research. Examples of proven designs are Plano Clark and Creswell, (2008) and Headley and Plano Clark (2020), these include:

1. Concurrent mixed methods design with merged results, including the validation of findings using quantitative and qualitative data sources;
2. Sequential exploratory mixed methods to explain findings;
3. Sequential exploratory mixed methods design with instrument development;
4. Using qualitative data to augment a quantitative outcomes study; and
5. Involving community-based stakeholders.

This *exploratory sequential design* that was followed allowed for the initial step of collecting qualitative exploratory data. This was done through the interviews conducted with the practitioners from three different roles (UX designer, product owner and developer) working within an agile a software development environment. The information collected from the interviews was analysed and the themes and key findings from the interviews were used to develop a quantitative instrument. The mixed methods design of the study allowed for the development of a suitable quantitative instrument that provided accurate measures in the study context.

According to Creswell and Plano Clark (2011), there are many *advantages* to using mixed methods:

1. Quantitative and qualitative data can be compared (contradictions between qualitative and quantitative findings can be identified and understood);
2. Reflection on the participants' point of view [participant experiences remain central to the data];
3. It encourages and establishes scholarly collaboration by contributing through collaboration with scholars following quantitative, qualitative, and mixed methods;
4. Methodological flexibility [mixed methods studies are adaptable to different types of research designs]; and
5. The collection of comprehensive, rich data [mixed methods allow for a more comprehensive representation of data than one method could achieve].

Mixed method work well with a pragmatist research approach (Creswell & Plano Clark, 2011). This supports the use of the appreciative inquiry lens used in the research. The use of mixed methods is driven by pragmatism rather than principle and motivated by the believed insufficiency of quantitative methods alone to cover the complexity of specific research contexts (O'Cathain, Murphy, & Nicholl, 2007). By using mixed methods, a comprehensive look at the research collected form many perspectives was ensured. Additionally mixed methods also ensured a more complete picture when the results were analysed (Creswell, 2014).

There are, however, also some challenges and limitations to using mixed methods (Johnson & Onwuegbuzie, 2004) such as:

1. The capacity of a single researcher to conduct both quantitative and qualitative research;
2. The researcher has to upskill and learn about both quantitative and qualitative research methods and understand how to use them together in the same study;
3. The viewpoint that research should be conducted in either a quantitative or qualitative paradigm;
4. Conducting mixed methods research is more expensive;
5. Conducting mixed methods research is more time consuming; and
6. Some areas of interpretation needed by researcher (such as conflicting results and how to analyse qualitatively and interpret quantitative data).

After consideration of the benefits of using mixed methods in the research as well as looking at the challenges associated with mixed methods, it was still considered viable to choose the route of a mixed methods study based on the practical environment of the study and the need for validation of the information collected from the practitioners in their real-world environments.

The use of both qualitative and quantitative methods supported the study to investigate the following *primary research question (PRQ)*:

PRQ: What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?

In qualitative research an intervention or an exposure is not always evident in a qualitative research question as the research aim is to understand specific phenomenon and individual experiences more effectively through understanding the why and the how (Cooke, Smith, & Booth, 2012).

In the study of Milton, Watkins, Studdard, and Burch (2003), a sequential exploratory mixed method design with instrument development was used. The research design was formulated to have the interviews first in order to collect qualitative data from practitioners (Plano Clark &

Creswell, 2008). Creswell (2014) suggests that the qualitative portion should be conducted first to explore data and that this data are to be used as findings for the second quantitative portion of the research.

4.5 Research process

The research process can be broken up into three basic phases. Figure 4.5 presents the high-level research design for the study, which consists mainly of three phases. Firstly, the foundational phase focussed on the literature and formed the theoretical component of the research, the second explorative phase allowed for the collection of information from a small sample of practitioners and, thirdly, the validating phase allowed for the validation of the information retrieved from the practitioners through a larger sample in the agile software development domain.

Phase I is considered to be the *foundational* phase of the research, as it is comprised of the following steps:

- the systematic literature review, discussed in Section 3.2;
- the systematic literature review produced the novel conceptual UX framework for BI based on the elements identified from UX frameworks in literature;
- a novel theoretical framework was produced to guide and support the study;
- the research philosophy was explored and established;
- the research strategy and design were formalised; and
- the research methodological decisions were made, including the data collection methods and the sequence of subsequent research phases were decided upon.

Phase II can be considered as the *explorative* phase of the research:

- the qualitative data collection method was formalised;
- the interview questions were compiled, with guidance from the theoretical framework;
- interview sample was determined;
- interviews were conducted;
- data were collected through interviews; and
- data were thematically analysed.

Phase III comprised of the *validating* phase of the research; it included:

- the compilation of a survey questionnaire based on the themes identified from the interviews that had been conducted in Phase II;
- a survey sample was determined;
- the survey was sent out;
- responses were collected;
- the survey data were statistically analysed (descriptive as well as through factor analysis);
- a verified UX framework for BI dashboards was produced;
- a focus group was held to validate the conceptual practitioners' framework; and
- the verified UX frameworks were compared to produce the validated practice-oriented UX framework for BI dashboards.

Plano Clark and Creswell (2008) refer to this type of research design as a sequential exploratory mixed methods design with instrument development.

4.5.1 Research Phase I – research foundation

Phase I was foundational to the research. It included an investigation of past research and literature available on the research topic and problem. This was done to gain a view of the research that has been conducted; it also allowed for a view of the content presented in the literature and provided a view of the different contexts in which the research had been conducted.

This Phase I consisted of a systematic literature review, which produced a conceptual UX framework for BI dashboards (Section 3.5), a reflection on the philosophical considerations (Section 4.2), the formulation of a theoretical framework (Section 4.3) to guide the construction of the research design that was utilised to guide the carrying out of the research.

The systematic literature review which was conducted allowed for an in-depth review of existing literature, enabling the identification of gaps in the evidence base (Grant & Booth, 2009). From the systematic literature review, the UX elements were identified that were proposed by existing UX frameworks in literature. These existing UX framework elements, identified from the literature review, were organised and synthesised. The systematic literature review was discussed in a step-by-step manner in Section 3.2 which presented the literature review strategy and the execution thereof, Section 3.3 presented the literature analysis that followed the systematic review of the literature.

A novel conceptual UX framework for BI dashboards of elements present in current UX frameworks in literature was produced during Phase I of the research. An original theoretical framework was also produced to guide the study. This theoretical framework was chosen to be discussed in Chapter 4 as it is connected to the philosophical lens of appreciative inquiry that was utilised as an approach in this study and supported and guided the design of the research.

As mentioned earlier, the theoretical framework was used to create a structure that guided the research, including the data collection methods and the data analysis. The theoretical framework also allowed for the exploration of the specific research questions as framed within the logic model, affordances theory and Agile model, and this is presented in Section 4.5.2.3, Table 4.3, where the development of the interview instrument will be discussed. The application of the theoretical framework in the research was presented in Section 4.3.

Next, the primary data collection of the research will be discussed.

4.5.2 Research Phase II – exploration through practitioner interviews

The purpose of Phase II of the research was to interview practitioners (input) about which elements are required for the best UX of BI Dashboards as per the exploratory sequential mixed method research design where the qualitative data gathering part of the research occurred before the quantitative data collection (Fetters & Freshwater, 2015). During this phase of the research the objective was to produce an original conceptual compilation of elements required for the best UX of BI Dashboards as per practitioners' perspective in the field (the intended output).

The elements promoted by interview participants were embedded in rich, detailed and context-specific qualitative data, which were analysed through systematic analysis, coding, categorising, and theming of data (the process), to produce sets of elements within the identified overarching themes that emerged from the interviews. The themes that emerged from the data analysis are discussed in at the qualitative analysis in Section 5.1.3.

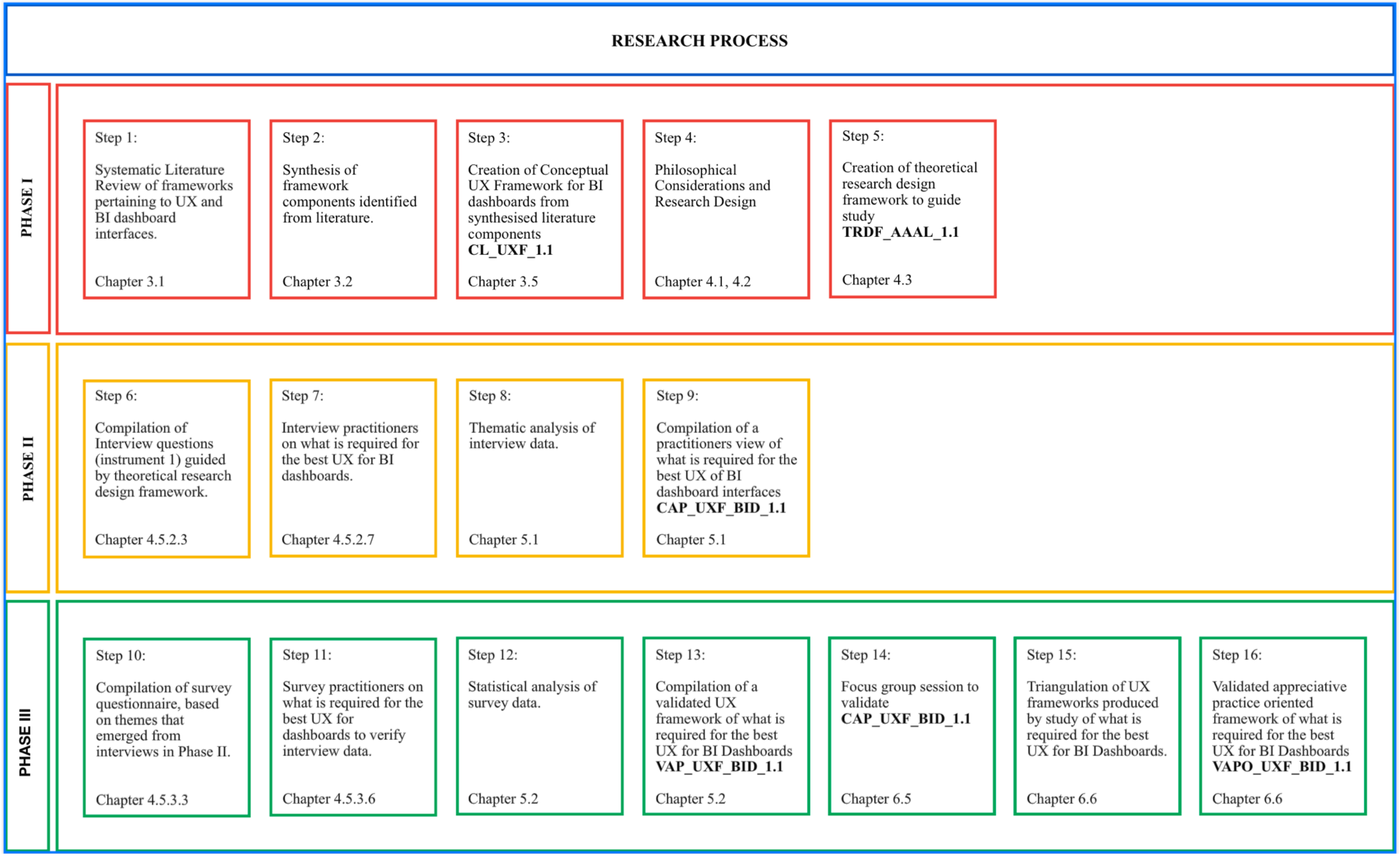

Figure 4.5 High-level research process.

The themes and related elements that emerged from the interviews produced a conceptual *practitioners' framework for the UX of BI dashboard interfaces*. The framework presents elements based on two overarching groupings: 1) design specific, where the elements can be used for conceptual planning *before*, *during* and *after* the design of the BI dashboard before the delivery of the software, and 2) evaluation specific, where the framework elements can be used for the purpose of evaluating the UX of a delivered dashboard solution – after a piece of software has been delivered and is being used by users.

The data from the interviews were analysed and served as input into the development of the instrument utilised to validate the data from the interviews quantitatively from which a novel practitioners' view was determined and also to allow for statistical analysis of the quantitative data.

4.5.2.1 High-level process

The research consisted of the development of the qualitative interview instrument with guidance from the theoretical framework compiled in the research. The interview sample was determined and purposefully selected, interviews were conducted, data were collected through the interviews, the data were thematically analysed to produce a practitioners view of what is required for *the best UX of BI dashboard interfaces.*

4.5.2.2 Justification of data collection method

The design was guided by the research philosophy presented in Section 4.2 that focussed on pragmatism as an underpinning research philosophy to the study and the use of mixed methods as a data collection methodology. The theoretical research design framework, discussed in Section 4.3, as well as the methodological choice, discussed in Section 4.4, provided guidance in terms of: 1) the data collection method used (which was mixed methods); and 2) the data collection technique that was used (which was appreciate inquiry). An interview instrument was compiled, described in Section 4.5.2.3, which guided the steps of appreciative inquiry to collect data from interview participants on the research question. The synthesises and analysed output of the qualitative portion of the research served as the input to the quantitative part of the research.

4.5.2.3 Development of the qualitative data collection instrument

As the research was conducted through the lens of appreciative inquiry, the way the questions were asked was presented through this lens, looking for the 'best' of 'what is' according to the practitioners. The interview process was also aligned to the appreciative inquiry process structure.

The appreciative inquiry process was used to structure the interview questions. The approach makes use of four phases that take the interview participant on a journey of defining concepts as they know and understand them, *discovering* what they know and exploring past positive experiences, asking them to focus on the best parts of the past or current experience. Then the process took the interview participants on a journey to *dream* about what they would like to see to allow them to be innovative; then, in the *design* phase, participants look at practical requirements and how they would work to make the dreams a reality to create the best UX for BI front-ends, and, finally, they investigate what would be required for the delivery of such a user experience.

An open (inductive) qualitative instrument was developed to guide the practitioner interviews. The interview questions were also framed in an appreciative way. The interview made use of the appreciative inquiry approach to reach the goal of identifying what participants would consider to be the elements necessary for the 'best' UX of BI front-ends specifically for dashboards. See Appendix D for the Interview instrument and interview questions (Given, 2012).

Additional objectives to enrich the understanding of the views of the different roles (units of analysis):

- Explore the understanding of software development with regards to the creation of dashboards in an agile work environment;
- Explore the understanding of UX within software development with regards to the creation of dashboards in an agile work environment;
- Explore the experiences of developers, designers, and product owners (POs) of their best past work performances in an agile work environment;
- Explore existing strengths; and
- Describe the best software development for dashboard experiences that could improve best work practices.

To recap, the primary research problem has been identified as:

Problem identified: **currently there is a lack of UX frameworks specific to the development or use of BI dashboards.**

The research questions, objectives, data capturing strategies and the research outcomes were derived to address this problem (presented in Table 1.1). The interview design also included the design and development of the interview instrument. Considerations of what information was to be collected from the interviews influenced and formed the questions.

The interview followed the prescribed pattern in appreciative inquiry and commenced by discovery and defining topics. Hence questions were included in the interview to orientate the participant and to allow for the probing of the different views, to collect his/her unique understanding according to the different roles (the units of analysis used in the research) to:

- Explore the different participants' understanding and view of the role of UX within software development, specifically with regards to the creation of dashboards in an agile work environment;
- Explore the developers, UX designers and product owners' best past experiences of building BI dashboard interfaces in an agile software development work environment;
- Explore the developers, designers, and Product owners' views on their existing strengths; and
- Describe what is needed for the best UX for dashboards that could improve software development work practices.

The Theoretical Research Design Framework allowed the identification of the most important focus areas for the interview instrument. The theoretical framework was also used to structure the interview according to the appreciative inquiry steps of Discovery, Dream, Design and Deliver to allow for the collection of the data in a systematic and logical order of progression during the interview process. Table 4.3 provides an overview of the theoretical considerations utilised to ensure the questions in the interview phase were complete and representative of the areas of each of the approaches and theory selected. This structure was used to guide the creation of the questions for the interviews.

The interview questions were framed through the appreciative inquiry approach to determine 'the best' experience. The trademark of appreciative inquiry is the positive orientation of the interview questions. Questions asked in an interview influence the answers received. The information retrieved determines output generated by the interviews. In appreciative inquiry, instrument questions are recommended to be posed in positive language and as an invitation, to be phrased in sometimes ambiguous conversational language, and to evoke storytelling about peak experiences. Questions should be designed to invite participants to share positive stories (Given, 2012).

Table 4.3 Application of the theoretical framework to structure interview questions according to the appreciative inquiry phases discover, dream, design and deliver.

Appreciative Inquiry		
Discover	**Dream & Design**	**Deliver**
Logic Model HOW things work	**Affordances Theory** How things COULD work / potential	**Agile Model** What is needed to MAKE things work in practice
1. Inputs - Financial, human, and material resources.	1. Technology question	1. Individuals and interactions
2. Activities - Services or functions carried out by a program (i.e., what the program does).	2. Functional question	2. Working software
3. Outputs - Things produced in the course of services or functions.	3. Participation question – process and practice	3. Customer collaboration
4. Outcomes - to be identified at three stages, - Changes in knowledge or learning (short-term); - Changes in behaviour (or medium-term); and - Changes in the conditions specified in original situation expected to occur (in the long-term).	5. Development question	4. Responding to change

These questions have been mapped to the theoretical framework structure to ensure that all areas of the structure have been addressed. The interview instrument (see Appendix D) consisted of an introductory part where the context for the research was established. Then the second part of the instrument focussed on the appreciative inquiry phases as per the appreciative inquiry approach.

4.5.2.4 Sampling

The interview sample was determined by considering the composition of the Agile team as it would generally look in practice. In some contexts, there are more roles in the agile team than in others, for example where business analysts would not be dedicated members and part of the software development agile team. In general, the agile team consists of a product owner or manager, a scrum master, one or more business analysts, one or more UX designers, quality assurance testers, developers and, sometimes, the team also has one or more UI designers (Layton, 2012).

A sample should be representative of the target population. Normally, representative sampling is achievable by making use of a large random sample. In qualitative samples that would take a long time. It is more logical and efficient to select a sample purposively that is diverse and will cover a broad range of the phenomenon (to reach saturation sooner) (Jansen, 2010). Hence, a representative practitioner sample was purposefully selected, based on the population of software development team members. Three roles in the agile team were selected and included as part of the research participant selection criteria. The practitioner roles that were selected for inclusion in the research were: as the product representative the product manager/owner; as the user and design representative the UX designer; and as the technical representative the software developer.

These three roles were selected as they play major roles in the development of software within an agile environment. These roles were also selected as the UX design role, which is central to this research study, is connected to both the Product role and the Development role and, normally, there would be a flow of work and information between the three roles in practice. This section will look more closely at the different practitioner roles that were employed in the interviews, briefly considering the contributions of each role.

Contributions made by UX designers in Agile environments typically include, but are not limited to, the following (Bruun *et al.*, 2018; Frost, 2016):

- Conceptualising designs (including conducting of research with users and stakeholders, gathering data, creating, and testing information architectures, creating and testing information flows, creation of prototypes);
- Creating user insights from data analysis;
- Communicating and sharing concept design with stakeholders for feedback and collaboration;
- Incorporating changes required from product and development;
- Testing conceptual design with users;
- Updating the concept design with feedback from users;

- Once the conceptual design is acceptable, the UX designer goes into subsequent stages of incremental design and refines the concept features until stakeholders are satisfied and user testing passes according to agree upon usability testing metrics and experience criteria metrics;
- The UX designer produces wireframes (a skeletal structure of the interface with the basic design elements) as an output which are reviewed, refined, and handed over to the visual designer to apply the visual design requirements and brand requirements to the design and
- The UX designer continues to work with the team to improve product features incrementally.

Contributions made by Product Owners in Agile environments typically include, but are not limited to:

- Managing and prioritising the product backlog (Remta, Doležel, & Buchalcevová, 2020; Schwaber & Sutherland, 2017);
- Developing usable and useful software (Kristinsdottir, Larusdottir, & Cajander, 2016);
- Acting as a motivator within the team (Remta *et al*., 2020);
- Acting as a gatekeeper to decide when a feature or story is ready to be included in releases, to act as the release master, approving, and controlling release plans (Bass, Beecham, Razzak, Canna, & Noll, 2018);
- Answering to the return on investment of the project (Sverrisdottir, Ingason, & Jonasson, 2014);
- Acting as the spokesperson or major communicator of the team (Bass *et al*., 2018);
- Identifying and mitigate risk where identified (Bass *et al.*, 2018);
- Acting as the combined representative of authority responsibility of the customer, product manager and project manager (Pichler, 2010);
- Taking responsibility for the project requirements and project objectives (Sverrisdottir *et al*., 2014); and
- The performance of the product owner is critical to the success of the project (Dikert, Paasivaara, & Lassenius, 2016).

Contributions made by software developers in Agile environments typically include, but are not limited to:

- Delivering working software on a continuous basis (Drury, Conboy, & Power, 2012);
- Having to self-organise within the team (Kropp, Anslow, Meier, & Biddle, 2018);
- Playing a part in increasing the value of the product (Drury *et al*., 2012);
- Being involved in the selection of work tasks (Tessem, 2014);
- Being able to influence the priority of work because of team empowerment (Tessem, 2014);
- Contributing to decision making within the agile team (Drury *et al*., 2012);
- Communicating and effectively collaborating with colleagues, using their collective expertise to solve development problems (Kudaravalli, Faraj, & Johnson, 2017); and
- Ensuring that all development work is safely kept and routinely backed up (Kudaravalli *et al*., 2017).

The sample was purposefully selected, based on the practitioner's role in an agile software development environment. A small sample size was acknowledged as a limitation of the research as the number of participants meeting the selection criterion was low.
Selection criteria were:

1. The practitioner needed to have experience of being part of an agile team;
2. The practitioner needed to have experience of being part of a team that developed dashboards in an agile software development environment; and
3. The practitioner needed to have experience in at least any one of the three roles specified, i.e., a UX designer, software developer or product owner/manager.

The participant criteria were compiled in such a way that the participants could be company agnostic and domain specific, to provide a representative sample of participant perspectives across the research domain and not too exclusively focussed on practice and views within a single organisation. The research aimed to be inclusive of the views of practitioners across the research domain and representative of the research population.

Subsequently, the interviews incorporated five practitioners from the three (3) different roles, viz. developers, UX designers and product owners. The small sample size was acknowledged as a limitation, and during the interviews participants were probed until data saturation was reached. The participants were purposefully selected according to their proven experience and contribution in the domain of software development within an agile software development environment. Owing to the scare nature of the practitioners, with specialised expertise and experience in the field, the sample comprised of practitioners from different domains (for example, banking, insurance, and medical aid) and different geographies (New Zealand, United Arab Emirates, Unites States) (see Table 4.4).

The interview participants were requested to sign and return the consent form if they agreed to participate in the study. The consent forms of the research study were securely stored online. The interview cover letter and consent form can be viewed as part of Appendix D. The participants were asked whether they might be recorded during the interview process. Participants agreed and the recordings were stored in a secure online location. The recordings were anonymised, and participant's names and video were not included in any of the data analysis, thereby ensuring that the participants' anonymity was protected and respected, ensuring that none of the participants were identifiable. The interviews were recorded for the purpose of accurate capturing and collection of the data. This allowed the interviews to be transcribed and captured word by word. This also allowed for a thorough analysis of the interviews. The analysis of the interview data is described in Section 5.1, while Chapter 6 presents the results from the analysis.

Table 4.4 Interview sample – participant location and practitioner role.

Location	Role	Participants
South Africa	Product Owner 1 Product Owner 2 Product Owner 3 UX Designer 1 UX Designer 2 UX Designer 3 Developer 1 Developer 2 Developer 3	9
USA	Product Owner 4 UX Designer 4	2
UK	Product Owner 5 UX Designer 5	2
New Zealand	Developer 4	1
United Arab Emirates	Developer 5	1
	Total	15

4.5.2.5 Interview preparation

To prepare for the interview process and to ensure that all relevant questions were asked and information retrieved during the interviews, the theoretical framework was used to ensure that all parts or areas that needed to be covered in the interviews to collect data were considered. The theoretical framework also provided guidance in terms of the method of inquiry. A request for ethical clearance was submitted to the Ethics Council of Unisa after the SLR was completed; ethical clearance was obtained before the primary data collection via interviews, surveys and the focus group session was conducted. See attached ethical clearance as Appendix K.

4.5.2.6 Interview pre-test

To test the interview process, an initial interview was conducted with a UX designer. The designer had signed and returned the consent form before the interview was started. Upon commencement of the interview, the researcher asked whether the interview might be recorded for analysis purposes. The UX designer agreed, and the interview was recorded on the researcher’s personal computer. Background to the research was provided to the interview participant to help establish context and allow the interview participant to orientate herself to the study. The interview questionnaire was used to ask the same questions for every interview. The interview was recorded, and this allowed the researcher to reflect on the process followed with interview participants. The process by which the consent form was sent to the participant before the time of the interview allowed for the participant to read through the background to the study and for signing and returning the signed consent form before the interview was conducted. From the pre-test interview minor adjustments were made to the interview questions to ensure clarity of the questions.

4.5.2.7 Data collection – interviews

At the start of the interview, background was provided to the interview participants pertaining to the study. The participants were also informed that participation in the study was entirely voluntary, that there were no right or wrong answers, the participants were encouraged to honestly say what they thought; they were also reminded that they could stop participating at any time during the interview and that they were participating out of their own free will. To ensure confidentiality and anonymity participants were informed that their names were not required for the study. See appendix D for the interview cover letter and the interview consent form.

Practitioners were interviewed by using the qualitative instrument (Appendix D) that was compiled as per the structure provided by the theoretical framework to find out what practitioners consider to be required for the best UX for BI dashboard interfaces (as part of the appreciative inquiry approach to find the best of what could be) from their perspective.

These interviews included practitioners from three (3) different roles, UX designers, Product Owners/Managers and Developers. During the interviews the research participants were taken on an appreciative inquiry journey, through the phases of discovery, dream, design, and delivery and probed for answers until information retrieval saturation was reached.

The interview process continued in the same manner as the pre-test interview process. Five of the interviews were conducted in person; the remainder of the interviews (10) were conducted remotely through making use of video conferencing software. Participants were asked whether the interview might be recorded for record keeping and analysis purposes, and the interviews were recorded on the researcher's personal computer.

The interviews were conducted in different locations, based on the location of the participant; most were conducted online owing to the geographic disparity of the participants. The interview followed the structure of appreciative inquiry taking the participant on an appreciative journey considering what they know and what they have seen to work (discover phase) to produce the best of what is. The participants were then taken along on an appreciative journey to discover, dream, design and deliver the best of what could be for the UX of dashboards in an agile software development environment.

4.5.2.8 Researcher's role

The researcher conducted all parts of the research herself. This included the research planning, research design, choice of methodology, understanding her own beliefs that underpin her philosophical outlook, which, in turn, influences how research is viewed. The researcher created and compiled the research instrument, the purposeful selection of the interview sample, and conducted the interviews and collected the interview data. The researcher also performed the qualitative data analysis, interpreting the qualitative data from the researcher's philosophical view and perspective.

4.5.2.9 Data analysis

From the practitioners' interviews, the data were collected and analysed. An original and novel practitioners view of what was required for the best UX of dashboards within an agile software development environment was produced as the output at the end of Phase II of the study. The data analysis is discussed in detail in Chapter 5 with the results presented in Chapter 6.

4.5.2.10 Output

The practitioners' view allowed for insight into what practitioners consider important for the best UX for dashboards. The practitioners' view also spanned both areas of the software development cycle, that is pre-delivery (where the software is designed and developed) and post-delivery (when the software is incrementally improved and used by the user).

The output from Phase II served as input into Phase III to construct a quantitative survey questionnaire to validate the views of the interviews held with the practitioners by surveying a larger sample of agile software development practitioners.

4.5.3 Research Phase III – validation

In Phase III the focus was on validating the data collected. A survey was conducted to capture quantitative data and validate the views of the practitioners interviewed with a larger group of practitioners. A focus group with practitioners was also held to validate the views collected from practitioners interviewed.

4.5.3.1 High level process

A survey was conducted through the use of a survey questionnaire to validate the elements identified and synthesised from the practitioner interviews. This quantitative instrument was compiled from the themes that had emerged from the practitioners' perspectives of what elements are important for the best UX of dashboards in an agile software development environment. This questionnaire was then distributed to a larger sample in the form of a survey. After responses to the survey had been collected, a statistical analysis of the data followed. This allowed for the compilation of the verified UX framework for BI dashboards (VAP_UXF_BID_1.1).

4.5.3.2 Justification of data collection method

The design of the third research phase was guided by the theoretical framework. This determined the research method that was used. A survey was constructed from the output of the qualitative portion of the research and this served as the input to determine the structure, the categories and questions that needed to be asked in the questionnaire. After the data had been collected from the completed surveys, statistical analysis was conducted on the data in the form of inferential statistics, discussed in Chapter 5 with the data analysis and results.

4.5.3.3 Development of the quantitative data collection instrument

From the qualitative data analysis in the study, major themes emerged that formed a practitioners' perspective framework for what is required for the best UX in the development of dashboards in an agile software development environment. These themes are discussed in Section 5.1.3 where the research data analysis and results are presented. The emerging themes were reviewed with the research supervisors, and the two themes for BI UX, those are UX Design and Technical Development (as most relevant to the study) with their sub-categories, were selected to be included in the survey to validate the views of the practitioners interviewed. This was done to keep the survey manageable, i.e., limiting the number of questionnaire items which would result in a higher participation rate and a higher completion rate of the survey. It was decided to focus on the UX designer and the developer themes as these two roles were considered to be contextually more relevant in the environment of information system, the greater domain in which the research is conducted.

Therefore, the research instrument was formulated and structured based on two major themes selected from the qualitative analysis. The instrument was drafted on a word application. The draft instrument was reviewed with the research supervisors, and, thereafter, minor updates were made to the instrument. The instrument was then re-created in a survey software tool which would allow for efficient administration of the survey by sending out the survey as well as collecting the data from survey participants. The survey tool also allowed for the survey data to be exported to a .CSV file format, which was sent to the statistician for the purpose of the statistical analysis.

4.5.3.4 Sampling

Suitable participants had to be purposefully identified for participation in the survey. The sample also had to be of sufficient size to qualify the statistical requirements for the quantitative portion of the research. The sample was purposefully identified as being practitioners working in an agile software development environment.

Participant criteria were:

1. The practitioner needed to have experience being part of an agile team; and
2. The practitioner needed to have experience being part of a team that developed dashboards in an agile software development environment.

Similar to the participant criteria for the interviews, the participant criteria were compiled such that the participants could be company agnostic and domain specific, provide a representative sample of participant perspectives from across the globe on the research domain and not be exclusively focussed on practice and views within a single organisation.

4.5.3.5 Survey pre-test

A pre-test was done on 7 May 2020, with a purposefully selected UX designer to test the Survey and provide feedback in terms of (1) clarity of the questions in the survey and (2) any formatting or typos that may have been overlooked. The Designer completed the survey and pointed out one question that was unclear in her view. This question was then discussed with the research supervisors and a consensus was reached as to how the question copy would be formulated to be as clear as possible to indicate to the participant what would be meant and measured by the question.

4.5.3.6 Data collection – survey

Initially, an invitation to participate in the research was published to two interest groups on LinkedIn, an UX group and an Agile group, inviting agile practitioners who had been part of a team that had built software for dashboards to participate in the research. The response rate was extremely low, with only nine participants reacting to and completing in the survey.

An alternative method of collecting data from a suitable population had to be found. The researcher hosted a meet-up group which consisted mainly of agile practitioners. An invitation to participate in the research survey was sent to members of the meet-up. At all times during this process members' information was treated as confidential and the communication to the Meet-up members was done through the Meet-up platform, taking care not to expose member details to other members. From this request to participate in the research study, 93 more responses were collected. This brought the total number of responses to 102 participants. This sample was considered to be relatively small for the quantitative phase but was deemed sufficient considering the size of the research population and scarcity of participants that would make up the population of practitioners who have been part of developing software for dashboards in an agile software development environment.

4.5.3.7 Researcher's role

During this part of the research, Phase III, the researcher was involved in the research by creating and compiling the research instrument. The researcher also administered and conducted the online survey via the survey application software. The researcher introduced the survey to potential participants and also collected the data from the survey and then passed on the survey data to an independent statistician for the statistical analysis of the data. The independent statistician was involved in the statistical analysis of the data using only a statistical software package. The analysis is discussed in Chapter 5 with the data analysis and results of the research.

4.5.3.8 Data analysis

The survey allowed the collection of data from agile practitioners across the globe to validate the perspectives collected from the interviews. When the closing date of the survey was reached, the survey was closed in the survey application, which meant that no further responses would be accepted by the survey. The survey data were then exported from the online software application and downloaded for safekeeping. The downloaded data set were then shared with the statistician who would be performing the independent data analysis. The statistical analysis is presented in Chapter 5.2.

4.5.3.9 Output

The following outputs were produced by Phase III of the research:

1. The survey allowed for the validation of the data collected in the practitioners' interviews;
2. The output allowed for the triangulation of data from 1. the survey, 2. the practitioners, and the focus group session; and

3. A validated appreciative practice-oriented framework for the UX of dashboards developed in an agile software development environment.

4.6 Ethical considerations

The research at all times upheld the ethical research requirements as set out in the UNISA Ethical Clearance certificate. A request for approval to conduct the data collection via interviews and a survey were submitted to the Ethical Research Committee of Unisa. Approval was obtained to conduct the study through the Ethical Research Committee (ethics clearance number: 035/CJ/2018/CSET_SOC). See Appendix K for the ethical clearance certificate.

In the following sections the ethical research considerations as deemed important by Lincoln and Guba (1985), Forero *et al*., (2018), Morse, Barrett, Mayan, Olson, and Spiers (2002) and Babbie and Mouton (2001) are outlined and the application of these ethical considerations within the research study are discussed.

4.6.1 Research quality and methodological rigour

Rigour in research is paramount, and the following sections attest to the application of rigour in the study. It is important to note that *credibility* can be viewed as the *qualitative* equivalent to the *quantitative* criterion of *internal validity*; *transferability* as the *qualitative* equivalent to the *quantitative* criteria of *external validity* and *generalizability*; *dependability* as the *qualitative* equivalent to the *quantitative* criterion of *reliability*; and *confirmability* as the *qualitative* equivalent to the *quantitative* criterion of *objectivity* (Shenton, 2004). The measures taken in the research study to ensure qualitative rigour are presented in Table 4.5.

4.6.2 Qualitative research

For qualitative research (discussed in Section 4.5.2), the research study is assessed based on the following appropriate qualitative criteria (Shenton, 2004). These criteria are **trustworthiness** (Morse *et al.*, 2002) **authenticity** (Bryman & Bell, 2011; Morse *et al*., 2002) and **adequacy**. According to Forero *et al*. (2018) trustworthiness has four aspects, namely **credibility**, **transferability**, **dependability**, and **confirmability** (Bryman & Bell, 2011; Forero *et al*., 2018)

Table 4.5 Measures taken in research to ensure qualitative rigour.

Measure	Qualitative measures of research rigour	Application in research
Trustworthiness	Trustworthiness according to Guba's model (Guba & Lincoln, 1998) comprises of 1) credibility; 2) transferability; 3) confirmability; and 4) dependability (Babbie & Mouton, 2001; De Vos, Strydom, Fouché, & Delport, 2011).	Trustworthiness was ensured in the study by using Guba's criteria of credibility, transferability, confirmability, and dependability as per the discussion of each point of consideration in the following sections of this table. These provided confidence in the research results.
Credibility	Qualitative research can be evaluated according to the research credibility. Credibility according to Lincoln and Guba (1986) speaks to adequate involvement of participants in the research, observation of the phenomenon studied, use of triangulation within the research, target group consensus and adequate referencing of supporting research. This is done to create confidence in the research results (Terre Blanche et al., 2006).	Credibility was ensured through conducting a one-to-one interview with the practitioners that are specialists in the domain of the study. The interview participants were requested to describe their practicing context, as well as past and current experiences in detail of what is required for the best UX for dashboards. The practitioners were probed until data saturation was reached. Credibility was also achieved by making use of triangulation, employing different research methodologies to produce complementary views and to cover any potential research gaps.
Transferability	Transferability refers to the extent that the research findings are transferable to other contexts or to other participants (Babbie & Mouton, 2001; Maher, Hadfield, Hutchings, & de Eyto, 2018). Transferability is achieved through the creation of rich, detailed descriptions of contexts as the qualitative research is specific to a unique context. These 'thick' descriptions of a particular context, allow the readers to assess whether the research is transferable to their contexts or not (Terre Blanche et al., 2006).	Thick (also called comprehensive) descriptions of the research context were utilised in Chapter 1, 2, and 3 where the research context was described to allow for the better understanding of the research context and to allow for the identification of opportunities of transferability of the research to other contexts and domains.
Dependability	Dependability is a measure used to determine the degree to which the audience can know with certainty that the findings did actually occur (Terre Blanche et al., 2006). The measure of credibility will indirectly ensure the measure of dependability (Babbie & Mouton, 2001).	Dependability in this research was ensured by a thick (that is comprehensive) descriptions of the research methods (as per Chapter 4), and the data analysis and validation of data collected by subsequent data collection (survey and focus group) (Chapter 5).

Confirmability	Confirmability is the measures used to ensure that the findings of the research are the product of the research inquiry and not those of the researcher's bias (Babbie & Mouton, 2001; Mouton, 2003).	Confirmability was ensured through the involvement of an independent reviewer of the qualitative coding of the research interviews.
Adequacy	Adequacy refers to the scientific adequacy followed in the research (Lincoln & Guba, 1985). The concept of adequacy was built on the foundation laid by credibility, confirmability, dependability, and transferability. According to Morse *et al.*, (2002) science primarily relates to scientific adequacy, Morse *et al.*, (2002) maintains that if the concepts of validity and reliability be rejected that the concept of adequacy would also be rejected. A clear research methodology adds to improved scientific adequacy in research (Mays & Pope, 1995).	Adequacy was ensured by upholding the concepts of credibility, confirmability, dependability, and transferability in the research as laid out in this table. Adequacy was also addressed by ensuring that the research methodology was clearly presented as set out in Chapter 4, where the different parts of the research were presented.
Authenticity	The aim of authenticity in research is to collect an 'authentic' and true understanding of participants' experiences. Open-ended questions are usually the most effective way to achieve an authentic participant view (Seale & Silverman, 1997).	The research aimed to collect authentic data that reflects the genuine views of the research participants, this was done to produce participant authentic research, that mirrors the actual experiences of the research participants.

4.6.3 Quantitative research

For the survey portion of the research, discussed in Section 4.5.3, internal validity, external validity, reliability and objectivity (Lincoln & Guba, 1985) were ensured through the following means: See Table 4.6 that presents the measures taken to ensure quantitative rigour.

Table 4.6 Measures taken in research to ensure quantitative rigour.

Measure	Quantitative measures of research rigour	Application in research
Internal validity	Exploratory research usually values internal validity over external validity, whereas descriptive surveys value representativeness and generalizability of findings.	As the research was of an exploratory nature internal validity was valued. The sample size (102) was deemed sufficient for the context of the study but still noted as a limitation.

External validity or Generalizability	External validity (also referred to as Generalizability) is the degree to which it is possible to make generalisations from the research data, as well as the results of the research study to broader populations and settings. External validity is essential in survey research. It is important to distinguish that external validity refers to other populations and samples, and not to different contexts as representative samples are used in surveys to make sure that sample descriptions could be used to describe populations (Terre Blanche *et al*., 2006).	In order to ensure that research is generalizable the sample included participants from outside South Africa in the study. Furthermore, a double participant representativeness technique was employed as a qualifying question was added to the start of the questionnaire asking the participant if the participant had been part of agile team in the past, for how long, in what role (capacity) and whether the participant had been part of an agile team the built dashboards.
Validity	Validity refers to the extent to which the conclusions made from the research are sound. Validity is ensured in quantitative research through the use of acknowledged standardised measures and statistical techniques to ensure that correct and accurate research conclusions are made *(*Preece *et al*., 2002). Validity aims to determine whether the chosen evaluation method measures what it set out to measure, this does not only mean it measures the output but also how the measurement was performed (Terre Blanche *et al*., 2006).	The research made use of an independent statistician to load the survey questionnaire data into a standard statistical application (SPS) to perform descriptive as well as exploratory factor analysis on the four constructs that emerged from the practitioners' interviews.
Reliability	Reliability, also referred to as the consistency of a method, speaks to how well the same result is produced, under similar circumstances on separate occasions. Reliability refers to the degree to which the research results are repeatable (Preece *et al*., 2002). Reliability applies to both the research participant scoring of measures being surveyed (measure reliability) as well as the overall outcome of the research study (research reliability) (Terre Blanche *et al*., 2006).	Reliability have been addressed by making use of standardised methods to collect and process data. The use of a theoretical framework further provided structure and improved reliability for the repetition of the study to produce similar results and outcomes. The complexity of prolonged engagement with participants were acknowledged. The methods undertaken to collect data were intrinsically linked to the philosophical position taken in the research, that employed a pragmatic philosophical approach as the research is primarily interested in the experiences of practitioners within an agile software development environment.

Quantitative rigour was further ensured through the following measures:

1. The researcher had been in a work setting (agile software development environment) with the research interview participants at various points in time over the past four years, had observed the interview sample participants in a number of project-related situations and

had formed a contextualised understanding on the role players in the research setting to include them in a purposeful sample.

2. At the time of the research interviews and surveys, the research participants were not working at the organisation where the researcher observed the interview participants. By then, the participants had moved on and the interview research participants were working at different organisations across the globe in agile software development environments. It is important to note that, at all times during the research, care was taken not to approach or request organisational specific information from the research participants, but rather domain specific information as the context of the research was that of finding what is required for the best UX within the software development for dashboards in an agile software development environment.

3. The research was designed, structured, and conducted in a manner that fostered justice and excluded any harm and exploitation of participants.

4.6.4 Measures taken to ensure trustworthiness

Guba and Lincoln (1998) placed emphasis on the principles of credibility, transferability, dependability, and confirmability to ensure trustworthiness in research. These principles were adhered to in the research study and were applied in this study to ensure the trustworthiness of the data obtained:

1. Credibility
    a. Previous and prolonged involvement with the participants in the interview sample group through a common context and shared values established trust to share their perspectives in the interviews.
    b. Target group consensus was achieved in the research through the acquisition of informed consent and voluntary participation in the research study.
    c. The interview participants in the UX designer roles have observed users using the dashboard interfaces as part of their research and also the validation of the dashboard interfaces; this allowed for an in-depth understanding of the needs, challenges and frustration experienced by users.
    d. The use of triangulation of research methods, that is the collection and compilation of a conceptual framework for UX of dashboards within an agile software

development environment, the collection of rich data from the interviews with practitioners, and the validation of the practitioners' perspectives with a larger sample of practitioners through a quantitative survey all allowed for the collection of evidence from divergent sources.

e. Adequate referencing was achieved in the study through the collection of primary raw data. This was done through exploratory interviews using appreciative inquiry as a technique to collect data until the point of data saturation occurred, as well as the collection of raw data from an original survey questionnaire constructed and based on the thematic analysis of the interview data.

2. Transferability
   a. Thick descriptions of the research context were provided in Chapter 3 to provide a comprehensive picture of the context in which the research was taking place. Although the research was based on software development in different physical locations, the context remained a constant in the research, and that was the development of software for dashboard in an agile software development environment.
   b. Transferability to similar contexts would allow the design and evaluation of what would be required for the best UX of dashboards in an agile software development environment.

3. Dependability
   a. Dependability was addressed through the use of triangulation of research methods.
   b. Dependability was also addressed through the measures taken to ensure credibility.

4. Confirmability
   a. All effort has been made to prevent inference in any way.
   b. The research study was conducted in a logical and methodologically correct manner by coordinating the correct times for the collection of the relevant data to be available as input into subsequent phases of the research as recommended by the mixed method protocol. The different data collection methods also allowed for the triangulation and comparison of the data collected.
   c. The research findings are all based on the raw primary data collected during the research.

d. From the data collected, the data were analysed, and, in the process of analysis, much analytical thought and contemplation was put into how best to analyse and study the data that were collected.
e. From the unbiased collection and analysis of data, categories and themes emerged that allowed the data to be organised in an effective way.
f. The study was approached and conducted by utilising critical reflection throughout the process of the study; this allowed for a purposeful study, for the data collected in the study to be optimally analysed and for the results and findings to be presented in an objective and impartial manner.

4.6.5 Research bias and mitigation

Research **bias** refers to research results that become distorted. This typically occurs when researchers selectively gather data that they consider to be important. Interviewers may unconsciously influence responses from interviewees by using a tone of voice, by facial expressions, by the way a question is phrased, or by leading a participant in answering a question (Preece *et al*., 2002).

Research bias was mitigated in the research conducted through remaining conscious of not influencing participants and not leading questions during the interview process, to accurately capturing participant data, and analysing and producing research results in a reliable and valid manner at all times. Mouton (2003) describes the epistemic imperative of science as the moral commitment that scientists have to search for truth and knowledge.

4.7 Chapter summary

This chapter has been dedicated to the design and the mechanics of the research. It addresses the philosophical roots, the supporting theory, the composition of the research design, the methodology followed, and the ethical considerations taken into account during the research.
The chapter objectives have been addressed by:

- presenting the philosophical perspective (first chapter objective) of the research as the underlying philosophy influencing the design and approach followed in the research. In Section 4.2, the philosophical approach adopted during the research was presented as a *pragmatic viewpoint* which has been linked to an appreciative inquiry approach in that both are concerned with measuring knowledge by what works in practice. In the search to understand practitioners' views, appreciative inquiry is used as a technique to collect real world contextual data relative to what practitioners consider to be the *best of what works and of what could be*.

- The novel theoretical framework that was constructed as theoretical underpinning to the study was presented (second chapter objective). The framework included appreciative inquiry, the affordance theory, the Agile model, and the logic model. In Section 4.3 the different parts of the framework were discussed as well as their influence on the research.

- Mixed method was presented in Section 4.4 as the methodological choice for the study (third chapter objective). The chapter also explained why mixed methods was an appropriate method for the study. The different methods used were discussed, both qualitative and quantitative, as well as the sequence in which the methods were used, with the qualitative part taking place before the quantitative part. This sequence was chosen as an explorative data collection strategy to collect rich, thick descriptions from the practitioners' views before conducting the quantitative validating part.

- The research process as was presented in Section 4.5 (fourth chapter objective), as it constitutes three major parts, viz. Phase I, which was presented as the foundational phase, Phase II the explorative phase, and Phase III the validating phase of the research.

- The ethical research considerations taken during the study were presented (fifth objective) in Section 4.6. The application of the ethical considerations was presented, alongside the measures taken to ensure trustworthiness in the research. Ethical considerations, such as research bias and the mitigation thereof, were considered in Section 4.6.5.

In summary, the chapter was dedicated to the philosophical views of the research study, the research design choices, how the research was conducted and how the different types of data were collected. It became clear how the data collected during the interview phase of the research flowed into and shaped the survey stage of the research allowing for the validation of the data collected from the interviews with practitioners. Following the description of the data collection, the data analysis will be presented in Chapter 5.

Chapter 5

Data Analysis

Chapter 5 follows from the research design and methodology presented in Chapter 4. As the study made use of an exploratory sequential mixed methods design with instrument development, the output from the interviews (the themes that emerged from the data analysis) were utilised as input to create an instrument to refine the findings from the practitioners' interviews through a survey conducted with a larger population of practitioners. Chapter 5 focuses on the analysis of data collected from the practitioners' interviews as well as the data collected from the survey with the larger population of practitioners to validate the data collected during the interview.

The chapter has been compiled with the following objectives:

- To present the data collected and analysed from the practitioner interviews (Section 5.1); the demographics described (Section 5.1.1); the essence of the practitioner interviews according to the appreciative inquiry process (Section 5.1.2); and the major themes identified from the practitioner interviews (Section 5.1.3);

- To present the data collected and analysed from the practitioner surveys (Section 5.2). The data analysis is divided into four parts: Descriptive frequency analysis (Section 5.2.1); Item analysis (Section 5.2.2); Principal component analysis (Section 5.2.3); and Exploratory factor analysis (Section 5.2.4).

Chapter 5 continues by discussing the analysis of the practitioner interviews conducted in Section 5.1. Section 5.2 presents the analysis of the practitioner surveys conducted. The chapter is summarised in Section 5.3.

5.1 Interview data analysis

Section 5.1.1 to 5.1.3 will next present the analysis of the data collected from the research interviews.

5.1.1 Demographics of participants

The interviews were conducted with 15 participants. All participants were part of agile software development teams, five participants from each role, from different geographic regions. Refer to Table 5.1 to see the participant roles, their predominant work location, nationality and years of experience.

Table 5.1 Demographics of interview participants.

Participant identifier	Role	Work location	Nationality	Years of experience
Participant_A_PO1	Product Owner 1	South Africa	South African	12
Participant_B_PO2	Product Owner 2	South Africa	South African	3
Participant_C_PO3	Product Owner 3	United States of America	American	2
Participant_D_PO4	Product Owner 4	United Kingdom	American	6
Participant_E_PO5	Product Owner 5	South African	South African	2
Participant_F_UXD1	UX Designer 1	South Africa	South African	2
Participant_G_UXD2	UX Designer 2	South Africa	South African	7
Participant_H_UXD3	UX Designer 3	South Africa	South African	8
Participant_I_UXD4	UX Designer 4	United Kingdom	South African	9
Participant_J_UXD5	UX Designer 5	United Kingdom	South African	8
Participant_K_DEV1	Developer 1	South Africa	South African	3
Participant_L_DEV2	Developer 2	South Africa	South African	2
Participant_M_Dev3	Developer 3	South Africa	South African	4
Participant_N_DEV4	Developer 4	New Zealand	New Zealand	12
Participant_O_DEV5	Developer 5	United Arab Emirates	South African	5
Total: 15				

5.1.2 Practitioner interviews: data analysis

The recorded interviews were transcribed using a text application. The codes-to-theory model for qualitative inquiry as from Saldana (2015) was used to guide the qualitative analysis with upwards open coding, moving from granular towards a higher level of abstraction. Guidance was obtained from consulting and adapting the data analysis process of Braun and Clarke (2020) towards theme development. The phase-approach was not strictly followed as Braun and Clarke emphasised that the phased approach was not intended to be followed rigidly (Braun & Clarke, 2020). Figure 5.1 depicts the interview data analysis process.

As part of *data familiarising* (phase 1 from Braun and Clarke, 2020) the transcribed interviews were read through in order to refresh the researcher's memory, to gain an overview of the content of the interviews and also to gain an idea of the extent of the different texts. Thereafter, the transcribed interviews were read through again for a second time with the aim of being immersed in the data. To improve comprehension of the content, key parts of the interviews that stood out from the interview were highlighted (Maher *et al.*, 2018). The transcribed interviews were read through a third time, and this time round labels were added (as a start of systematic coding), texts were highlighted as relevant topics, nuances and relationships were identified (Phase 2, from Braun and Clarke, 2020).

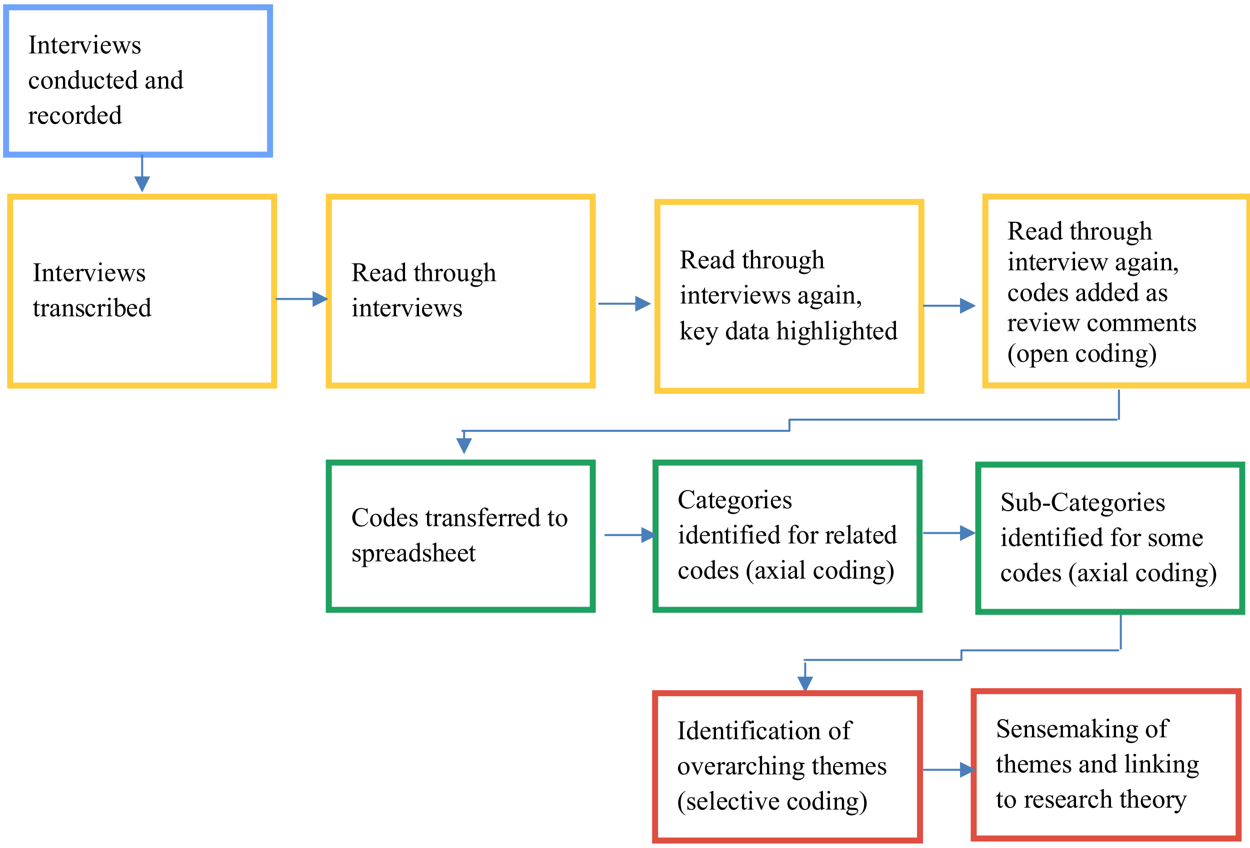

Figure 5.1 Interview data analysis process adapted from Braun and Clarke (2020).

Labels were added to the text in the word application and these were used as codes and captured in a spreadsheet to identify the diversity of codes that appeared across all the interview texts. This process of marking, tagging and sensemaking of the text is also known as open coding (Burnard, 1991). Relationships between topics and patterns of categories were considered (Braun & Clarke phase 3 - generating initial themes from coded and collated data). From the interpretative codes generated in this manner, the grouping of codes produced categories which started to appear for a collection of codes; in some cases, subcategories also appeared for the categories identified. The transcripts were then read through again to ensure that all the categories and subcategories sufficiently covered all the aspects of the different interviews. From the collection of categories that belong together the major themes across the interviews emerged (Braun & Clarke phase 4, developing and reviewing themes), Figure 5.2 depicts the codes to theory process as adapted from Saldana (2015).

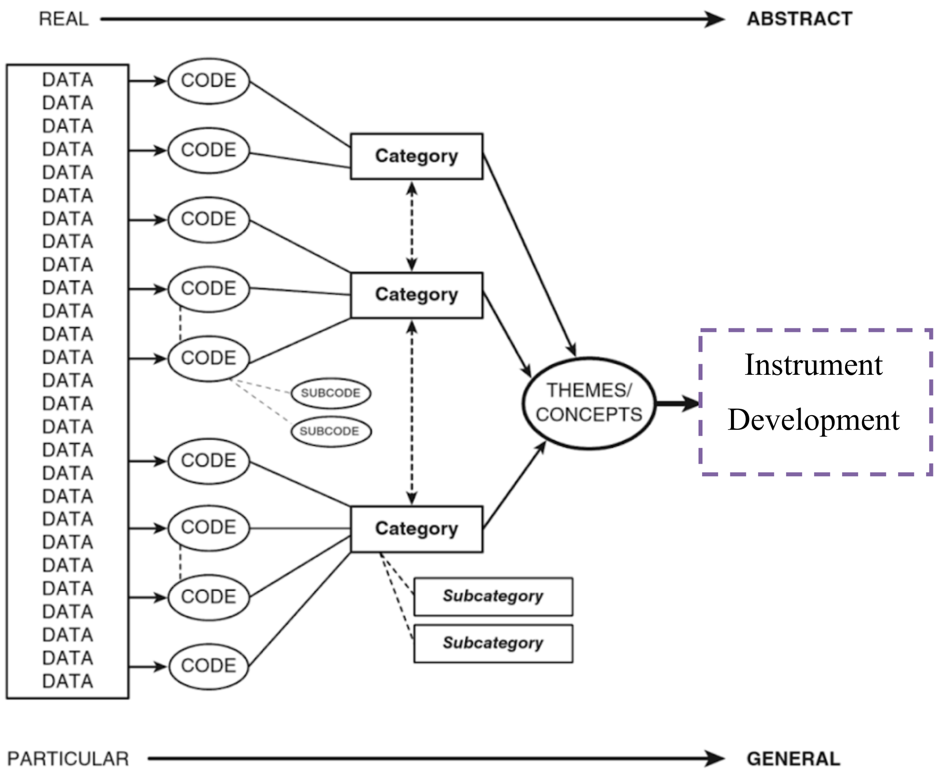

Figure 5.2 A codes-to-theory model for qualitative inquiry (Saldana, 2015) adapted by indicating the 'instrument development' activity to follow.

The qualitative analysis (with manual coding) was done in a spreadsheet at the time as this was the most cost-effective way to disassemble the texts and the simplest way to filter and search for common topics that emerged from the interviews [see Figure 5.3 for an overview of coding process applied on the interview data].

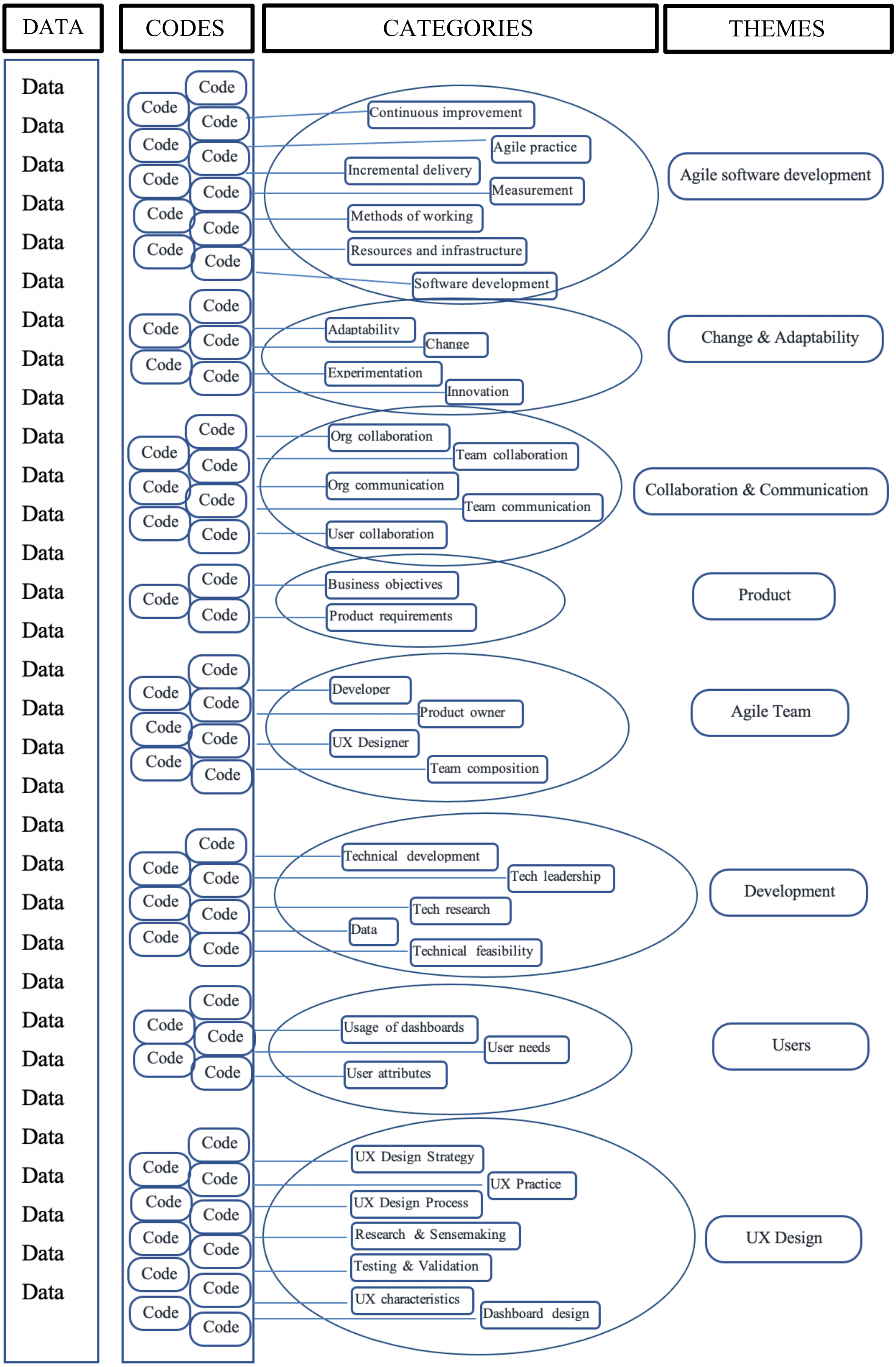

Figure 5.3 The codes-to-theme model for qualitative data analysis as applied and adapted from Saldana (2015).

The spreadsheet that was used for the analysis consisted of the following columns: 1. Appreciative Inquiry phase; 2. Source; 3. Code Detailed; 4. Primary Category; and 5. Theme.

1. Appreciative Inquiry phase – this was used to keep track of which phase of appreciative inquiry the interview text pertained to according to the theoretical *perspectives framework* that was followed.

2. Source – this was used to document the participant interviewed in an anonymous way, by noting the: interview participant (for example participant A); the role the participant fulfilled in practice (for example designer, developer, or product owner); and a numeric identifier for each role to differentiate between comments from different participants for the same role to produce an example source code of Participant_A_PO1.

3. Code Detailed – the descriptive code allocated to the topic that was mentioned.

4. Primary Category – where similar detailed pieces of text were grouped.

5. Theme – where overarching themes emerged housing several of the Primary Categories.

Saldana (2015) recommends the use of short codes to encompass the essence of what the participant shared. An effort was made to keep the codes as concise as possible, without losing the inherent meaning of what had been said; hence the codes ended up being longer than advised by Saldana (2015). This was accepted as a limitation in the study for the benefit of providing rich and accurate coding of the data collected through the interviews. See Table 5.2 as an example of the data analysis structure. For the full table of coded data from the interviews, please see Appendix E.

Table 5.2 Extract from interview data to show analysis structure.

Appreciative inquiry phase	Source	Code detailed	Category primary	Theme
Discover	Designer 1	Discovering the practice of agile	Agile practice	Agile software development
Discover	Designer 1	Established interactive collaboration between role players	Collaboration in organisation	Collaboration & Communication

Discover	Designer 2	Adaption of design process with the availability of data to direct design	Adaptability	Change & Adaptability
Discover	Designer 1	Continuous iterative process of design, test and refinement of requirements with users	Collaboration with users	Users

As part of the sensemaking and synthesis of the data:

- The data were organised in the structure of the appreciative inquiry framework that was utilised during the interviews, plotting the discussion point against a specific part of the appreciative inquiry journey, which were *discover, dream, design and deliver.*

- The topics were then synthesised after all the different role perspectives across the different stages of appreciative inquiry had been analysed to provide a practitioners' view of what is required for the best UX for BI dashboards in agile software environments.

It was decided to keep the codes at a granular level with the visibility of distinctive nuances to allow for a rich description of the participants' past experiences and also to convey their passion and dreams of what could be incorporated for what is required for the 'best' UX of dashboards in an agile software development environment.

As the appreciative inquiry technique of inquiry was utilised to guide the interview, all the interviews started in a *discovery* phase asking the participants to think back to what they had previously experienced and to pick out selectively from that experience what they considered to be positive and what *worked* in their view. [Refer to Section 4.5.2.3 that provided the breakdown of how the theoretical perspectives framework provided structure to the qualitative instrument development.]

The appreciative inquiry phase of *discovery* utilised the *logic model* part of the theoretical perspectives' framework developed in Phase I of the research (refer to Section 4.3.4) to ensure all the areas of the topic had been explored to allow for a comprehensive view on the past experience of what *worked*. The participants were asked to recall the input that they considered important, to describe the processes, the outputs and outcomes that had been positive in their view.

The appreciative inquiry phase of *dreaming and designing* utilised the affordance theory. [Refer to Section 4.3.3 which expands on an affordance as the possibility of an action.] This allowed participants to focus on what they would like to see in the future (dreaming of possibilities) and then asked them how they imagined something like that might work (designing).

The appreciative inquiry phase of *delivery* utilised the Agile model to consider the reality and execution thereof in practice utilising short continuous incremental developmental cycles to counter change and unclear requirements as per Section 4.3.2. Once the process of qualitative analysis has been described, the thematic relationships that next emerged from the research will be presented and described in Section 5.1.3.

5.1.3 Major themes

From the analysis of the data collected from the interviews ***8 major themes*** emerged:

Theme name	Theme colour
1. Agile software development	
2. Change and adaptability	
3. Collaboration and communication	
4. The agile team	
5. Product	
6. Development	
7. Users	
8. UX design	

These eight major themes were formed from a collection of related minor secondary elements. Each of the major themes and the informing categories that emerged from the data analysis is presented and discussed further in the subsections Section 5.1.3.1 - Section 5.1.3.8.

The structure through which the analysis is presented as follows: categories that constitute the theme will be presented first, followed by a relevant thematic practitioner quote; thereafter the analysed practitioner views will be presented, in accordance with the appreciative inquiry structure that was followed during the interview process. The analysed views collected during the discovery, dream, design and deliver phases will be similarly presented.

5.1.3.1 THEME 1: AGILE SOFTWARE DEVELOPMENT

Agile software development emerged as a central theme from the interviews. The participants in the research were all agile practitioners, working in an agile domain daily. Although a qualifying criterion for participation in the research was that the participant needed to have worked in an agile environment, it became clear in the interviews that the agile way of working was at the centre of the role-players and activities.

Within this major theme that emerged, there were six identifiable focus areas that were interwoven as the participants talked about their own experiences, their dreams, designs for the future and the possibility of practical delivery.

The categories that constituted the ***theme of*** a***gile software development*** were:

1. Agile practice and process;
2. Continuous improvement;
3. Incremental, quick value delivery;
4. Measurement;
5. Way of working; and
6. Resources and infrastructure.

Practitioner quotes:

> *"To me it's really about building the actual interface – the software development with regards to what you want to do. It involves a number of different people. For me often, people see Tech but it's really more involved like business as well as product and other stakeholders – it could be a third party. Software development has changed over the years, software used to entail Tech and IT side of things - it involves many aspects now"*
>
> *~ Participant_I_UXD4 ~*

> *"The different capabilities that we have, how do you take business requirements, how do you take customer requirements, how do you take customer understanding, technological understanding, and just people experience and come up with something that's useful. Because it was a*

genuine collaborative effort of everything to make it happen. So, it wasn't just someone's thoughts that made it happen"

~ Participant_A_PO1 ~

<table>
<tr><th colspan="3">THEME 1: AGILE SOFTWARE DEVELOPMENT</th></tr>
<tr><td rowspan="6">Theme 1: Agile Software Development</td><th colspan="2">Category 1: Agile practice and process</th></tr>
<tr><td colspan="2">During the interviews participants spoke about agile software development as part of their context (also considered to be input in this research according to the logic model). The topic of agile in practice was brought into the conversation during the three phases of the appreciative inquiry process; those were: discovery, design and deliver phases.
Practitioner quote:
"For me that is like the biggest thing I think sometimes you get so consumed in trying to do too much or become amazing so just stick to the basics, get the basics right and you'll be great, and the people around will be as well, let them be that as well".
~Participant_A_PO1~</td></tr>
<tr><td>Discover</td><td>All three roles interviewed talked about agile in practice. Looking back, the product role was especially interested in the benefits of increased speed when incorporating agile in practice (Participant_C_PO3). The product role also emphasised the importance of research by user experience designers, user interface designer and business analysts in agile software development (Participant_B_PO2). Another common topic was experiencing the practice of agile for themselves first-hand. This was recurrently emphasised (Participant_F_UXD1, Participant_K_DEV1). It required someone to be shown in practice what it means to work in an agile team (Participant_N_DEV4). It became clear that a deep understanding of agile software development practice could only be acquired through sufficient exposure (Participant_G_UXD2). Additionally, the design role reflected that agile was not just about ceremonies and mechanics, but about practicing it as a philosophy (Participant_J_UXD5).</td></tr>
<tr><td>Dream</td><td>Not mentioned by practitioners.</td></tr>
<tr><td>Design</td><td>Looking forward, product and development roles were eager to suggest areas that could be looked at to improve the agile practice, specifically agile processes that could be improved further (Participant_K_DEV1). Emphasis was placed on mastering the agile basics fully to also ensure that the people in the team will be well (Participant_A_PO1). In practice it is a process for team members taking ownership of their responsibilities; only through that process of accepting responsibility can teams become accountable for their responsibilities (Participant_A_PO1, Participant_O_DEV5).</td></tr>
<tr><td>Deliver</td><td>As practical ways of delivering this in future practice, participants mentioned: to sustain the course of practicing agile the team has to be able to measure the improvement of the incremental delivery; the adoption of agile practices is essential; and the importance of critical agile ceremonies has to be understood.</td></tr>
</table>

		(Participant_D_PO4, Participant_L_DEV2). Critical ceremonies were described as constant sync ups, those could be daily or couple of times a week to ensure the team knows what it is working on is still relevant and to gain visibility of what other people are doing. Retrospectives were also mentioned as a critical ceremony to aid understanding of how the team improved their way of work through their own feedback (Participant_L_DEV2). Retrospectives were also mentioned as the ceremony that a team should keep after a disaster has struck again with the purpose of aiding understanding of what exactly happened, how all the things had happened and how the team could make it happen better next time round. Planning ceremonies are essential in ensuring that the things the team are attempting to achieve are in line with the business as well as what the customer wants, as well as what the team expects from themselves (Participant_L_DEV2).
Theme 1: Agile Software Development	**Category 2: Continuous improvement**	
	The topic of continuous improvement was brought into the conversation during the three phases of the appreciative inquiry process; those were discovery, dream and deliver phases. Practitioner quote: *"The assumption has to be that's how it's going to happen, that you are not going to release something that is a hundred present, and that you are going to have to see whether people are doing what you expected them to do and make the necessary changes".* *~ Participant_G_UXD2 ~*	
	Discover	Looking back at what practitioners have seen, experienced and considered to have worked, included consciously striving towards continuous improvement (Participant_N_DEV4) and looking for ways to accomplish that, such as the continuous polishing of work, continuous support, continuous participation on a journey of purposeful progress (Participant_C_PO3, Participant_A_PO1), this has also been achieved through incorporating continuous research throughout the agile process (Participant_J_UXD5), looking at continuous improvement as a continuous process (Participant_N_DEV4) and not something that will cease at some point (Participant_A_PO1) but will continue as software delivery continues (Participant_J_UXD5).
	Dream	Practitioners dreamt of an environment where there was an opportunity to learn continuously (Participant_N_DEV4), and where they had the freedom to make products that customers love (Participant_C_PO3).
	Design	Not mentioned by practitioners.
	Deliver	As practical ways of delivering this in future practitioners proposed that to be able to work in a continuously improving manner there would need to be a shared upfront understanding and commitment to improve the product after delivery continuously (Participant_G_UXD2). Driving the continuous improvement of a product through incremental delivery, thereby really improving the product with each delivery in a meaningful way (Participant_G_UXD2).

	Category 3: Incremental, quick delivery	
		The topic of incremental delivery was brought into the conversation during all four phases of the appreciative inquiry process; those were discovery, dream, design and deliver phases. This category was perceived to be different from the previous category of continuous improvement, which was more focussed towards the commitment from the team to improve a product after each release. The continuous improvement sentiment was directed towards improving the product with each delivery and focused not only on the speed and increments of delivery. Practitioner quote: *"Piece by piece, little by little and every project increment that we started we learned a lot and it developed as we developed".* *~ Participant_A_PO1 ~*
	Discover	All three roles spoke about what has worked in the past in the *way* the software deliveries happened. Some key insights were that the length of work was not fixed (Participant_J_UXD5); flexibility was allowed to adapt to the work, the team's level of comfort to move through the development phases impacted the delivery (Participant_F_UXD1), the efficiency in development of the product for immediate use played a part (Participant_F_UXD1), the building of pieces (components) for the dashboard in the team (Participant_L_DEV2) and the part that efficiency played in a quicker return on investment (Participant_A_PO1).
	Dream	Practitioners dreamt of an environment where the importance of iterations in agile work was understood (Participant_G_UXD2). Where each increment of development would give back to the user and where each increment would contribute towards customer value (Participant_K_DEV1).
	Design	Looking forward to how these dreams can be achieved practitioners emphasised the importance of the process, the order and manner of execution (Participant_I_UXD4) and ensured a feature richness of each delivery in a consistent iterative way (Participant_N_DEV4). Participants also mentioned that the short increments facilitate the optimal way for learning to happen, providing contained periods where new knowledge could be applied and tested in the increment (Participant_B_PO2, Participant_N_DEV4).
	Deliver	To be able to deliver quickly and in increments, practitioners suggested building and releasing the smallest possible pieces of *value* to customers as soon as possible (Participant_L_DEV2). This would not only speed up delivery but also the rate of continuous customer feedback in cadence with the incremental deliveries (Participant_L_DEV2).
Theme 1: **Agile Software Development**	**Category 4: Measurement**	
		The topic of measurement was brought up by all three practitioner roles interviewed, during all the phases of the appreciative inquiry process. Practitioner quote: *"so, I am a fan of data that tells us what's happening with the product, and what people are doing with it, but that's the machine view of it, not the people element, and I think in most instances we lack the post testing once a product has been built, to me that component is really, really important,*

	really about understanding what the users do with it, why they are doing it and how they are doing it". *~ Participant_A_PO1 ~*	
	Discover	The product owner role looked back reflecting on how measurement allowed the product owner/manager to measure whether what he/she had asked the team to build was worthwhile (Participant_A_PO1). This was worthwhile not only for the product owner/manager but also hugely beneficial for stakeholders to improve understanding of what they had asked someone to build (Participant_D_PO4).
	Dream	Dreaming about what could be the product role ventured into the area of measurement, dreaming of what could be possible for measurement in the future. The practitioner spoke specifically about the ability to measure a product's performance to understand how the product is being used by customers, what it is being used for and, ultimately, what value the product is adding to customer (Participant_C_PO3).
	Design	Designers emphasised the importance of the availability of and being able to make use of system analytics to measure consistently and accurately (Participant_I_UXD4, Participant_J_UXD5. Participants added that estimates of what would team success look like need to be defined and then tracked with the use of analytics (Participant_K_DEV1).
	Deliver	To be able to deliver this, multiple practitioners stressed the importance measuring the use of the product through continuous testing and analytics post development and release, looking at whether people are using what has been built in the way that was expected to be used, using data to refine the product continuously (Participant_G_UXD2). Measurement is also of key importance to be able to measure the impact of changes made (Participant_L_DEV2). Product owners highlighted that the welcoming of feedback from customers is also essential in measuring the performance of a product (Participant_C_PO3). Customer feedback could then also be used for insight into how the product is used by customers, what it is used for and ultimately what value the product is adding (Participant_A_PO1).
Theme 1: Agile Software Development	**Category 5: Way of working**	
	Practitioners discussed specific ways of working. This was a common topic during the interviews and was touched on by all three practitioner roles during the discovery, design and delivery phases of the appreciative inquiry process. Although this ties in well with agile it was decided to keep it separate from agile specifically as not all methods described by the practitioners are considered to be associated with the traditional execution of agile. Practitioner quote: *"I think what we have been able to do is that when a challenge comes up break through it, find a way even if there is no way of doing something and getting it done at the end of the day so that you can deliver"* *~ Participant_B_PO2 ~*	
	Discover	Practitioners mentioned the past importance of prioritising the phases of the product work into a clear picture of activities that are accessible to everyone (Participant_F_UXD1, Participant_G_UXD2). Work that was outcome driven

		assisted in the fast tracking of development (Participant_A_PO1). The importance of daily stand ups (Participant_G_UXD2), sprint planning for the analysis of work (Participant_G_UXD2), making use of white boards and stickies (Participant_A_PO1), online boards (Participant_N_DEV4), prioritising the backlog (Participant_G_UXD2), grooming the backlog (Participant_O_DEV5) were emphasised during interviews. Practitioners also agreed that the team determined the process, together they were proud of the product they created, and everyone in the team had a sense of ownership (Participant_A_PO1, Participant_B_PO2, Participant_O_DEV5)
	Dream	Practitioners dreamt of a team with transparency (Participant_F_UXD1), of a flexible work environment (Participant_G_UXD2), where the importance of research is understood (Participant_H_UXD3), of an environment where they could innovate (Participant_I_UXD4), where all the team members were equal, where they would listen to one another, respect and acknowledge one another (Participant_J_UXD5), where work was non repetitive and practitioners could be co-located (Participant_K_DEV1) and where team members were empowered (Participant_N_DEV4) and focussed (Participant_N_DEV4).
	Design	When asked how these dreams could be made a reality, the practitioners suggested the incorporation of elements, such as short sprints, stand ups, deadlines, blocked out time (Participant_J_UXD5), cataloguing, and writing up and storytelling of the work done by the team (Participant_H_UXD3, Participant_J_UXD5). The importance of planning was emphasised (Participant_O_DEV5), incorporating a hybrid co-location and remote working model (Participant_N_DEV4, Participant_L_DEV2). It was also specifically mentioned that, for an optimal way of working, it was important to include the design function from the start as part of the process (Participant_N_DEV4, Participant_O_DEV5).
	Deliver	For this to be delivered in practice, the practitioners again emphasised commitment to own work (Participant_N_DEV4), the ability to be adaptable, to be open to change, to have a good attitude (Participant_K_DEV1), clear ownership of work (Participant_C_PO3), to build smartly (Participant_K_DEV1) and individual responsibility (Participant_C_PO3), the importance of prioritising (Participant_C_PO3) to team.
Theme 1: Agile Software Development	**Category 6: Resources and infrastructure**	
	The topic of the importance of resources and infrastructure was mentioned during the dream, design and delivery phases of the appreciative inquiry process. Practitioner quote: *"I think firstly funding would help with the resourcing. I would think that getting the right people, you can have a big team with a lot of people, but if you don't have the right people, you've got a big team that's not efficient"* *~ Participant_B_PO2 ~*	
	Discover	Not mentioned.

	Dream	Practitioners dreamt of how beneficial research funding would be in building the best products (Participant_B_PO2). They also dreamt of having adequate access to users when designing and building products (Participant_G_UXD2).
	Design	When practitioners thought of what would be required to for the creation of the best UX for dashboards they highlighted the importance of enough high-quality resources (Participant_G_UXD2), having stable connectivity (Participant_I_UXD4), access to databases and systems (Participant_O_DEV5, Participant_J_UXD5), enough time to do the work properly (Participant_G_UXD2) and enough budget to do the work (Participant_G_UXD2).
	Deliver	To deliver optimal software a design practitioner emphasised the importance of availability of suitable software, infrastructure and processes specifically to support design work, to avoid a scenario where designers have to build design infrastructure and create processes in addition to producing design work (Participant_I_UXD4).

For each of the major themes Atlas.ti was utilised to generate: (1) the co-occurrence of codes; this was used to have visibility of the intersection of codes; (2) a word cloud representation to bring the most mentioned concepts to the foreground visually; and (3) a network visualisation of how concepts are connected. These can be found in Appendix E.

5.1.3.1.1 Co-occurrence of concepts within agile software development

The co-occurrence of concepts was identified within this theme. From the intersecting codes it is shown that the 'way of working' was mentioned most often by both developers and UX designers. This points to the importance of the concept to both these roles. This code was supported by the 'agile practice and process' and 'incremental, quick value delivery' codes that had a similar focus in attention from practitioners also connected to the way of working in practice. 'Measurement' and 'continuous improvement' also had intersecting attention from practitioners, but to a lesser extent. See Figure 5.4 for the co-occurrence of concepts within the theme of 'agile software development'.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals
Agile Practice & Process 12	5	4	3	12
Continuous Improvement 7	2	3	2	7
Incremental, Quick Value Delivery 11	5	2	4	11
Measurement 10	2	5	3	10
Resources & Infrastructure 7	1	1	5	7
Way of Working 23	10	3	10	23
Totals	25	18	27	70

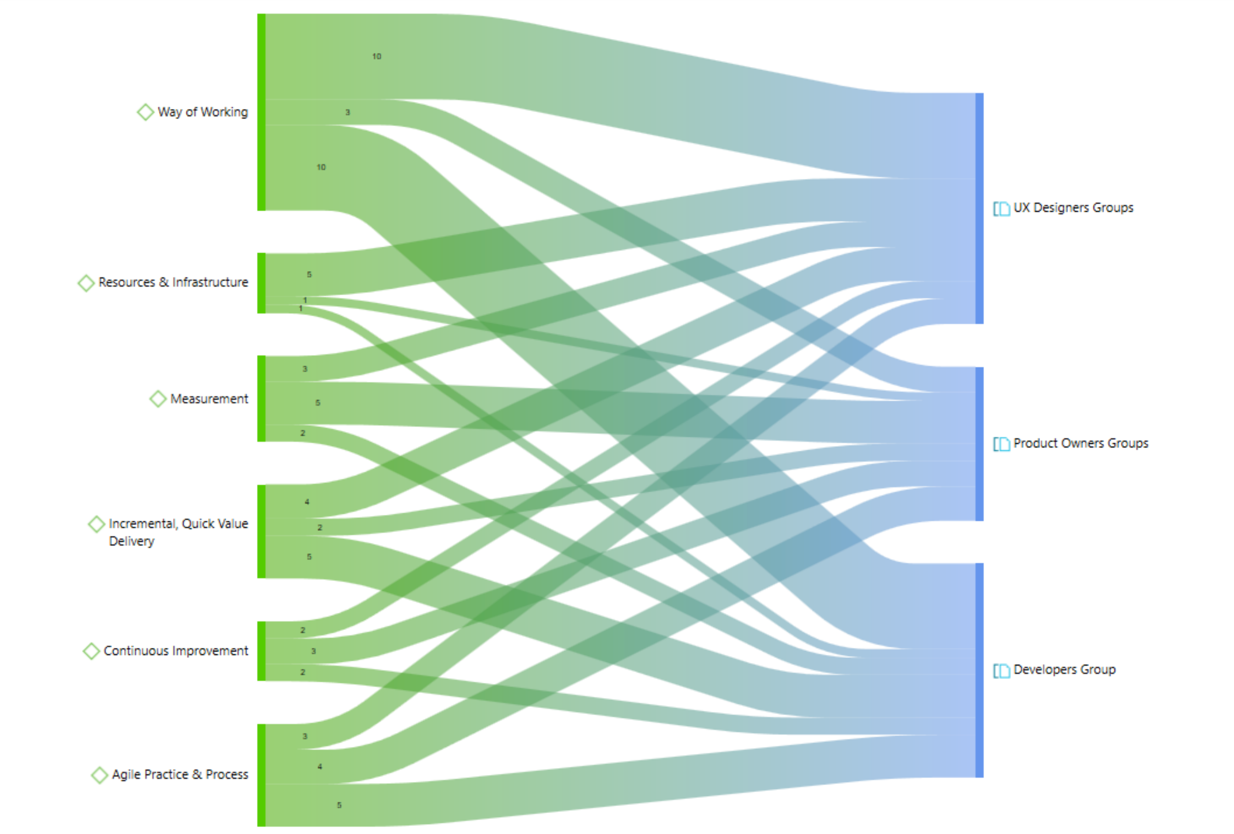

Figure 5.4 Co-occurrence of concepts within agile software development theme.

5.1.3.1.2 Word cloud for agile software development

From the word cloud generated from this theme, the focus on concepts by participants of ‘team’, ‘work’, ‘design’, ‘agile’, ‘product’ and ‘deliver’ is visible. See Figure 5.5 for the word cloud visualisation for the ***agile software development*** theme. The network map of the agile software development theme, showing the intricate connections between the codes mentioned in the co-occurrence, can be viewed in Appendix E.

Figure 5.5 Word cloud visualisation for the theme agile software development.

5.1.3.2 THEME 2: CHANGE AND ADAPTABILITY

The concept of ***change*** and the ability to ***adapt*** to change emerged as another central theme from the interviews. This theme was formed from four distinctive categories.

The categories that constituted the ***theme of change and adaptability*** were:

1. Adaptability;
2. Change;
3. Experimentation; and
4. Innovation.

Practitioner quote:

> *"Because it was so multi-dimensional, and the iterative nature of the environment meant that as we discovered more information either through user research, usability testing, or just understanding the business constraints better, we were able to evolve the design over quite a long timeframe, and we ended up with something quite different and much more fit for purpose than when we started out with"*
>
> *~ Participant_G_UXD2 ~*

<table>
<tr><th colspan="3">THEME 2: CHANGE AND ADAPTABILITY</th></tr>
<tr><td rowspan="3">Theme 2:
Change and adaptability</td><td colspan="2">Category 1: Adaptability</td></tr>
<tr><td colspan="2">The topic of the ability to adapt was brought into the conversation during three phases of the appreciative inquiry process. Those were discovery, dream and design phases. Adaptability was specifically emphasised by the design and development roles that were interviewed.

Practitioner quote:
"Definitely something that I have learned over the last 10 years is that you cannot always follow the ideal process, you have to be prepared to adapt it to the situation, but sometimes you can't even follow the right process for a specific situation, and sometimes you just need to do what your team expects you to do, which can be very challenging".
~ Participant_G_UXD2 ~</td></tr>
<tr><td>Discover</td><td>Practitioners reflected on past experiences and how the ability to adapt has been essential (Participant_A_PO1, Participant_G_UXD2, Participant_N_DEV4). There was also specific mention of the adaption of processes in relation to other components, for example the adaption of the design process with the availability of data to change the direction of a design (Participant_G_UXD2).</td></tr>
</table>

	Dream	Practitioners dreamt of an environment where they could have full independent flexibility to adapt the process where needed with the support of a flexible and accepting team to adapt to that (Participant_G_UXD2).
	Design	Practitioners emphasised the importance of having to adapt to not only internal workings but also adaption at a higher level in reaction to an externally changed environment where the software will be received (Participant_N_DEV4). It was also highlighted by the practitioners that at the end of the process the output that is produced by the team still needs to have *relevance* to customers (Participant_N_DEV4).
	Deliver	To deliver optimal software adaptability was required (Participant_K_DEV1).
Theme 2: **Change and adaptability**	**Category 2: Change**	
	The topic of *change* was emphasised during three phases of the appreciative inquiry process; those were the discovery, dream, and design phases. The concept of change was emphasised by all three the roles interviewed. Practitioner quote: *"I think there is a lot of collaboration, and a lot of changes I think from the user's side, while they go through this journey as well, figuring out what they want, what they need, what works best".* *~ Participant_F_UXD1 ~*	
	Discover	Looking back practitioners were aware of the change that has taken place (internally) within the organisations and environment of software development, specifically compared to how things have been done in the past. Looking back at past experiences it has worked to be prepared to adapt processes to the team's requirements (Participant_G_UXD2). Change has taken place on many levels, within the team and within the organisation, in the form of different transformations that have taken place (Participant_A_PO1), and, at a customer level, where the user's world was dynamic and constantly changing and as a result impacting the product (Participant_F_UXD1).
	Dream	A practitioner in a product role dreamt about change on the cultural organisational level to get the organisation as a whole to accept change and lead from the top, moving away from a self-centredness to a servant leadership culture where people ask one another how they can help one another to achieve the other person's goals (Participant_A_PO1).
	Design	Practitioners recommend expecting change and working towards limiting the impact of change (Participant_L_DEV2). On a technical level the developer practitioners were keen to talk about the searching out change in the tech domain, especially progress made in the front-end technologies, as tech continuously changes over time (Participant_N_DEV4).

	Deliver	Not mentioned by practitioners.
Theme 2: Change and adaptability	**Category 3: Experimentation**	
	The topic of experimentation was emphasised during all phases of the appreciative inquiry process. Those were discovery, dream design and delivery phases. The concept of experimentation was emphasised by two of the three roles interviewed, which were development and design. Practitioner quote: *"You see what I am finding now is, the opportunity to talk beyond design thinking, to bring things in you know, even more advanced agile concepts from cynefin methods and all that kind of stuff, I think people are more receptive to being introduced to all of these things, and to create opportunities where you can start running some more experiments in an organisation".* *~ Participant_H_UXD3 ~*	
	Discover	A participant highlighted that in the past where there had been room to explore the unknown and discover new things the value permeated throughout the process (Participant_N_DEV4).
	Dream	A participant dreamt of being able to look for opportunities to run experiments in the organisation to find the best of what could be (Participant_H_UXD3).
	Design	A participant thought of trying new things without fear of failure in finding alternative or better ways, to learn and mature in perspective of what works the best Participant_K_DEV1).
	Deliver	Participants steady the course by accepting trial and error as part of the process towards improvement. Experimentation is also used as a tool to identify what deserves attention (Participant_L_DEV2). The importance of allowing for reflection and asking what we have learnt through experimentation was considered to be necessary for application in practice (Participant_N_DEV4).
Theme 2: Change and adaptability	**Category 4: Innovation**	
	The topic of innovation was emphasised during all phases of the appreciative inquiry process, discovery, dream, design, and delivery phases. The concept of innovation was emphasised by all three of the roles interviewed. Practitioner quote: *"This whole notion of finding the purpose of design really from my point of view in a kind of innovation space is to find the hidden, you know, the opportunities, the needs of the customer or whatever and design and if you find that, then you find the innovation opportunities".* *~ Participant_H_UXD3 ~*	
	Discover	Looking back, participants emphasised the importance of the desire to *want to make things better* (Participant_G_UXD2). Reflecting on the role of design specifically highlighted that the purpose of design from the participant's point of view is to find the hidden opportunities; if those were found, then the innovation opportunities were

		uncovered (Participant_H_UXD3). Participants also mentioned that in some past situations creative problem-solving made a positive difference when there was no way forward (Participant_B_PO2).
	Dream	Participants dreamt of novel ways to advance the product; they also dreamt of being encouraged to innovate in the team and organisation (Participant_I_UXD4). Additionally, practitioners dreamt of not being afraid to build stuff, and to explore the characteristics of the product people love (Participant_A_PO1).
	Design	Practitioners emphasised the importance of making space for an agile, lean start-up, design thinking kind of way to innovate and experiment to allow the team to innovate freely (Participant_H_UXD3).
	Deliver	To plot the course for execution, innovation is required to overcome new barriers. Some of these barriers include mastering new tech, trying out new roles and coming up with completely new products (Participant_K_DEV1).

5.1.3.2.1 Co-occurrence within change and adaptability

Co-occurrence of coded concepts was identified within this theme. From the intersecting codes it is shown that the 'innovation', 'change' and 'adaptability' are areas of focus by all three roles - product owners, developers and UX designers. Notice the common focus by developers and designers on 'experimentation', interpreted as more important owing to their practical hands-on work context. See Figure 5.6 for the co-occurrence of codes for 'change and adaptability'.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals
Adaptability 5	2	1	2	5
Change 6	2	2	2	6
Experimentation 5	4		1	5
Innovation 7	1	2	4	7
Totals	9	5	9	23

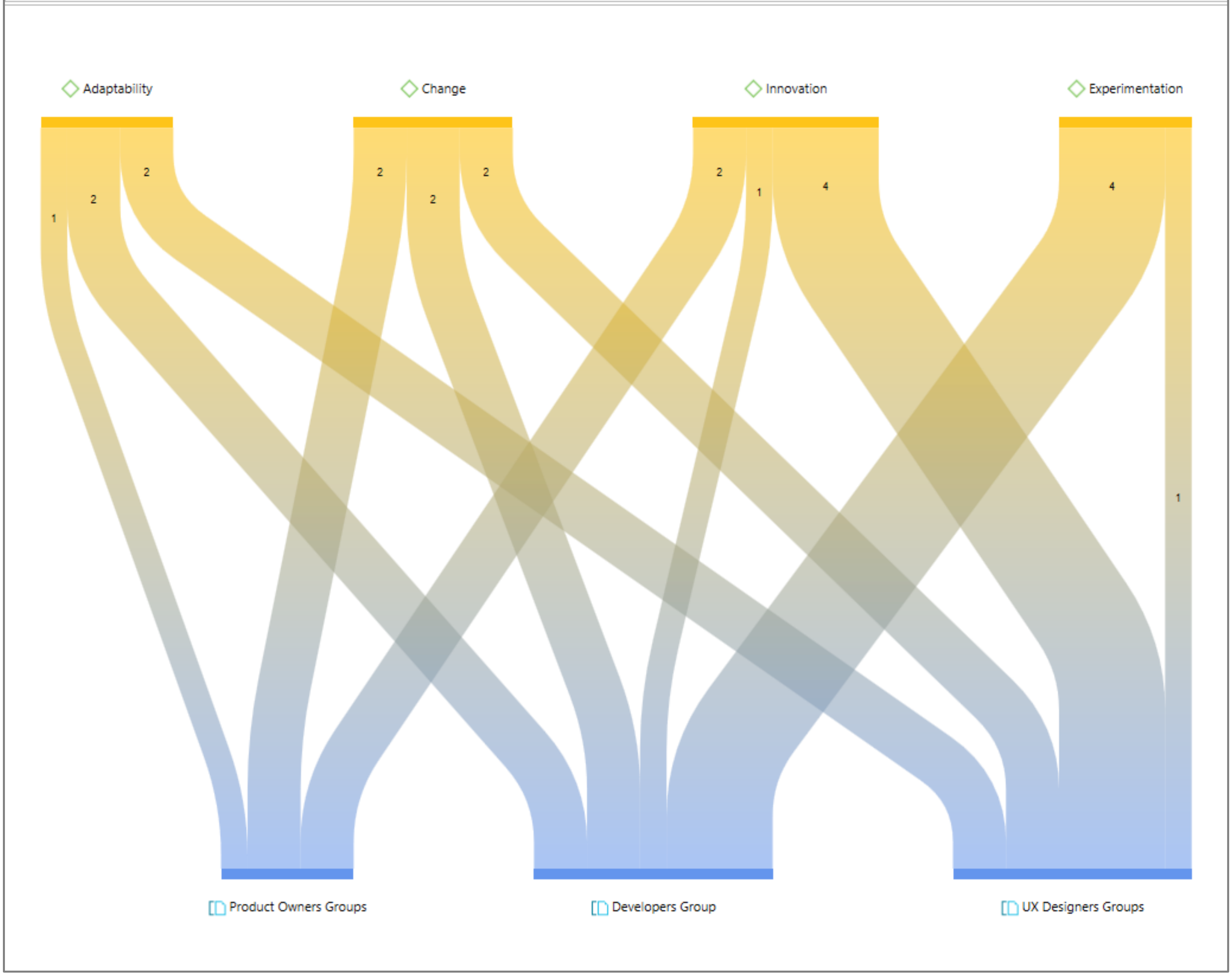

Figure 5.6 Co-occurrence of concepts within change and adaptability theme.

5.1.3.2.2 Word cloud for change and adaptability

The word cloud visualisation for the theme of ***change and adaptability*** highlighted concepts such as 'design', 'adapt', 'past', 'change', 'team' and 'experiences' as focus areas, see Figure 5.7. The network map of the change and adaptability theme, the granular network view, is accessible in Appendix E.

Figure 5.7 Word cloud visual representation for the theme of change and adaptability.

5.1.3.3 THEME 3: COLLABORATION AND COMMUNICATION

The concept of *collaboration and communication* emerged as another major theme from the interviews. This theme was discussed at length by many of the participants. The theme comprised five categories.

The categories that constituted the ***theme of collaboration and communication*** were:

1. Collaboration within the organisation;
2. Collaboration within the team;
3. Communication within the organisation;
4. Communication within the team; and
5. Collaboration with the product users.

Practitioner quote:

"… we had a lot of enablers, so a lot of the stakeholders from the business that we ran through the ideas and the concepts obviously and as we were progressing we were making our team aware the development team, that they kind of had a bit of input into it, and context, so when it came time to build it wasn't like a complete surprise, they actually had already bought into the process because they understood what we were doing."

~ Participant_A_PO1 ~

Theme 3: Collaboration and communication	
	Category 1: Collaboration within the organisation
	The topic of collaboration within the organisation was emphasised during all phases of the appreciative inquiry process, discovery, dream, design and delivery phases. The concept of collaboration within the organisation was emphasised consistently throughout interviews by all three of the roles as a critical requirement contributing to the creation of the best UX for BI dashboards in an agile environment. Practitioner quote: *"… I think you need to because the problem is that the customer experience departments are so cut off from the rest of the organisations in a lot of the companies, what we did in the very last study, we tried to, bring the customer experience people along on the journey, and the marketing people, so besides the normal roles that you had in the team, we would also try get someone from*

		marketing involved if there was a strong marketing component to the project and also get the marketing people involved in the testing as well" *~ Participant_H_UXD3 ~* *"cross-functional teams are wonderful, and they get rid of a lot of the silos that we used to find in software development, but you still have silos at a bigger level than that. There is a disconnect between maybe what you are doing from a product development point of view to what marketing are doing and what customer services are doing and having a cross functional team that actually included the marketing people and the customer services people, and maybe the product people whose product you were building seem to support, like a fully cross functional team not just a software cross functional tea. I think that could make an amazing difference"* *~ Participant_G_UXD3 ~*
Theme 3: Collabo-ration and communi-cation	Discover	Reflecting on past experiences it worked best when practitioners took the initiative to approach people for information especially during the initiation of a new project (Participant_F_UXD1). The takeout from practitioners was not to wait for people to bring you information, but to go to them searching for the information you need to be able to continue the work (Participant_F_UXD1). Practitioners also emphasised that collaboration during all phases of software development is important, and that collaboration spans across the team, stakeholders, and customers (Participant_C_PO3). Practitioners reflected that it worked well when collaboration was established in an interactive way between the different role-players, as various role-players are needed for the developing of the dashboard (Participant_L_DEV2, Participant_A_PO1). Specific collaboration required in the past was between back-end system dependencies and cross team dependencies (Participant_C_PO3). Another important piece of the puzzle was collaboration with enablers from across the business, specifically to validate concepts (Participant_A_PO1).
	Dream	Not mentioned by practitioners.
	Design	When practitioners were asked what would be needed in future, collaboration was also mentioned during the design phase of appreciative inquiry. Practitioners suggested that cross-functional involvement would assist collaboration within the organisation (Participant_I_UXD4), allowing people to build a network of stakeholders (Participant_I_UXD4), stakeholders need to be involved early on in the process to improve the quality of discussions (Participant_N_DEV4). This should also improve timely stakeholder collaboration (Participant_A_PO1). Collaboration should include but should not be limited to business owners. Participant emphasised that collaboration needs to exist across the entire organisation from marketing to finance to business to work optimally (Participant_N_DEV4). Practitioners emphasised that it is of critical importance to stay extremely close to your sponsorship layer and to ensure that this layer has a vested interest throughout the lifespan of the product (Participant_A_PO1). Throughout discussions the emphasis was constantly on people; to the practitioners, people are the key to a successful product.
	Deliver	Practitioners stressed that it is essential to educate and inform stakeholders to allow them a deep understanding of what they ask from teams. Practitioners referred to the past where the tech industry was siloed from the rest of the organisation. This should

		be changed; more generalists would enable cross-functional tech that would assist delivery better (Participant_I_UXD4, Participant_A_PO1).
Theme 3: Collaboration and communication	**Category 2: Collaboration within the team**	
	The topic of collaboration within the team was emphasised during all phases of the appreciative inquiry process, discovery, dream, design and delivery phases. This concept was emphasised at length and consistently throughout interviews by all three of the roles as an essential requirement contributing to the creation of the best UX for BI dashboards in an agile environment. Practitioners' quotes: *"How can you help them to make their lives easier, because I think what happens in a lot of environments is the people in the backend always feel like there's just all this demand everyone is just demanding stuff of us, so I have the view that you have to turn around and say, how can I support you to make your life a little easier, so what can I do to make it better for you, what are the challenges you face and how can we help you to do those things so that would be from like a back end perspective"* *~ Participant_A_PO1 ~* *"I think that it's necessary for a high level of collaboration, I don't think a dashboard is something you can kinda like have a plan and then work from home most of the time, there is so many complicated elements to it, the team needs to spend a lot of time together and figuring stuff out together".* *~ Participant_F_UXD1 ~*	
	Discover	Looking back, practitioners referred to the importance of collaboration in a team specifically. This was required as the team moved towards clarity (Participant_F_UXD1). It was helpful to collaborate as a team in the early stages of design reviews to enable buy-in in the team of the design solutions (Participant_G_UXD2). As the team consisted of multi-disciplinary functions, the team comprised of a great pool of knowledge (Participant_L_DEV2). The combined knowledge within the team was utilised to reflect on the workability of possible ideas. The collaborative environment also allowed for effective feedback loops within the team (Participant_N_DEV4). From the product owner perspective practitioners gave a granular account of what has worked in the past when collaborating within the team. Be sure to capture important information, coordinate collaborative time, coordinate the flow of ideas, coordinate the resulting work and discussions, enable the smooth flow of things, too fast now means slow later on (get the basics right first; if information is lost at the earlier stages, the work would slow down in the long run) (Participant_C_PO3). Practitioners emphasised the importance of a collaborative environment, especially effective collaboration within the team (Participant_F_UXD1, Participant_N_DEV4, Participant_G_UXD2).
	Dream	Participants dreamt of an effective team that is focussed on delivering a quality product by means of participative development (Participant_G_UXD2). Participants also imagined building cohesion towards establishing strong and close team (Participant_F_UXD1). Participants considered the collaboration in the team to more of a partnership than working together (Participant_C_PO3).
	Design	Practitioners recommended that, to practise collaborative teamwork, emphasis should be placed on collaboration with developers to test ideas quickly (Participant_B_PO2),

<table>
<tr><td rowspan="2"></td><td></td><td>design reviews, feature reviews, to have quick feedback cycles, developer and code reviews (Participant_K_DEV1). Designers emphasised the importance of having developers in the team who are critical but collaborative (Participant_G_UXD2), developers highlighted the importance of having designers in the teams (Participant_N_DEV4), from the inception of the team and to have them along during the discovery with the rest of the team (Participant_H_UXD3). It is important to also include designers in squads where important organisational problems are being identified and the selection of problems determined (Participant_H_UXD3). At the end of the day the people are the key ingredient to make the team collaborate as a team to solve challenges (Participant_N_DEV4, Participant_L_DEV2).</td></tr>
<tr><td>Deliver</td><td>Practitioners recommended the co-ownership of work to ensure durability of work and to address the maintenance of the product (Participant_L_DEV2).</td></tr>
<tr><td rowspan="5">Theme 3: Collaboration and communication</td><td colspan="2">Category 3: Communication within the organisation</td></tr>
<tr><td colspan="2">The topic of communication within the organisation was emphasised during three phases of the appreciative inquiry process, discovery, dream and design phases. The concept of communication within the organisation was emphasised throughout interviews by the product and design roles as a critical requirement contributing to the success of the best UX for BI dashboards in an agile environment.

Practitioner quote:

"... getting products in the company to be known by everyone in the company, like the product we worked on, ... just like anyone seeing the value of it so it's a lot easier to get things done later if you need to help other teams, then people actually know what is going on".

~ Participant_F_UXD1 ~

"So, I think from a sponsorship layer, ... is extremely close and has a vested interest, and that is providing input on a regular basis, not only getting feedback but also giving input in so to me that is extremely key".

~ Participant_A_PO1 ~</td></tr>
<tr><td>Discover</td><td>Looking back to what has contributed to their success, practitioners mentioned the importance of making all planning visual. This is essential to aid communication of work and timeframes. There needs to be a clear roadmap that needs to be visible to anyone interested as well as the stakeholders (Participant_A_PO1).</td></tr>
<tr><td>Dream</td><td>During the dream phase of the appreciative inquiry process the design role dreamt of better understanding the flow of communication within the business as well as being able to address the challenges of communication between the business and the team (Participant_F_UXD1).</td></tr>
<tr><td>Design</td><td>The importance of sharing learnings outside of the team, of what has been discovered and how the thinking was evolving was underscored (Participant_H_UXD3). The socialisation of work within the company led to increased visibility and improved communication (Participant_C_PO3). The importance of continued communication and regular stakeholder engagement throughout the product development iterations was emphasised (Participant_A_PO1).</td></tr>
</table>

	Deliver	Not mentioned by practitioners.
	Category 4: Communication within the team	
	The topic of communication within the team was emphasised during two phases of the appreciative inquiry process, namely the discovery and design phases. The concept of communication within the team was emphasised throughout interviews by all three the roles as a critical requirement contributing to the success of the best UX for BI dashboards in an agile environment. Practitioner quote: *"We all sat together, was very collaborative, if someone said something to someone else and someone else heard it, and they thought it was important, it was always a comfortable space, for people to be like what are you saying there, it should be this, comfortably chipping into each other's conversations".* *~ Participant_F_UXD1 ~*	
	Discover	Looking back practitioners stressed the importance of clear communication in building software (Participant_L_DEV2). Looking back to what has worked in the past, a routine of sound ethical principles to guide communication and way of working ensures a solid foundation for communication in the team (Participant_B_PO2).
	Dream	Not mentioned by practitioners.
	Design	Practitioners consider the following important to communicate optimally within the team: firstly, begin by speaking with people, convey ideas openly (Participant_N_DEV4), consult with team members, ensure communication channels are open, talk about goals and make those visible (Participant_I_UXD4), create a space for interactive communication in the team (Participant_L_DEV2), practice and grow communication skills (Participant_K_DEV1).
	Deliver	Not mentioned by practitioners.
Theme 3: Collaboration and communication	**Category 5: Collaboration with users**	
	The topic of collaboration within the users was emphasised during all phases of the appreciative inquiry process, namely the discovery, design, dream and deliver phases. Collaboration of the agile team with software users was emphasised throughout interviews by all three of the roles as a critical requirement contributing to the success of the best UX for BI dashboards in an agile environment. The concept of *Users* emerged as a major theme during the research study, and it is discussed in Theme 7. The agile team's collaboration with users was grouped together with the other collaboration categories as collaboration is to a lesser extent user driven and to a greater extent driven from the agile team's side. Practitioner quote: *"... and access to users, readily access to lots and lots of users."*	

		~ Participant_G_UXD2 ~
	Discover	Looking back, practitioners found it critical to collect information from users about what they needed as well as feedback from users, to collaborate with users in designing products (Participant_A_PO1). The continuous iterative process to design, test and refine requirements with users demanded close collaboration with users (Participant_F_UXD1). Participant_F_UXD1 reflected that collaboration produces authentic user journeys and facilitates critical thinking between UX designers and users to obtain an appropriate result. Collaboration with users also made it possible to test and validate the correctness of the sequencing of tasks and the correctness of the screen flows (Participant_G_UXD2). This agrees with participants' view on the importance of showing conceptual design work to users before it goes into further detail design and development. Together the designer and the users collaborate to adapt and shape ideas during a collaborative process of change. The 1:1 designer/user connection is still the best according to participants. Participants also mentioned that product buy-in is improved through participation by the user in developing a product of value Participant_F_UXD1.
	Dream	Practitioners dreamt of having access to *many* users to collect information from and to test with (Participant_B_PO2, Participant Participant_G_UXD2).
	Design	Practitioners consider it very important to include collaboration with customers on what they are trying to solve to find new innovative ways of addressing those customer problems (Participant_H_UXD3). It was also mentioned that the software market is influenced by customer need, and collaboration with users allows for that insight of what is needed (Participant_K_DEV1). Collaboration with users at all levels of product expertise is important to avoid building for a small set of expert users only (Participant_B_PO2). Additionally showing the benefit to customers should make the acceptance and adoption in the business easier (Participant_A_PO1). Including customers in beta testing was also recommended (Participant_N_DEV4).
	Deliver	Practitioners consider continuous participative decision making with the customer essential (Participant_L_DEV2), practitioners regard it as important to focus on feedback from the user on the product as well as to share the value of work delivered with customers continuously (Participant_C_PO3).

5.1.3.3.1 Co-occurrence within collaboration and communication

From the intersecting codes it is shown that the 'collaboration within the team' was a key focus area for all three roles. Also notable was the importance of 'collaboration with users' by all three roles. Notice the focus by both product and design to foster communication within the larger organization. See Figure 5.8 for the co-occurrence of codes for 'change and adaptability'.

5.1.3.3.2 Word cloud for collaboration and communication

The word cloud visual representation for the theme of ***collaboration and communication***, see Figure 5.9, brought concepts such as ‘collaboration’, ‘design’, ‘team’, ‘communication’, ‘product’, ‘users’ and ‘people’ to the foreground, emphasising their importance to participants. The network map of the change and adaptability theme, the granular network view is accessible in Appendix E.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals	
Collaboration with users 12	3	5	4	12	
Collaboration within the organiza... 9	2	4	3	9	
Collaboration within the team 15	6	4	5	15	
Communication within the organ... 5		3	2	5	
Communication within the team 5	3	1	1	5	
Totals	14	17	15	46	

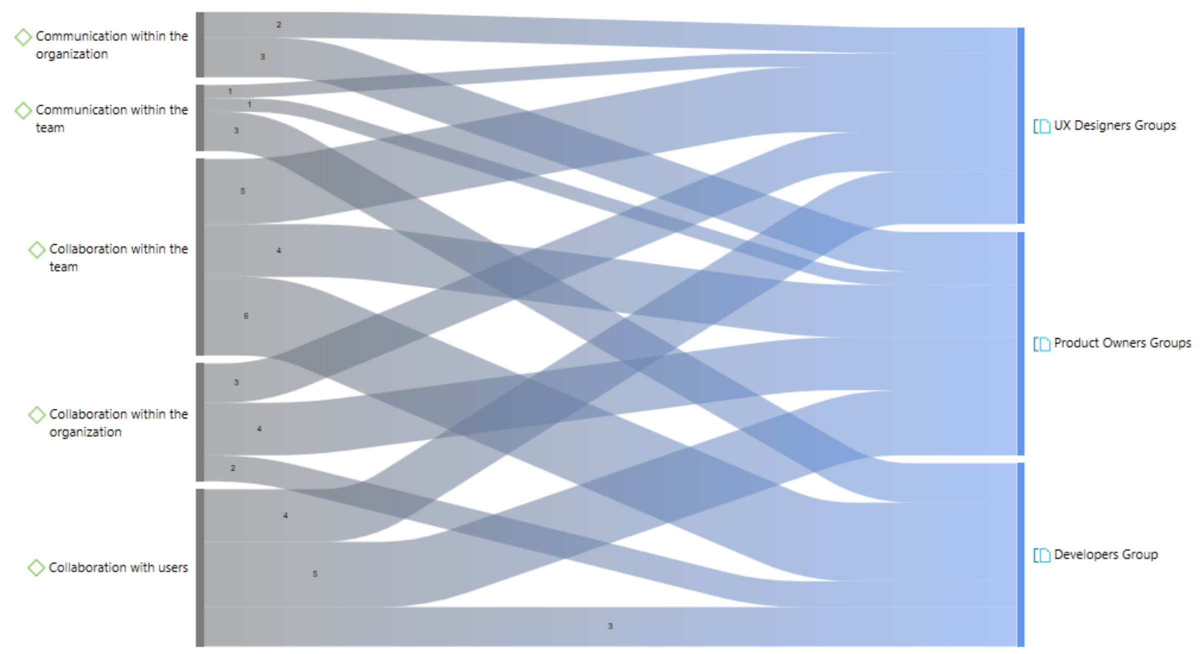

Figure 5.8 Co-occurrence of concepts within collaboration and communication theme.

Figure 5.9 Word cloud visual representation for the theme of collaboration and communication.

5.1.3.4 THEME 4: THE AGILE TEAM

The concept of *the Agile Team* emerged as another major theme from the interviews. Participants felt particularly passionate about the categories in this theme. The theme comprised of three distinctive categories.

The categories that constituted the ***theme of the agile team*** were:

1. Developer;
2. Product owner; and
3. UX designer.

Practitioner quote:

" to play an active role, basically a whole team that is focussed on delivering a quality product, not people who just see their job as to write a user story or to write some code or whatever, and then in terms of from the point of you being able to do user experience properly, you know as having the, first of all having constraints in place, because otherwise you can go off the rails and never deliver anything, but also having the flexibility to say we need to do a big chunk of research here it's going to take 2 sprints and the rest of the team goes, cool, we'll work on tech debt in the meantime".

~ Participant_G_UXD2 ~

"The team was led by three people, the UX lead, the product lead and the technical lead, so you got all three flavours of what you need, so you got the customer representation, the business representation and the technological representation, and through that all decisions that we made, were made by the 3 never by one, and to me that was really important, because a technical person cannot make a business call a business person cannot make a customer call".

~ Participant_A_PO1 ~

THEME 4: THE AGILE TEAM	
	Category 1: Developer
	The developer in the team emerged as a category that formed part of the larger theme of the *Agile* Team. The category of the developer was emphasised during all four phases of the appreciative inquiry process phases. All three roles addressed the importance of the developer to produce the best UX for BI dashboards in an agile environment.

<table>
<tr><td rowspan="5">Theme 4: The agile team</td><td colspan="2">Practitioner quote:

"… having developers who are critical but collaborative who will call you over to do a desk check who will ask you if we could consider a different way of implementing something because it would be easier to maintain, or faster or whatever and get the same result."
~ Participant_G_UXD2 ~

"… the more designers pair with developers the better, because the only time you will really have a full picture, of what has been designed, is when a designers actually sees it being built right in front of them, it's like building a house, if you're a construction manager and you've got a plan of you need to build a two storey house, you've got two ways of doing it, you can say, here's the plan, just build it, I don't want to see what you guys do, at the end of the day, if you don't constantly consult the plan, see what needs to be changed, look at what's been built, try to sort of retrospect and match up the design and the product the whole time, you're probably going to end up with the wrong product."
~ Participant_O_DEV5 ~

I think the main thing as well is from a technical point of view we were using technologies that we wanted to, not that we chose them from the start but when we started working on this project, the technologies we were using was really great
~ Participant_N_DEV4 ~</td></tr>
<tr><td>Discover</td><td>Looking back practitioners emphasised the importance of developers that had had a specific and detailed focus, that showed a passion for getting software to the production phase (Participant_L_DEV2). Developers that were critical and precise made a difference in building the best UX for BI dashboards (Participant_N_DEV4). The importance of having a development lead that worked hard and could keep the team members motivated but also kept a watchful eye over the developers to protect them against burnout was stressed (Participant_N_DEV4).</td></tr>
<tr><td>Dream</td><td>Some practitioners dreamt of developers having an appreciation of the role and process of design to work better together (Participant_G_UXD2).</td></tr>
<tr><td>Design</td><td>The importance of having developers who are critical, but collaborative, was emphasised during this phase (Participant_G_UXD2); the importance of developers growing their skill (Participant_O_DEV5), being empowered to contribute more, was mentioned (Participant_N_DEV4), as well as the importance of the technical lead in the team to make building software more effective (Participant_B_PO2).</td></tr>
<tr><td>Deliver</td><td>To stay the course the need for developers to be open to criticism and feedback was also mentioned (Participant_L_DEV2).</td></tr>
<tr><td rowspan="2"></td><td colspan="2">Category 2: Product owner</td></tr>
<tr><td colspan="2">The product owner in the team emerged as a category that formed part of the larger theme of the Agile Team, the category of the product owner was emphasised during all the phases of the appreciative inquiry process. All three roles spoke at length of the importance of the product owner to produce the best UX for BI dashboards in an agile environment.</td></tr>
</table>

<table>
<tr><td rowspan="4">Theme 4: The agile team</td><td colspan="2">Practitioner quote:

"... you need to respect and understand the different disciplines that will make up your team and the skills people bring to the team and value that they add, and you need to be prepared to listen and discuss and negotiate with your team, but you also need to be prepared to make decisions if other people don't necessarily agree with you. You need to be prepared to protect your team even if it means you take all the flack, and you need to not be wishy washy, if something has been defined and agreed on then that is the path forward, unless there is a good reason to change, you don't just change things on the whim, or re-arrange priorities halfway through the sprint, you got to be somebody that actually your team can trust and respect, also needs to be someone that has the maturity the seniority, back bone, experience to push back, when exec level business stakeholders are pushing for things that don't make sense. So, it's a big ask".

~ Participant_G_UXD2 ~</td></tr>
<tr><td>Discover</td><td>Looking back practitioners recalled that it required discipline to get the agile basics right (Participant_O_DEV5). They reflected on the importance on an organised product owner to keep track of past and future work. It was important for the product owner to understand agile software development fully and to be able to lead the team in that way (Participant_G_UXD2). The product owner ensured a stable backlog and priority list for the team (Participant_G_UXD2). Some characteristics of successful product owners were the ability to break through barriers to deliver, fairness, being good with people and the ability to sell the desired UX to the team and to stakeholders (Participant_G_UXD2).</td></tr>
<tr><td>Dream</td><td>Practitioners dreamt of a determined product owner who would be accountable for measuring and results (Participant_B_PO2). Practitioners considered it important for product owners to set goals for the team (Participant_C_PO3), to set the team direction and strategy (Participant_F_UXD1), to make sure that the team is enabled to do their work (Participant_B_PO2), to understand business objectives, to push back when business has requests that are unreasonable (Participant_A_PO1), unnecessary, or need has not been validated (Participant_A_PO1), to protect the team from politics and to protect the team even if it means they take all the flack (Participant_G_UXD2).

It is important that the product owner has the trust and respect of the team (Participant_G_UXD2). Some characteristics of good product owners that practitioners mentioned are: they are mature and senior; they can make a decision even if people don't agree; they are able to listen to the team and discuss and negotiate with the team; they need to be steadfast, if something has been defined and agreed that is the path forward; they take changing priorities very seriously (needs to be a very good reason for change); they need to understand and respect the different disciplines, skillsets in the team and the value people add (Participant_B_PO2).</td></tr>
<tr><td>Design</td><td>Practitioners spoke about the importance of the product owner, describing the product owner role as the 'grand master'; the product owner is the face, and voice of the product, he/she needs to ensure two-way communication between the team and other parties (Participant_H_UXD3).

The importance of the product owner having a clear vision of the way ahead, a clear product strategy, making these things visible by mapping them out</td></tr>
</table>

		(Participant_A_PO1). They should be able to digest and make sense of customer research (Participant_J_UXD5). The product owner should be good at managing work and leading people, bringing focus to the team, tracking of work, and driving to delivery (Participant_G_UXD2). The role should also enable team members to succeed, work towards getting the team on the same page, allow the team to get along, and be able to talk the same language as developers and designers and translate between them, connecting different roles (Participant_A_PO1). Product owners also need to be able to find the people that they need to solve problems (Participant_F_UXD1). The product owner also needs to have extensive business knowledge, needs to understand and guide the building prioritisation, keeping the objectives in scope. He/she needs to understand the product that is being built as well as the problems that need to be solved (Participant_C_PO3). This role should also have sight of any risk factors and would determine compromises; to be effective the product owner needs autonomy to make decisions without interference from company politics (Participant_L_DEV2). They need to be able to play the problem back to stakeholders to influence them (with the support of the team) and to back the team (Participant_A_PO1).
	Deliver	Practitioners emphasised that, ultimately, the product owner takes the team from an idea to delivering a product, bringing all the components together (Participant_A_PO1).
Theme 4: The agile team	**Category 3: UX Designer**	
	The UX designer in the team emerged as a category that formed part of the larger theme of the *Agile* Team, the category of the UX designer was emphasised during the discover, dream and design phases of the appreciative inquiry process. All three roles interviewed spoke to the importance of the UX designer to produce the best UX for BI dashboards in an agile environment. Practitioner quote: *"So, I think the role of UX is always clearly understated. In most of the projects I worked on a lot of the project managers turn to me and said, just add a button or just quickly make something look pretty, it's almost like UX and UI like security is the last thing that get thought of, when actually, when your product is not easily usable and it's not designed well, users aren't going to use it."* *~ Participant_N_DEV4 ~*	
	Discover	Considering past experience, practitioners regarded the UX designer's ability to think at a high level as well as being able to focus on the detail as important (Participant_F_UXD1). Looking back, it was important for UX designers to be good at balancing and negotiating the user requirements, business and technical constraints to create concepts that were feasible and delivered business as well as user value (Participant_G_UXD2). It was important for the UX designer to evangelise the importance of usability testing, to mentor and grow junior designers in team (Participant_G_UXD2). It was important for the UX designer to be able to show the team that he/she understands the basics of other domains such as product and tech and that he/she is cognisant of those things, for the rest of the team to listen to what the designer had to say (Participant_G_UXD2). The importance of upskilling and

		reskilling people in design and business areas was also mentioned (Participant_H_UXD3).
	Dream	Participants imagined a team that consisted of creative thinking that sets out a logical picture, with the ability to create and test concepts at speed (Participant_B_PO2).
	Design	Participants mentioned the importance of self-leadership in a UX design capacity, initiating momentum in a younger generation (Participant_G_UXD2). (Participant_H_UXD3). The importance of upskilling and mentoring Junior designers entering the job market was also mentioned by participants to fast-track growth (Participant_G_UXD2) (Participant_H_UXD3). Specifically, on UX designer growth and development, participants suggested that junior designers "run with it" taking accountability for their own growth and more senior designers work with them to set real milestones, so they can evaluate whether they are making progress (Participant_H_UXD3). Participants also suggested that senior designers help junior designers to do specific things that will help them make progress in the things that they want to learn about. The importance of designers being able to run workshops (design is becoming more a group activity) and to truly understand a topic beyond the platonic concepts (Participant_H_UXD3). Designers can also optimise their output by focussing on the skills they already have (Participant_H_UXD3). Participants mentioned working with designers towards their growth - an emergent way of working with people rather than top down telling them what they should do (Participant_H_UXD3).
	Deliver	Not mentioned by practitioners.

5.1.3.4.1 Co-occurrence within the Agile team

Looking at the co-occurrence of coded concepts within this theme, it was identified that all three roles focussed on all three roles included in this research in the team. It was also noticed that the UX designers expressed most focus on these concepts, especially on the roles of design and product within the team. It was also identified that all roles predominantly focussed on their own role within the team. See Figure 5.10 for the co-occurrence of codes for 'the agile team'.

5.1.3.4.2 Word cloud for the Agile team

A word cloud visual representation was generated for the theme of the ***Agile team*** [see Figure 5.11]. This visualisation brought to the foreground the concepts of 'team', 'product', 'design', 'owner', '

	Developers Group (4, 101)	Product Owners Groups (4, 100)	UX Designers Groups (5, 153)	Totals	
Developer 9	6	1	2	9	
Product Owner 16	2	6	8	16	
UX Designer 16	1	3	12	16	
Totals	9	10	22	41	

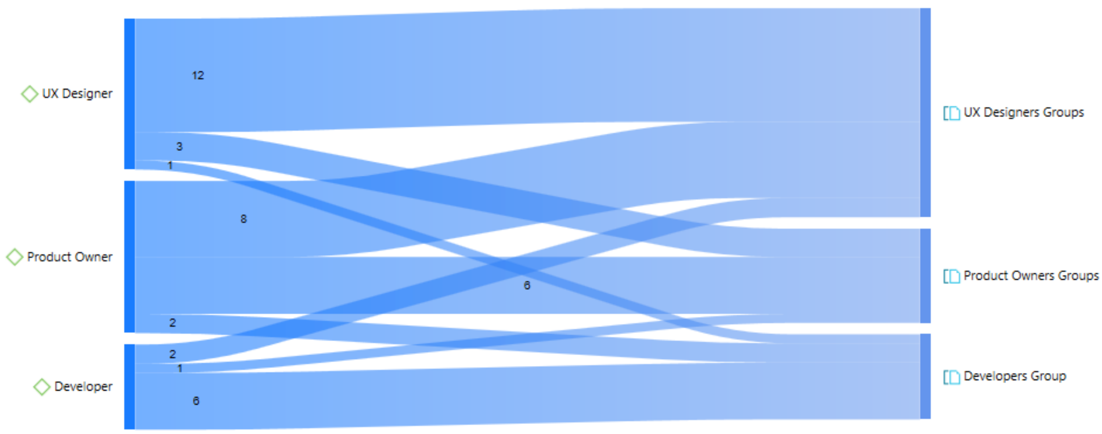

Figure 5.10 Co-occurrence of concepts within the Agile team theme.

need', 'understand' and 'business, allowing what is important to the team to become clearer.

The network view of the Agile team theme showing the connection of codes is accessible in Appendix E.

Figure 5.11 Word cloud visual representation for the theme of the Agile team.

5.1.3.5 THEME 5: PRODUCT

The concept of *product* emerged as another major theme from the interviews. This theme was discussed with enthusiasm by many of the participants. The theme comprised three distinctive categories.

The categories that constituted the ***theme of product*** were:

1. Business objectives;
2. Product requirements; and
3. Product use.

Practitioner quote:

> *"… so, what I have experienced here is that, oh well the product is being used so it is successful, that actually means nothing, so how is that product being used, what is it being used for, what value is it actually adding…".*
>
> *~ Participant_A_PO1 ~*

<table>
<tr><th colspan="3">THEME 5: PRODUCT</th></tr>
<tr><td rowspan="4">Theme 5: Product</td><td colspan="2">Category 1: Business objectives</td></tr>
<tr><td colspan="2">The category of business objectives within the organisation was emphasised during three phases of the appreciative inquiry process, which were discovery, dream and design phases. All three roles considered the business objectives to impact the ability to produce the best UX for BI dashboards in an agile environment.

Practitioner quote:

"So, it was an extremely streamlined effort, unknown well within the organisation it was an unknown concept, but that was purely built based on customers feedback because we created personas … also aligned to the business objective".

~ Participant_A_PO1 ~</td></tr>
<tr><td>Discover</td><td>Looking back, practitioners emphasised the importance of a thought-through business case (Participant_J_UXD5).</td></tr>
<tr><td>Dream</td><td>Practitioners dreamt of an organisation that considered it important to understand why it is building a specific piece of software, what the purpose of going digital is, what the success criteria and business objectives are (Participant_G_UXD2). These objectives could be translated to suitable business requirements, which should also allow a place for customer requirements (Participant_A_PO1).</td></tr>
</table>

	Design	Practitioners practically require the business objectives to form part to feed into a product plan (Participant_B_PO2). The business strategy will influence the product strategy (Participant_B_PO2). The importance of a business case and a supporting customer case was emphasised to determine the real need before commitments are made to start up a team (Participant_H_UXD3). Clarity of the business requirements were important to derive product requirements (Participant_B_PO2).
	Deliver	Not mentioned by practitioners.
Theme 5: Product	**Category 2: Product requirements**	
	The category of product requirements within the organisation was emphasised during all four phases of the appreciative inquiry process. All three roles considered the product requirements to impact the ability to produce the best UX for BI dashboards in an agile environment. *Practitioner quote:* *"I think clear requirements set out in a very clear very detailed and I wanna says almost as detailed as possible set of requirements whether that is just an epic or a story of what we write when the designers pick up that story, they know exactly what is required of the design. Secondly and maybe even more importantly are the interviews with the end users the people we're designing for… Those are the elements that if you do not have those, everything you do, I think, would just crumble…".* *~ Participant_B_PO2 ~*	
	Discover	Reflecting on past experience, practitioners mentioned that knowing the product expectations from the start was important to work together actively as a team towards a clear endpoint (Participant_F_UXD1). Meeting product requirements was influenced by having a stable backlog, which ensured the team did not have to juggle work and allowed for continuous focus (Participant_G_UXD2). A clear view on the end purpose of the software also assisted in supporting product requirements (Participant_F_UXD1). It was important for the team really to understand the scope of the work; this went hand in hand with the development timeframes and allowed for more accurate estimates of development (Participant_N_DEV4). Previous experiences with product requirements included deciding what would be included as part of the product requirements; the practitioners' views were that the product's experience should never be a trade-off for other product requirements (Participant_A_PO1).
	Dream	Practitioners dreamt of product requirements where a clear product vision led the product requirements (Participant_K_DEV1) (Participant_N_DEV4) (Participant_I_UXD4), forming part of a greater product strategy (Participant_K_DEV1), where there were guidelines for product requirements, where the importance was understood of defining the MVP in terms of experience requirements as well as functional features (Participant_G_UXD2). Practitioners also dreamt of having clear constraints in place to focus work for the team (Participant_G_UXD2).
	Design	Practitioners emphasised what would be needed to get to the best state of product requirements would be a clear product vision (Participant_C_PO3), from an organisational viewpoint clear product strategy as well(Participant_C_PO3), including a

		clear roadmap to prevent delivering a half-baked product (Participant_G_UXD2, a prioritised backlog also indicating priority in features) (Participant_G_UXD2) (Participant_K_DEV1), understanding the product requirement's purpose (Participant_J_UXD5), the ability to change scope if necessary and to design for the product requirements (Participant_J_UXD5).
	Deliver	Practitioners emphasised that the product needed to bring value to the customer, including a good user experience as soon as possible and with that also value to business (Participant_J_UXD5). Practitioners also mentioned the importance of the product owner or manager being able to measure the success of the product once it has been delivered (Participant_A_PO1).
Theme 5: Product	**Category 3: Product use**	
	Use of the software by users emerged as a category that formed part of the larger theme of the Product. Participants addressed the importance of understanding the use of the product to produce the best UX for BI dashboards in an agile environment. This category was addressed from the perspective of the product uptake and not the usability of the product. Practitioner quote: *"Marty Cagan talks about we need to build products that customers love, not just want to use, they must love the product, so even if it is a banking app, or a financial institution app, they must love using it otherwise they are not going to come back and use it."* *~ Participant_A_PO1 ~* *" I am a fan of data that tells us what's happening with the product, and what people are doing with it, but that's the machine view of it, not the people element, and I think in most instances we lack the post testing once a product has been built, to me that component is really, really important, really about understanding what the users do with it why they are doing it and how they are doing it, there's some amazing tools out there that empower UX to get that kind of information, but there is nothing quite like the one on one"* *~ Participant_A_PO1 ~*	
	Discover	Participants mentioned the importance of refining the product with users based on their use of the product (Participant_F_UXD1, Participant_G_UXD2). The importance of *beta* testing products with users, to determine usability (Participant_C_PO3) was also mentioned.
	Dream	Not mentioned during the dream phase.
	Design	Participants considered it important to understand how users use the product, the people element is needed to understand 'why' users are doing something (Participant_A_PO1).
	Deliver	Participants mentioned that the real test is understanding how the software is being used by users in the real-world post release (Participant_L_DEV2). Systems analytics will only partially tell you 'how' users are using the product; collaborating with users will

		provide data on ‘why’ they are using the product in a particular way (Participant_A_PO1).

5.1.3.5.1 Co-occurrence within product

Looking at the co-occurrence of coded concepts within this theme, it was identified that the concept of product requirements was most important to all roles, especially to the UX design role. It was also identified that product owners had an intersecting focus on the product use with the designers. The streams visualisation also emphasised the lack of the developer role on business objectives.

The co-occurrence also shown the intersection with product owners and designers with regards to business objectives, pointing to the connectedness of design sitting between product and development, keeping the business objectives top of mind while also focussing on realising the product requirements alongside development. See Figure 5.12 for the co-occurrence of codes for ‘product’.

5.1.3.5.2 Word cloud for product

A word cloud visual representation was generated for the theme of ***product*** [see Figure 5.13]. This visualisation brought to the foreground the concepts of ‘product’, ‘requirements’, ‘users’, ‘objectives’, ‘clear’ and ‘business’. This emphasised the importance of requirements, the influence of users, the need for clarity, objectives, and the part that the business plays as key areas of focus.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals
Business Objectives 6		3	3	6
Product Requirements 15	4	4	7	15
Product Use 9	1	6	2	9
Totals	5	13	12	30

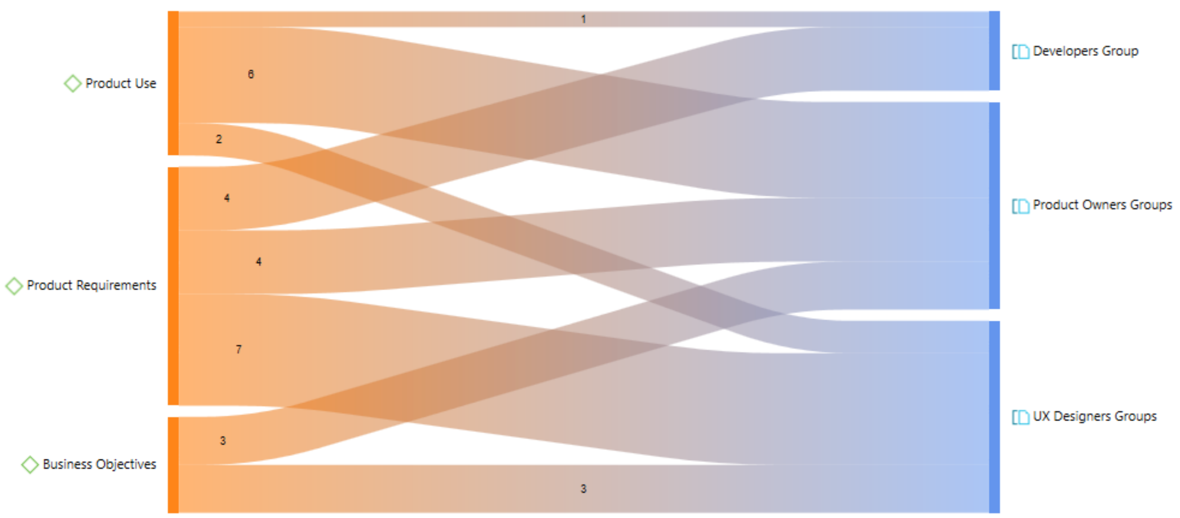

Figure 5.12 Co-occurrence of concepts within the theme of product.

The network view of the product theme, with a granular view of how codes are connected, is accessible in Appendix E.

Figure 5.13 Word cloud visual representation for the theme of product.

5.1.3.6 THEME 6: DEVELOPMENT

The concept of *software Development* emerged as another major theme from the interviews. The theme comprised of five distinctive categories.

The main categories that constituted the ***theme of development*** were:

1. Software development;
2. Tech leadership;
3. Tech research;
4. Tech feasibility; and
5. Data.

Practitioner quote:

> *"… it wasn't about taking on every single responsibility, it was about sort of understanding all the various aspects you know going from inception, working with the business owners and then working with the UX and design teams and understanding their views and their points and then moving on to actual development, which actually came very late in the stage where previous experiences were all about let's get in there let's just start straightaway you know in a way a misinterpretation of delivering quickly as it was almost being too eager, not really understanding the scope of things which is a big shift for me and that is what became very clear to me it was it was not about taking on all of the work it was about understanding everybody's role within the team learning how to work with them in order to show that, deliver that, all the ways to the QA and the eventual delivery."*
>
> *~ Participant_N_DEV4 ~*

THEME 6: DEVELOPMENT	
	Category 1: Software development
	Technical software development emerged as a category that formed part of the larger theme of Development. All three roles spoke to the importance of exceptional software development to produce the best UX for BI dashboards in an agile environment. Practitioner quote: *So, not just building something, because it needs to be built, I think making it in a way that the customer would actually enjoy using the software, irrespective of whether it's a mundane thing to use*

<table>
<tr><td rowspan="5">Theme 6: Development</td><td colspan="2">or something exciting to use. It's got to be a friend to the customer because I think the objective is to get them to keep on coming back in using it.

~ Participant_A_PO1 ~

"…is necessary you've got practice what you've learned and become good at it but there's a whole other aspect to development and that's going into the unknown and figuring out how you tackle that, how do you attain that additional knowledge, additional learning in the space that you don't really know anything about"

~ Participant_N_DEV4 ~

"using online boards to sort of try and breakdown our stories and divide the tasks up between the teams again it all really helped, I think the smaller the team sizes, I feel like was it was quite crucial, the reason why we delivered so much, it wasn't very large teams we were very focused … the expectation was that you get stuck in wherever you can, if something needs to be delivered and there's something missing, an area that needs someone to look after it was your prerogative to take it up and run with it"

~ Participant_N_DEV4 ~</td></tr>
<tr><td>Discover</td><td>Participants reflected on what they had experienced in the past that they consider to be important for software development. Developing effectively new version of an application in parallel (Participant_N_DEV4), the development of feature toggles nowadays a standard feature in development (Participant_N_DEV4), the use of tools to chunk stories (Participant_N_DEV4), and matrices with components to allow for quick component selection for developers were mentioned (Participant_A_PO1).

The concept of "change" within development was mentioned, and specifically new ways of technology interfacing (Participant_A_PO1) and being able to use the technology that the team wanted to (Participant_B_PO2).</td></tr>
<tr><td>Dream</td><td>Participants dreamt of the ability to identify failing data requirements (Participant_F_UXD1), to achieve accurate data visualisation (Participant_F_UXD1) and sufficient developer knowledge in teams to ensure correct data rendering on the dashboard (Participant_F_UXD1).</td></tr>
<tr><td>Design</td><td>Participants identified the use of biometrics (Participant_I_UXD4) and component-based design and development in the future (Participant_J_UXD5) (Participant_K_DEV1) (Participant_N_DEV4), the need to isolate code (Participant_N_DEV4). The ability to use up to date technology with continuous deploys (Participant_L_DEV2) (Participant_K_DEV1) and feedback from customers (Participant_L_DEV2). The importance of tracking performance improvements (Participant_N_DEV4).</td></tr>
<tr><td>Deliver</td><td>Delivering an effective product through automated delivery where possible (Participant_K_DEV1) (Participant_L_DEV2), ensuring up to date technology through new and continuous deploy changes and by getting continuous feedback from customers (Participant_L_DEV2), continuous integration system (Participant_K_DEV1), through making assets available to developers (Participant_K_DEV1). Following component-based development (Participant_K_DEV1) (Participant_N_DEV4), effectively isolating</td></tr>
</table>

<table>
<tr><td></td><td></td><td>through development (Participant_N_DEV4), focussing on continuous performance improvement.</td></tr>
<tr><td rowspan="6">Theme 6: Develop ment</td><td colspan="2">Category 2: Tech leadership</td></tr>
<tr><td colspan="2">Tech leadership emerged as a category that formed part of the larger theme of Software Development. The category was especially mentioned by developers.

Practitioner quote:

“We had a great leader in our team … but we literally went through you know like I felt like it was the most productive phase of my life, we went through like feature after feature product after product of delivery.”

~ Participant_N_DEV4 ~

“I feel like when you have got leadership within the development team, they make better decisions. They build faster and just having that one voice that kind of leads the team in terms of let’s build it this way, let’s build the logic like that, moving forward, these are the principles, and they build faster”

~ Participant_B_PO2 ~

“The head of development I feel like was very in tune with their software development and what practices were coming along that were helping the software development lifecycle, he was very motivating, everyone in the team was generally having a good time coming into work and were happy coming into work, but we worked hard and at the same time you know he was very watchful that everyone wasn't overworking themselves”

~ Participant_N_DEV4 ~</td></tr>
<tr><td>Discover</td><td>Looking back, participants recalled that an appreciative leader (Participant_N_DEV4), that provided strong tech leadership through a clear tech vision (Participant_N_DEV4) (Participant_O_DEV5) and who executed with foresight (Participant_N_DEV4), contributed to the best development experiences. Practitioners also mentioned leadership being aware or ‘in tune’ with tech trends and motivating developers to try and learn about new technologies (Participant_N_DEV4) (Participant_B_PO2). Practitioners also reflected on the importance of having technical mentorship (Participant_O_DEV5) to develop and grow developers (Participant_O_DEV5).</td></tr>
<tr><td>Dream</td><td>Not mentioned by practitioners.</td></tr>
<tr><td>Design</td><td>Participants mentioned the need for tech leadership that mentors more junior developers (Participant_O_DEV5), keeps a watchful eye over team members, protecting them from burnout (Participant_N_DEV4).</td></tr>
<tr><td>Deliver</td><td>Practitioners mentioned that Tech leadership is important to deliver effectively on a continuous basis, (Participant_B_PO2) to keep team members motivated and balanced (Participant_N_DEV4).</td></tr>
</table>

<table>
<tr><td rowspan="6">Theme 6: Development</td><td colspan="2">Category 3: Tech research</td></tr>
<tr><td colspan="2">Tech research emerged as a category that formed part of the larger theme of Software Development. The category was mentioned by product, design and development roles.

Participant quote:

"… they just found they kept researching and found better ways in which to sort of use the platform they were working with to get the data to be processed to be read to be written multitude of times faster"

~ Participant_N_DEV4 ~</td></tr>
<tr><td>Discover</td><td>Participants recalled the significance of technology exposure in past projects (Participant_I_UXD4). Participants also mentioned that rushing into using new tech without exploring it first should be avoided (Participant_N_DEV4).</td></tr>
<tr><td>Dream</td><td>Participants dreamt of having the freedom to stay relevant with new tech through continuous research (Participant_N_DEV4).</td></tr>
<tr><td>Design</td><td>Participants recommend spending the largest portion of time on actual development work, but also spending time to reflect on work, to explore how and with what the developers work (Participant_N_DEV4) (Participant_O_DEV5).</td></tr>
<tr><td>Deliver</td><td>Not mentioned by practitioners.</td></tr>
<tr><td rowspan="5">Theme 6: Development</td><td colspan="2">Category 4: Tech feasibility</td></tr>
<tr><td colspan="2">Tech feasibility emerged as a category that formed part of the larger theme of Development. The category of Tech feasibility was emphasised during the discover, design and deliver phases of the appreciative inquiry process. All three roles interviewed addressed the importance of tech feasibility to produce the best UX for BI dashboards in an agile environment.

Practitioner quote:

"Balancing user business and technical constraints or requirements to come up with a concept that will be feasible and deliver business and user value"

~ Participant_G_UXD2 ~</td></tr>
<tr><td>Discover</td><td>Participants reflected back on the compatibility of tech to designs (Participant_A_PO1), addressing technological constraints and marrying those to design concepts in the most effective ways (Participant_G_UXD2).</td></tr>
<tr><td>Dream</td><td>Not mentioned by practitioners.</td></tr>
<tr><td>Design</td><td>Looking forward, participants talked about exploring the initial plan for the design for the availability and ideal format of data (Participant_L_DEV2), as well as the</td></tr>
</table>

<table>
<tr><td rowspan="2"></td><td></td><td>importance of understanding the technical viability of the product (Participant_L_DEV2).</td></tr>
<tr><td>Deliver</td><td>When addressing the delivery of the product, the importance of testing the feasibility of the desired functionality was also mentioned (Participant_L_DEV2).</td></tr>
<tr><td rowspan="6">Theme 6: Development</td><td colspan="2">Category 5: Data</td></tr>
<tr><td colspan="2">Data were mentioned repeatedly during the interviews by participants and emerged as a category that formed part of the larger theme of Development, the category of ‘data’ was emphasised during all the phases of the appreciative inquiry process, discover, dream, design and deliver phases. All three roles interviewed spoke to the importance of ‘data’ to produce the best UX for BI dashboards in an agile environment.

Practitioner quote:

“Just trying to find better ways of trying to deal with the data not necessarily still using a document stack but using the same methods they would say for reading data that they would for writing it out for processing it for reading it”

~ Participant_N_DEV4 ~

“I think what happens is users need data aggregated, data comes in various formats, some of it is consumable, some of it structured and some of it unstructured. And because of this, we want a snapshot view of what is outlined data, our clients’ data, our business data. Aggregation also helps us with MI and BI so certain analytics around management and business”

~ Participant_B_PO2 ~</td></tr>
<tr><td>Discover</td><td>Looking back, participants spoke to the importance of dashboard visualisation for the best UX for BI dashboards (Participant_G_UXD2), participants also mentioned the importance of up-to-date data (Participant_N_DEV4), accurate data, data relevance (Participant_N_DEV4), meaningful data (Participant_N_DEV4), the importance of data performance (Participant_N_DEV4) and reporting on data performance (Participant_N_DEV4).</td></tr>
<tr><td>Dream</td><td>Looking forward participants dreamt of having accurate data in the end product (Participant_F_UXD1), data which reflects a correct logical perspective (Participant_F_UXD1).

Participants also dreamt of having access to the right information (Participant_K_DEV1), to do their jobs properly. Participants also spoke to the importance to analyse data (Participant_K_DEV1), to be able to retrieve data (Participant_K_DEV1) and having usable clean data (Participant_K_DEV1).</td></tr>
<tr><td>Design</td><td>When thinking about future use, participants spoke of the importance of understanding the data, the ability to process data at different levels (Participant_N_DEV4), the processing of data at improved speeds (Participant_N_DEV4) and the importance of data robustness (Participant_C_PO3).</td></tr>
</table>

	Deliver	The context of the data was also mentioned by participants as important to ensure the best UX for BI dashboards (Participant_N_DEV4).

5.1.3.6.1 Co-occurrence within development

The visualisation generated for the co-occurrences of codes, Figure 5.14, showed the predominantly developer focus on the domain of development, especially for concepts like 'software development' and 'tech leadership' pointing to the importance for developers of tech leadership in relation to software development.

All three roles had intersecting focus on the concept of 'software development' emphasising the common goal for all three roles.

5.1.3.6.2 Word cloud for development

A word cloud visual representation was generated for the theme of ***development*** [see Figure 5.15]. This visualisation brought to the foreground the concepts of 'data', 'development', 'design', 'tech' and 'use'. These concepts focus our attention on the importance of data in the context of development for role players.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals	
Data 9	5	2	2	9	
Software Development 19	9	6	4	19	
Tech Feasibilty 4	2	1	1	4	
Tech Leadership 8	8			8	
Tech Research 6	5		1	6	
Totals	29	9	8	46	

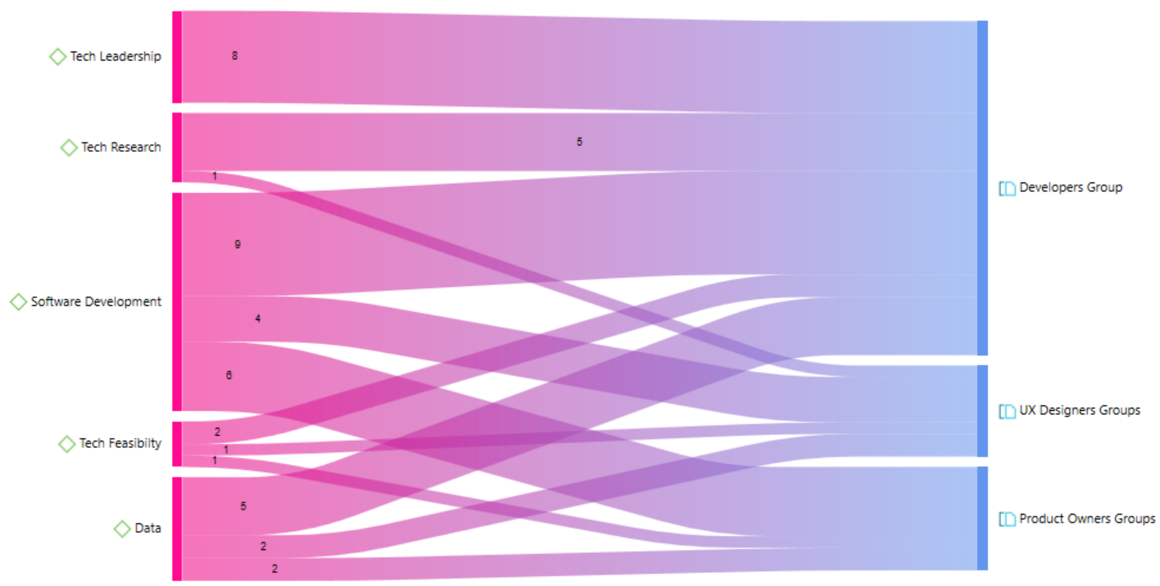

Figure 5.14 Co-occurrence of concepts within the theme of development.

Figure 5.15 Word cloud visual representation for the theme of development.

5.1.3.7 THEME 7: USERS

The concept of the 'Users' emerged as another major theme from the interviews. The theme comprised of three distinctive categories.

The categories that constituted the ***theme of users*** were:

1. User attributes; and
2. User needs.

Practitioner quote:

"You need to do your research and you need to understand your users' goals and needs and objectives"

~ Participant_G_UXD2 ~

THEME 7: USERS		
Theme 7: Users	**Category 1: User attributes**	
	User attributes emerged as a category that formed part of the larger theme of the User. The category was mentioned by product and design participants. Practitioner quote: *"User interviews and studies have been done to see what the subset of features should be. Of course when they built new websites they had one user who would relate to them what the features were they needed to build – only one - they ended up having a subset of features that were highly technical that only advanced users (a super user) could use and other users said why, what is this, what is that, because it was very in-depth and what people actually needed was just an aggregation of basic data"* *~ Participant_B_PO2 ~*	
	Discover	Not mentioned during the discovery phase.
	Dream	Not mentioned during the dream phase.
	Design	Participants addressed understanding the user attributes during the design phase of the appreciative inquiry process. The importance of designing for the user's abilities was emphasised to by participants (Participant_H_UXD3) (Participant_E_PO5).

	Deliver	Not mentioned during the delivery phase.
Theme 7: Users	User needs emerged as a category that formed part of the larger theme of the User. The category was mentioned by product and design roles. Practitioner quote: *"Everything had to be re-designed basically, based on, you know the testing and making everything accessible to people that had all sorts of disabilities, so I think that was career wise my first introduction to usability if you like and UX. And then after that everything changed, if you're a developer or a designer and you're in your own head, that's not what the user actually needs or sees, you know, they have a very different view, so that was the big change for me I think."* *~ Participant_H_UXD3 ~* *"The best most flexible technology will not help if the interface does not fulfil user needs"* *~ Participant_B_PO2 ~*	
	Discover	Looking back participants spoke to the importance of understanding the user needs before starting to develop a product (Participant_F_UXD1) (Participant_H_UXD3) (Participant_J_UXD5). Participants reflected on past experience and spoke to how the best, and most flexible technology will not help if the user needs are not addressed (Participant_B_PO2).
	Dream	User needs were not mentioned by participants during the dream phase.
	Design	When looking forward participants spoke to the importance of having sight of user needs through collaboration with users (Participant_H_UXD3) (Participant_B_PO2), different user's need for different data views (Participant_B_PO2), emphasis was placed by participants specifically on the need by management for aggregated data supported by analytics (Participant_B_PO2).
	Deliver	User needs were not mentioned by participants during the delivery phase.

5.1.3.7.1 Co-occurrence within users

The visualisation of the co-occurrence of codes showed the simplicity of focus around users [see Figure 5.16]. The developer role did not focus on the user as a concept. The UX design role was mostly focused on user needs. While the product owner role also demonstrated an interest in the user attributes, with the UX designer to a lesser extent.

5.1.3.7.2 Word cloud for users

A word cloud visual representation was generated for the theme of ***users*** [see Figure 5.17]. This visualisation brought to the foreground the concepts of 'user', 'needs', 'design', 'collaboration' and 'features', pointing to the importance for practitioners of the user needs and collaborating with users towards the design of features.

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals
User Attributes 5		4	1	5
User Needs 4			4	4
Totals	0	4	5	9

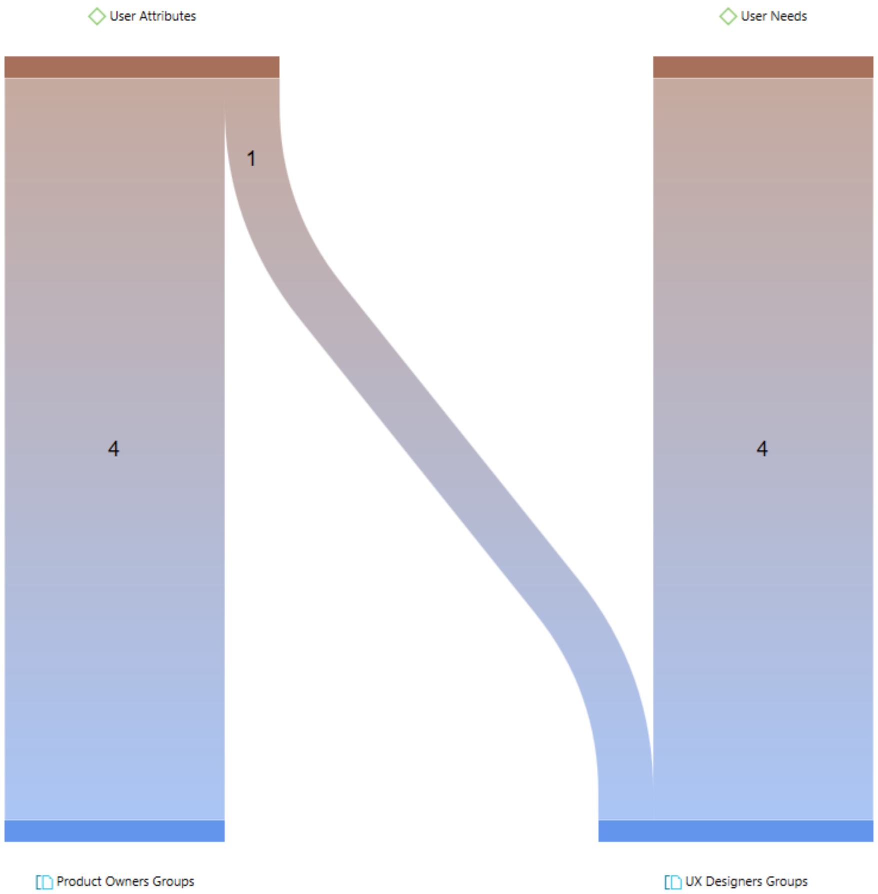

Figure 5.16 Co-occurrence of concepts within the theme of users.

Figure 5.17 Word cloud visual representation for the theme of users.

5.1.3.8 THEME 8: UX DESIGN

The concept of 'UX Design' emerged as another major theme from the interviews. The theme comprised of seven distinctive categories.

The categories that constituted the ***theme of UX design*** were:

1. UX Design Strategy;
2. UX Design Practice;
3. UX Design Process;
4. UX Research and Sensemaking;
5. UX Testing and Validation;
6. Desired experience characteristics; and
7. UX Dashboard Design.

Practitioner quote:

> *"I think that having both cross functional teams and business stakeholders all the way up to exec level would actually understand what it is about, and don't see it just as the wire frames or usability testing, for me that would be ideal, and I think it needs serious exec level, not just buy in but I think for UX to work properly you need an executive level champion, because we generally don't have a place at the table, and it's very challenging and exhausting to have to constantly evangelise, and it takes up a lot of time as well, when you constantly have to explain what your job is, you don't have time to do your job."*
>
> *~ Participant_G_UXD2 ~*

THEME 8: UX DESIGN	
	Category 1: UX Design Strategy
	UX Design Strategy emerged as a category that formed part of the larger theme of UX Design. Participants addressed the importance of a thought-through UX Design Strategy to be able to design the best UX for dashboards in an agile software development environment. The category that emerged as UX Design Strategy was addressed by all three roles interviewed (Product, Design and Development) Practitioner quote:

Theme 8: UX Design	*"For design to be a strategic differentiator, we have to be able to ask are we making the right thing?"* *~ Participant_J_UXD5 ~*	
	Discover	Looking back, participants addressed the value of having a clear design strategy for the UX team to follow (Participant_G_UXD2) (Participant_J_UXD5) (Participant_L_DEV2), such as a *dual track design approach* (Participant_J_UXD5). Participants also addressed a common and agreed understanding of the purpose of UX (Participant_L_DEV2) (Participant_G_UXD2). The importance of effectively onboarding designers into the design team as well as the agile teams in which they have to work was also mentioned *approach* (Participant_J_UXD5). Participants also mentioned the importance of understanding the business landscape (Participant_G_UXD2), the business objectives (Participant_G_UXD2) and the technical environment (Participant_G_UXD2) that the product needed to be developed. Importance of the team and business understanding the fact that every little decision can have far reaching consequences on the user experience as influencing factors for the UX strategy (Participant_A_PO1) (Participant_G_UXD2).
	Dream	Not mentioned by participants during the dream phase.
	Design	During the design phase of the appreciative inquiry process, when participants were asked what they would put in place to ensure the best UX, participants spoke about the importance of following a design strategy (Participant_G_UXD2), such as a *dual track design approach of designing and delivering strategy or the double diamond approach* to maximise value *approach* (Participant_J_UXD5). Other points mentioned by participants were around the vision of the type of UX design (Participant_G_UXD2), such as the importance of coordinating inclusive design (Participant_I_UXD4), knowing the customer that they are designing for (Participant_I_UXD4) (Participant_H_UXD3), designing for people firstly and foremostly (Participant_H_UXD3), to provide guidance to the design team in using an established interaction model and utilising suitable design methodologies (Participant_J_UXD5). Participants also motioned the importance of a foundational understanding of what UX is within the organisation, what are the goals as UX practitioners, what are the expectations of UX practitioners, and also the importance of an executive level champion for UX design in an organisation (Participant_J_UXD5) (Participant_G_UXD2) (Participant_H_UXD3). The alignment and the understanding at an organisational level should inform the importance of UX design to be included in product work from the discovery phase onwards throughout the process to be able to

<table>
<tr><td rowspan="2"></td><td></td><td>influence the direction of the product, as every decision taken along the journey of developing a product has an impact on the user experience in the end (Participant_G_UXD2).

The importance of a design system to optimise designer efficiency (speed of execution was specifically mentioned) (Participant_I_UXD4) (Participant_J_UXD5), to improve consistency and ensure quality of output, was mentioned by practitioners interviewed. The strategy should include producing designs that support a unified brand and consistent UI (Participant_K_DEV1) (Participant_F_UXD1) (Participant_I_UXD4).

Practitioners also addressed the importance of continuously educating design team members, and importantly to create opportunities for UX designer self-development and career growth (Participant_B_PO2).</td></tr>
<tr><td>Deliver</td><td>Looking forward, practitioners stressed the importance of laying design infrastructure and processes to support design work (Participant_B_PO2).</td></tr>
<tr><td rowspan="3">Theme 8: UX Design</td><td colspan="2">Category 2: UX Design Practice</td></tr>
<tr><td colspan="2">UX Design Practice emerged as a category that formed part of the larger theme of UX Design. The category was mentioned by product, design and development participants.

Practitioner quote:

"The experienced designer knows their role is more than just to design something the users will love; it's about negotiating with business and working with development towards the best solution".

~ Participant_G_UXD2 ~</td></tr>
<tr><td>Discover</td><td>When looking back at what was important, practitioners addressed the importance of getting the conceptual design right (Participant_G_UXD2), practitioners mentioned that sketching out lots and lots of different options was helpful during conceptual design stage (Participant_G_UXD2); it was also mentioned that designers should be prepared to discard ideas and look at the holistic design of solutions (Participant_G_UXD2).

The importance of balancing business environment, business objectives and goals with the user needs and understanding the technical constraints that exist was repeatedly mentioned by practitioners (Participant_G_UXD2).</td></tr>
</table>

		Participants had conflicting views on what constituted User Experience; one practitioner remarked that in his view user experience would be everything (all interactions) that would happen in the screen (physical interface) (Participant_H_UXD3). Other practitioners saw user experience as something that has visual and non-visual experience aspects (Participant_B_PO2). Participants found *personas* helpful in their past work, specifically *personas* for geographical areas (Participant_A_PO1). The importance of the visibility of screen designs to the rest of the team and the mapping of different of flows to indicate the process and user journey through the screens (Participant_A_PO1). Participants also mentioned that a modular approach to design was followed to make flows flexible (Participant_A_PO1).
	Dream	Practitioners dreamt of UX designers that would be able to design with confidence, that would be designing for people, Product owners dreamt of fast working UX designers to work ahead and test concepts quickly, not over focussing on design (Participant_B_PO2).
Theme 8: UX Design	Design	Practitioners mentioned what they thought to be important to be included in UX design practice for the best UX of BI dashboards; these were cataloguing and categorisation as a fundamental part of a solid information architecture and vocabulary modelling ensuring the correct use of words in the architecture (Participant_J_UXD5). Practitioners emphasised the importance of the design of navigation in a dashboard context to enable way finding and allow focus on flow/navigation (Participant_C_PO3) (Participant_J_UXD5). The suggested visual cues such as pebble paths or breadcrumbs to improve navigation, including path finding and back tracking experience of navigation (Participant_C_PO3). The design of Search, including search mechanism, user search strategies and search results displays were considered to be of utmost importance (Participant_J_UXD5). Participants regarded the practice of UX as a multi-faceted domain that has structural and more surfaced layer customer journey elements (Participant_I_UXD4). Participants recommended utilising techniques, such as mapping out user journeys in the form of flows (Participant_I_UXD4), conducting detailed task analysis with users, the creation of wireframes for task analysis and designs and to employ user tested interaction models (Participant_J_UXD5).

		Participants also mentioned that it is beneficial for designers to know and understand all the visual elements available for best experience, such as the use of animations and motion communicative designs (Participant_J_UXD5).
	Deliver	In order to make this a reality, practitioners emphasised the UX designer had to look with care at the detail connecting features, the importance of designers asking more specific and pressing questions when designing (Participant_G_UXD2). For example, what are you trying to do? Is this what you are trying to do? This is needed to finding clarity and certainty to guide the designs.
Theme 8: UX Design	**Category 3: UX Design Process**	
	The UX Design Process emerged as a category that formed part of the larger theme of the UX Design. The category was mentioned by product and design roles. Practitioner quote: *"we followed a user centred design process, but it was an adapted piece of work, so there were for example the overall design of how ... should work in this space was completely new piece of work and it required a lot of testing and validation with users in terms of whether or not the flow was correct, the sequencing of the fields made sense, and that sort of thing, initially fairly low fidelity sketches and prototypes where we tested those conceptual elements first and then we started refining the screens, figuring out what sequence the input fields could potentially go in in testing, that again with users but also testing across all the different transaction types, because there were many transaction types that varied a great deal, whatever kinda basic flow we put in place had to flesh to those different requirements."* *~ Participant_G_UXD2 ~*	
	Discover	Looking back at what worked, participants also addressed the importance of having senior or lead designers assist with the formation and testing of concepts before these designs are refined in the design process (Participant_G_UXD2) (Participant_J_UXD5). Participants remarked that UX designers at times felt stressed in moving to the unknown when designing a product, an iterative design process allowing users to articulate what they want and need, this iterative process in designing and prototyping for participative design and decision-making (Participant_F_UXD1). The use of a user-centred design process where users collaborated closely with designers was expressed as being critical to the success of the design (Participant_F_UXD1). Participants also mentioned that the inclusion of visual design (high fidelity interface design) in process (Participant_F_UXD1).

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<tr><td rowspan="4"></td><td></td><td>Iterations allow for the evolution of the design to be more fit for purpose (Participant_G_UXD2). The UX design process should include requirements, specifications, initial research, conceptual design, refined design components, prototyping, testing and development to produce a minimum viable product (Participant_G_UXD2).</td></tr>
<tr><td>Dream</td><td>Participants dreamt of a willingness and understanding of team members that design does not always follow the same process and a willingness and ability to accommodate that (Participant_G_UXD2).</td></tr>
<tr><td>Design</td><td>Practitioners considered it important for the designer/the design team to lead and explore conceptual design work (Participant_G_UXD2). The importance of a well-tested concept before detail design was started was emphasised (Participant_J_UXD5).

To carry out the design process properly, sufficient time should be spent at the inception phase of the project (Participant_H_UXD3), research has to be conducted well (Participant_H_UXD3), the problem statement need to be formulated and refined (Participant_H_UXD3), solutions need to evolve around pain points (Participant_H_UXD3), ideation should happen around those and testing should be conducted to validate (Participant_H_UXD3), for the designers to be assured that they are solving the right customer problem in in the right way (Participant_H_UXD3).

Practitioners remarked that a solid design process would give designers confidence in the design and assist decision-making (Participant_C_PO3) (Participant_H_UXD3).</td></tr>
<tr><td>Deliver</td><td>The testing and validation of work at different stages of the process was also mentioned by participants (Participant_G_UXD2) (Participant_F_UXD1), such as validating user flows with users, validating task analysis with users as well as testing designs with users (Participant_B_PO2).</td></tr>
<tr><td rowspan="2">Theme 8:
UX Design</td><td colspan="2">Category 4: Research and sensemaking</td></tr>
<tr><td colspan="2">The concept of research and sensemaking emerged as a category that formed part of the larger theme of the UX Design. The topics constituting this category were mentioned by all three roles (product, design, and development).

The most emphasised concept within this category was without a doubt understanding the users' needs; everything else stems from this.

Practitioner quote:</td></tr>
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<td colspan="2">
"Designing for behaviour change, that's one of my favourites, that sort of sums it up in a sense, of um, ultimately what you are trying to do, is you are trying to change people's behaviour to save more, or we want them to get healthier, or whatever, or if you're a bank, make more profit, or help clients that are struggling or whatever, so I guess maybe it's like the jobs to be done, find out what is the job people want to do and then, design a solution around that. "
~ Participant_H_UXD3 ~
"I think the design that I am more interested in and experiencing more in my work is the design of things that's not visible, and a lot of the tools and techniques that you need, to do that, and to make sense of that so that the people that you work with have confidence in the things that you are doing"
~ Participant_I_UXD4 ~
</td>
</tr>
<tr>
<td>Discover</td>
<td>
On reflecting on what was important for the best UX of BI dashboards, participants recalled that research was critical for the best experience (Participant_F_UXD1) (Participant_G_UXD2) (Participant_H_UXD3) (Participant_A_PO1) (Participant_J_UXD5). The importance of research was repeatedly emphasised, even the value of the smallest robust research could not be underestimated (Participant_G_UXD2). Multiple iterations of research also improved the understanding of technical constraints and business requirements (Participant_G_UXD2). Research allowed the designer to form a picture of the end user and user journey (Participant_F_UXD1). Research included fieldwork, market, competitor, and customer analysis (Participant_H_UXD3).
Research included conducting fieldwork by designers to establish user needs, this was done in search of clarity and certainty (Participant_F_UXD1). The real needs of the customer should be articulated in clear language (Participant_L_DEV2).
The research included identifying the data, collecting the data, synthesising, and connecting the data, and the sensemaking of the data (Participant_F_UXD1).
The sensemaking of the data was crucial to relate the design to customer experience, and to further relate design to service design (Participant_F_UXD1).
Looking back practitioners mentioned the user need for building distinctive customised software products (Participant_H_UXD3).
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</table>

	Dream	Practitioners dreamt of "fascinating discoveries" when conducting research and making sense of the data (Participant_I_UXD4). They saw research as an excavation opportunity to grow a deep *understanding* of the root problem (Participant_C_PO3) (Participant_A_PO1) (Participant_I_UXD4). Research also could allow for the alignment to customer needs to identify the jobs customers need to get done (Participant_C_PO3).
	Design	When asked what is required for the best UX of BI dashboards, participants spoke of the importance of conducting research continually (Participant_J_UXD5); this would allow the requirements to become clear (Participant_F_UXD1), allowing the team to answer the questions: Is this the actual problem? Are we making the right thing? (Participant_J_UXD5). The importance of designers to understand the reason for design was highlighted (Participant_J_UXD5) ((Participant_H_UXD3). Participants stressed that it was important for the product team to see the problem in real life, visit the users in the field (Participant_H_UXD3) (Participant_J_UXD5). Laying emphasis on the importance of understanding the problem before starting to design (Participant_H_UXD3) (Participant_F_UXD1). This ties in with understanding the unique customer needs (Participant_L_DEV2) (Participant_A_PO1), and crucial to designing custom solutions (products and services) that will suit the customer needs. Participants mentioned that user research will allow for increased comprehension (Participant_I_UXD4); it will allow the team to discover, uncover and collect all the information (Participant_I_UXD4) that would assist them to design better. Research particularly allows for the collection of information around customers or users which allows for the correct participant selection in later activities (Participant_I_UXD4). Primary research, collecting data directly from customers and the deep questioning of users through interviews, inform customer needs and wants, identify customer pain points, enable design objectives to become clearer based on the user needs identified (Participant_J_UXD5). The importance of real mindfulness of what and why something is being done was mentioned as being important for effective research and sensemaking of the problem space and topic (Participant_H_UXD3). Participants felt it was important to allow enough time for research and sensemaking, not just to rehash the wheel as software development is very output- and results-oriented (Participant_H_UXD3). For the research part of the software development process, it is critical to ask the right questions to understand whether the product objective is actually relevant or not (Participant_A_PO1).

		From the research, user archetypes can be formed, with practitioners emphasising the importance of *knowing* your customers (Participant_J_UXD5). Apart from customer and user research, it will be invaluable to collect information from stakeholders through interviews customers (Participant_J_UXD5) customers (Participant_B_PO2) and other methods, this will allow the team to start to understand the product better, to gain exposure to the use of language between different users customers (Participant_F_UXD1) towards an effective end-product, the content required, the information available that is already available, it will allow for the clarification of information requirement (Participant_B_PO2). Product participants specifically remarked that about the importance of research findings which empower the Product Owner to make decisions about customers (Participant_A_PO1).
	Deliver	Practitioners suggested preferably asking customers what the problem was, instead of asking them what they wanted (Participant_A_PO1) (Participant_J_UXD5). The importance of the linking the product to the job they need to do was emphasised (Participant_H_UXD3).
Theme 8: UX Design	**Category 5: Testing and Validation**	
	The concept of testing and validation of design work emerged as a category that formed part of the larger theme of the UX Design. The topics constituting this category were mentioned by all three roles (product, design and development). Practitioner quote: *"I think, once the work has really been researched, it's been prototyped, it has been tested, and for me it's all about finding certainty, the team needs to get to a point of confidence in their decision making"* *~ Participant_G_UXD2 ~*	
	Discover	Participants remarked that looking back the testing of concepts and refined solutions was critical (Participant_F_UXD1) (Participant_G_UXD2). Clients often have difficulty in conceptualising the end product and the opportunity to see and respond to designs and prototypes is most useful in bringing clarity and certainty (Participant_F_UXD1). This allows sensemaking by the client in the realisation of the effectiveness of the design (Participant_F_UXD1).

		The importance of validating conceptual designs, building and testing with low-fidelity prototypes during conceptual design was emphasised to establish whether the direction of the solution was correct (Participant_G_UXD2). The importance of detailed wireframes for usability testing was also stressed for the purposes of usability testing and interviewing (Participant_G_UXD2).
Theme 8: UX Design	Dream	Not mentioned by participants.
	Design	Looking forward practitioners emphasised the importance of testing in the delivery of a product (Participant_A_PO1). The testing of ideas and wireframes including experimental components (Participant_J_UXD5), making a dedicated place for testing, having clear sight of the consequence of testing (Participant_I_UXD4), continuous incremental testing (Participant_I_UXD4), testing specific facets (Participant_I_UXD4), having proper channels of feedback into research plans and designs (Participant_J_UXD5). Testing and validation can be conducted in a number of ways; it can be done as an in-person test (moderated), observed, unobserved, online (Participant_C_PO3). Emphasis was made on selecting the correct participants (purposeful sampling) with clear testing participant criteria beforehand to prevent wasting the participant's and the interviewer's time (Participant_C_PO3). Practitioners also mentioned the use of analytics to provide additional data on the use of products (Participant_C_PO3), customers should be encouraged to test and engage with products, even non-customers should be consulted to collect their views on work (Participant_C_PO3).
	Deliver	Participants regarded the validation of products as critical (Participant_A_PO1) (Participant_G_UXD2) (Participant_I_UXD4) (Participant_I_UXD4) (Participant_L_DEV2). The importance to testing in the same physical environment as where the product was intended to be used was emphasised (Participant_A_PO1) (Participant_G_UXD2). Both pre- and post-testing should be conducted as the software is being built and is being maintained (Participant_A_PO1).
	Category 6: Desired experience characteristics	
	The concept of desired user experience characteristics of dashboards emerged as a category that formed part of the larger theme of the UX Design. The topics constituting this category were mentioned by all three roles (product, design, and development).	

Theme 8: UX Design	*Practitioner quote:* *"To first understand what it is that we would want to try and change, by means of display or visualizing data, and you work from there, but you don't start with the concept of a dashboard, you start with what change do you want to create by presenting data to someone, how do they need to use it"* *~ Participant_H_UXD3 ~*	
	Discover	Looking back practitioners recalled that the best UX for dashboards were produced when no training was required to use the product (Participant_F_UXD1) (Participant_A_PO1), when the simplicity of the product was recognised (Participant_F_UXD1) (Participant_A_PO1), when the usability of the product was proven (Participant_F_UXD1), when the usefulness of the product was established (Participant_F_UXD1) (Participant_A_PO1), when there was an appreciation for the product by the user (Participant_F_UXD1), when the product was perceived to be friendly, enjoyable, exciting, pleasurable to use routinely and adding value to the customers (Participant_A_PO1).
	Dream	Practitioners dreamt of being able to ensure compatibility between the team and the end-user in contextual usage of concepts for the best UX of dashboards (Participant_F_UXD1). They also dreamt of creating something useful (Participant_A_PO1).
	Design	Looking forward, practitioners addressed the importance of products being functional (Participant_J_UXD5), satisfying the need of the customer (Participant_J_UXD5), for the user to have control (Participant_J_UXD5) and to ensure ease of use (Participant_I_UXD4). The importance of understanding the context of use (Participant_F_UXD1) and a consistent focus on ease of information consumption (Participant_C_PO3) were also highlighted.
	Deliver	The user should not be burdened by changes in the logic layer if the product were to be changed or improved (Participant_A_PO1). A simple visual interface layer with complexity in the logic layer was recommended. Interface solutions should be streamlined, easy to use, effective and simple (Participant_A_PO1).
	Category 7: UX Dashboard Design	

		The concept of UX design for dashboards emerged as a category that formed part of the larger theme of the UX Design. The topics constituting this category were mentioned by all three roles (product, design and development). Practitioner quote: *"If you can interpret the data to reflect that information in the form of a dashboard or a tool that can be utilised by someone at a quick glance rather than a report or an email or something like that then that would be amazing"* *~ Participant_A_PO1 ~* *"The BI/dashboard elements surfacing relevance, potentially time sensitive information, in a way that people can easily consume"* *~ Participant_B_PO2 ~* *"Based on best practice and research I've been able to help them identify where there is room for improvement, which dashboard components are useful and which ones are less useful, and also in terms of prioritizing"* *~ Participant_F_UXD1 ~*
Theme 8: UX Design	Discover	Looking back at what is required for the best UX for Dashboard front-ends, practitioners emphasised the essence of the dashboard for the client is at the top level (Participant_F_UXD1). Furthermore, the importance of the top layer of the interface to surface important lower-level info of interest was also mentioned (Participant_G_UXD2). Users should be able to drill down into information (Participant_F_UXD1) (Participant_N_DEV4), as clients find value in deeper layers of information as well as surface level information. Users should be able to customise the level of information to be displayed (Participant_F_UXD1). Practitioners remarked that the combination of elements for the correct dashboard view was complicated to get right (Participant_F_UXD1) (Participant_N_DEV4). They emphasised designing the dashboard to be a suitable fit for the context of use (Participant_F_UXD1). The structural difference of a dashboard with multiple levels of data was mentioned to be different from traditional web information architecture, and designers needed to have experience in data structures to aid their understanding of the data fields and the consumption of them by users (Participant_L_DEV2) (Participant_F_UXD1). Emphasis was laid on designers making the link between the information needed and the dashboard composition (Participant_F_UXD1).

		Practitioners emphasised that functionality was prioritised over user friendliness in the interim stages of design, to get the dashboard to work correctly first before incrementally improving the usability (Participant_F_UXD1). Practitioners also reflected on the fact that they have in the past prioritised components based on their usefulness to the users (Participant_F_UXD1). Practitioners emphasised that the BI/dashboards should surface relevant elements, potentially time sensitive information, in a way that people can easily consume them (Participant_G_UXD2). The visual nature of dashboards was consistently emphasised (Participant_G_UXD2), such as making use of dashboard visualisation, for example making use of current comparative examples/future relevant examples, using visualisation to make important information visible (Participant_G_UXD2), to represent the same data in different ways to improve understanding of the data (Participant_G_UXD2), to improve the understanding the logical perspective (Participant_G_UXD2), to allow for improved visualisation of the data (Participant_G_UXD2) and the components and to allow for improved understanding of complex concepts (Participant_G_UXD2). Reflecting on what worked best, the importance of research in dashboard design and the ability of the customer to consume the dashboard information were highlighted as critical for the best UX of dashboards (Participant_F_UXD1) (Participant_G_UXD2).
Theme 8: UX Design	Dream	Participants dreamt of building dashboards that could support the complexity of the data (Participant_F_UXD1). Participants also dreamt of being able to find the best way to show information to users ((Participant_K_DEV1) and to organise data visually for mobile interfaces to improve use (Participant_F_UXD1).
	Design	Looking forward, practitioners talked about how they would design for the best UX of dashboards. A summary of information at the highest level was mentioned as an ideal dashboard characteristic (Participant_I_UXD4). The need for purposeful data views (Participant_B_PO2) (Participant_N_DEV4), different views for different purposes (Participant_C_PO3) was repeatedly mentioned by practitioners, different levels of views, different views that would allow different ways of presenting the information to someone. Users need to be able to move (navigate) back and forth in data structures (Participant_K_DEV1). The importance of dashboard visualisation such as motion communicative design was emphasised (Participant_J_UXD5).

		Avoid information duplication or the splitting of information in different places on the dashboard (Participant_F_UXD1). Synthesise data and understand relationships between data (Participant_F_UXD1). The importance of researching the information journey and ideal navigation was mentioned as well as the importance of looking at language in detail in dashboard design (Participant_K_DEV1). More focus should be placed on user goals, such as KPIs or KPAs, as a means towards product development (compared to *persona* creation) (Participant_F_UXD1) (Participant_H_UXD3). Linking a time management functionality of the dashboard with the needs of the customer was emphasised (Participant_H_UXD3). This was further emphasised by the mention of the critical importance of linking the data or information to an action or behaviour change was emphasised; that is, to initiate action based on information available (Participant_H_UXD3).
	Deliver	Practitioners stressed the goal of making decisive information available to the user (Participant_H_UXD3). In practice data exposes performance, data exposes risk/opportunities, data should tell the story at quick glance with support of other channels (report/email) (Participant_B_PO2).

5.1.3.8.1 Co-occurrence within UX design

From the co-occurrence visualisation and representation, it is clear that the UX design role placed most emphasis on this theme. It is noticed that the product owner role coincided with all the concepts that the UX design role paid attention to. Key areas of focus for the design role were 'research and sensemaking' and the 'design process'. The product owner role also had an intersecting interest in the concept of 'research and sensemaking' interpreted as the role's need to understand the user need and product requirements.

The second highest product concept is 'desired experience characteristics' pointing to the product owner roles' interest in the product and its use. All three roles had an intersecting co-occurrence on the concept of 'UX dashboard design'. [See Figure 5.18 for the visual representation of the co-occurrence of codes for the theme 'UX design'].

5.1.3.8.2 Word cloud for UX design

A word cloud visual representation was generated for the theme of ***UX design*** [see Figure 5.19]. Atlas.ti was also utilised to generate a network map of the intricate concepts related to UX design [see Appendix E].

	Developers Group 4 101	Product Owners Groups 4 100	UX Designers Groups 5 153	Totals	
Desired Experience Characteristics 9		4	5	9	
Research and Sensemaking 18	2	5	11	18	
Testing and Validation 11	1	3	7	11	
UX Dashboard Design 15	5	2	8	15	
UX Design Practice 10		4	6	10	
UX Design Process 12		2	10	12	
UX Design Strategy 13	2	3	8	13	
Totals	10	23	55	88	

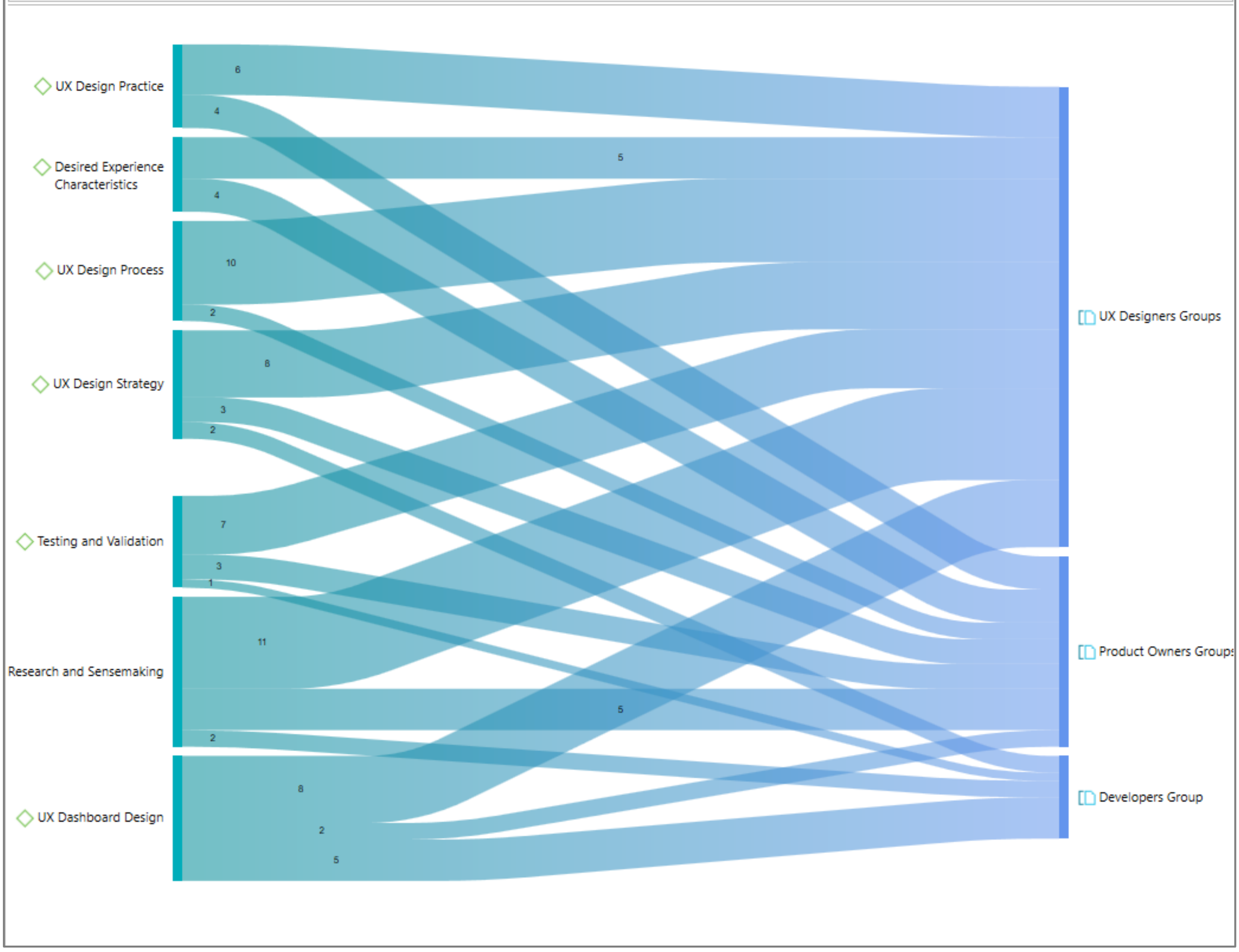

Figure 5.18 Co-occurrence of concepts within the theme of UX design.

Figure 5.19 Word cloud visual representation for the theme of UX design.

In Section 5.1.3 the practitioners' views of what would be required for the best UX for BI dashboards were presented, based on the themes that emerged from the practitioner interviews conducted. From the data analysis of the practitioners' interviews, eight overarching themes emerged: (1) agile software development; (2) change and adaptability; (3) collaboration and communication; (4) product; (5) the agile team; (6) development; (7) users; and (8) UX design.

Table 5.3 represents an overview of the elements that are required for the best UX of BI dashboards in an agile software development environment according to the practitioners in the field.

This practitioner-based UX framework served as input for the development of a validating survey sent to a larger population to verify or dispute the practitioner views. The quantitative survey analysis is discussed in Section 5.2.

As the study made use of an exploratory sequential mixed methods design with instrument development, the **output from Phase II** (the themes that emerged from the research) were utilised as **input to Phase III** to develop the survey instrument to validate the practitioners' view with a larger group of practitioners. Note that the goal of the quantitative analysis was not to discover new themes but to validate the smaller group of practitioners' views against the larger group of practitioners' views to produce a validated framework. Accordingly, Chapter 5 continues with the analysis of the data collected from the survey in Section 5.2.

5.2 Survey questionnaire data analysis

Next the quantitative data analysis discussed in terms of the statistical analysis and the exploratory factor analysis performed.

As described in Section 4.4, the research design utilised an exploratory sequential design which, firstly, collected qualitative data; the data were then analysed and produced the themes that were presented in Section 5.1. The findings from the qualitative data analysis identified, according to practitioners, which elements are important for the best UX of BI dashboards. The output from the interviews was utilised to develop an instrument to be tested with a larger portion of the population of practitioners. It is a commonly accepted strategy to conduct qualitative research on a particular topic of interest or within a specific population, and then utilise this information gathered to develop a suitable survey instrument to collect quantitative data (Creswell, 2014). The development of the quantitative data collection instrument is discussed in Section 4.5.2.3.

Table 5.3 Practitioners' UX framework.

Interview Themes	**Interview Categories**
1. Agile software development	1. Agile practice and process 2. Continuous improvement 3. Incremental, quick value delivery 4. Measurement 5. Methods of working 6. Resources and infrastructure
2. Change and adaptability	1. Adaptability 2. Change 3. Experimentation 4. Innovation
3. Collaboration and communication	1. Collaboration within the organisation 2. Collaboration within the team 3. Communication within the organisation 4. Communication within the team 5. Collaboration with the product users
4. The agile team	1. Developer role 2. Product owner role 3. UX designer role
5. Product	1. Business objectives 2. Product requirements 3. Usage
6. Development	1. Development technical 2. Development leadership 3. Development research 4. Technical feasibility 5. Data
7. Users	1. User attributes 2. User needs
8. UX Design	1. UX Design Strategy 2. UX Design Practice 3. UX Design Process 4. UX Research and Sensemaking 5. UX Testing and Validation 6. Desired experience characteristics 7. UX Dashboard Design

Including all themes (from the interviews) in the quantitative instrument would increase the risk of participants not completing the survey (increase the drop-off rate). With eight major qualitative themes and 20 questions per theme (grouped in four parts) the total number of questions would be eight times 20, resulting in 160 questions. To mitigate survey participant drop-off, the research was focussed on the areas relevant to the domain the study, which is information systems. Subsequently, the most relevant themes based on the domain of research, information systems, namely UX Design and Technical Development, were selected to be included in the survey.

Explorative qualitative research was employed to develop new knowledge in the form of a practitioner's view of what is required for the best UX for BI dashboards. The subsequent quantitative part of the study was used to examine the output from the interviews in a more generalisable manner. Next, the quantitative survey analysis will be presented.

As previously mentioned, the survey instrument was constructed from the two major themes that emerged from the interviews with the practitioners relevant to information systems. These two themes were UX Design and Development, and the instrument consisted of three parts. Part 1 focussed on the demographics of the participants, Part 2 (questions 1-20) focussed on the Development of BI Dashboards, and Part 3 (questions 21-40) focussed on UX Design. The analysis of the data collected from the survey is presented in the following order: descriptive frequency analysis, item analysis, explorative factor analysis and correlation with principal component analysis.

In quantitative research, after collecting data, the first step of statistical analysis is to describe characteristics of the data; descriptive statistics are used to describe the basic characteristics of data in a study (Bhandari, 2020). They allow for simple summary views about the sample and the measures. Descriptive statistics are used to summarise and organise these characteristics of a data set. In this survey the data set is a collection of responses from a population of agile practitioners.

Section 5.2.1 continues by presenting the descriptive frequency analysis, then Section 5.2.2 presents the survey item analysis, Section 5.2.3 presents the principal component analysis, and the quantitative data analysis is concluded by presenting the exploratory factor analysis in Section 5.2.4

5.2.1 Descriptive frequency analysis

Frequency analysis is a part of descriptive statistics. A total of 102 participants started the survey; there was a 79.41% completion rate with 81 participants completing the survey. Section 5.2.1.1 presents the survey demographics, Section 5.2.1.2 presents the frequency analysis for the questions pertaining to development, while Section 5.2.1.3 presents the frequency analysis for the questions pertaining to UX design.

5.2.1.1 Survey - Part 1: Demographics

Q1: Agile software development experience

The sample of 81 participants, consisting of developers, UX designers, product owners and other roles to a lesser extent [see distribution in question 3], included 79 participants, that is 97.53% of participants who reported having agile software development experience, with two participants (2.47% of participants) not having previous agile software development experience.

Q2: Dashboard experience

From the sample of 81 participants, 64 participants (79.01% of participants) indicated having had experience building dashboards. The remainder of the sample, 17 participants (20.99%) indicated that they had not previously had experience building dashboards.

Q3: Participant occupational role distribution

The sample consisted of 24 UX designers (29.63%), 23 developers (28.40%), 13 product owner/managers (16.05%) and 21 participants who indicated ‘other roles’ that were grouped as ‘other’ (25.93%), with participants specifying their role in the free text field. The roles that make up this ‘other’ group are described in Table 5.4. Note the inclusion of the ‘cumulative count’ and ‘cumulative percent’ in subsequent tables to assist in checking that all responses are accounted for.

Table 5.4 Occupational role, 'other' distribution.

Other roles	Count	Cumulative count	Percent	Cumulative percent
Agile coach (agile)	1	1	4,76%	4,76%
Business analyst (systems)	1	2	4,76%	9,52%
Business owner (business)	1	3	4,76%	14,29%
CX and service designer (design)	1	4	4,76%	19,05%
Customer experience designer (design)	1	5	4,76%	23,81%
Design lead (design)	1	6	4,76%	28,57%
Development team member (business analyst) (systems)	1	7	4,76%	33,33%
Director (business)	1	8	4,76%	38,10%
Graphic designer (design)	1	9	4,76%	42,86%
Principal architect - UX director (design)	1	10	4,76%	47,62%
Product analyst (product)	1	11	4,76%	52,38%
Product designer (design)	2	13	9,52%	61,90%
Scrum master (agile)	1	14	4,76%	66,67%
Service designer (design)	1	15	4,76%	71,43%
Service designer, UX, UI designer (design)	1	16	4,76%	76,19%
Software quality assurance engineer (engineer)	1	17	4,76%	80,95%
UI designer (design)	1	18	4,76%	85,71%
UX & UI designer (design)	1	19	4,76%	90,48%
Web designer (design)	1	20	4,76%	95,24%
Product designer (design)	1	21	4,76%	100,00%

Q4: Years of experience

The sample of 81 participants (consisting of developers, UX designers, product owners and combined other roles) each indicated their years of experience. 11 (13.58%) participants had 1 year of experience, 9 (11.11%) participants had 2 years' experience, 15 (18.52%) participants had 3 years' experience, 10 (12.35%) participants had 4 years' experience, 5 (6.17%) participants had 5 years' experience, 4 (4.94%) participants had 6 years' experience, 6 participants (7.41%) had 7 years' experience, 3 (3.70%) participants had 8 years' experience, 4 (4.94%) participants had 9 years' experience and 14 (17.28%) participants indicated 10 or more years of experience. From the distribution it can be seen that 55.56% of participants had had from 1 to 4 years' experience, 27.16% of participants had had from 5 to 9 years' experience and 17.28% had had 10 or more years' experience [see Figure 5.20].

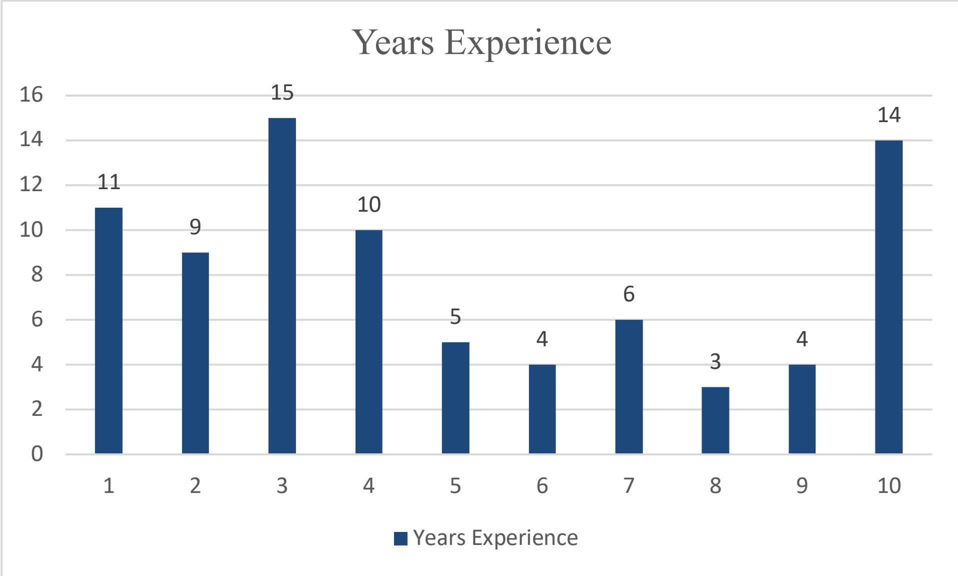

Figure 5.20 Number of participants per number of years' experience.

Q5: Years agile experience

The sample of 81 participants (consisting of developers, UX designers, product owners and combined other roles) each indicated their years of agile experience. 7 (8,64%) participants had 1 year of experience, 3 (3,70%) participants had 2 years' experience, 13 (16,05%) participants had 3 years' experience, 11 (13,58%) participants had 4 years' experience, 14 (17,28%) participants had 5 years' experience, 11 (13,58%) participants had 6 years' experience, 6 participants (7.41%) had 7 years' experience, 4 (4,94%) participants had 8 years' experience, 4 (4.94%) participants had 9 years' experience and 8 (9,88%) participants indicated 10 or more years of experience. From the distribution it can be seen that 49 (60.49%) participants had had from 3 to 6 years' experience, 10 participants (12.35%) had had from 1 to 2 years' experience and 22 participants (27.16%) had had 7 or more years' experience [see Figure. 5.21].

Q6: Domain

The sample consisted of 6 participants from Education (7.41%), 28 participants from Finance (34.57%), 1 participant from a Health-related domain (1.23%), 28 participants from IT (34.57%), 6 participants from Retail (7.41%) and 12 participants (14.81%) from 'other' domains.

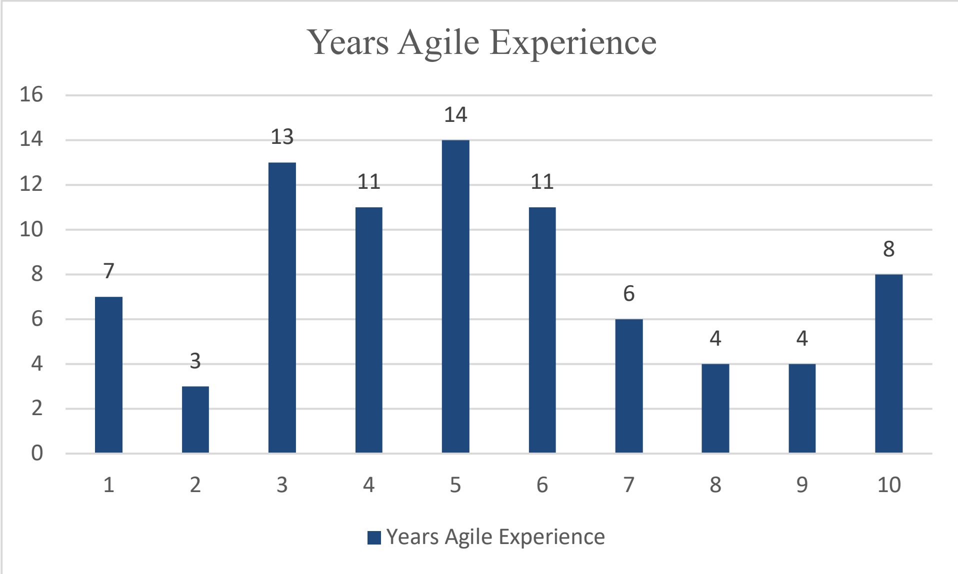

Figure 5.21 Number of participants per Agile years of experience.

Q7: Country

In summary, most survey participants had had experience with agile software development, which is 97.53% of respondents. With regards to having experience with BI dashboard design, 79.01% of respondents indicated that they had been part of software development for dashboards. With regards to the participants' job titles/roles, 29.63% of participants associated with the title of UX designer, 28,40% associated with the title of developer and 16.05% associated with the title of product owner/manager. The smaller proportion of product owners/manager are aligned with the smaller number of product people involved in the team considering other roles.

Of the job titles provided in the open text field, 13 of 21 respondents (61.90%) indicated to be associated with design related roles; that brought the total design representation in the responses to 45.67%. Respondents worked mainly within the domains of Finance (34.57%) and IT (34.57%), respondents predominantly (67.90%) had between 3- and 7-years agile experience, with 7 respondents having a year of experience and 8 respondents having more than 10 years' experience. Respondents were distributed across 11 countries, with most respondents indicating that they were South African nationals (80.25%) [see Table 5.5].

Table 5.5 Frequency distribution of country.

Country	Count	Cumulative count	Percent	Cumulative percent
Australia	1	1	1,23%	1,23%
India	1	2	1,23%	2,47%
Ireland	1	3	1,23%	3,70%
Israel	1	4	1,23%	4,94%
Kuwait	2	6	2,47%	7,41%
NZ	3	9	3,70%	11,11%
Netherlands	1	10	1,23%	12,35%
RSA	65	75	80,25%	92,59%
UAE	2	77	2,47%	95,06%
UK	2	79	2,47%	97,53%
USA	2	81	2,47%	100,00%

5.2.1.2 Survey - Part 2: Development (Q1-Q20)

Part 2 of the survey asked participants to what extent they agreed with the following statements regarding the development of software within an agile environment. Note that, where a Likert Scale is missing from a table, no respondents selected that option.

Q1: The need for automated delivery to enable the development of an effective product.
Automated delivery addresses the ability to move software between testing and production environments by using automated processes. Automated delivery was emphasised as important by the practitioners interviewed. From the survey it can be seen that 86.42% of the participants agreed with this recommendation, while 4.94% of participants disagreed [see Table 5.6]. This topic of automated delivery is supported by the literature, confirming its importance to encourage and motivate teams to deliver working software frequently (Arachchi, 2018; Mohammad, 2017).

Table 5.6 Automated delivery.

Automated delivery	Count	Cumulative count	Percent	Cumulative percent
Disagree	2	2	2,47%	2,47%
Slightly Disagree	2	4	2,47%	4,94%
Neutral	7	11	8,64%	13,58%
Slightly Agree	13	24	16,05%	29,63%
Agree	34	58	41,98%	71,60%
Strongly Agree	23	81	28,40%	100,00%

Q2: The need for testing the feasibility of the desired functionality.

Testing the feasibility of the desired functionality addresses assessing whether the software functionality can be easily or conveniently built. From the survey, Table 5.7, it can be seen that 97.53% of participants agreed with this statement, while 2.47% of participants disagreed. This agrees with the literature on the importance of determining the feasibility of functionality to reduce uncertainty within agile software development environment (Faiza, Shabib, Usman, & Syed Shah, 2017; Hostettler, Böhmer, Lindemann, & Knoll, 2017).

Table 5.7 Functional feasibility.

Functional feasibility	Count	Cumulative count	Percent	Cumulative percent
Disagree	1	1	1,23%	1,23%
Slightly Disagree	1	2	1,23%	2,47%
Neutral	0	0	0%	2,47%
Slightly Agree	3	5	3,70%	6,17%
Agree	22	27	27,16%	33,33%
Strongly Agree	54	81	66,67%	100,00%

Q3: The need for exploring the initial UX design plan for data availability.

The need for exploring the initial UX design for data availability addresses the team's confirming that the data that are specified in the UX design are indeed available to be included in the software functionality. From the survey in Table 5.8 it can be seen that 92,59% of participants agreed with this statement, while 3,70% of participants disagreed.

Table 5.8 Available data.

Available data	Count	Cumulative count	Percent	Cumulative percent
Missing	1			
Disagree	1	1	1,25%	1,25%
Slightly Disagree	2	3	2,50%	3,75%
Neutral	2	5	2,50%	6,25%
Slightly Agree	7	12	8,75%	15,00%
Agree	35	47	43,75%	58,75%
Strongly Agree	33	80	41,25%	100,00%

The number of missing values is 1.

The overall count including missing values is 81.

The overall percentage of missing values is 1.23%.

Q4: The need for clear design artefacts for technical development.

The requirement of clear design artefacts for technical development addresses the need of development team members to receive UX and UI design output that can be taken into development with a high level of confidence. From the survey, Table 5.9, it can be seen that 96.30% of participants agreed with this statement, while 0% of participants disagreed with this statement and 3.70% were indifferent.

Table 5.9 Clear design artifacts.

Clear design artifacts	Count	Cumulative count	Percent	Cumulative percent
Neutral	3	3	3,70%	3,70%
Slightly Agree	16	19	19,75%	23,46%
Agree	26	45	32,10%	55,56%
Strongly Agree	36	81	44,44%	100,00%

Q5: The need to use tools to chunk user stories for development.

The need to use tools to chunk user stories addresses the utilisation of structure or systems to break up user stories for smaller parts for development. From the survey it can be seen that 79.01% of participants agreed with this statement, while 9.88% of participants disagreed with this statement. While the majority of participants agreed with the statement, the almost 10% that disagreed could point to teams not having a need to chunk user stories, or less structured environments where user stories are not used as input to development [see Table 5.10].

Table 5.10 Chunking of user stories.

Chunking user stories	Count	Cumulative count	Percent	Cumulative percent
Disagree	5	5	6,17%	6,17%
Slightly Disagree	3	8	3,70%	9,88%
Neutral	9	17	11,11%	20,99%
Slightly Agree	18	35	22,22%	43,21%
Agree	30	65	37,04%	80,25%
Strongly Agree	16	81	19,75%	100,00%

Q6: The need for data relevance when a product is being developed.

The need for data relevance addresses the importance of products having data that will be perceived by users to be relevant to their needs for the product. From the survey it can be seen that 97.53% of participants agreed with this statement, while 1.23% of participants disagreed with this statement. This points to the importance of relevant data in a context specific interface, such as a BI dashboard [see Table 5.11].

Table 5.11 Relevant data.

Relevant data	Count	Cumulative count	Percent	Cumulative percent
Slightly Disagree	1	1	1,23%	1,23%
Neutral	1	2	1,23%	2,47%
Slightly Agree	7	9	8,64%	11,11%
Agree	42	51	51,85%	62,96%
Strongly Agree	30	81	37,04%	100,00%

Q7: The need for up-to-date data when a product is being developed.

The need for up-to-date data addresses the importance of data that are current and include the most recent changes, that could influence a decision that could be made based on the data (to produce information). From the survey it can be seen that 95.06% of participants agreed with this statement, while 1.23% of participants disagreed with this statement. This points to the importance of current data in a context specific interface such as a BI dashboard [see Table 5.12].

Table 5.12 Up-to-date data.

Up-to-date data	Count	Cumulative count	Percent	Cumulative percent
Slightly Disagree	1	1	1,23%	1,23%
Neutral	3	4	3,70%	4,94%
Slightly Agree	14	18	17,28%	22,22%
Agree	36	54	44,44%	66,67%
Strongly Agree	27	81	33,33%	100,00%

Q8: The need for clean data when a product is being developed.

The need for clean data addresses the importance of having a view of how the data would look (influencing spacing and layout) and behave (data manipulation) to develop effectively for the actual data. From the survey it can be seen that 92,59% of participants agreed with this statement, while 1.23% of participants disagreed with this statement and 6.17% of participants were indifferent about the need. The neutral and disagreeing participants could point to environments where data hygiene is not practised or where there could be a lack of resources or capacity constraints to maintain and ensure clean data [see Table 5.13].

Table 5.13 Clean data.

Clean data	Count	Cumulative count	Percent	Cumulative percent
Disagree	1	1	1,23%	1,23%
Neutral	5	6	6,17%	7,41%
Slightly Agree	21	27	25,93%	33,33%
Agree	27	54	33,33%	66,67%
Strongly Agree	27	81	33,33%	100,00%

Q9: The need for accurate data when a product is being developed.

The need for accurate data addresses the importance of precision in data. From the practitioner interviews it was mentioned that a single development 'adjustment' to prevent a numeric error caused the results presented in the dashboard not to make sense and, in essence, displayed incorrect data, which led to incorrect assumptions and affected decision-making negatively. From the survey it can be seen that 95,06% of participants agreed with this statement, while 0% of participants disagreed with this statement and 4.94% of participants were indifferent about the need [see Table 5.14].

Table 5.14 Accurate data.

Accurate data	Count	Cumulative count	Percent	Cumulative percent
Neutral	4	4	4,94%	4,94%
Slightly Agree	7	11	8,64%	13,58%
Agree	35	46	43,21%	56,79%
Strongly Agree	35	81	43,21%	100,00%

Q10: The need for meaningful data when a product is being developed.

The need for meaningful data addresses the potential of the data to be processed and organised to produce information that can be utilised. From the survey it can be seen that 98.77% of participants agreed with this statement, while 0% of participants disagreed with this statement and 1.23% of participants were indifferent about the need. This points to the critical need for data that is meaningful in the context of BI dashboards [see Table 5.15].

Table 5.15 Meaningful data.

Meaningful data	Count	Cumulative count	Percent	Cumulative percent
Neutral	1	1	1,23%	1,23%
Slightly Agree	7	8	8,64%	9,88%
Agree	27	35	33,33%	43,21%
Strongly Agree	46	81	56,79%	100,00%

Q11: The need for processing data at different levels.

The need for processing data at different levels addresses the ability to control the processing of data. From the survey it can be seen that 86,42% of participants agreed with this statement, while 2,47% of participants disagreed with this statement and 9.88% of participants were indifferent about the need. This could point to the need for processing at different levels in more specialised environments and less of a need in more unstructured less performance focussed environments [see Table 5.16].

Table 5.16 Processing of data.

Data processing	Count	Cumulative count	Percent	Cumulative percent
Missing	1			
Disagree	1	1	1,25%	1,25%
Slightly Disagree	1	2	1,25%	2,50%
Neutral	8	10	10,00%	12,50%
Slightly Agree	13	23	16,25%	28,75%
Agree	41	64	51,25%	80,00%
Strongly Agree	16	80	20,00%	100,00%

The number of missing values is 1.
The overall count including missing values is 81.
The overall percentage of missing values is 1.23%.

Q12: The need to componentise for quick selection by developers.

The need to componentise addresses the technique in development where components are used to create smaller, modular units that can be isolated and re-used. From the survey it can be seen that 83,95% of participants agreed with this statement, while 4,94% of participants disagreed with this statement and 9.88% of participants were indifferent about the need. This could point to some environments being more mature than others, having identified the need to componentise to develop phased implementation with less risk and with more flexibility [see Table 5.17].

Table 5.17 Componentising.

Componentising	Count	Cumulative count	Percent	Cumulative percent
Missing	1			
Strongly Disagree	1	1	1,25%	1,25%
Disagree	1	2	1,25%	2,50%
Slightly Disagree	2	4	2,50%	5,00%
Neutral	8	12	10,00%	15,00%
Slightly Agree	13	25	16,25%	31,25%
Agree	32	57	40,00%	71,25%
Strongly Agree	23	80	28,75%	100,00%

The number of missing values is 1.
The overall count including missing values is 81.
The overall percentage of missing values is 1.23%.

Q13: The need to isolate code to manage change.

The need for code isolation addresses where one piece of code knows little or nothing about another piece of code. From the survey it can be seen that 82,72% of participants agreed with this statement, while 6,17% of participants disagreed with this statement and 11,11% of participants were indifferent about the need. The concepts of code isolation and that of componentising are related in that they involve the structuring of code purposefully. From the results, the proportions of respondents correlate closely with one another [see Table 5.18].

Table 5.18 Code isolation.

Code isolation	Count	Cumulative count	Percent	Cumulative percent
Missing	1			
Strongly Disagree	1	1	1,23%	1,23%
Disagree	1	2	1,23%	2,47%
Slightly Disagree	3	5	3,70%	6,17%
Neutral	9	14	11,11%	17,28%
Slightly Agree	13	27	16,05%	33,33%
Agree	29	56	35,80%	69,14%
Strongly Agree	25	81	30,86%	100,00%

Q14: The need for performance data reporting.

The need for reporting the performance of the data addresses the need to measure and monitor the data performance and report on that. From the survey it can be seen that 88,89% of participants agreed with this statement, while 1.23% of participants disagreed with this statement and 9,88% of participants were indifferent about the need. This need was also mentioned by practitioners in environments with the need to process data at different levels and the ability to track and report on that [see Table 5.19].

Table 5.19 Performance reporting.

Performance reporting	Count	Cumulative count	Percent	Cumulative percent
Disagree	1	1	1,23%	1,23%
Neutral	8	9	9,88%	11,11%
Slightly Agree	9	18	11,11%	22,22%
Agree	35	53	43,21%	65,43%
Strongly Agree	28	81	34,57%	100,00%

Q15: The need to develop new versions of applications in parallel.

The need to develop new or different versions of the application in parallel addresses the need the development team has to build and maintain evolving applications at the same time. From the survey it can be seen that 67.90% of participants agreed with this statement, while 17.28% of participants disagreed with this statement and 14.81% of participants were indifferent about the need. The results could indicate that not many environments have been exposed to this way of development or point to environments that do not have the capacity or maturity to work in this way [see Table 5.20].

Table 5.20 Parallel app development.

Parallel app development	Count	Cumulative count	Percent	Cumulative percent
Strongly Disagree	1	1	1,23%	1,23%
Disagree	6	7	7,41%	8,64%
Slightly Disagree	7	14	8,64%	17,28%
Neutral	12	26	14,81%	32,10%
Slightly Agree	16	42	19,75%	51,85%
Agree	28	70	34,57%	86,42%
Strongly Agree	11	81	13,58%	100,00%

Q16: The need for the developer to stay relevant with tech research.

This points to the need for developers to stay relevant with technology through ongoing research. From the survey it can be seen that 97,53% of participants agreed with this statement, while 1,23% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. This result points to a major awareness of the need for developers to stay relevant to technology [see Table 5.21].

Table 5.21 Stay technically relevant.

Stay technically relevant	Count	Cumulative count	Percent	Cumulative percent
Slightly Disagree	1	1	1,23%	1,23%
Neutral	1	2	1,23%	2,47%
Slightly Agree	6	8	7,41%	9,88%
Agree	37	45	45,68%	55,56%
Strongly Agree	36	81	44,44%	100,00%

Q17: The need to get feedback from customers on continuous deploy changes.

The need to receive feedback from customers continuously on deploy changes addresses receiving timeous feedback to act and improve upon. From the survey it can be seen that 97,53% of participants agreed with this statement, while 1,23% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. This result indicates the significant importance of the need to receive timeous continuous feedback from customers. See Table 5.22.

Table 5.22 Continuous customer feedback.

Continuous customer feedback	Count	Cumulative count	Percent	Cumulative percent
Slightly Disagree	1	1	1,23%	1,23%
Neutral	1	2	1,23%	2,47%
Slightly Agree	3	5	3,70%	6,17%
Agree	24	29	29,63%	35,80%
Strongly Agree	52	81	64,20%	100,00%

Q18: The need for development (Tech) vision and foresight.

This question addresses the need of team members to be part of a team and an organisation where there is a technological vision and where development is informed by the strategy and foresight aligned to the technical vision. From the survey it can be seen that 98,77% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. This result indicates the significant importance of the need to work in an environment where there is a technological vision and foresight provided by leadership [see Table 5.23].

Table 5.23 Development (Tech) vision and foresight.

Development vision and foresight	Count	Cumulative count	Percent	Cumulative percent
Neutral	1	1	1,23%	1,23%
Slightly Agree	9	10	11,11%	12,35%
Agree	24	34	29,63%	41,98%
Strongly Agree	47	81	58,02%	100,00%

Q19: The need for time to reflect on the most appropriate approach to the task.

Time to reflect addresses the need options to be considered and investigative research be conducted before commencing tasks. From the survey it can be seen that 95,06% of participants agreed with this statement to some or other extent, while 3,70% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. The results point to a strong need still to pause and consider the best way of tackling a task even though the participants mainly worked in agile environments where everything is expected to happen at speed. A thought-through approach has an impact on the time required to deliver downstream [see Table 5.24].

Table 5.24 Time for reflection.

Time for reflection	Count	Cumulative count	Percent	Cumulative percent
Slightly Disagree	3	3	3,70%	3,70%
Neutral	1	4	1,23%	4,94%
Slightly Agree	12	16	14,81%	19,75%
Agree	26	42	32,10%	51,85%
Strongly Agree	39	81	48,15%	100,00%

Q20: The need to investigate new technology (to explore the fundamentals) before starting development

This question addresses being able to investigate new and other technologies, and to learn about the fundamentals of that technology before starting development. From the survey it can be seen that 96,30% of participants agreed with this statement to some or other extent, while 2,47% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. Participants remarked in interviews how, once development has started, certain aspects or constraints of the technology are 'discovered' and, at that point in the development, changing the technology becomes costly and impacts delivery [see Table 5.25].

Table 5.25 Explore technology fundamentals before development.

Explore before development	Count	Cumulative count	Percent	Cumulative percent
Disagree	1	1	1,23%	1,23%
Slightly Disagree	1	2	1,23%	2,47%
Neutral	1	3	1,23%	3,70%
Slightly Agree	15	18	18,52%	22,22%
Agree	31	49	38,27%	60,49%
Strongly Agree	32	81	39,51%	100,00%

5.2.1.3 Survey - Part 3: UX design (Q21-Q40)

Part 3 of the survey: asked participants to what extent they agreed with the following statements regarding the **UX design** of software within an agile development environment.

Q21: The need for designers to produce clear design artefacts as input to technical development.

This question addresses the need for the requirement of the role of designers to produce UX/UI design output that is clear and understandable for development to continue. From the survey, see Table 5.26, it can be seen that 96,00% of participants agreed with this statement to some or other extent, while 2,47% of participants disagreed with this statement and 1,23% of participants were indifferent about the need. This question was added as a control question and achieved a similar result of 96.00% to a similar question about the need for clear design artefacts in the development part of the survey with 96.30% of participants agreeing. This also informs the view that designers are responsible for producing designs that can be taken into development easily.

Table 5.26 Designers to produce clear design artefacts as input to development.

Design artefacts	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	1	1	1,33%	1,33%
Slightly Disagree	1	2	1,33%	2,67%
Neutral	1	3	1,33%	4,00%
Slightly Agree	9	12	12,00%	16,00%
Agree	35	47	46,67%	62,67%
Strongly Agree	28	75	37,33%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q22: The need for UX to get the conceptual design right through the building of and testing of low-fi prototypes.

This question addresses the need for UX designers to become confident in the conceptual design through testing before continuing with further UX design. From the survey, see Table 5.27, it can be seen that 89,33% of participants agreed with this statement to some or other extent, while 4,00% of participants disagreed with this statement and 6,67% of participants were indifferent about the need. Having a well-tested concept prevents the introduction of unnecessary change later on in the design process.

Table 5.27 Importance to get conceptual UX design right.

Conceptual design	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	1	1	1,33%	1,33%
Slightly Disagree	2	3	2,67%	4,00%
Neutral	5	8	6,67%	10,67%
Slightly Agree	9	17	12,00%	22,67%
Agree	29	46	38,67%	61,33%
Strongly Agree	29	75	38,67%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q:23 The need to align business objectives with the user needs within the technical constraints that exist.

This question addresses the ability of the UX designer to balance the user needs and business objectives within the technical constraints. From the survey results, see Table 5.28, it can be seen that 97,33% of participants agreed with this statement to some or other extent, while 1,33% of participants disagreed with this statement and 1,33% of participants were indifferent about the need. This points to the need for UX designers to be able to design within constraints so as still to serve users optimally.

Table 5.28 Considering business objectives, user needs and technical constraints.

Alignment of business, user and tech	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Slightly Disagree	1	1	1,33%	1,33%
Neutral	1	2	1,33%	2,67%
Slightly Agree	5	7	6,67%	9,33%
Agree	19	26	25,33%	34,67%
Strongly Agree	49	75	65,33%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q24: The need for UX design to contribute from the discovery phase to the final phase of the product, and not just designing wireframes and performing usability testing.

This question addresses the inclusion of a UX design early on in the initial stages of the planning towards building a software product. From the survey results, see Table 5.29, it can be seen that 96,00% of participants agreed with this statement to some or other extent, while 1,33% of participants disagreed with this statement and 2,67% of participants were indifferent about the need. This confirms the views of the practitioners interviewed who believed that the late inclusion of UX designers in the software development process hindered the efficiency and effectiveness of the process.

Table 5.29 UX design to participant during all phases of product.

UX in agile process	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	1	1	1,33%	1,33%
Neutral	2	3	2,67%	4,00%
Slightly Agree	7	10	9,33%	13,33%
Agree	13	23	17,33%	30,67%
Strongly Agree	52	75	69,33%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q25: The need to understand the user's real problems when designing the dashboard interface.

This question addresses knowing and understanding the user's actual problems during the design phase to produce useful designs. From the survey results, see Table 5.30, it can be seen that 98,65% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 1,33% of participants were indifferent about the need. This confirms the critical importance of understanding the user's problems.

Table 5.30 Understand the user's problems.

Understanding user problems	Count	Cumulative count	Percent	Cumulative percent
Missing	7			
Neutral	1	1	1,35%	1,35%
Slightly Agree	1	2	1,35%	2,70%
Agree	14	16	18,92%	21,62%
Strongly Agree	58	74	78,38%	100,00%

The number of missing values is 7.

The overall count including missing values is 81.

The overall percentage of missing values is 8.64%.

Q26: The need to surface (*place*) the essence of information at the top level of the dashboard.

This question addresses the layout, structural layers, and presentation of the information on the dashboard. From the survey results, see Table 5.31, it can be seen that 96,00% of participants agreed with this statement to some or other extent, while 1,33% of participants disagreed with this statement and 2,67% of participants were indifferent about the need. This further supports the practitioners' viewpoint that critical information should be elevated on the dashboard.

Table 5.31 Essential information at the top level.

Information placement	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Slightly Disagree	1	1	1,33%	1,33%
Neutral	2	3	2,67%	4,00%
Slightly Agree	10	13	13,33%	17,33%
Agree	32	45	42,67%	60,00%
Strongly Agree	30	75	40,00%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q27: The need for the surfacing of time sensitive relevant information on the dashboard.

The question addresses the importance of presenting information that could be linked to a potential action required on the dashboard. From the survey results, see Table 5.32, it can be seen that 97,33% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 2,67% of participants were indifferent about the need.

Table 5.32 Surfacing of time sensitive relevant information on the dashboard.

Time sensitive relevant information	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Neutral	2	2	2,67%	2,67%
Slightly Agree	9	11	12,00%	14,67%
Agree	32	43	42,67%	57,33%
Strongly Agree	32	75	42,67%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q28: The need to use user KPIs in task-driven environments to focus design instead of using *personas*.

This point speaks to adapting the design approach for contexts where task completion is a priority to support that optimally. From the survey results, see Table 5.33, it can be seen that 72,00% of participants agreed with this statement to some or other extent, while 12,00% of participants disagreed with this statement and 16,00% of participants were indifferent about the need. From the results it could be assumed that respondents that disagreed have not yet designed guided by user KPIs, or, alternatively, *personas* are still used in contexts where *personas* have an influence on effective and efficient task completion.

Table 5.33 User KPI driven dashboard design.

KPI driven design	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	5	5	6,67%	6,67%
Slightly Disagree	4	9	5,33%	12,00%
Neutral	12	21	16,00%	28,00%
Slightly Agree	21	42	28,00%	56,00%
Agree	17	59	22,67%	78,67%
Strongly Agree	16	75	21,33%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q29: The need for linking actions to be initiated by the customer based on the dashboard information.

This question speaks to the need to assist the user by providing the possibility of linking an action to information viewed on the dashboard. From the survey results, see Table 5.34, it can be seen that 85,33% of participants agreed with this statement to some or other extent, while 4,00% of participants disagreed with this statement and 10,67% of participants were indifferent about the need. This agrees with the participants' view that information should be linked to action at a dashboard level.

Table 5.34 Potential actions linked to dashboard information.

Initiated user actions	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	1	1	1,33%	1,33%
Slightly Disagree	2	3	2,67%	4,00%
Neutral	8	11	10,67%	14,67%
Slightly Agree	18	29	24,00%	38,67%
Agree	31	60	41,33%	80,00%
Strongly Agree	15	75	20,00%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q30: The need to prioritise dashboard components according to their usefulness.

This question addresses the importance of organising dashboard components according to their priority. From the survey results, see Table 5.35, it can be seen that 89,33% of participants agreed with this statement to some or other extent, while 1,33% of participants disagreed with this statement and 9,33% of participants were indifferent about the need. The high participant agreement with this statement supports the practitioners' view that useful components should receive priority placing.

Table 5.35 Component usefulness prioritisation.

Component usefulness prioritisation	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Disagree	1	1	1,33%	1,33%
Neutral	7	8	9,33%	10,67%
Slightly Agree	7	15	9,33%	20,00%
Agree	24	39	32,00%	52,00%
Strongly Agree	36	75	48,00%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q31: The need for data to be searchable by users on the dashboard.

This question addresses the need for data on the dashboard to be searchable. From the survey results, see Table 5.36, it can be seen that 86,67% of participants agreed with this statement to some or other extent, while 1,33% of participants disagreed with this statement and 12,00% of participants were indifferent about the need. It can be reasoned that search is not necessary on the dashboard as the data are mostly summarised; participants, however, still agreed that there is a need for the ability of a user to search for data on a dashboard.

Table 5.36 Searchable dashboard data.

Searchable data	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Slightly Disagree	1	1	1,33%	1,33%
Neutral	9	10	12,00%	13,33%
Slightly Agree	18	28	24,00%	37,33%
Agree	27	55	36,00%	73,33%
Strongly Agree	20	75	26,67%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q32: The need for 'user understandable' language when designing dashboards.

This question addresses the need for language that is understandable and natural for the user and not technical or legacy-related language that make sense to technical stakeholders. From the survey results, see Table 5.37, it can be seen that 98,67% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 1.33% of participants were indifferent about the need.

Table 5.37 Use of understandable language.

Use of understandable language	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Neutral	1	1	1,33%	1,33%
Slightly Agree	3	4	4,00%	5,33%
Agree	19	23	25,33%	30,67%
Strongly Agree	52	75	69,33%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q33: The need to provide for interactivity in dashboard design.

This question addresses the need for dashboards to accept input from users as it runs. From the survey results, see Table 5.38, it can be seen that 93,33% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 6,67% of participants were indifferent about the need. The need for intelligent interactive dashboards was confirmed by this result.

Table 5.38 Dashboard interactivity.

Dashboard interactivity	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Neutral	5	5	6,67%	6,67%
Slightly Agree	15	20	20,00%	26,67%
Agree	25	45	33,33%	60,00%
Strongly Agree	30	75	40,00%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q34: The need for the user to be able to customise the level of information to be displayed.

This question addresses the need by the user to control and change the level of information presented. From the survey results, see Table 5.39, it can be seen that 84,00% of participants agreed with this statement to some or other extent, while 2,67% of participants disagreed with this statement and 13,33% of participants were indifferent about the need. This was mentioned by practitioners interviewed as important in scenarios where a lower level of data was important to the user for some reason.

Table 5.39 Ability to customise the level of information displayed.

Customisation information displayed	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Slightly Disagree	2	2	2,67%	2,67%
Neutral	10	12	13,33%	16,00%

Slightly Agree	22	34	29,33%	45,33%
Agree	27	61	36,00%	81,33%
Strongly Agree	14	75	18,67%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q35: The need for navigation path design.

This question speaks to the purposeful design of navigational structures to allow wayfinding for users. From the survey results, see Table 5.40, it can be seen that 94,67% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 5,33% of participants were indifferent about the need. The results agree with the need for the design of navigation on a dashboard.

Table 5.40 Navigational design.

Navigational design	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Neutral	4	4	5,33%	5,33%
Slightly Agree	12	16	16,00%	21,33%
Agree	33	49	44,00%	65,33%
Strongly Agree	26	75	34,67%	100,00%

The number of missing values is 6.

The overall count including missing values is 81.

The overall percentage of missing values is 7.41%.

Q36: The need for visualising the logical perspective.

This question speaks to the need for the user to be able to see how the data or processed information is connected or structured logically. For example, a supplier could be connected to multiple purchase orders and a purchase order could contain multiple items at lower levels of the data. From the survey results, see Table 5.41, it can be seen that 86,67% of participants agreed with this statement to some or other extent, while 0% of participants disagreed with this statement and 12,00% of participants were indifferent about the need.

Table 5.41 Logical perspective.

Logical perspective visualisation	Count	Cumulative count	Percent	Cumulative percent
Missing	7			
Neutral	9	9	12,16%	12,16%
Slightly Agree	9	18	12,16%	24,32%
Agree	35	53	47,30%	71,62%
Strongly Agree	21	74	28,38%	100,00%

The number of missing values is 7.

The overall count including missing values is 81.

The overall percentage of missing values is 8.64%.

Q37: The need for making complex concepts visible.

This question addresses the need to compare or describe a complex concept for the user to better grasp the concept and potential relationships or its effect on other concepts. From the survey results Table 5.42, it can be seen that 87,84% of participants agreed with this statement to some or other extent, while 5,41% of participants disagreed with this statement and 6,76% of participants were indifferent about the need. The need mentioned by practitioners was confirmed by the survey participants.

Table 5.42 Making complex concepts visibility.

Complex concepts visibility	Count	Cumulative count	Percent	Cumulative percent
Missing	7			
Slightly Disagree	4	4	5,41%	5,41%
Neutral	5	9	6,76%	12,16%
Slightly Agree	15	24	20,27%	32,43%
Agree	27	51	36,49%	68,92%
Strongly Agree	23	74	31,08%	100,00%

The number of missing values is 7.

The overall count including missing values is 81.

The overall percentage of missing values is 8.64%.

Q38: The need to represent the same data in different ways

This question addresses the need to provide perspective on the data, pivoting the view. From the survey results, Table 5.43, it can be seen that 76,00% of participants agreed with this statement to some or other extent, while 4,00% of participants disagreed with this statement and 20,00% of participants were indifferent about the need. The results for participants being indifferent about the need could indicate the vertical nature of most dashboards where the users are able to drill up and down.

Table 5.43 Flexibility to present data.

Data representation flexibility	Count	Cumulative count	Percent	Cumulative percent
Missing	6			
Strongly Disagree	1	1	1,33%	1,33%
Disagree	1	2	1,33%	2,67%
Slightly Disagree	1	3	1,33%	4,00%
Neutral	15	18	20,00%	24,00%
Slightly Agree	22	40	29,33%	53,33%
Agree	25	65	33,33%	86,67%
Strongly Agree	10	75	13,33%	100,00%

The number of missing values is 6.
The overall count including missing values is 81.
The overall percentage of missing values is 7.41%.

Q39: The need for motion communicative methods for designs.

This question addresses the need to help to break down complex information, delivering the message simply and clearly through motion graphics. From the survey results, see Table 5.44, it can be seen that 71,23% of participants agreed with this statement to some or other extent, while 0,00% of participants disagreed with this statement and 28,77% of participants were indifferent about the need. The high indifference result could pertain to participants not being familiar with the term ‘motion communicative methods’ or suggest that the value of motion is not considered to be high on dashboards.

Table 5.44 Motion communitive designs.

Motion communitive designs	Count	Cumulative count	Percent	Cumulative percent
Missing	8			
Neutral	21	21	28,77%	28,77%
Slightly Agree	24	45	32,88%	61,64%
Agree	19	64	26,03%	87,67%
Strongly Agree	9	73	12,33%	100,00%

The number of missing values is 8.

The overall count including missing values is 81.

The overall percentage of missing values is 9.88%.

Q40: The need for visual cues to improve navigation.

This question addresses providing cues visible to users pertaining to navigation. From the survey results, Table 5.45, it can be seen that 95,95% of participants agreed with this statement to some or other extent, while 0,00% of participants disagreed with this statement and 4,05% of participants were indifferent about the need. Although many applications rely on users tapping an area to identify interactivity, participants agreed that there is a need for visual cues to improve navigation.

Table 5.45 Visual cues to improve navigation.

Navigational visual cues	Count	Cumulative count	Percent	Cumulative percent
Missing	7			
Neutral	3	3	4,05%	4,05%
Slightly Agree	11	14	14,86%	18,92%
Agree	30	44	40,54%	59,46%
Strongly Agree	30	74	40,54%	100,00%

The number of missing values is 7.

The overall count including missing values is 81.

The overall percentage of missing values is 8.64%.

5.2.2 Item analysis

Quantitative item analysis happens after the questions (that have a rating scale referred to as items) have been administered via the survey and the answers have been converted from, for example, a ‘strongly agree’ to a number ‘7’ on a 7-point Likert scale. A 7-point scale was chosen as it provides more options to choose from (than a 5-point Likert scale), a 7-point scale is easier to use, and a better reflection of a respondent's evaluation. The responses and item scores provide numeric data that provide information on the *quality* of each item. This is sometimes referred to as ‘item behaviour’ pointing to how well an item functions as an indicator of participator knowledge (Benson, 1977). Item analysis provides evidence that an instrument measures what it intended measuring and that it produces consistent results. Reviewing item quality helps to ensure that optimal data are collected. When survey items are well-written and cover relevant content, fewer of them are needed to obtain consistent results (McMillan, 2019).

5.2.2.1 Item analysis results

Cronbach's Alpha is a measure of internal consistency, indicating how closely related a set of items as is a group. It is, therefore, considered to be a measure of an instrument's scale of reliability.

The formula used to calculate the Cronbach's Alpha is:

$$\alpha = \frac{N\underline{c}}{\underline{v} + (N-1)\underline{c}}$$

In this formula N is equal to the number of items, $\underline{c}$ is the average inter-item covariance among the items and $\underline{v}$ equals the average variance. From this formula it can be seen that, if the number of items is increased, the Cronbach's Alpha is increased. Additionally, if the average inter-item correlation is low, the alpha will be low. As the average inter-item correlation increases, Cronbach's alpha increases as well (holding the number of items constant) (UCLA: Statistical Consulting Group, July 22, 2021).

There are different views about the acceptable values of the Cronbach's Alpha, but values ranging from 0.70 to 0.95 are generally acceptable (Tavakol & Dennick, 2011). A low Cronbach Alpha value could be caused by a low number of questions and/or the poor inter-relatedness between items or heterogeneous constructs (Tavakol & Dennick, 2011). A value that is too high may indicate that some items are redundant as they are testing the same question but from a different appearance. A maximum alpha value of 0.90 has been recommended (Streiner, 2003).

5.2.2.2 Item analysis: Q9.1-Q12.5 numbered as Q1-Q20 to simplify

A Cronbach's Alpha value of 0.856913 was identified from the item values [refer to Table 5.46]. These values, when compared to the description provided of acceptable Cronbach Alpha values in Section 5.2.2.1, are considered to be acceptable, indicating high relatedness, and, additionally, the values are still sufficiently below the maximum recommended value. This value shows that the questionnaire is reliable. A Cronbach's Alpha value of between 0.81 and 0.9 is considered to be good (Konting, Norfaryanti, & Man, 2009).

Table 5.46 Item values Q1-Q20.

Variable	Mean	Standard Deviation	Total Mean	Total Std.Dev	Coef Alpha	Corr Total	Other Items
Automated delivery	5,7595	1,1790	114,6835	10,2213	0,8610	0,2149	0,2918
Functional feasibility	6,5316	0,8599	113,9114	10,1643	0,8522	0,4001	0,4610
Available data	6,1392	1,0094	114,3038	10,0286	0,8496	0,4669	0,5175
Clear design artifacts	6,1519	0,8784	114,2911	10,0934	0,8496	0,4736	0,4914
Chunking user stories	5,3797	1,3616	115,0633	9,8753	0,8521	0,4339	0,4127
Relevant data	6,2025	0,7575	114,2405	10,1492	0,8499	0,4855	0,4346
Up to date data	6,0253	0,8767	114,4177	10,1484	0,8518	0,4095	0,5531
Clean data	5,8734	1,0174	114,5696	9,9829	0,8478	0,5096	0,5379
Accurate data	6,2278	0,8157	114,2152	10,1207	0,8496	0,4816	0,5586
Meaningful data	6,4430	0,7116	114,0000	10,1767	0,8503	0,4816	0,4283
Data processing	5,7342	1,0090	114,7089	9,9165	0,8449	0,5841	0,5239
Componentising	5,7342	1,2477	114,7089	9,7955	0,8455	0,5538	0,5078
Code isolation	5,6835	1,3062	114,7595	9,8712	0,8504	0,4613	0,5281
Performance reporting	5,9747	1,0374	114,4684	9,8811	0,8440	0,6015	0,4458
Parallel app development	5,0000	1,5191	115,4430	9,7976	0,8539	0,4281	0,5410
Stay technically relevant	6,3165	0,7770	114,1266	10,1190	0,8489	0,5118	0,5309
Continuous customer feedback	6,5443	0,7476	113,8987	10,2926	0,8554	0,2955	0,4343
Tech foresight	6,4304	0,7456	114,0127	10,1722	0,8506	0,4624	0,4630
Time for reflection	6,1899	1,0010	114,2532	10,1052	0,8525	0,3919	0,3983
Explore before development	6,1013	0,9687	114,3418	10,0382	0,8491	0,4803	0,5580
Total			**120,4430**	**10,5378**	**0,8569**		

5.2.2.3 Item analysis: Q13.1-Q16.5 numbered as Q21-Q40 to simplify

Item Values

A Cronbach's Alpha value of 0.857337 was identified from the item values [refer to Table 5.47]. These values, when compared to the description provided of acceptable Cronbach Alpha values in Section 5.2.2.1, are considered to be acceptable, indicating high relatedness, and, additionally, the values are still sufficiently below the maximum recommended value. The values indicate that the questionnaire is considered to be reliable.

Table 5.47 Item values Q21-Q40.

Variable	Mean	Standard Deviation	Total Mean	Total Std.Dev	Coef Alpha	Corr Total	Other Items
Design artefacts	6,10	0,95	113,59	9,63	0,85	0,53	0,48
Conceptual design	6,00	1,12	113,69	9,74	0,86	0,34	0,36
Alignment of business, user and tech	6,54	0,77	113,14	10,00	0,86	0,19	0,34
UX in agile process	6,53	0,90	113,16	10,01	0,86	0,14	0,37
Understanding user problems	6,77	0,46	112,91	9,98	0,85	0,40	0,37
Information placement	6,13	0,87	113,56	9,71	0,85	0,50	0,46
Time sensitive relevant information	6,24	0,79	113,44	9,72	0,85	0,54	0,54
KPI driven design	5,17	1,45	114,51	9,34	0,85	0,52	0,54
Initiated user actions	5,64	1,10	114,04	9,47	0,84	0,60	0,54
Component usefulness prioritisation	6,11	1,10	113,57	9,65	0,85	0,44	0,31
Searchable data	5,73	1,03	113,96	9,74	0,85	0,37	0,43
Use of understandable language	6,61	0,64	113,07	9,89	0,85	0,42	0,39
Dashboard interactivity	6,07	0,94	113,61	9,62	0,85	0,55	0,55
Customisation of information displayed	5,54	1,05	114,14	9,66	0,85	0,45	0,45
Navigational design	6,10	0,85	113,59	9,72	0,85	0,50	0,37
Logical perspective visualisation	5,90	0,97	113,79	9,55	0,84	0,62	0,67
Complex concepts visibility	5,77	1,13	113,91	9,48	0,85	0,57	0,61
Data representation flexibility	5,29	1,21	114,40	9,69	0,86	0,35	0,32
Motion communitive designs	5,21	1,02	114,47	9,65	0,85	0,48	0,47
Navigational visual cues	6,21	0,80	113,47	9,73	0,85	0,52	0,47
Total			**119,69**	**10,17**	**0,86**		

The Cronbach Alpha values for questions 1-20, focussed on ***Technical Development,*** produced a Cronbach's Alpha of **0.856913.**

The Cronbach Alpha values for questions 21-40, focussed on ***UX Design,*** produced a Cronbach's Alpha of **0.857337**.

From these item values presented, in Tables 5.46 and 5.47, the values indicate that the questions (items) in both sections in the instrument (Development and UX Design) show a high measure of internal consistency. They also confirm that there is a close relationship between the items in the two sections. The instrument is, therefore, considered to have high scale reliability.

5.2.3 Principal component analysis correlation

Principal Component Analysis is a dimension-reduction tool that can be used in scenarios where we have many variables. Principal component analysis aims at reducing a large set of variables to a smaller set that still contains most of the information in the large set (ITL, accessed 22 July 2021).

Principle component analysis was performed by:

1. Standardising the range of continuous initial variables;
2. Computing the ***covariance matrix*** to identify correlations;
3. Computing the ***eigenvectors*** and ***eigenvalues*** of the covariance matrix to identify the principal components;
4. Creating a ***feature vector*** to decide which principal components to keep; and
5. Recasting the data along the principal components axes to produce a view on the correlation.

5.2.3.1 Pearson correlation matrix report (Q1-Q20)

The Pearson correlation coefficient can describe the linear correlation between two features.

In Table 5.48 the Pearson correlation matrix is shown for Q1-Q20 related to development. In the table it can be seen that some question concepts have a strong linear correlation with other question concepts, for example, “functional feasibility” and “available data”.

When the Pearson correlation coefficient between two concepts reports as the value one, they measure the same concept. From Table 5.48 it can be seen that there is a positive correlation between the concepts of:

- ‘Functional feasibility and ‘available data’ (0.56). This could point to the importance of data availability to ensure the product is functionally feasible.

- ‘Clean data’ positively correlates to ‘accurate data’ (0.55), addressing the importance of the data being clean to ensure data accuracy.

- ‘Up-to-date data’ and ‘clean data’ (0.54); this result could point to the dependence of up-to-date data on being clean.

- ‘Up-to-date data’ also positively correlates to ‘accurate data’ (0.51); this again addresses the issue of up-to-date data needing to be accurate when being presented.

These concepts point to their importance in ensuring *data quality* of BI dashboards.

The Pearson correlation coefficient also showed a positive linear correlation between “componentising” and “parallel app development” of 0.55. This could point to the relationship between using components as base structures for effective parallel app development.

Table 5.48 Pearson correlation matrix report for Development related questions.

Variables	Automated delivery	Functional feasibility	Available data	Clear design data	Chunking user stories	Relevant data	Up to date data	Clean data	Accurate data	Meaningful data	Data processing	Componentising	Code isolation	Performance reporting	Parallel app development	Stay technically relevant	Cont. customer feedback	Tech foresight	Time for reflection	Explore before development
Automated delivery	1	0,09	0,09	0,13	0,16	0,04	-0,01	0,09	-0,05	-0,04	0,31	0,31	0,3	0,23	0,07	0,13	-0,01	0,08	0,06	-0,01
Functional feasibility	0,09	1	0,56	0,23	0,25	0,13	0,2	0,21	0,26	0,22	0,34	0,15	0,37	0,39	0,05	0,13	0	0,12	0,15	0,17
Available data	0,09	0,56	1	0,28	0,25	0,25	0,29	0,32	0,23	0,23	0,49	0,21	0,27	0,47	0,11	0,14	0,09	0,14	0,15	0,21
Clear design artifacts	0,13	0,23	0,28	1	0,22	0,38	0,49	0,35	0,36	0,36	0,21	0,25	0,11	0,26	0,01	0,4	0,2	0,35	0,21	0,34
Chunking user stories	0,16	0,25	0,25	0,22	1	0,33	0,06	0,17	0,19	0,19	0,23	0,35	0,37	0,28	0,42	0,25	-0,1	0,27	0,07	0,19
Relevant data	0,04	0,13	0,25	0,38	0,33	1	0,3	0,2	0,34	0,38	0,34	0,22	0,34	0,27	0,25	0,3	0,21	0,39	0,17	0,16
Up to date data	-0,01	0,2	0,29	0,49	0,06	0,3	1	0,54	0,51	0,31	0,28	0,1	-0,04	0,24	0,11	0,29	0,17	0,12	0,26	0,31
Clean data	0,09	0,21	0,32	0,35	0,17	0,2	0,54	1	0,55	0,36	0,24	0,26	0,14	0,4	0,24	0,15	0,24	0,26	0,3	0,3
Accurate data	-0,05	0,26	0,23	0,36	0,19	0,34	0,51	0,55	1	0,46	0,34	0,22	0,12	0,34	0,21	0,27	0,03	0,26	0,28	0,18
Meaningful data	-0,04	0,22	0,23	0,36	0,19	0,38	0,31	0,36	0,46	1	0,24	0,18	0,22	0,33	0,09	0,35	0,31	0,46	0,31	0,25
Data processing	0,31	0,34	0,49	0,21	0,23	0,34	0,28	0,24	0,34	0,24	1	0,44	0,37	0,41	0,29	0,39	0,13	0,29	0,18	0,25
Componentising	0,31	0,15	0,21	0,25	0,35	0,22	0,1	0,26	0,22	0,18	0,44	1	0,43	0,4	0,55	0,33	0,12	0,25	0,16	0,26
Code isolation	0,3	0,37	0,27	0,11	0,37	0,34	-0,04	0,14	0,12	0,22	0,37	0,43	1	0,31	0,28	0,29	0,22	0,13	0,17	0,08
Performance reporting	0,23	0,39	0,47	0,26	0,28	0,27	0,24	0,4	0,34	0,33	0,41	0,4	0,31	1	0,36	0,26	0,18	0,3	0,26	0,26
Parallel app development	0,07	0,05	0,11	0,01	0,42	0,25	0,11	0,24	0,21	0,09	0,29	0,55	0,28	0,36	1	0,23	0,09	0,16	0,16	0,38
Stay technically relevant	0,13	0,13	0,14	0,4	0,25	0,3	0,29	0,15	0,27	0,35	0,39	0,33	0,29	0,26	0,23	1	0,34	0,43	0,15	0,48
Continuous customer feedback	-0,01	0	0,09	0,2	-0,1	0,21	0,17	0,24	0,03	0,31	0,13	0,12	0,22	0,18	0,09	0,34	1	0,29	0,37	0,4
Tech foresight	0,08	0,12	0,14	0,35	0,27	0,39	0,12	0,26	0,26	0,46	0,29	0,25	0,13	0,3	0,16	0,43	0,29	1	0,34	0,31
Time for reflection	0,06	0,15	0,15	0,21	0,07	0,17	0,26	0,3	0,28	0,31	0,18	0,16	0,17	0,26	0,16	0,15	0,37	0,34	1	0,46
Explore before development	-0,01	0,17	0,21	0,34	0,19	0,16	0,31	0,3	0,18	0,25	0,25	0,26	0,08	0,26	0,38	0,48	0,4	0,31	0,46	1

The Pearson correlation coefficient matrix can also be expressed as a heatmap (see Figure. 5.22). This allows for quick visual identification of positive and negative correlation. The negative correlations are shown as 'cold' or blue values, where the positive correlation values (higher than 0.2) are shown with shades of red. The yellow squares added to the diagram indicates 'hot' pockets, where high correlation between concepts emerge.

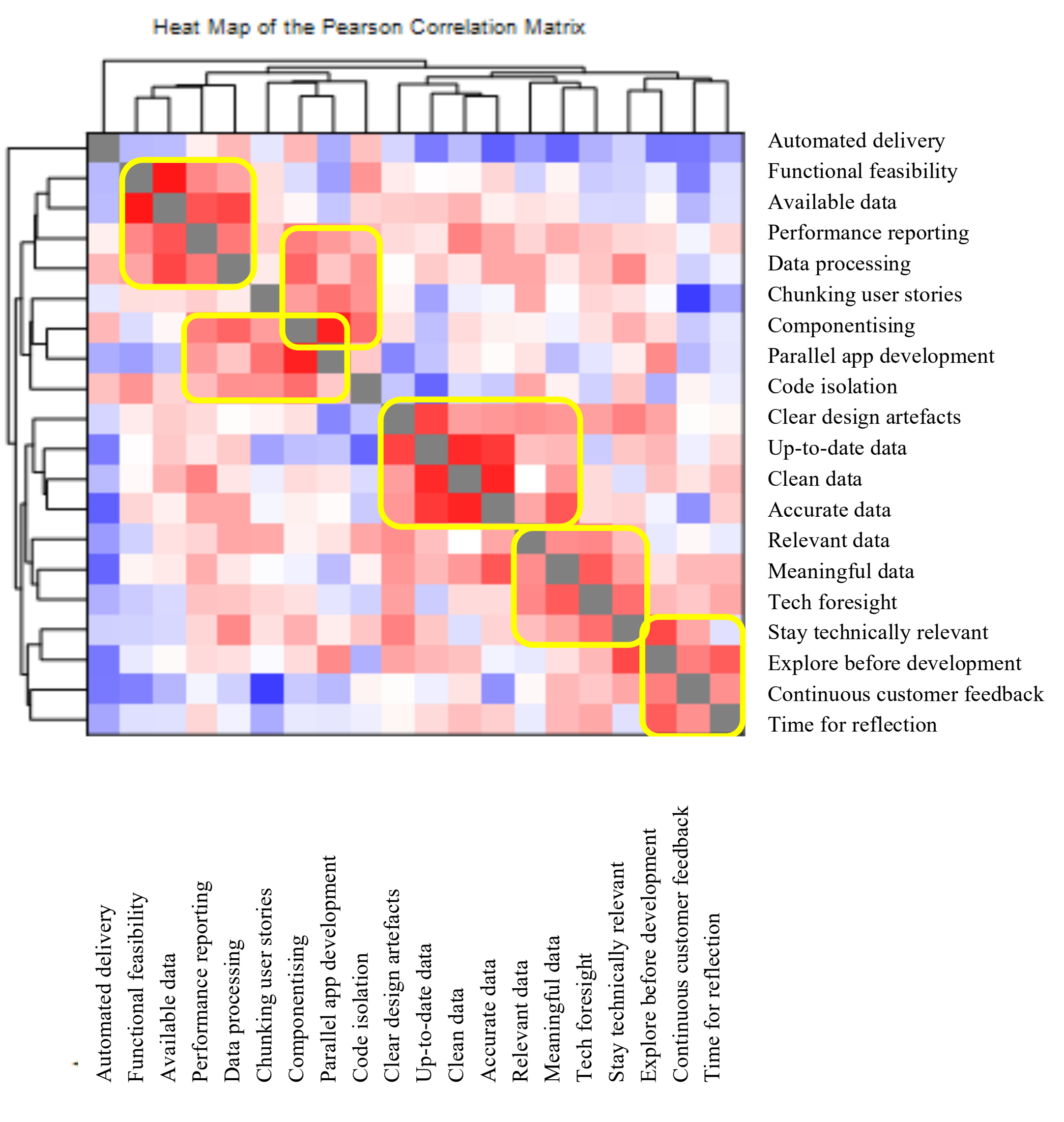

Figure 5.22 Heat map of the Pearson correlation matrix (Q1-Q20).

From the heatmap, the positive correlations of data quality stand out visually (up-to-date data, clean data, accurate data). The availability of data for functional feasibility can also be seen when looking at the top left dark red cross.

5.2.3.2 Spearman correlation matrix report (Q1-Q20)

The Spearman correlation can be calculated by applying the Pearson correlation formula to the ranks of the data; this produces a matrix of differences to compare the two types of correlation matrices. The matrix points to pairs of variables to be investigated [see Table 5.49]. The heat map of the Spearman correlation matrix visually highlights these pairs of interest [see Figure 5.23]. From the heatmap we can see that 'up to date data' is linked to 'accurate data' and 'meaningful data' is linked to 'tech foresight'.

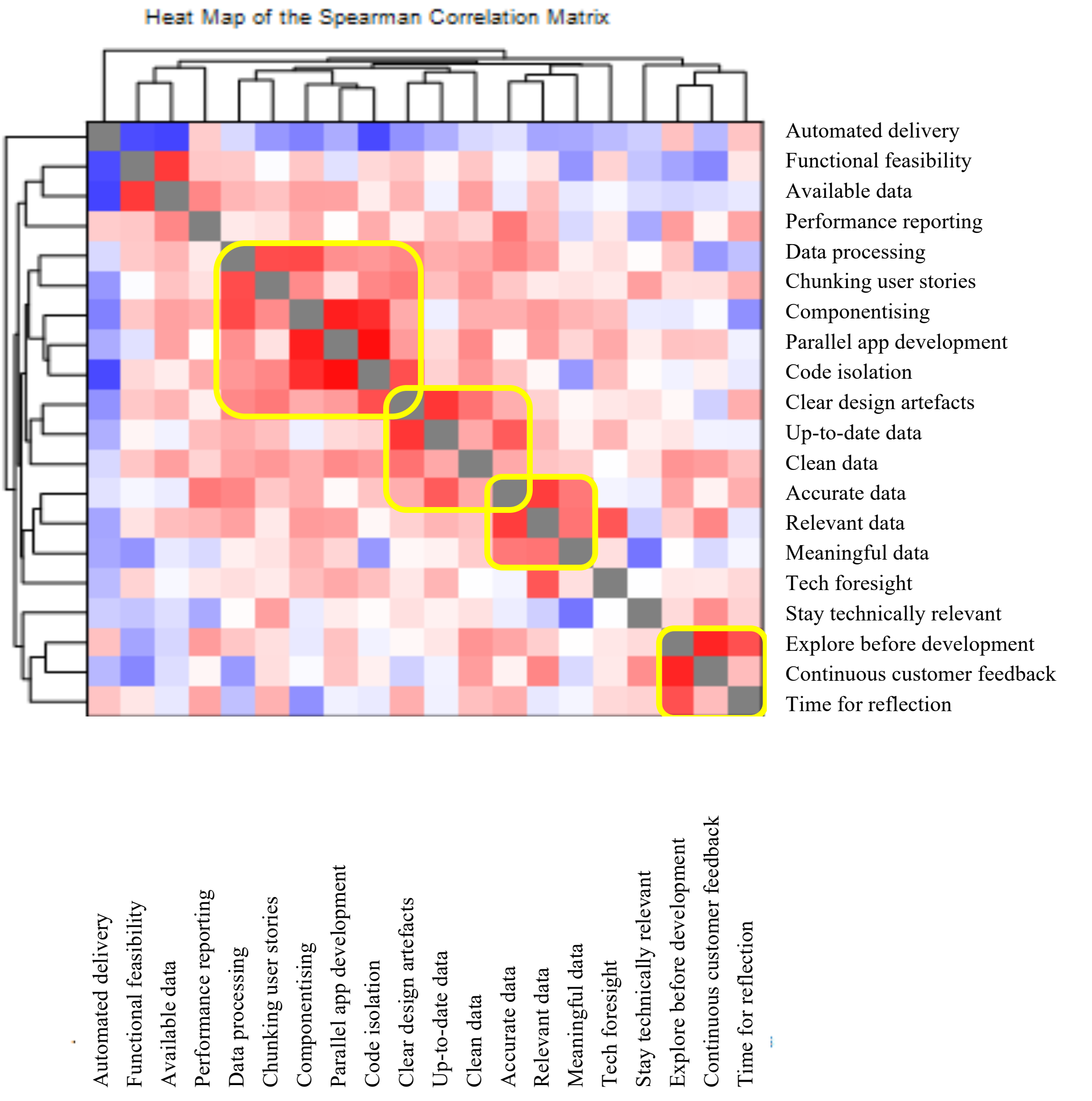

Figure 5.23 Heat map of the Spearman correlation matrix (Q1-Q20).

Table 5.49 Spearman correlation matrix report for Development related questions.

Variables	Automated delivery	Functional feasibility	Available data	Clear design artifacts	Chunking user stories	Relevant data	Up to date data	Clean data	Accurate data	Meaningful data	Data processing	Componentising	Code isolation	Performance reporting	Parallel app development	Stay technically relevant	Con customer feedback	Tech foresight	Time for reflection	Explore before development
Automated delivery	1,00	-0,08	-0,09	0,14	0,12	0,04	0,00	0,07	-0,08	0,03	0,28	0,30	0,29	0,14	0,09	0,15	0,06	0,07	0,09	0,06
Functional feasibility	-0,08	1,00	0,51	0,28	0,11	0,20	0,29	0,15	0,26	0,29	0,29	0,06	0,24	0,29	0,01	0,19	0,03	0,22	0,27	0,25
Available data	-0,09	0,51	1,00	0,31	0,15	0,30	0,35	0,35	0,23	0,32	0,39	0,14	0,16	0,35	0,15	0,17	0,17	0,18	0,19	0,30
Clear design artifacts	0,14	0,28	0,31	1,00	0,20	0,48	0,49	0,38	0,36	0,39	0,23	0,29	0,10	0,34	0,04	0,39	0,22	0,33	0,25	0,35
Chunking user stories	0,12	0,11	0,15	0,20	1,00	0,35	0,17	0,23	0,21	0,25	0,07	0,26	0,27	0,25	0,38	0,17	-0,02	0,22	0,20	0,12
Relevant data	0,04	0,20	0,30	0,48	0,35	1,00	0,38	0,25	0,39	0,41	0,25	0,25	0,32	0,36	0,25	0,29	0,25	0,30	0,23	0,23
Up to date data	0,00	0,29	0,35	0,49	0,17	0,38	1,00	0,55	0,53	0,33	0,33	0,17	0,03	0,33	0,19	0,33	0,32	0,17	0,30	0,36
Clean data	0,07	0,15	0,35	0,38	0,23	0,25	0,55	1,00	0,58	0,36	0,20	0,30	0,18	0,38	0,29	0,21	0,27	0,26	0,33	0,35
Accurate data	-0,08	0,26	0,23	0,36	0,21	0,39	0,53	0,58	1,00	0,48	0,33	0,18	0,17	0,36	0,22	0,29	0,04	0,27	0,30	0,21
Meaningful data	0,03	0,29	0,32	0,39	0,25	0,41	0,33	0,36	0,48	1,00	0,23	0,21	0,33	0,42	0,13	0,33	0,21	0,51	0,24	0,27
Data processing	0,28	0,29	0,39	0,23	0,07	0,25	0,33	0,20	0,33	0,23	1,00	0,36	0,34	0,27	0,21	0,41	0,14	0,30	0,24	0,32
Componentising	0,30	0,06	0,14	0,29	0,26	0,25	0,17	0,30	0,18	0,21	0,36	1,00	0,47	0,37	0,54	0,34	0,20	0,24	0,24	0,28
Code isolation	0,29	0,24	0,16	0,10	0,27	0,32	0,03	0,18	0,17	0,33	0,34	0,47	1,00	0,30	0,31	0,33	0,18	0,18	0,26	0,16
Performance reporting	0,14	0,29	0,35	0,34	0,25	0,36	0,33	0,38	0,36	0,42	0,27	0,37	0,30	1,00	0,35	0,33	0,28	0,34	0,20	0,29
Parallel app development	0,09	0,01	0,15	0,04	0,38	0,25	0,19	0,29	0,22	0,13	0,21	0,54	0,31	0,35	1,00	0,22	0,14	0,18	0,23	0,39
Stay technically relevant	0,15	0,19	0,17	0,39	0,17	0,29	0,33	0,21	0,29	0,33	0,41	0,34	0,33	0,33	0,22	1,00	0,41	0,46	0,18	0,50
Continuous customer feedback	0,06	0,03	0,17	0,22	-0,02	0,25	0,32	0,27	0,04	0,21	0,14	0,20	0,18	0,28	0,14	0,41	1,00	0,22	0,25	0,42
Tech foresight	0,07	0,22	0,18	0,33	0,22	0,30	0,17	0,26	0,27	0,51	0,30	0,24	0,18	0,34	0,18	0,46	0,22	1,00	0,32	0,32
Time for reflection	0,09	0,27	0,19	0,25	0,20	0,23	0,30	0,33	0,30	0,24	0,24	0,24	0,26	0,20	0,23	0,18	0,25	0,32	1,00	0,46
Explore before development	0,06	0,25	0,30	0,35	0,12	0,23	0,36	0,35	0,21	0,27	0,32	0,28	0,16	0,29	0,39	0,50	0,42	0,32	0,46	1,00

5.2.3.3 Pearson correlation matrix report (Q21-Q40)

The Pearson correlation coefficient for UX design is presented next. The linear correlation between the question concepts can be seen in Table 5.50 where the Pearson correlation matrix is shown for Q21-Q40 relating to UX design. In the table it can be seen that some question concepts have a strong linear correlation with other question concepts, for example, ‘information placement’ and ‘time sensitive relevant information’ (0.51).

From Table 5.50 it can be seen where the most positive correlations between the concepts are:

- ‘Complex concept visibility’ and ‘logical perspective visualisation’ (0.63). This could be interpreted as the need for assisting visually to make complex concepts more logical and understandable to derive insight.
- ‘Initiate user actions’ and ‘KPI driven design’ (0.59). This correlation could point to the importance of allowing the user to have control to kick off actions as triggered by KPIs or needed for KPI accomplishment.
- ‘Logical perspective visualisation’ and ‘dashboard interactivity’ (0.55). The correlation between these concepts could indicate the importance of the dashboard being interactive to interact with visualisation perspectives and manipulate or change perspectives to see data from different perspectives.
- ‘Initiate user actions’ and ‘time sensitive relevant information’ (0.48). Again, this points to the user need to react to information with action that would influence the situation or reality as presented by the data produced through the dashboard.

These concepts point to their importance in ensuring interactivity, visual perspectives and control of subsequent actions required for use of BI dashboards.

Table 5.50 Pearson correlation matrix report for UX design related questions.

Variables	Design artefact	Conceptual design	Alignment of business, user and tech	UX in agile process	Under-standing user problem	Info Place-ment	Time sensitive relevant info	KPI driven design	Initiated user actions	Component usefulness prioritisation	Search-able data	Use of understandable language	Dashboard interactivity	Customisation of info displayed	Navigational design	Logical perspective visualisation	Complex concept visibility	Data representation flexibility	Motion communitive designs	Navigational visual cues
Design artefact	1,00	0,41	0,18	0,09	0,22	0,39	0,41	0,25	0,41	0,28	0,28	0,32	0,37	0,13	0,29	0,34	0,25	0,01	0,34	0,45
Conceptual design	0,41	1,00	0,13	0,09	0,20	0,22	0,26	0,03	0,16	0,30	0,00	0,18	0,14	0,05	0,20	0,31	0,16	0,17	0,33	0,28
Alignment of business, user and tech	0,18	0,13	1,00	-0,06	0,27	0,11	0,07	0,11	0,13	0,20	0,06	0,28	0,03	-0,07	0,25	0,09	-0,01	0,14	-0,06	0,30
UX in agile process	0,09	0,09	-0,06	1,00	0,26	0,17	0,25	0,11	0,00	0,06	-0,06	0,08	-0,05	0,14	-0,03	0,06	0,31	-0,01	-0,03	0,18
Understanding user problems	0,22	0,20	0,27	0,26	1,00	0,26	0,28	0,19	0,21	0,20	0,20	0,39	0,17	0,17	0,28	0,24	0,15	0,25	0,04	0,14
Info placement	0,39	0,22	0,11	0,17	0,26	1,00	0,51	0,48	0,34	0,17	0,20	0,12	0,20	0,26	0,26	0,33	0,33	0,17	0,18	0,30
Time sensitive relevant info	0,41	0,26	0,07	0,25	0,28	0,51	1,00	0,43	0,48	0,37	0,03	0,30	0,25	0,33	0,29	0,17	0,29	0,14	0,28	0,22
KPI driven design	0,25	0,03	0,11	0,11	0,19	0,48	0,43	1,00	0,59	0,31	0,26	0,26	0,24	0,43	0,25	0,30	0,30	0,23	0,18	0,18
Initiated user actions	0,41	0,16	0,13	0,00	0,21	0,34	0,48	0,59	1,00	0,39	0,22	0,35	0,43	0,31	0,32	0,40	0,32	0,21	0,31	0,27
Component usefulness prioritisation	0,28	0,30	0,20	0,06	0,20	0,17	0,37	0,31	0,39	1,00	0,17	0,23	0,23	0,22	0,33	0,24	0,15	0,13	0,20	0,24
Searchable data	0,28	0,00	0,06	-0,06	0,20	0,20	0,03	0,26	0,22	0,17	1,00	0,32	0,47	0,26	0,20	0,44	0,31	0,09	0,12	0,27
Use of understand-able language	0,32	0,18	0,28	0,08	0,39	0,12	0,30	0,26	0,35	0,23	0,32	1,00	0,38	0,19	0,26	0,24	0,14	0,05	0,11	0,19
Dashboard interactivity	0,37	0,14	0,03	-0,05	0,17	0,20	0,25	0,24	0,43	0,23	0,47	0,38	1,00	0,33	0,28	0,55	0,38	0,24	0,42	0,41
Customisation of info displayed	0,13	0,05	-0,07	0,14	0,17	0,26	0,33	0,43	0,31	0,22	0,26	0,19	0,33	1,00	0,34	0,16	0,41	0,27	0,28	0,15
Navigational design	0,29	0,20	0,25	-0,03	0,28	0,26	0,29	0,25	0,32	0,33	0,20	0,26	0,28	0,34	1,00	0,35	0,31	0,25	0,39	0,25
Logical perspective visualisation	0,34	0,31	0,09	0,06	0,24	0,33	0,17	0,30	0,40	0,24	0,44	0,24	0,55	0,16	0,35	1,00	0,63	0,32	0,43	0,39
Complex concepts visibility	0,25	0,16	-0,01	0,31	0,15	0,33	0,29	0,30	0,32	0,15	0,31	0,14	0,38	0,41	0,31	0,63	1,00	0,36	0,42	0,34
Data representation flexibility	0,01	0,17	0,14	-0,01	0,25	0,17	0,14	0,23	0,21	0,13	0,09	0,05	0,24	0,27	0,25	0,32	0,36	1,00	0,26	0,25
Motion communitive designs	0,34	0,33	-0,06	-0,03	0,04	0,18	0,28	0,18	0,31	0,20	0,12	0,11	0,42	0,28	0,39	0,43	0,42	0,26	1,00	0,41
Navigational visual cues	0,45	0,28	0,30	0,18	0,14	0,30	0,22	0,18	0,27	0,24	0,27	0,19	0,41	0,15	0,25	0,39	0,34	0,25	0,41	1,00

The Pearson correlation coefficient matrix for the UX design related questions can also be expressed as a heatmap (see Figure. 5.24). This allows for quick visual identification of positive and negative correlation. The negative correlations are shown as ‘cold’ or blue values, where the positive correlation values (higher than 0.2) are shown with shades of red. The yellow squares added to the diagram indicates ‘hot’ pockets, where high correlation between concepts emerge.

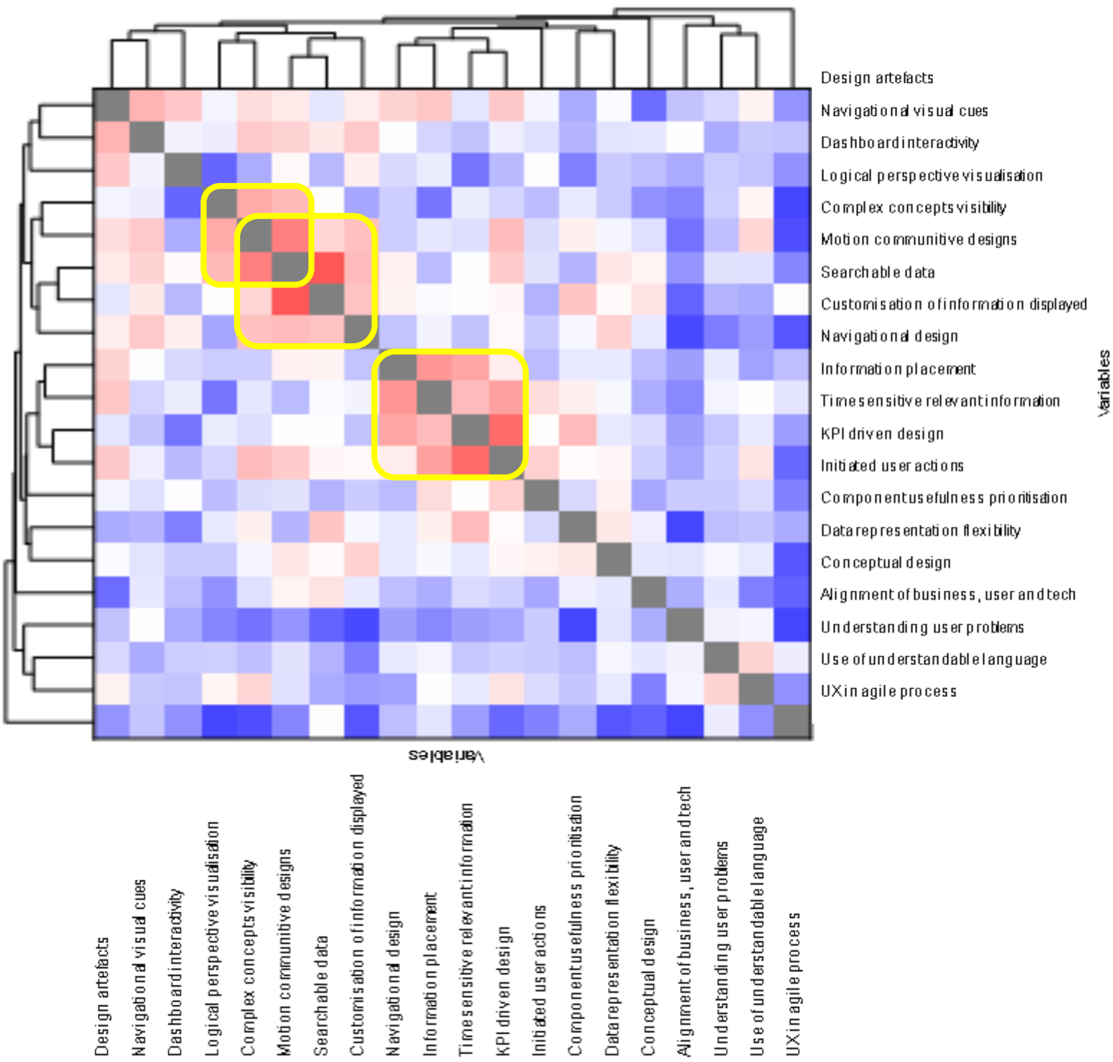

Figure 5.24 Heat map of the Pearson correlation matrix (Q21-Q40).

The heat map of the Pearson Correlation Matrix (see Figure 5.24) highlights these pairs of interest. From the heatmap we can see that ‘customisation of information displayed’ is linked to multiple concepts such as ‘making complex concepts visible’ and ‘motion communicative design’.

The Spearman correlation can be calculated by applying the Pearson correlation formula to the ranks of the data; this produces a matrix of differences to compare the two types of correlation matrices. The matrix points to pairs of variables to be investigated [see Table 5.51]. The heat map of the Spearman correlation matrix (Q21-Q40) visually highlights these pairs of interest [see Figure 5.25].

5.2.3.4 Spearman correlation matrix report (Q21-Q40).

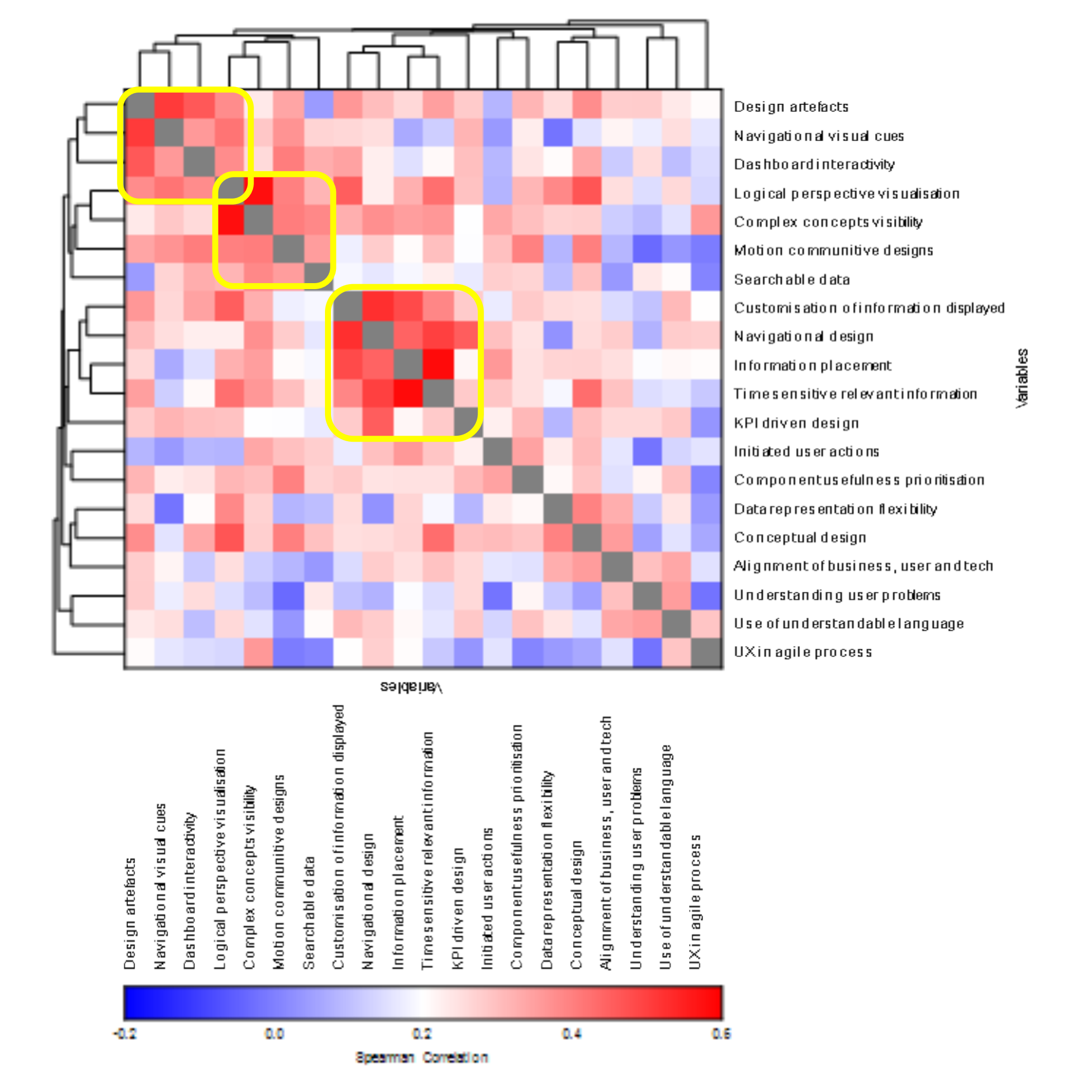

Figure 5.25 Heat map of the Spearman correlation matrix (Q21-Q40).

The Spearman Correlation Matrix (see Figure 5.25) visually highlights the links between ‘information placement’ and ‘time sensitive information’, and between ‘KPI driven design’ and ‘user-initiated actions’.

Table 5.51 Spearman correlation matrix report for UX design related questions.

Variables	Design artefact	Conceptual design	Alignment of business, user and tech	UX in agile process	Under-standing user problem	Info Place-ment	Time sensitive relevant info	KPI driven design	Initiated user actions	Component usefulness prioritisation	Search-able data	Use of understandable language	Dashboard interactivity	Customisation of info displayed	Navigational design	Logical perspective visualisation	Complex concept visibility	Data representation flexibility	Motion communitive designs	Navigational visual cues
Design artefact	1,00	0,51	0,28	0,21	0,23	0,36	0,30	0,26	0,35	0,28	0,25	0,28	0,38	0,08	0,32	0,38	0,23	0,04	0,34	0,46
Conceptual design	0,51	1,00	0,17	0,16	0,25	0,26	0,25	0,07	0,12	0,32	-0,02	0,22	0,16	0,04	0,23	0,42	0,29	0,27	0,37	0,36
Alignment of business, user and tech	0,28	0,17	1,00	-0,02	0,35	0,10	0,08	0,20	0,15	0,26	0,12	0,30	0,05	-0,02	0,22	0,15	0,09	0,23	-0,03	0,25
UX in agile process	0,21	0,16	-0,02	1,00	0,29	0,20	0,28	0,20	0,11	0,03	0,04	0,15	0,06	0,16	0,01	0,14	0,36	0,01	0,00	0,15
Understanding user problems	0,23	0,25	0,35	0,29	1,00	0,31	0,28	0,21	0,16	0,29	0,24	0,34	0,16	0,13	0,30	0,26	0,15	0,21	0,03	0,10
Info placement	0,36	0,26	0,10	0,20	0,31	1,00	0,53	0,48	0,39	0,28	0,26	0,14	0,25	0,17	0,28	0,45	0,33	0,19	0,17	0,35
Time sensitive relevant info	0,30	0,25	0,08	0,28	0,28	0,53	1,00	0,45	0,50	0,45	0,03	0,28	0,25	0,30	0,24	0,23	0,38	0,16	0,28	0,23
KPI driven design	0,26	0,07	0,20	0,20	0,21	0,48	0,45	1,00	0,59	0,21	0,27	0,25	0,27	0,36	0,25	0,32	0,35	0,19	0,21	0,15
Initiated user actions	0,35	0,12	0,15	0,11	0,16	0,39	0,50	0,59	1,00	0,28	0,19	0,30	0,43	0,29	0,25	0,43	0,36	0,23	0,30	0,21
Component usefulness prioritisation	0,28	0,32	0,26	0,03	0,29	0,28	0,45	0,21	0,28	1,00	0,09	0,26	0,30	0,22	0,31	0,30	0,20	0,17	0,20	0,30
Searchable data	0,25	-0,02	0,12	0,04	0,24	0,26	0,03	0,27	0,19	0,09	1,00	0,33	0,40	0,23	0,21	0,39	0,27	0,10	0,08	0,21
Use of understand-able language	0,28	0,22	0,30	0,15	0,34	0,14	0,28	0,25	0,30	0,26	0,33	1,00	0,36	0,16	0,15	0,25	0,12	0,04	0,08	0,12
Dashboard interactivity	0,38	0,16	0,05	0,06	0,16	0,25	0,25	0,27	0,43	0,30	0,40	0,36	1,00	0,31	0,29	0,47	0,28	0,30	0,40	0,34
Customisation of info displayed	0,08	0,04	-0,02	0,16	0,13	0,17	0,30	0,36	0,29	0,22	0,23	0,16	0,31	1,00	0,35	0,08	0,34	0,28	0,30	0,09
Navigational design	0,32	0,23	0,22	0,01	0,30	0,28	0,24	0,25	0,25	0,31	0,21	0,15	0,29	0,35	1,00	0,31	0,30	0,27	0,40	0,24
Logical perspective visualisation	0,38	0,42	0,15	0,14	0,26	0,45	0,23	0,32	0,43	0,30	0,39	0,25	0,47	0,08	0,31	1,00	0,58	0,32	0,40	0,38
Complex concepts visibility	0,23	0,29	0,09	0,36	0,15	0,33	0,38	0,35	0,36	0,20	0,27	0,12	0,28	0,34	0,30	0,58	1,00	0,39	0,40	0,26
Data representation flexibility	0,04	0,27	0,23	0,01	0,21	0,19	0,16	0,19	0,23	0,17	0,10	0,04	0,30	0,28	0,27	0,32	0,39	1,00	0,35	0,33
Motion communitive designs	0,34	0,37	-0,03	0,00	0,03	0,17	0,28	0,21	0,30	0,20	0,08	0,08	0,40	0,30	0,40	0,40	0,40	0,35	1,00	0,40
Navigational visual cues	0,46	0,36	0,25	0,15	0,10	0,35	0,23	0,15	0,21	0,30	0,21	0,12	0,34	0,09	0,24	0,38	0,26	0,33	0,40	1,00

5.2.4 Exploratory factor analysis (EFA)

To test the ***validity of the constructs*** (dimensions/elements) in the questionnaire, an exploratory factor analysis is performed to determine whether the individual questions load (or contribute) onto the constructs as intended in the questionnaire.

Factor analysis is a statistical method used to describe ***variability*** among observed variables in terms of fewer unobserved variables called factors (the constructs). There are two types of Factor Analysis: Exploratory Factor analysis (EFA) and Confirmatory Factor analysis (CFA). EFA attempts to uncover complex patterns by exploring the dataset and testing prediction. CFA is used to confirm a factor structure. However, it is important to establish the constructs or factors with EFA before the factors can be confirmed with CFA (Statistics Solutions, 2013). Only Exploratory Factor Analysis will be considered here.

Factors can be considered as factor 'loadings' used to determine which items (according to the Likert scale statements) belong together and are grouped to form a factor. The loading of an item indicates the extent to which an individual item 'loads' onto a factor. A value near 1 indicates an item that loads highly on to a specific factor. A loading of 0.40 and higher can be considered as meaningful.

5.2.4.1 EFA: Development of software in an agile environment

The number of factors (constructs) of the "develop software in an agile environment" was determined. Firstly, the number of factors from the 20 individual statements (for questions: 9.1-9.5, 10.1-10.5, 11.1 - 11.5, 12.1-12.5) of the "develop software in an agile environment" scale was determined. An Exploratory Factor analysis will yield one or more factors from the items/statements under consideration.

To determine the number of factors, the following criteria were applied:

- Cumulative percentage explained by the factors > 60%;
- Eigenvalues > 1 (also called the Kaiser Guttman rule); and
- Look at a significant decline in the Scree plot.

Applying this, Figure 5.26 follows, indicating the distribution of the Eigenvalues for Q1-Q20.

Number	Eigenvalue	Percent	20 40 60 80	Cum Percent
1	5.8885	29.442		29.442
2	2.0141	10.071		39.513
3	1.6320	8.160		47.673
4	1.2358	6.179		53.852
5	1.1781	5.891		59.742
6	1.0352	5.176		64.918
7	0.9730	4.865		69.783
8	0.8232	4.116		73.900
9	0.7520	3.760		77.659
10	0.6722	3.361		81.021
11	0.6497	3.249		84.269
12	0.5221	2.610		86.880
13	0.4862	2.431		89.310
14	0.4419	2.209		91.520
15	0.3791	1.896		93.415
16	0.3308	1.654		95.070
17	0.2966	1.483		96.553
18	0.2613	1.306		97.859
19	0.2469	1.234		99.094
20	0.1813	0.906		100.000

Figure 5.26 Distribution of the Eigenvalues for Q1-Q20.

The output shows 6 factors have Eigenvalues larger than 1 (see Figure 5.26 and Figure 5.27), the distribution of the Eigenvalues with number of components for Q1-Q20, with 65% of the cumulative variance explained by the 6 factors. However, all 6 factors must have at least 3 items, which is not the case. So, the 5-factor solution which explains 59.74% of the cumulative variance is considered instead. The Scree plot also shows a possible 5 factors with a tailing-off of the variation explained. Therefore, 5 factors will be used for the rotation.

The extraction method: Most common extraction methods are Maximum likelihood (ML), Principal Component Analysis (PCA) and Principal Axis factoring. Usually Principal Component Analysis (PCA) is used with orthogonal rotation and Principal axis factoring with oblique rotation.

Determine the rotation method: Before the factors can be calculated, an extraction and rotation method must be chosen.

Two main rotation methods exist, namely Orthogonal or Oblique. The orthogonal method ensures that the rotated factors are NOT correlated with each other. This is the preferred method if further modelling like regression is to be performed.

The Oblique method allows for correlation between the rotated factors (or constructs). This method is preferred when the correlation between constructs needs to be explored. The orthogonal method most recommended is the Varimax method, and Oblimin is recommended for the Oblique method.

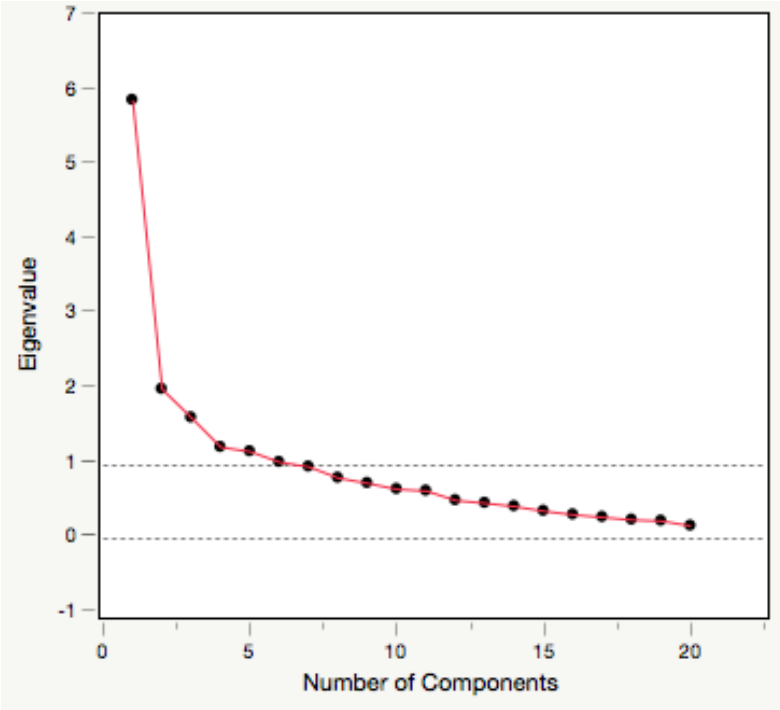

Figure 5.27 Distribution of the Eigenvalues with number of components for Q1-Q20.

After the extraction and rotation of the factors, the communalities and factor loadings are produced.

Principal axis factoring (extraction used for validation usually) with Oblimin rotation (extracted factors are allowed to correlate which is part of the research objective to assess relationships between factors/constructs) was used.

The output shows the communalities for the 5 extracted factors. Communality refers to common variance (the variance that is shared with other items) as opposed to unique variance that is unique to that item. Communality indicates the proportion of an item's variance that is shared with the other items (factor structure).

The communalities, therefore, indicate the extent to which an individual item 'relates' to the factor structure (the rest of the items). A value near 1 indicates a high proportion of 'common' variance.

This item, therefore, 'relates' to the other items as opposed to a communality near 0 where the item is 'unique'. Items with low communalities (0.2 or lower) could be considered for removal (Q9.1) when this scale from the questionnaire will be used in future studies. For now, with the purpose of validation of constructs, it will simply be reported.

5.2.4.1.1 Development output: Determining the factors

Rotated Factor Loading

The output shows the factor loadings for the 5 extracted factors. The loading of an item indicates the extent to which an individual item 'loads' onto a factor. A value near 1 indicates that an item loads highly on a specific factor. A loading of 0.40 (absolute value) and larger can be considered as meaningful. Table 5.52 shows the factor values used to decide how the factors would be grouped.

Table 5.52 EFA factor groupings for development of dashboards.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q9.3	0,74	-0,1	-0,1	0,13	0,04
Q9.2	0,73	0	-0,1	0,06	0
Q11.1	0,48	0,15	0,2	0	0,06
Q11.4	0,45	0,03	0,24	0,14	0,14
Q11.3	0,44	0,23	0,21	-0,3	0,02
Q9.1	0,27	0,03	0,19	-0,2	0
Q10.1	0,04	0,62	0,07	0,08	-0,1
Q12.3	-0,1	0,58	0,02	0	0,2
Q10.5	0,08	0,52	-0,1	0,2	0,14
Q12.1	0	0,49	0,12	-0,1	0,3
Q9.4	0,1	0,48	-0,1	0,27	0,07
Q11.5	-0,1	-0,1	0,8	0,11	0,1
Q11.2	0,13	0,09	0,62	0	0,07
Q9.5	0,1	0,3	0,42	0	-0,2
Q10.2	0,11	0,15	0	0,64	0,1
Q10.4	0,08	0,3	0,12	0,61	-0,1
Q10.3	0,17	0,01	0,18	0,58	0,14
Q12.2	0,02	0,15	-0,1	-0,1	0,65
Q12.5	0	0	0,26	0,13	0,6
Q12.4	0,1	0,02	0,04	0,13	0,5

For the **interpretation of the factors/constructs,** the following will be used: for an item to be loaded on a factor, that item must have a value of 0.40 for that factor and less than 0.40 for the other factors. If an item has loadings of greater than 0.40 on more than one factor the item is 'cross-loading', closer inspection is warranted, and a decision made to which factor the item belongs. Cross loadings may be the result of ambiguity in the item/statement. On closer investigation, the categories represented by these factor groupings become visible. Table 5.53 shows the descriptions according to the factor grouping.

Table 5.53 EFA factor description for development of dashboards.

Topic	No	Value	Question description
Practicable Methodology	Q9.3	0,74	9.3 The need for exploring the initial UX design plan for data availability.
	Q9.2	0,73	9.2 The need for testing the feasibility of the desired functionality.
	Q11.1	0,48	11.1 The need for processing data at different levels.
	Q11.4	0,45	11.4 The need for performance data reporting.
	Q11.3	0,44	11.3 The need to isolate code to manage change.
Contextual Adaptation	Q10.1	0,62	10.1 The need for data relevance when a product is being developed.
	Q12.3	0,58	12.3 The need for tech vision and foresight.
	Q10.5	0,52	10.5 The need for meaningful data when a product is being developed.
	Q12.1	0,49	12.1 The need for the developer to stay relevant with tech research.
	Q9.4	0,48	9.4 The need for clear design artefacts for technical development.
Structure Seeking	Q11.5	0,8	11. 5 The need to develop new version of applications in parallel.
	Q11.2	0,62	11.2 The need to componentise for quick selection by developers.
	Q9.5	0,42	9.5. The need to use tools to chunk user stories for development.
Data Quality	Q10.2	0,64	10.2 The need for data currency (up to date data) when a product is being developed.
	Q10.4	0,61	10.4 The need for accurate data when a product is being developed.
	Q10.3	0,58	10.3. The need for clean data when a product is being developed.
Tactical Development	Q12.2	0,65	12.2 The need to get feedback from customers on continuous deploy changes.
	Q12.5	0,6	12.5 The need to investigate the new technology (to explore the fundamentals) before starting development.
	Q12.4	0,5	12.4 The need for time to reflect on the most appropriate approach to the task.

Next, the categories represented by these factor groupings will be looked at more closely.

Category 1: Practicable methodology

This category included: exploring the initial UX design plan for data availability; testing the feasibility of the desired functionality; processing data at different levels; reporting performance; and isolating code to manage change.

These concepts are related in that they play a part in determining and ensuring the feasibility of the software being developed. The UX design of the product is essential if one is to know exactly what needs to be built and what the product should do in very clear and specific terms. The development team then needs to assess whether the data specified in the design exist, whether they are available for development use, whether the required functionality would be buildable, how it would be built; considering that isolating code to manage code plays an important part in how the functionality will be built; and how the data to be used would be processed as part of the required functionality; the processing performance would need to be monitored to improve the functionality of the product continuously.

In the foreground is the concept of investigating the design specification for data availability and from this all the other concepts follow. Without the data required being available, the rest of the software build would be meaningless, time would be wasted, and product cost would escalate uncontrollably. Therefore, the other concepts move backward and wait to enter the stage based on the first qualifying criterion. Whilst the development takes place in an agile environment, planning, investigating, and working in an organised performance driven way is essential to ensure the successful development of the product.

Other possible alternative explanations for this factor grouping could include the need for the development team to have control over what is being developed or, alternatively, to manage the output generated by the development team effectively.

Category 2: Contextual adaptation

The category of contextual adaptation included: data relevance when a product is being developed; meaningful data when a product is being developed; clear design artefacts for technical development; tech vision and foresight; developer to stay relevant with tech research.

The concepts of data relevance (that is products having data that will be perceived by users to be relevant to their need/problem) and meaningful data (data that bring the story and provide insights behind the data to life) are closely related, and both are needed for the data needed for the task at hand. For this to be delivered, a clear design artefact is required to inform the development. Technical foresight, careful and thought-through guidance should direct the technical vision for the product. The technical leadership that sets the vision and manages the alignment across teams (to that vision) should also ensure that developers have the opportunity not only to code, but also to stay relevant with intentional tech research that would support the development of the product early on.

In the foreground is the technical vision required. Under the guidance of technical leadership, development teams face a need for contextual adaptation in line with the technical vision. In the background the product is developed, meeting the user needs through providing relevant and meaningful data while carefully following the clear design specification.

Other alternative explanations for this grouping could be a focus on technology within development or the need to innovate technically to improve the performance of a specific product.

Category 3: Structure seeking

The category of structure seeking included: developing a new version of applications in parallel; componentising for quick selection by developers; and the use of tools to chunk user stories for development.

These concepts are all related in that they are aimed at putting structures in place to improve development. In environments where application features are built to be toggled on or off, and where applications evolve at speed, new versions are continuously built and released. To support this overarching process, optimisation techniques, like the breaking up of user stories into small pieces to speed up the process and the componentisation of components involves breaking up software into identifiable pieces that developers independently write, can re-use and that ease deployment. It also makes it easier to change or swap existing versions with no impact on the other components or the application as a whole. Building in a structured way saves time, and, ultimately, it reduces the cost of development.

Other alternative explanations for this grouping could be a focus on speedy delivery or improved control in development.

Category 4: Data quality

The category of data quality included the concepts of current data (up to date data), accurate data and clean data when a product is being developed.

These concepts are all related to the quality of the data. Clean data are data that are correct, consistent and usable. This is needed to develop dashboards with accurate data presented to the user; in addition, presenting up-to-date data allows the user to make timely decisions based on the most recent data available. Data quality plays an important part in the overall quality of the product.

Other alternative explanations for the grouping could be a data awareness or a focus on improving the precision of the data presented to the user.

Category 5: Tactical outlook

The category of tactical outlook includes the concepts of receiving feedback from customers on continuous deploy changes, investigating the new technology (exploring the fundamentals) before starting development, and time to reflect on the most appropriate approach to the task.

These concepts are related in that they inform the way the work is approach on a tactical level. Collecting feedback from customers on changes allows the team to gain information about the success of the deploy and product; if anything should be changed, the team can be made aware and plan accordingly. Similarly collecting information on a new technology before commencing development informs developers about the technology fundamentals and allows for informed decision making upfront before so much time and other resources have been spent that a technology change cannot be justified any longer. This also is related to collecting information before a development task is started and not rushing in headfirst, allowing for choosing a suitable technique or approach for a problem and taking into consideration factors which would otherwise have been missed or ignored.

The tactical outlook on development outlines specific actions to achieve short-term goals and improves the position of a team to succeed in those goals.

Other alternative explanations for the grouping could be a continuous change of a dynamic environment where investigation and supporting information is required to adapt or pivot.

Next, the exploratory factor analysis of UX design will be presented.

5.2.4.2 EFA: UX design

Next the number of factors (constructs) of the "UX Design" part will be considered. The number of factors from the 20 individual statements (for questions: 13.1-16.5) of the "UX Design" scale was determined. An Exploratory Factor analysis yielded factors from the items/statements under consideration.

The number of factors (constructs) of "UX Design" was determined. Firstly, the number of factors from the 20 individual statements (for questions: 13.1-13.5, 14.1-14.5, 15.1 - 15.5, 16.1-16.5) of the "UX Design" scale was determined. An Exploratory Factor analysis will yield one or more factors from the items/statements under consideration.

To determine how many factors, the following criteria were applied:

- Cumulative percentage explained by the factors > 60%;
- Eigenvalues > 1 (also called the Kaiser Guttman rule); and
- Look at a significant decline in the Scree plot.

Applying this, Figure 5.28 follows indicating the distribution of the Eigenvalues for Q21-Q40 and Figure 5.29 follows indicating the distribution of the Eigenvalues for Q21-Q40 with number of components.

UX design output: Decide on the number of factors

In Figure 5.28 the output shows 6 factors have Eigenvalues larger than 1 with 64% of the cumulative variance explained by the 6 factors. However, all 6 factors must have at least 3 items, which is not the case. So, the 4-factor solution which explains 51.44% of the cumulative variance is preferably considered. The Scree plot also shows the possible factors (see the red arrow) with a tailing off of the variation explained. Therefore 4 factors will be used for the rotation.

The extraction method:

The most common extraction methods are Maximum likelihood (ML), Principal Component Analysis (PCA) and Principal Axis factoring. Usually Principal Component Analysis (PCA) is used with orthogonal rotation and Principal axis factoring with oblique rotation.

Determine the rotation method:

Before the factors can be calculated, an extraction and rotation method must be chosen.
Two main rotation methods exist, namely Orthogonal or Oblique. The orthogonal method ensures that the rotated factors are NOT correlated with each other. This is the preferred method if further modelling, like regression, is to be performed.

Number	Eigenvalue	Percent	20 40 60 80	Cum Percent
1	5.5470	27.735		27.735
2	1.8985	9.492		37.227
3	1.4820	7.410		44.637
4	1.3610	6.805		51.442
5	1.2509	6.255		57.697
6	1.1869	5.934		63.631
7	0.9748	4.874		68.505
8	0.8553	4.276		72.781
9	0.7594	3.797		76.578
10	0.7187	3.593		80.172
11	0.6460	3.230		83.402
12	0.5235	2.618		86.019
13	0.4962	2.481		88.501
14	0.4434	2.217		90.718
15	0.4188	2.094		92.811
16	0.3718	1.859		94.670
17	0.3259	1.629		96.300
18	0.3093	1.546		97.846
19	0.2589	1.295		99.141
20	0.1719	0.859		100.000

Figure 5.28 Distribution of the Eigenvalues for Q21-Q40.

The Oblique method allows for the correlation between the rotated factors (or constructs); this method is preferred when the correlation between constructs needs to be explored. The orthogonal method most recommended is the Varimax method and Oblimin is recommended for the Oblique method. After the extraction and rotation of the factors, the communalities and factor loadings are produced.

Principal axis factoring (extraction used for validation usually) with Oblimin rotation (extracted factors are allowed to correlate which is part of the research objective to assess relationships between factors/constructs) was used. The output shows the communalities for the 4 extracted factors. Communality refers to common variance (the variance that is shared with other items) as opposed to unique variance that is unique to that item.

Communality indicates the proportion of an item's variance that is shared with the other items (factor structure).

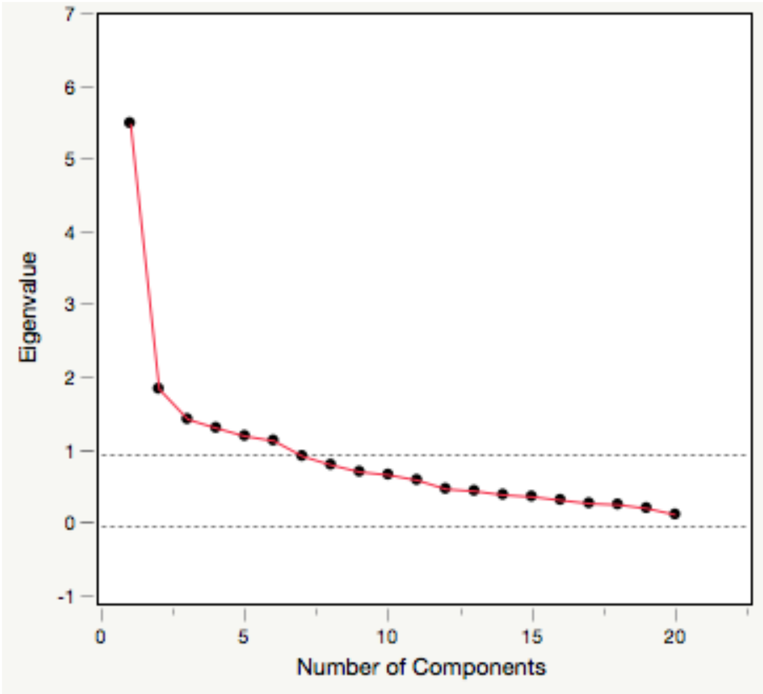

Figure 5.29 Distribution of the Eigenvalues with number of components for Q21-Q40.

The communalities, therefore, indicate the extent to which an individual item ‘relates’ to the factor structure (the rest of the items). A value near 1 indicates a high proportion of ‘common’ variance. This item, therefore, ‘relates’ to the other items as opposed to a communality near 0 where the item is ‘unique’. No items with low communalities (0.2 or lower) were found, which could have been considered for removal from the questionnaire in future studies.

5.2.4.2.1 UX design output: Determining the factors

Rotated Factor Loading

The output shows the factor loadings for the 4 extracted factors. The loading of an item indicates the extent to which an individual item 'loads' onto a factor. A value near 1 indicates that an item loads highly on a specific factor. A loading of 0.40 (absolute value) and larger can be considered as meaningful. Table 5.54 shows the factor values used to decide how the factors would be grouped.

Table 5.54 EFA factor groupings for UX design.

Survey Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q14.3	0,76	0,06	0	-0,2	-0,1
Q14.2	0,72	-0,1	0	0,2	0,2
Q14.4	0,63	0,05	0,07	0,07	-0,2
Q14.1	0,52	0,11	0	0,08	0,11
Q15.3	0,41	0,36	0,01	-0,3	0,06
Q16.2	0,09	0,76	-0,1	0,03	0,22
Q16.1	0	0,7	0,11	0,22	-0,1
Q15.3	0,07	0,49	0,15	0,09	-0,4
Q16.4	0,11	0,45	-0,2	0,43	-0,1
Q16.3	0,07	0,42	0	0	0,08
Q15.1	0	0,42	0,28	-0,2	-0,3
Q13.5	0	0,07	0,6	0	0,36
Q15.2	0,17	0,01	0,55	0,02	-0,1
Q13.3	0	-0,1	0,54	0,07	0,02
Q13.2	0	0,06	0,18	0,53	0,17
Q13.1	0,28	0,02	0,19	0,46	-0,1
Q16.5	0,07	0,28	0,04	0,37	0
Q13.4	0,02	0,11	0,13	0,01	0,56

Table 5.55 shows the descriptions according to the factor grouping.

Table 5.55 EFA factor description for development of dashboards.

Topic	Question Number	Value	Question Description
Effective Dashboard Design	Q14.3	0,76	14.3 The need to use user KPIs in task-driven environments to focus design instead of using *personas*.
	Q14.2	0,72	14.2 The need for the surfacing of time sensitive relevant information on the dashboard.
	Q14.4	0,63	14.4 The need for linking actions to be initiated by the customer based on the dashboard information (for example timed reminders).
	Q14.1	0,52	14.1 The need to surface the essence of information at the top level of the dashboard.
	Q14.5	0,36	14.5 The need to prioritise dashboard components according to the usefulness.
	Q16.2	0,76	16.2 The need for making complex concepts visible.

Progressive Data Presentation	Q16.1	0,7	16.1 The need for visualising the logical perspective.
	Q15.3	0,49	15.3 The need to provide for interactivity in dashboard design.
	Q16.4	0,45	16.4 The need for motion communicative methods for designs.
	Q16.3	0,42	16.3 The need to represent the same data in different ways.
	Q15.1	0,42	15.1 The need for data to be searchable by users on the dashboard.
Know and understand the User	Q13.5	0,6	13.5 The need to understand the user's real problems when designing the dashboard interface.
	Q15.2	0,55	15.2 The need for user understandable language when designing dashboards.
	Q13.3	0,54	13.3 The need to align business objectives with the user needs within the technical constraints that exist.
Design Artifacts	Q13.2	0,53	13.2 The need for UX to get the conceptual design right through the building of and testing of low-fi prototypes.
	Q13.1	0,46	13.1 the need for designers to produce clear design artefacts as input to technical development.
	Q16.5	0,37	16.5 The need for visual cues to improve navigation. Note: This value is still included despite it being below 0,4 as the constructs sit well together, having a combined mean of 0,45.

Category 1: Effective dashboard design

This category included: the use of user KPIs in task-driven environments to focus design instead of using *personas*; the surfacing of time-sensitive, relevant information on the dashboard; linking actions to be initiated by the customer based on the dashboard information (for example, timed reminders); surfacing the essence of information at the top level of the dashboard; and prioritising dashboard components according to the usefulness.

These concepts are all related in that they are specific to dashboards on a practical design level. In the foreground is the use of user KPIs in task-driven environments, that allows designers to design for, and thereby meet the user's objective for having the most important information visible, driving effective and focussed user behaviour. In an environment where information is considered and compared against what is considered to be 'normal' or against a predefined target, the design is focussed by the intended outcome of the task, for example, the availability of critical spare parts in a given time. The design is focussed on the task at hand and also the operational requirements of the business.

The way the information is delivered should be appropriate for the context primarily. This is where the important of context can be seen, for example, considering real-time information from a submarine dashboard concerning oxygen levels and considering real-time information from sales history on a dashboard. Looking at these examples, the importance of concepts such as *temporal* use can be seen; that is the exact time when the dashboard is being used as well as the *situational consequence* of use, where both scenarios will have considerably different experiences *during* use as well as *after* the use of the dashboard. All of these will be context determined.

The surfacing of time sensitive relevant information on the dashboard is related to the way the dashboard has been designed, utilising a most important information first (MIIF) approach. Similarly, this also is related to the temporal use of the dashboard. Linking actions to be initiated by the customer, based on the dashboard information, is also related to this KPI or MIIF design approach. These “important” pieces of information, surfaced in a timely manner, will support an “action” component linked to it to intervene based on the information presented on the dashboard. Similarly, to surface the essence of information at the top level of the dashboard focuses the attention of the user on the most important aspects to consider. This supports the prioritisation of dashboard components according to the usefulness for the task at hand.

Other alternative explanations for the grouping could be a grouping based on visual location or a grouping based on the adaptive requirement in the agile environment.

Category 2: Progressive data presentation

This category included making complex concepts visible, visualising the logical perspective, providing for interactivity in dashboard design, motion communicative methods for designs, representing the same data in different ways and data to be searchable by users on the dashboard.

These concepts are all related in that they speak to the way the information is presented and made discoverable, searchable and interpretable. Making complex concepts visible is related to the visual design treatment and application of visual design guidelines. Visualising the logical perspective again speaks to the visual treatment and way data and information is presented. This is closely related to representing the same data in different ways, providing perspective on the data or information. These concepts are related to motion communicative designs with movement in the design assisting the telling of a story when presenting the design, for example the value of stocks moving up or the expansion of customer conversion in a specific geographic location. Providing for interactivity in dashboard design is also related to how the data are presented, how user input can be provided, and how information is received. This concept of interactivity is linked to the user’s being able to search for something specific (data to be searchable by users) and allowing users to act with the intention of finding exact pieces of data or information.

Another alternative explanation for this grouping could be the automation of information being displayed or the intelligent dashboard selection of data that needs to be displayed for the user.

Category 3: Know and understand the user

This category included understanding the user's real problems when designing the dashboard interface, using understandable language when designing dashboards and aligning business objectives with the user's needs within the technical constraints that exist.

These concepts are all related as they revolve around the user who is in the foreground. The importance of understanding the user's real problems cannot be understated, understanding the user's problems is essential to be able to design for the solving these problems The use of understandable language is user-specific need. Only through getting to know and understand the user can alignment between the user's needs and the business objectives be established (within the technical constraints). These are important not only for the design but also the use and uptake of the product. Other possible reasons for the grouping could be the common 'problem' focus of these elements and another possibility for this grouping could be the participants' desire to 'understand'.

Category 4: Design artefacts

This category included UX to get the conceptual design right through the building of and testing of low-fi prototypes with designers producing clear design artefacts as input to technical development and visual cues to improve navigation.

These concepts all are related in that they speak about the practice of design. At the foreground is the notion of UX design to get the conceptual design right through the building of, and testing of, low-fi prototypes.

Building confidence in the conceptual design is important in determining that the design successfully addresses the problem and is suitable for use by users. This is specifically important to achieve because change becomes more costly as work progresses through the agile software development process. Related to this is the production of clear design artefacts by designers as input to technical development. Visual cues for improved navigation would form part of the clear design artefacts. Clear design artefacts should be created once the concept has been proven to be viable and the design has been tested. The clearer the design artefacts, the more thought through the designs would have been which means that the uncertainty becomes less, the possibility of misinterpretation by the development team is reduced and the potential for required reworking becomes less, which means cost is effectively being managed by clear designs.

Other possible reasons for the grouping would be the software development process or responsibilities of the design team.

5.3 Chapter summary

This chapter has presented the data analysis conducted during this study. The chapter was divided into two sections, each pertaining to the data collection method used. The qualitative part was reported on first as this part of the research weighed more owing to the explorative sequential research design which followed. Section 5.1 presented the qualitative analysis of the practitioner interviews.

The practitioner interviews produced eight major themes, each comprising of its own supporting categories. The major themes were: (1) Agile software development; (2) Change and adaptability; (3) Collaboration and communication; (4) The agile team; (5) Product; (6) Development; (7) Users; and (8) UX Design.

Section 5.2 presented the quantitative analysis:

- The descriptive frequency analysis was presented in Section 5.2.1; the data was described by means of descriptive statistics and basic information was presented about the variables in the datasets.

- The item analysis of the instrument was presented in Section 5.2.2. The instrument reliability was confirmed by a meaningful high Cronbach Alpha value for the development related question (Q1-Q20) (Cronbach's Alpha 0.856913) and a meaningful high Cronbach Alpha value for the UX design related questions (Q21-Q40) (Cronbach's Alpha 0.857337).

- The principal component analysis was presented in Section 5.2.3, enabling the standardisation of the range of continuous initial variables by computing the *covariance matrix* to identify correlations, computing the *eigenvectors* and *eigenvalues* of the covariance matrix to identify the principal components.

- The validity of constructs was tested with the Exploratory Factor Analysis in Section 5.2.4:
    - The exploratory factor analysis for **Development** of BI dashboards (Q1-Q20) identified the grouping of five key factors: **1. Feasible Development; 2. Contextual Adaptation; 3. Structure Seeking; 4. Data Quality; and 5. Reflective Development.**
    - The exploratory factor analysis for **UX Design** (Q21-Q40) identified the grouping of four key factors: **1. Dynamic Dashboard Design; 2. Progressive Data Presentation; 3. User Alignment; and 4. Design Artifacts.**

To sum up, Chapter 5 focused on the analysis of primary data collected from the practitioners' interviews as well as the analysis of the data collected from the survey with the larger population of practitioners.

Chapter 6 follows next, and here the results and findings from the research study will be presented.

Chapter 6

Results & Findings

Chapter 6 follows from the data analysis presented in the previous chapter. Chapter 6 is dedicated to presenting the results obtained from the research. The chapter has been compiled with the following objectives:

- to present an overview of the process of the development of the frameworks during the study (Section 6.1);
- to present the evolution of the CL_UXF_1.2 (the conceptual literature-based UX Framework) developed for BI dashboards (Section 6.2);
- to present the CAP_UXF_BID_1.1 (the conceptual practitioners' UX framework for BI dashboards) (Section 6.3);
- to present the VAP_UXF_BID_1.1 (the validated practitioners' UX Framework for BI dashboards) (Section 6.4);
- to present the focus group expert validation of Practitioners' UX framework for BI dashboards (Section 6.5); and
- to present the VAPO_UXF_BID_1.1 (the validated appreciative practice-oriented UX framework for BI dashboards (Section 6.6).

Chapter 6 continues as follows: Section 6.1 provides an overview of the frameworks developed; Section 6.2 presents the evolution of the CL_UXF_1.1 to CL_UXF_1.2; Section 6.3 presents the CAP_UXF_BID_1.1; Section 6.4 presents the VAP_UXF_BID_1.1; Section 6.5 presents the results from the focus group expert evaluation; Section 6.6 presents the VAPO_UXF_BID_1.1; and the chapter is concluded in Section 6.7.

6.1 Overview of frameworks developed

During the course of the research a number of frameworks were produced as output. Figure 6.1 visually depicts a diagram of the research design, data collection and output of study.

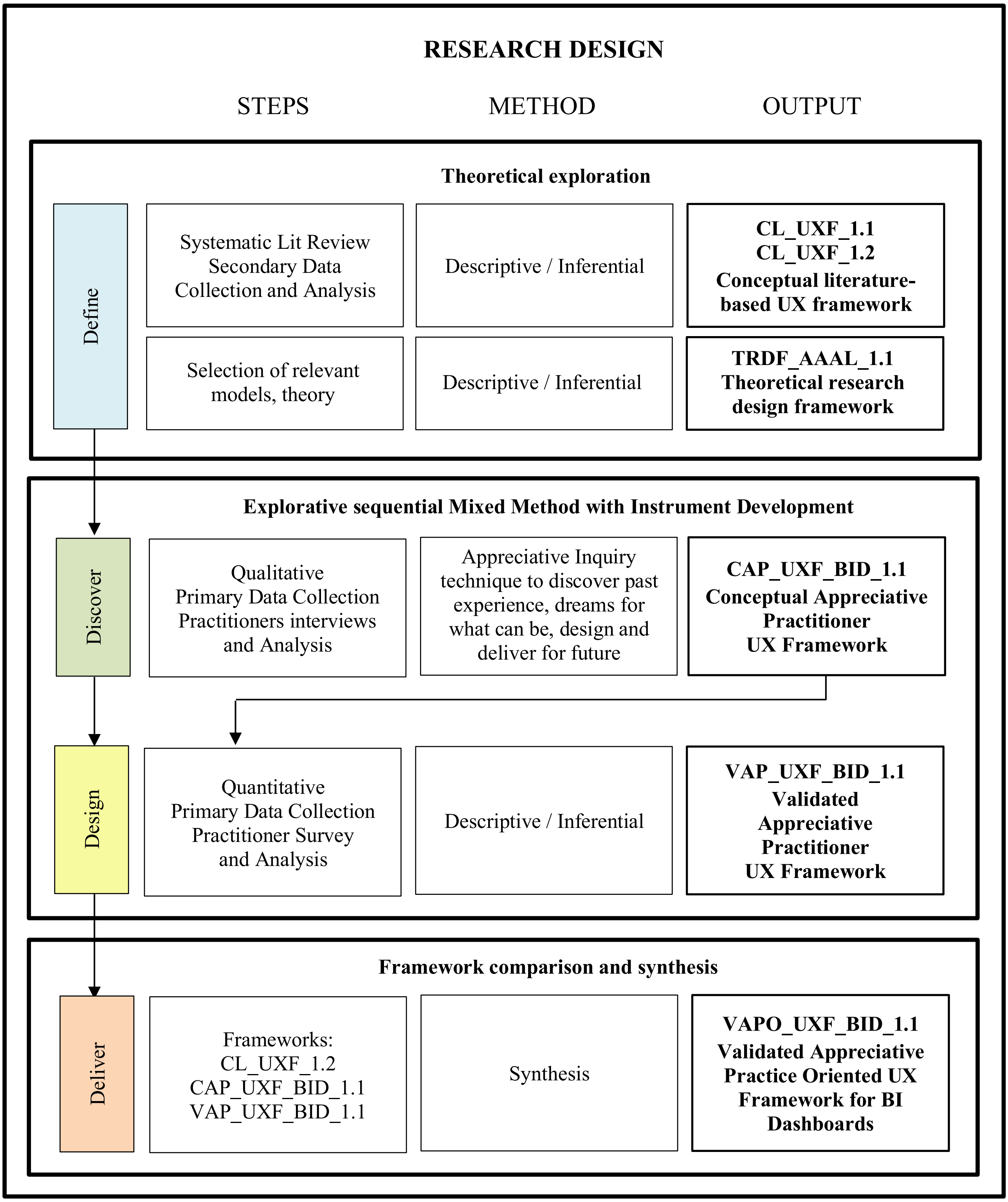

Figure 6.1 Research design, data collection method and frameworks produced.

The study made use of an exploratory sequential mixed methods design with instrument development (refer to Section 4.4). It is important to note that a research design with an exploratory sequential strategy places greater emphasis on the *qualitative phase* which is conducted prior to the quantitative phase to gain an understanding of, and insight into, an understudied field of study (Creswell, 2014). The goal of research is to produce new knowledge. For this reason research is mainly grouped into exploratory research: structuring and identifying new information; constructive research: which develops solutions to a problem; and empirical research: which tests the feasibility of a solution using empirical evidence (Oates, 2006). This study falls mainly into the first and second categories; developing a solution to the problem that a UX framework specific to BI did not exist at the time the research was initiated as well as gathering data from practitioners about what they considered to be required for the ‘best’ UX of BI dashboards. The qualitative output was validated with a larger sample of practitioners through a quantitative survey to determine whether a larger population of practitioners agreed with the elements suggested through the interviews with practitioners. The proposed UX framework that is produced based on the interviews and the survey was evaluated by means of triangulation with non-BI specific UX frameworks.

Qualitative studies are concerned with the diversity of information obtained from a population and not the distribution within a population (Babbie, 1989). Hence, the frequency of a specific topic was not tracked in the data analysis of the interviews, but rather from the different pieces of information obtained from the interviews. The practitioner interviews took the form an open (inductive) semi-structured interview. In open or inductive interviews, significant topics, dimensions, and categories are identified through the interpretation of raw data (Jansen, 2010).

In seeking to investigate and analyse what elements are required for the best UX of BI dashboards in an agile software development environment it is considered useful to regard who is included in the population of practitioners playing a part in the construction of BI dashboards in an agile environment, i.e., the different actors whose roles need to be roles considered (UX designer, product owner and developer). The agile team comprises of many more roles, but for the purposes of this research the study is limited to the three roles (UX designer, product owner and developer) selected to focus the research on what would be required for the best UX for BI dashboards as these three roles are more closely related to the shaping of the UX for BI dashboards than other roles such as, for example, business analysts, security engineers and QA testers.

Sections 6.2-6.3 present the frameworks that resulted as output from the research.

6.2 CL_UXF_1.2 Conceptual literature-based UX framework

UX frameworks from literature were interrogated to produce the conceptual UX Framework (CL_UXF_1.1) which included all the elements from UX frameworks investigated from the systematic literature review. See Table 6.1

Table 6.1 Detailed view of conceptual UX framework (CL_UXF_1.1).

Category	Elements
Product	• Perceivable (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status) • Use (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise diagnose and recover from errors, product use) • Features (meaningfulness, features, qualities, security) (new component: performance) • Support (pedagogical appropriateness, help and documentation) (new component: education/training) • Content (content, content fluency – right data, right time)
Development	• Possibilities (technical possibilities) • Challenges (technical challenges, technical constraints) • Support (technology support – context)
UX Strategy	• Brand, UX mission, UX philosophy, principles, accessibility strategy, measuring achievement of UX goals, data and analytics, UX KPIs, design/development processes, UCD process, HR – UX roles/competencies, HR training, change management and communication strategy
UX Goals	• Reason for product existence, tech possibilities and constraints, empathy, brand alignment, scientific understanding of humans [theory], understanding design context, simple design, intuitive design, essential design – only what is needed
UX Tools	• Processes available such as evaluation process, standardised questionnaires such as SUS, style guide, user representations, interaction flows
UX Designer	• Designer responsibilities, professionalism, approachability, selling design ideas
UX Design	• Design presentation, design functionality, design interaction, design attractiveness, compositional layout, emotional considerations, sensual, designing of cross-contextual activities, service coherence, minimalistic design (coinciding goal), consistency
User	• Emotions (mood, concerns, attitude) • User traits (skills/abilities, specialty/expertise, personal, physical attributes, knowledge/experience, competence, physical health) • Motivators (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy)

	• Association (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal) • Perceptions (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content)
Product/User interaction	• Touch point (product interaction, product use, touch point orchestration) • Context (usage context – experience driven innovation, context-related tasks, context physical, spatio-temporal – effects of place and time of experience) • Experience (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario, temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability)

This framework (Table 6.1) was updated when relevant new literature was published (Framework CL_UXF_1.2, Table 6.2) to produce an updated conceptual UX Framework. See Table 6.2 for a simplified high-level view of the main categories in the conceptual framework and also to see how the framework evolved.

Table 6.2 Progressive development of the conceptual UX framework (high level).

Main Categories	**Conceptual Literature UX Framework CL_UXF_1.1 (Jooste et al., 2018)**	**Updated Conceptual UX Framework CL_UXF_1.2**
Agile/Lean		x
Product	x	x
Technology	x	x
User	x	x
UX	x	x
UX design	x	x
UX strategy	x	x
UX goals	x	x
UX tools	x	x
UX designer	x	x
Usability	x	x
Context		x
Education/Training of user		x
Product/User interaction	x	x

Table 6.3 presents the detailed-view of the elements of Framework (CL_UXF_1.2) that form these high-level categories presented in Table 6.2.

Table 6.3 Updated conceptual UX framework (granular view) CL_UXF_1.2.

Category	Elements
Product	• Perceivable (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status) • Use (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise diagnose and recover from errors, product use) • Features (meaningfulness, features, qualities, security) (new component: performance) • Support (pedagogical appropriateness, help and documentation) (new component: education/training) • Content (content, content fluency – right data, right time)
Development	• Possibilities (technical possibilities) • Challenges (technical challenges, technical constraints) • Support (technology support – context)
UX	• UX Strategy (brand, UX mission, UX philosophy, principles, accessibility strategy, measuring achievement of UX goals, data and analytics, UX KPIs, design/development processes, UCD process, HR – UX roles/competencies, HR training, change management and communication strategy) (new component: content) • UX Goals (reason for product existence, tech possibilities and constraints, empathy, brand alignment, scientific understanding of humans [theory], understanding design context, simple design, intuitive design, essential design – only what is needed) • UX Tools (processes available such as evaluation process, standardised questionnaires such as SUS, style guide, user representations, interaction flows) • UX Designer (designer responsibilities, professionalism, approachability, selling design ideas) • UX Design (design presentation, design functionality, design interaction, design attractiveness, compositional layout, emotional considerations, sensual, designing of cross-contextual activities, service coherence, minimalistic design (coinciding goal), consistency)
User	• Emotions (mood, concerns, attitude) • User traits (skills/abilities, specialty/expertise, personal, physical attributes, knowledge/experience, competence, physical health) • Motivators (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy) • Association (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal) • Perceptions (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content)
Product / User interaction	• Touch point (product interaction, product use, touch point orchestration) • Context (usage context – experience driven innovation, context-related tasks, context physical, spatial-temporal – effects of place and time of experience)

	• Experience (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario, temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability)
Agile/Lean	• Agile development (new component)

6.3 CAP_UXF_BID_1.1 Conceptual appreciative practitioner UX framework for BI dashboards

The use of the appreciative inquiry approach enabled practitioners to reflect on what had "worked" in the past and allowed them to steer away from the "problem finder mindset" towards an appreciative optimistic mindset. Following an appreciative approach in researching what is considered important to practitioners in the UX of BI dashboards kept the participants from reverting to the traditional software development culture of identifying problems, blaming and finger pointing. This appreciative perspective is aligned to an aspirational perspective proposed by Toyama (2018). The overtly positive mindset underlying the approach sets the scene for a more balanced and constructive interview environment. Similarly, the practitioners who were interviewed drew from positive past experiences where inclusive discussions in open-plan work environments, making work visible to everyone and working within proximity of one another, allowed for an efficient work environment through ease of communication, collaboration and building trust in teams.

The practitioner interviews revealed what the practitioners had experienced to "work", what they would like to see in future and how they thought that could be made a reality. From the topics that emerged, it became clear that the practitioners considered elements required for the "best" UX of BI dashboards to be much wider than just UX design and evaluation.

From the data analysis of the practitioners' interviews, eight overarching themes emerged: (1) agile software development; (2) change and adaptability; (3) collaboration and communication; (4) product; (5) the agile team; (6) development; (7) users; and (8) UX design [see Table 6.4].

Table 6.4 Major themes from practitioners' interviews (CAP_UXF_BID_1.1).

	Interview Themes	Interview Categories
	1. Agile software development	1. Agile practice and process 2. Continuous improvement 3. Incremental, quick value delivery 4. Measurement 5. Methods of working 6. Resources and infrastructure
	2. Change and adaptability	1. Adaptability 2. Change 3. Experimentation 4. Innovation
	3. Collaboration and communication	1. Collaboration within the organisation 2. Collaboration within the team 3. Communication within the organisation 4. Communication within the team 5. Collaboration with the product users
	5. The agile team	1. Developer role 2. Product owner role 3. UX designer role
	4. Product	1. Business objectives 2. Product requirements 3. Usage
	6. Development	1. Development technical 2. Development leadership 3. Development research 4. Technical feasibility 5. Data
	7. Users	1. User attributes 2. User needs
	8. Design	1. UX Design Strategy 2. UX Design Practice 3. UX Design Process 4. UX Research and Sensemaking 5. UX Testing and Validation 6. Desired experience characteristics 7. UX Dashboard Design

The eight themes were further consolidated, and similar themes and categories were grouped to produce five distinct parts (CAP_UXF_BID_1.2).

The practitioner interviews produced a conceptual Practitioners' UX Framework for BI Dashboards within an agile environment (CAP_UXF_BID_1.2):

- **Agile software development**: Agile practice and processes; change and adaptability; collaboration and communication; the agile team.

- **Development**: Technical feasibility; software development; development leadership; development research; data.
- **Product**: Business objectives; product characteristics (use and experience).
- **UX**: UX strategy, UX design practice; UX design process; UX goals; UX tools; UX designer; education/training of user.
- **Users**: attributes; emotions; motivators (including needs); association; perceptions.

From the interviews, it became evident that the mental models of practitioners consisted of four primary elements: (1) the product being built with its inherent elements such as features, functionality, and usability; (2) the design; (3) the development of the product; and (4) the users of the product. Equally important to practitioners were the meta-elements supporting these four constructs, such as the process being used to develop the software, the ability to change and adapt, the roles involved in this process, and ways to work more optimally, such as collaboration and communication. These meta-elements were identified to be concomitant elements, laterally supporting the four primary elements, and they were deemed to be equally important from the practitioners' point of view, impacting the quality of the product, the efficiency of work and the overall morale of the team.

6.4 VAP_UXF_BID_1.1 Validated appreciative practitioner UX framework

After the primary data collected from the interviews were analysed and structured, the interview findings and survey findings were triangulated to produce the validated framework. [See Table 6.5, Overview of UX framework development.]

Findings from the interviews concur with findings of research confirming the elements required for the best UX of BI front-ends span wider than just UX evaluation, including the wider ecosystem in which the software is being developed. Practitioners emphasised structural and supportive elements such as UX design strategy and technology strategy. Having these foundational elements in place will assist role players in not being hindered by having to build infrastructure and create processes in addition to doing the product work. In an environment where everything is expected to happen at speed, design and technical foundation should be considered to be a basic requirement to do the best work.

Table 6.5 Overview of development of UX framework.

Primary Categories & Secondary Elements	Updated **CL_UXF_1.2**	**CAP_UXF_BID_1.1**	**VAP_UXF_BID_1.1**
Agile software development	x	x	x
Agile practice		x	x
Continuous improvement		x	x
Incremental, quick value delivery		x	x
Measurement		x	x
Methods of working		x	x
Resources and infrastructure		x	x
Software development process		x	x
Change and adaptability		x	x
Adaptability		x	x
Change		x	x
Experimentation		x	x
Innovation		x	x
Collaboration and communication		x	x
Collaboration within the organisation		x	x
Collaboration within the team		x	x
Communication within the organisation		x	x
Communication within the team		x	x
Collaboration with the product users		x	x
Product	x	x	x
Business objectives		x	x
Product requirements		x	x
Product usability			x
The agile team		x	x
Developer role		x	x
Product owner role		x	x
UX designer role		x	x
Team composition		x	x
Development	x	x	x
Software development (Structure seeking development) (Contextual adaptation)		x	x
Development leadership		x	x
Development research (Reflective development)		x	x
Technical feasibility (Feasible development)		x	x
Data (Data quality)		x	x
User	x	x	x
User attributes	x	x	x
User needs	x	x	x
UX design	x	x	x
UX strategy	x	x	x
UX goals	x	x	x
UX tools	x	x	x
UX designer	x	x	x
UX design practice	x	x	x
UX design process	x	x	x
Dashboard design (Data presentation) (Design artefacts)			x

User research (User alignment)			x
Education/Training of user	x		x
Product/User interaction	x		x
Contextual use	x		x
Temporal use	x		x
Situational consequence of use	x		x
Meaningful experience	x		x
Emotional experience	x		x
Aesthetic experience	x		x

6.5 Focus group validation of practitioners' UX framework

The conceptual UX framework (CAP_UXF_BID_1.1) that was produced during the study was evaluated by a group of expert reviewers during an online focus group session. Unlike the practitioner survey that was described in Section 4.5.3.3, which included the themes of UX and Development in the survey for the sake of manageability only, the focus group session included all the major themes that emerged from the interviews conducted.

The online focus group session was held to collect expert feedback by means of an expert review about the Practitioner Framework developed during the study.

Sample size: The focus group consisted of four experts, three of the participants being in design related domains with the occupational titles 'Experience Designer' (Participant A), 'UX/UI Designer' (Participant B) and 'Design Lead' (Participant C). The fourth participant indicated that his title was 'Web Developer' (Participant D).

Geographic locations: Three of the four participants were based in South Africa, and one participant was based in Germany.

See Appendix H for the cover letter and consent form that had been completed by participants before the focus group session.

The framework was evaluated for sufficiency, accuracy, relevance, comprehensiveness, mutual exclusiveness, clarity, usefulness and practicality and transferability [see Table 6.6].

The focus group session commenced with the researcher welcoming all the participants. The researcher provided the background to the study and ethical considerations were adhered to throughout the session. The researcher provided background to the framework. The framework was presented, and the participants then started by discussing the different sections of the framework. The evaluation criteria were presented (see the Framework Evaluation Form used in the focus group session in Table 6.6) and were discussed amongst participants until all the participants were aligned on both the purpose of the framework and the evaluation criteria.

The framework evaluation scores of participants were collected. The summarised results of the expert evaluation of the verified UX Framework are presented in Figure 6.2. The bar chart shows the evaluation criteria on the X axis and the number of participants that selected a specific rating on the Y axis (from 'strongly disagree' to 'strongly agree'). For example, question 1, pertaining to the sufficiency of the major categories had three participants strongly agreeing and one participant slightly agreeing that the major categories of the framework are sufficient, with zero participants being neutral, slightly disagreeing or strongly disagreeing. From the results it can be seen that participants mostly agreed that the framework goals of category sufficiency, accuracy, relevance, comprehensiveness, mutual exclusiveness, clarity, usefulness and practicality and transferability have been met.

Table 6.6 Framework evaluation form (blank) used in focus group evaluation.

Framework Evaluation Form					
Expert Information					
Occupation					
Number of years of experience					
Work location (country)					
	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
Major Categories					
The categories are sufficient to represent, all categories of the domain (Sufficiency)					
There is no overlap detected between descriptions of categories (Accuracy)					
Sub-Categories					
The sub-categories are relevant to the respective major category (Relevance)					
Sub-categories cover all aspects impacting/involved in the major categories (Comprehensiveness)					
Sub-categories are clearly distinct (Mutual Exclusion)					
Sub-categories are correctly assigned to their respective Category (Accuracy)					
Clarity					
The major categories are clear (Clarity)					
The sub-categories are clear (Clarity)					

Usefulness and practicality					
The framework is useful for assessing gaps in the design and development of dashboards (Usefulness)					
The framework is practical for use in industry (Practicality)					
The framework is considered simple enough for the purpose of presenting an overview of major elements required in practice (Simplicity).					
Transferability					
The framework is transferable to the development of other software besides dashboards (Transferability).					

The evaluation of each criterion by the participants during the focus group session will be discussed further in Section 6.5.1 – 6.5.10.

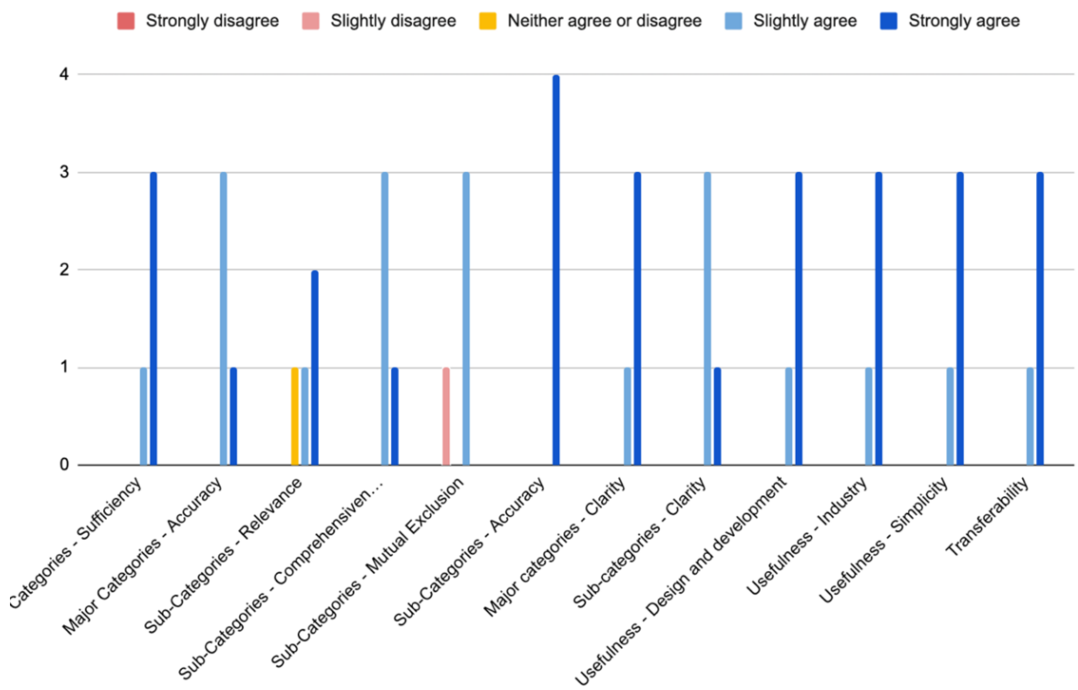

Figure 6.2 Summarised results of expert evaluation of UX framework.

6.5.1 Sufficiency

Participants A, B, C strongly agreed that the framework's major categories are sufficient. This was supported by participant D who slightly agreed that that the major categories are sufficient. No categories were identified as not being needed or were recommended to be removed.

Participant B suggested the inclusion of sub-categories detail when dealing with larger businesses. Participant C suggested the emphasis on the aspects of design that are most important for dashboard design include sharing, saving of analytics and reports, and also data compliance and governance. This also addresses the need of the framework users for having the lower level of detailed information available.

Participant A remarked that the framework encapsulates more than just a UX framework, “I see this as more than a 'UX Framework'. Perhaps a higher level exists, however I'm not too sure about this. I see ‘Development’, ‘Environment’, ‘People and Team’ and then ‘UX’”. Taking this focus group feedback into consideration, the main categories were adapted to separate the areas into their respective operational domains.

6.5.2 Accuracy

Participant D strongly agreed that the major categories are accurate. This was supported by participants A, B, C who slightly agreed that the framework’s major categories are accurate. None of the participants disagreed with the statement that the major categories are accurate.

Participants A, B, C and D all strongly agreed that the sub-categories were correctly assigned to the respective category. This strongly suggests that the sub-categories are correctly assigned to the respective category.

6.5.3 Relevance

Participants A and D strongly agreed that the sub-categories are relevant to the respective major category. This was supported by participant C who slightly agreed, while participant B was neutral about the criterion. None of the participants disagreed that the major categories are relevant.

6.5.4 Comprehensiveness

Participant A strongly agreed that the sub-categories covered all aspects impacting on, or involved in, the respective major category. This was supported by participants B, C and D who slightly agreed with the criterion. Participant D suggested that DevOps be added as a sub-category to the major category of Development; Participant B agreed with this and, additionally, suggested that DesignOps be added to the Major Category of UX Design. DevOps focus specifically on developing and making sure internal users adhere to standards, rules, and practices within the business.

6.5.5 Mutual distinctiveness

Participants A, C and D slightly agreed that the sub-categories were clearly distinct (mutual exclusion), while participant B slightly disagreed with the criterion, suggesting the merging of the major categories related to Agile.

Major categories were intentionally simplified to group domain related categories and separate domains to ensure mutual distinctiveness. However, participants A and B remarked that they consider a UX Leadership higher than the UX Design category with focus on strategy, sense making, etc. as these categories sit outside of what a normal designer would do in his/her day-to-day job. This aligns with the category structure of the Conceptual Framework (CL_UXF_1.2) that was created. Participant B remarked that merging the category of the Agile team into the major Agile category would make sense as they speak to Agile specifically. Participant C also agreed with splitting out UX Design into UX strategy, UX research and design.

6.5.6 Clarity

Participants B, C and D strongly agreed that the major categories were clear. This was supported by participant A who slightly agreed with this criterion. With regards to the sub-categories, Participant C strongly agreed that the sub-categories were clear; this was supported by Participants A, B and D who slightly agreed that the sub-categories were clear.

Participant D suggested that the subcategory “Data” under the category development be defined more clearly. Participant C remarked that the categories within the sub-categories need to be visible, such as understanding data and analytics, data visualisation, animation, etc, to that point the granular view of the final validated framework was developed (see Appendix I).

6.5.7 Usefulness

On whether the framework is useful for assessing gaps in the design and development of dashboards, Participants A, B and D strongly agreed that the framework would be useful. This was supported by Participant C who slightly agreed with the statement.

6.5.8 Practicality

On the practicality of the framework for use in industry, Participants A, C and D strongly agreed that the framework would be practical. This was supported by Participant B who slightly agreed with the statement.

6.5.9 Simplicity

On the simplicity of the framework for the purpose of presenting an overview of major sections required in practice, Participants A, C and D strongly agreed on the simplicity of the framework. This was supported by Participant B who slightly agreed with the statement.

6.5.10 Transferability

On the transferability of the framework to the development of other software besides the design and development of dashboards, Participants A, C and D strongly agreed that the framework would be transferable. This was supported by Participant B who slightly agreed with the statement.

6.6 VAPO_UXF_BID_1.1 Validated appreciative practice-oriented UX Framework

A validated appreciative practice oriented UX Framework for BI dashboards was produced during the study. Based on the feedback from the expert review, the following updates were made to the framework:

- The framework structure was adapted to group related major agile categories as suggested by the experts. Agile related categories were grouped (categories such as 'practice and process' and 'ways of working' and 'resources and infrastructure' with the 'agile team').

- The sub-category of 'DevOps' was added to the category of Development [see Table 6.7].

- A granular view of the VAPO_UXF_BID_1.1 practice oriented UX framework for BI dashboards was compiled for **practitioners**, with the elements that make up the different sub-categories made visible. The lower-level detail was added to aid clarity for use in practice (Appendix I), as the focus group experts pointed out that having the lower-level elements visible in practice would be beneficial. This granular view of the framework can be used in practice as a checklist when designing for BI dashboards.

- The conceptual framework elements were included in the final framework under elements identified from theory.

- The quantitative validation of the major theme **Development** (Q1-Q20) in Section 5.2.4 informed the inclusion of five key factors in VAP_UXF_BID_1.1: **1. Feasible Development; 2. Contextual Adaptation; 3. Structure Seeking; 4. Data Quality; and 5. Reflective Development.**

- The quantitative validation of the major theme **UX Design** (Q21-Q40) in Section 5.2.4 informed the inclusion of four key factors: **1. Dynamic Dashboard Design; 2. Progressive Data Presentation; 3. User Alignment; and 4. Design Artifacts.**

Table 6.7 Development overview of validated UX framework VAPO_UXF_BID_1.1.

Primary Categories & Secondary Elements	CL_UXF_1.2	CAP_UXF_BID_1.1	VAP_UXF_BID_1.1	VAPO_UXF_BID_1.1
Agile software development	x	x		x
Agile practice, ways of working & process		x		x
Continuous improvement		x		x
Incremental, quick value delivery		x		x
Measurement		x		x
Resources and infrastructure		x		x
Experimentation & Innovation		x		x
Change & Adaptability		x		x
Collaboration and communication		x		x
Team composition		x		x
Developer role		x		x
Product owner role		x		x
UX designer role		x		x
User	x	x		x
User attributes	x	x		x
User needs	x	x		x
Product	x	x		x
Business objectives		x		x
Product requirements		x		x
Product use (contextual, temporal and situational consequence of use)	x	x		x
UX design	x	x	x	
UX strategy & goals	x	x	x	x
UX design practice	x	x	x	x
UX design process	x	x	x	x
UX research & sensemaking (User alignment)		x	x	x

UX testing & validation		x	x	x
Usability & experience characteristics (meaningful, emotional, and aesthetic)	x		x	x
UX Dashboard design (Dashboard design, Data presentation, Design artefacts)		x	x	x
Development	**x**	**x**	**x**	**x**
Software development – technical (Structure seeking development)		x	x	x
Development leadership		x		x
Development research (Reflective development)		x	x	x
Technical feasibility (Feasible development)		x	x	x
Data (Data quality)		x	x	x
DevOps (Contextual adaptation)			x	x

The legend below indicates *where* a concept is anchored in the practitioner views within the appreciative inquiry phases:

Discover

Dream

Design

Deliver

6.6.1 Agile software development

The primary category of agile software development encompassed the agile-related concepts (except for the practitioner roles) such as agile practice, ways of working and process, continuous improvement, incremental, quick value delivery, measurement of delivery, resources and infrastructure, experimentation and innovation, change and adaptability and collaboration and communication.

6.6.1.1 Agile practice and process (incl. ways of working)

What works in practice: context, benefits of development at increased speed, research, experiencing the practice first-hand, not just about ceremonies and mechanics, but about practising agile as a philosophy. Prioritisation of work, clear activities, and deliverables accessible to everyone in the organisation. Outcome driven work, tracking of development, daily stand-ups, sprint planning, use of white boards and stickies, online boards, backlog prioritisation, backlog grooming, team determines process, team ownership of product.

How can it be made better: improve agile processes, planning, prioritisation, master agile basics, by accepting responsibility teams can become accountable, commitment from team to own work, measure the improvement of the incremental delivery, adoption of agile practices, critical agile ceremonies (constant sync ups, stand-ups, planning ceremonies and retrospectives), short sprints, deadlines, blocked out time, transparency within team, flexible work environment, co-location or remote working where possible, research is valued, design should be included in process upfront, innovation encouraged, adaptability, open to change, positive attitude, clear ownership of work, individual responsibility, team members are equal, team respect, empowered team, focussed team.

6.6.1.2 Continuous improvement

What works in practice: consciously striving towards continuous improvement, looking for ways to improve continuously, continuous polishing of work, continuous support, continuous participation towards progress, continuous research, continuous improvement as a continuous process and not something that will cease at some point, to continue as software delivery continues.

How can it be made better: learn continuously, freedom to make products that customers love, commitment to improve the product continuously after delivery, improvement of a product through incremental delivery.

6.6.1.3 Incremental, quick value delivery

What works in practice: length of work not fixed, flexibility to adapt to work, team's level of comfort to move through the development phases impact delivery, efficiency in development of the product for immediate use, the building of pieces (features) for the dashboard, the part that efficiency played in a quicker return on investment.

How can it be made better: the importance of iterations in agile work must be understood; each increment of development would give back to the user and where each increment would contribute towards customer value, importance of the process, order and manner of execution, feature richness of each delivery in a consistent iterative way, short increments facilitate the optimal way for learning to happen, providing contained periods where new knowledge could be applied and tested in the increment. Building and releasing the smallest possible pieces of *value* to customers as soon as possible. This will speed up delivery and also the rate of continuous customer feedback.

6.6.1.4 Measurement

What works in practice: measurement, of product, features, performance, this allowed the product owner/manager to measure whether what the team had built was worthwhile, beneficial for stakeholders to improve understanding of what they have asked to be built.

How can it be made better: the availability of system analytics to measure consistently and accurately, success estimates must be defined and tracked through analytics. Measuring the use of the product through continuous testing and analytics post development and release, tracking whether people are using what has been built in the expected way, using data to refine the product continuously, to measure the impact of changes made, feedback from customers is essential in measuring performance of a product, what it is used for and what value it is adding.

6.6.1.5 Resources and infrastructure (incl. the agile team)

What works in practice (from agile team perspectives):

- Development: software developers with a specific focus, passion for getting software to production phase, developers that were critical and precise, development team lead to guide, motivate and protect developers.

- Product owner: discipline to get agile basics right, organised, keeps track of past and future work, fully understands agile software development, leads the team, ensures stable backlog, prioritises work in team, overcomes challenges to deliver, fairness, good social skills, ability to sell the UX to the team and stakeholders.

- UX Design: able to think at a high level as well as to focus on detail, balance and negotiate user requirements, business, and technical constraints, promote usability testing, mentor and develop designers in team, upskilling and re-skilling designers, understand basics of other roles in team.

How can it be made better: research funding, enough budget to do work, access to users, high quality resources, stable connectivity, access to databases and systems, enough time to do work properly, suitable software, infrastructure, processes to support work.

Team members having an appreciation of team roles and processes:

- Development: having development lead to make building more effective, developers who are critical and collaborative, who are open to constructive criticism and feedback, developers to grow their skills, being empowered to contribute more.

- Product owner: face and voice of the product, understand the product being built, responsible for coordinating events in team, manage work and lead team, track work, driving work to delivery, has clear vision of way forward, clear product strategy, make work and planning visible, keep objectives in scope, make sense of customer research, understand the problems to be solved, protect the team, enable team members to succeed, work towards getting the team on the same page, allow the team to get along, able to talk the same language as developers and designers and translate between them, connecting different roles, needs extensive business knowledge, have sight of risk factors, decide on product compromises, needs autonomy to make decisions without interference from company politics.

- UX Design: need creative thinking to create logical picture, create and test concepts at speed, self-leadership, initiating product momentum, run workshops, understand topics in depth, find hidden opportunities.

6.6.1.6 Experimentation & Innovation

What works in practice: having room to explore the unknown and discover new things to generate value that is carried throughout the process, the desire to want to improve things, finding hidden opportunities to uncover innovation opportunities, creative problem solving to find a way forward when there seems to be none.

How can it be made better: look for opportunities to run experiments, ability to try new things without fear of failure, accepting trial and error as part of the process towards improvement, experimentation to identify what deserves attention, allowing for reflection on what has been learnt through experimentation, find new ways to advance the product, being encouraged to innovate, being able to explore the characteristics of products people love, to have space to innovate and experiment.

6.6.1.7 Change & Adaptability

What works in practice: awareness of change at different levels (team, process, organisation, technology, customer), being prepared to adapt processes, adaption of processes in relation to scenario requirements, ability to adapt and respond to change.

How can it be made better: cultural change at an organisational level required to accept change and lead from the top, change from self-serving to serving another to help achieve other people's goals. Expect change, work to limit impact of change. Environment should allow for flexibility of practitioners to adapt the process where needed. Search out change to stay relevant with progress made (by external factors such as technology and changed environment). The output (product) needs to have relevance to the customers.

6.6.1.8 Collaboration & Communication

Mentioned by practitioners to be essential for effective software development as well as the success of the product.

6.6.1.8.1 Collaboration & communication within the *organisation*

What works in practice: initiate collaboration, collaboration spans across the team, stakeholders, enablers and customers, collaboration during all phases of software development, collaboration in an interactive way, search for the information needed to continue work, making planning visible, aid communication of work and timeframes, clear roadmaps visible to entire organisation. Collaboration required where legacy dependencies exist.

How can it be made better: cross-functional collaboration in the organisation should include, but not be limited to, business owners (from marketing to finance to business), network of stakeholders, involve stakeholders early on to improve quality of discussions, stay close to sponsorship layer, ensure vested interest in product. Educate and inform stakeholders to build an understanding of what they ask from teams, share learnings outside of the team, what has been discovered and how thinking evolves. Socialisation of work in company to increase visibility and improve communication, continuous and regular communication throughout product development iterations. Cross-functional tech to assist delivery better. Understand flow of information in the organisation, address challenges of communication between business and team.

6.6.1.8.2 Collaboration & communication within the *team*

Practitioners emphasised the importance of a collaborative environment, especially effective collaboration within the team.

What works in practice: collaboration to move towards clarity together, collaboration at early stages of design reviews, collaboration to utilise combined knowledge to determine the workability of ideas, to form effective feedback loops, capture information, coordinate collaboration time, coordinate flow of ideas, coordinate resulting work and discussions, collect as much information as possible early on. Communication should be clear; a routine of ethical principles to guide communication and way of working provides a solid foundation for communication in the team.

How can it be made better: participative development to deliver quality product, cohesive team, partnership in building products, collaboration with developers to test ideas quickly, design reviews, quick feedback cycles, developer code reviews, critical but collaborative team members, design representation in the team from start to finish, inclusion of design in teams that deal with organisational problems. Co-ownership of work to ensure durability and maintenance of the product. Communication in the team should happen openly, have transparency in the team, separate space for sensitive conversations, people should primarily speak to one another, convey ideas openly, consult with team members, ensure communication channels are open, talk about goals, have a space for interactive communication, practice and grow communication skills.

6.6.1.8.3 Collaboration with the product users

Collaboration with users was identified by practitioners as a critical requirement contributing to the success of the best UX for BI dashboards in an agile environment.

What works in practice: it is critical to collect information from users about what they need, collect feedback from users, to collaborate with users to design products, to utilise continuous iterative process to design test and refine requirements with users, to produce authentic user journeys, to facilitate critical thinking between designers and users, to enable the validation and testing of designs (and sequencing of tasks and screen flows), showing conceptual designs to users before they are worked on further, designer and user together shape and adapt ideas, collaboration with users improves product buy-in and assists in developing a product of value.

How can it be made better: having access to many users to collect information and test with, collaborating to find new innovative ways of addressing customer problems, customer collaboration allows for insight of what is needed. Collaboration with users at all levels to avoid building for a specific sub-set of customers, including users in beta testing, showing benefits to customers to aid acceptance and adoption. Continuous participative decision making with the customers, focus on user feedback and sharing value delivered with customers continuously.

6.6.2 Users

From the conceptual (theoretically based) framework, the following key areas have been identified pertaining to the user: **emotions** (mood, concerns, attitude); **user traits** (skills/abilities, specialty/expertise, personal, physical attributes, knowledge/experience, competence, physical health); **motivators** (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy); **association** (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal); **perceptions** (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content)

6.6.2.1 User attributes

How can it be made better: understand the product user's attributes, the user's abilities should be purposefully designed for.

6.6.2.2 User needs

What works in practice: user needs should be understood before the development of a product starts; the best and most flexible technology will not help if the user needs are not met.

How can it be made better: collaborate with users to gain visibility of user needs, utilise data from different sources (system and user) to gain a view of user needs, research and identify the cause or reason of the user need to avoid symptomatic design to treat user needs.

6.6.3 Product

From the conceptual (theoretically-based) framework the following key areas have been identified pertaining to the product: **touch point** (interaction with device); **context of use** (usage context – experience driven innovation, context-related tasks, context physical, spatio-temporal – effects of place and time); **experience** (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario, temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability); **perceivable elements** (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status); **use** (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise, diagnose, and recover from errors); **features** (meaningfulness, quality, security, performance); **support** (pedagogical appropriateness, help, documentation and education/training); **content** (content fluency – right data, timely data, time relevant data).

6.6.3.1 Business objectives

☐ What works in practice: a thought-through business case.

☐ ☐ How can it be made better: understand why something is being built, what is the purpose, having success criteria, business objectives, suitable business requirements, place for customer requirements, business objectives to form part of a product plan, business strategy to inform the product strategy, business case and supporting customer case to determine real need for feature before commitments are made to start up a team, clarity of business requirements to derive product requirements.

6.6.3.2 Product requirements

☐ What works in practice: knowing the product expectations from the start to work towards a clear endpoint, clear view on end purpose of software supported product requirements, meeting product requirements required a stabled backlog, team to understand the scope of work well for development estimates and actual development timeframes, deciding on what would be included in the product requirements; requirement selection should not be at the cost of experience.

How can it be made better: clear product vision to lead the requirements, forming part of a product strategy, clear roadmap, prioritised backlog, guidelines for product requirements (MVP in terms of experience requirements, and functional features) clear constraints to allow for focussed work, understanding the product requirement's purpose and the ability to change scope if necessary to bring value to customers; the success of the product should be measurable once delivered.

6.6.3.3 Product use

What works in practice: refine the product with users, test products with beta users. Build an understanding about the use of the product, not just through system generated data on the use of the product (what users are doing – systems view of interaction) but also from the user feedback on the use of the product (why they are using the product in a certain way – user view of interaction).

How can it be made better: understand how users are using the product, people element needed to understand why users are doing something, real test is understanding the software use by users in the real-world post release.

6.6.4 Design

From the conceptual (theoretically-based) framework the following key areas have been identified pertaining to design: **UX strategy** (brand, UX mission, UX philosophy, principles, accessibility strategy, measuring achievement of UX goals, data and analytics, UX KPIs, design/development processes, UCD process, HR – UX roles/competencies, HR training, change management and communication strategy); **UX goals** (reason for product existence, tech possibilities and constraints, empathy, brand alignment, scientific understanding of humans [theory], understanding design context, simple design, intuitive design, essential design – only what is needed); **UX tools** (Processes available such as evaluation process, standardised questionnaires such as SUS, style guide, user representations, interaction flows); **UX Designer** (designer responsibilities, professionalism, approachability, selling design ideas); **UX Design** (Design presentation, design functionality, design interaction, design attractiveness, compositional layout, emotional considerations, sensual, designing of cross-contextual activities, service coherence, minimalistic design [goal coinciding], consistency).

6.6.4.1 UX design strategy

What works in practice: to have a clear design strategy for the UX team to follow, for example dual track design, a common and agreed understanding of the purpose of UX, effectively onboarding designers into the design team and agile teams, understand the business landscape, understand the business objectives, understand the technical environment in which the product needs to be developed, common understanding required in the organisation that every little decision can have far reaching consequences on the UX.

How can it be made better: having and following the design strategy (such as dual track designing and delivering strategy or the double diamond approach approach) for the design team, have a vision for the UX that is designed such as inclusive design, knowing the customer, primarily designing for people by providing guidance to the design team in using an established interaction model, utilising suitable design methodologies, utilising a design system to optimise designer efficiency, to improve consistency and control quality. Having a foundational understanding of what UX is in the organisation, what the expectations of UX practitioners are and having an executive level champion for UX design in the organisation. The understanding of the purpose of UX should facilitate the inclusion of UX in the entire life cycle of any product work from the initial phases of project inception. The strategy should include UX design producing designs that support a unified brand and consistent user interface. Design team members should be developed, and opportunities created for them to learn and grow their careers. Importantly design infrastructure should be laid and processes established to support design work, so that designers can focus on work and not on building design infrastructure.

6.6.4.2 UX design practice

What works in practice: getting the conceptual design right, sketching out many options was helpful during conceptual design stage, designers should be prepared to discard ideas and look at the holistic design of solutions. Understanding the business environment and balancing the business objectives and goals with user needs, understanding the technical constraints. Utilise *personas* where appropriate, map out different user flows and user journeys, incorporate a modular approach to design to make flows flexible, make the designs visible to the design team.

How can it be made better: designers should be supported and enabled to design with confidence, designers should be able to work ahead (clear roadmap), UX designers should also be able to work at speed when required to test concepts quickly.

6.6.4.3 UX design process

What works in practice: having senior or lead designers when designing, making use of an iterative design process to get to a fit-for-purpose design, including users in iterations, for users to articulate wants and needs, the inclusion of visual design in user collaboration sessions. Process should include requirements, specifications, initial research, conceptual design, refined design elements, prototyping, testing and development to produce a minimum viable product.

How can it be made better: realising that, in reality, design does not always follow the same process, the team's willingness to accept and accommodate that, having a well-tested concept, sufficient time should be spent on research, having a refined problem statement, validation of pain points, evolution of solutions, assurance that right user problem is being address in the right way, process to provide designers with confidence in decision-making within design, continuous testing and validating of work at different stages of process.

6.6.4.4 UX research and sensemaking

What works in practice: researching as much as possible, even the smallest robust amount of research is valuable, multiple iterations of research (to improve understanding of user, business, technical), fieldwork to provide clarity and certainty, articulation of real needs in clear language, research included identifying the data needed, collection of the data, synthesising the data, identifying connections within the data to support the sensemaking of the data, supporting user needs for customised products.

How can it be made better: continuous research is necessary, research enables experience discoveries, research required for deep understanding of the root problem, research required for alignment between user needs and 'jobs to be done' by the product, for clarity of problem, clarity of the requirements, clarity about the reason for design, mindfulness about what and why something is being designed, field studies on problem, understanding the user needs and problem before designing, understanding unique customer needs, ability to provide custom customer solutions, collect information from stakeholders for clarity, content required, product familiarity, sharing of research findings with team and stakeholders.

6.6.4.5 UX testing and validation

What works in practice: testing of concepts and refined solutions, using the right level of UI fidelity for the stage of testing (for example, low fidelity testing for concepts and high fidelity for detailed and refined designs) visual/prototype-based testing to aid user understanding, test towards clarity of design and certainty of requirements, testing effectiveness of design,

How can it be made better: continuous incremental testing also during delivery of product (pre- and post- delivery testing), experimental testing of ideas, dedicated place for testing, mindfulness, and consideration of consequences of testing, structured channels to feedback testing results, proper participant selection, clear testing criteria, testing in the intended environment of use, additional use of analytics, the testing of non-customers for additional perspective on products.

6.6.4.6 Usability and experience characteristics

What works in practice: design towards and experience where training of the user is not required for use of product, design towards simplicity, ease of use, usability should be proven, usefulness should be proven, effectiveness should be proven, product appreciation by user, product tested to be perceived as friendly, enjoyable, exciting, pleasurable to use routinely.

How can it be made better: ensure alignment between team and end user of contextual use of product and at conceptual design stage to create something useful, functional, that satisfies the need of the user, for the user to have control and ease of use, and ease of information consumption, complexity should be hidden.

6.6.4.7 UX dashboard design

What works in practice: surfacing the essence at the top level of the dashboard, surfacing important lower level info on the dashboard, ability to drill down into information of interest, ability to customise level of information displayed, useful combination of elements, design to be fit for context of use, designers should have experience and an understanding of multi-level data when designing dashboard interfaces, the structure and use is not the same as traditional information architecture or interface with ‘linear navigation’, functionality prioritised during design then incremental usability improvements, features prioritised based on usefulness to the user, surface relevant elements, surface potentially time sensitive information, visual nature, use of visualisation, use of comparative features, use of visualisation of important information, representing same data in different ways to aid understanding of data, use of visualisation to improve understanding of complex concepts, reflection by team members on dashboard design, gauging the ability of the user to consume the information presented.

How can it be made better: looking for ways that the dashboard can support complex data more effectively, looking for improved ways to present data and information visually to users, to organise data for mobile interfaces visually, having purposeful data views, different data level views, users need to be able to move up and down, forward and backward in data structure, use of motion communicative design, understand relationships between data, importance of researching information journey, and ideal navigation, use of language, focus on user goals (KPIs or KPAs) for design direction as opposed to a user *persona* focus, the linking of time management functionality of information presented on the screen to user need to initiate information driven action, make decisive information available to the user.

6.6.5 Development

The development of the software played a significant part in the ecosystem of what constitutes the best UX for dashboards. From the theoretical elements gathered were included: **possibilities** (technical possibilities); **challenges** (technical challenges, technical constraints); **support** (technology support – context).

6.6.5.1 Technical development

What works in practice: developing new versions of software in parallel, version control, development of feature toggles, use of tools to chunk stories, making use of the development of individual components, component matrices to allow for quick component selection, using technology the team preferred.

How can it be made better: identifying problematic data requirements, accurate data visualisation, optimal data rendering on dashboard, developer knowledge. Thought through use of biometrics, more component-based design and development, code isolation, use of up-to-date technology, automated delivery where possible, making assets available to developers, continuous feedback from customers, tracking performance improvements, use of DevOps practices, continuous deploys, continuous integration systems and continuous monitoring.

6.6.5.2 Development leadership

What works in practice: an appreciative leader, strong tech leadership through clear tech vision, a leader that executes with foresight, leadership to be in step with tech trends and motivate developers to learn new technologies and try new technologies, technical mentorship to develop and grow developers.

How can it be made better: tech leadership that mentors more junior developers and keeps an eye over team members, protects team members from burnout, to keep team members motivated and balanced, tech leadership to lead the development of software in the team effectively and to deliver on a continuous basis.

6.6.5.3 Development research

What works in practice: significant technology exposure in past projects, rushing into using new tech without exploring it properly first should be avoided.

How can it be made better: having the freedom to stay relevant with new tech through continuous research, spending the largest portion of time on actual development of software, but having time to reflect on work, to explore how and with what developers work.

6.6.5.4 Technical feasibility

What works in practice: compatibility of tech to designs, matching technological constraints to design concepts in the most effective ways.

How can it be made better: explore the initial plan of the design for data availability and ideal data format, understand the technical viability of the product, test the feasibility of the desired functionality.

6.6.5.5 Data

What works in practice: dashboard visualisation to display data on dashboards, up-to-date data, accurate data, data relevance, meaningful data, data performance and reporting on data performance.

How can it be made better: having accurate data in the end product, data that reflect the logical perspective, access to the right information for team members to do their jobs, ability to retrieve data and have useable, clean data, analyse the data, understand the data, ability to process data at different levels, processing data at different speeds, having robust data.

6.7 Chapter summary

Chapter six has presented the results and findings obtained from the research. These included the results from the conceptual literature-based UX framework which created the evolution and development of the conceptual literature-based UX framework, the practitioners' framework created, the validation of the practitioners' framework with a focus group session that conducted an expert evaluation on the proposed UX framework. The feedback from the expert evaluation was synthesised and analysed to inform changes to the validated UX framework. The final validated framework that was utilised after the triangulation of results from the literature-based conceptual framework, the interview-based practitioners' framework and the focus group informed practitioners' framework was then presented.

The chapter objectives have been addressed through the following:

- The updated original conceptual literature-based UX framework (CL_UXF_1.2) developed during the research was presented in Section 6.2.

- The practitioners' framework (CAP_ UXF_BID_1.1), formed by categories that emerged from the practitioner interviews, was presented in Section 6.3.

- The validated practitioners' framework (VAP_UXF_BID_1.1), validated by a larger sample of practitioners via a survey, was presented in Section 6.4.

- The feedback from the expert evaluation on the conceptual practitioners UX framework was presented in Section 6.5.

- The final, updated UX Framework (VAPO_UXF_1.1) for BI Dashboards was presented in Section 6.6.

Following the results presented in this chapter, the thesis is concluded with a high-level overview of the study, the researcher's reflection on the study and a summary of the contribution of the research in Chapter 7.

Chapter 7

Conclusion

Chapter 7 follows from the data results and findings presented in Chapter 6. Chapter 7 aims to conclude the presentation of the research. The chapter commences with Section 7.1 which provides an overview of the research; Section 7.2 presents the research contributions; Section 7.3 presents the research limitations recommendations and contextual considerations; Section 7.4 presents the research recommendations; and the chapter is concluded with Section 7.5 where the research insights and a reflection on the study are shared.

7.1 Research overview

The main question was, 'What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?' Figure 7.1 depicts the major research inputs, activities, outputs and how the resulting outputs were validated and triangulated to culminate in the Validated Appreciative Practice Orientated UX Framework for BI Dashboards (VAPO_UXF_BID_1.1).

The research went through multiple phases of convergent and divergent flows in that it started with the systematic literature review and focussed on UX frameworks specific to BI. The results spanned much more widely than originally anticipated usability and UX elements to include strategic UX enabling elements, producing the CL_UXF_1.1, an original conceptual UX framework for BI front-ends. This framework was updated to Framework CL_UXF_1.2 with the addition of new literature. In addition, the study produced a conceptual appreciative practitioners' framework from the interviews conducted, Framework CAP_UXF_BID_1.1, and validated an appreciative practitioners' framework for BI Dashboards VAP_UXF_BID_1.1.

The study triangulated the elements emerging from the practitioners' interviews (CAP_UXF_BID_1.1) with the results from the focus group (Framework VAP_UXF_BID_1.1) and the granular view of the updated conceptual framework (Framework CL_UXF_1.2) [see as depicted in Table 6.7]. The resulting UX framework from an appreciative international practitioners' view for BI dashboards is proposed in Section 6.6 (Framework VAPO_UXF_BID_1.1)

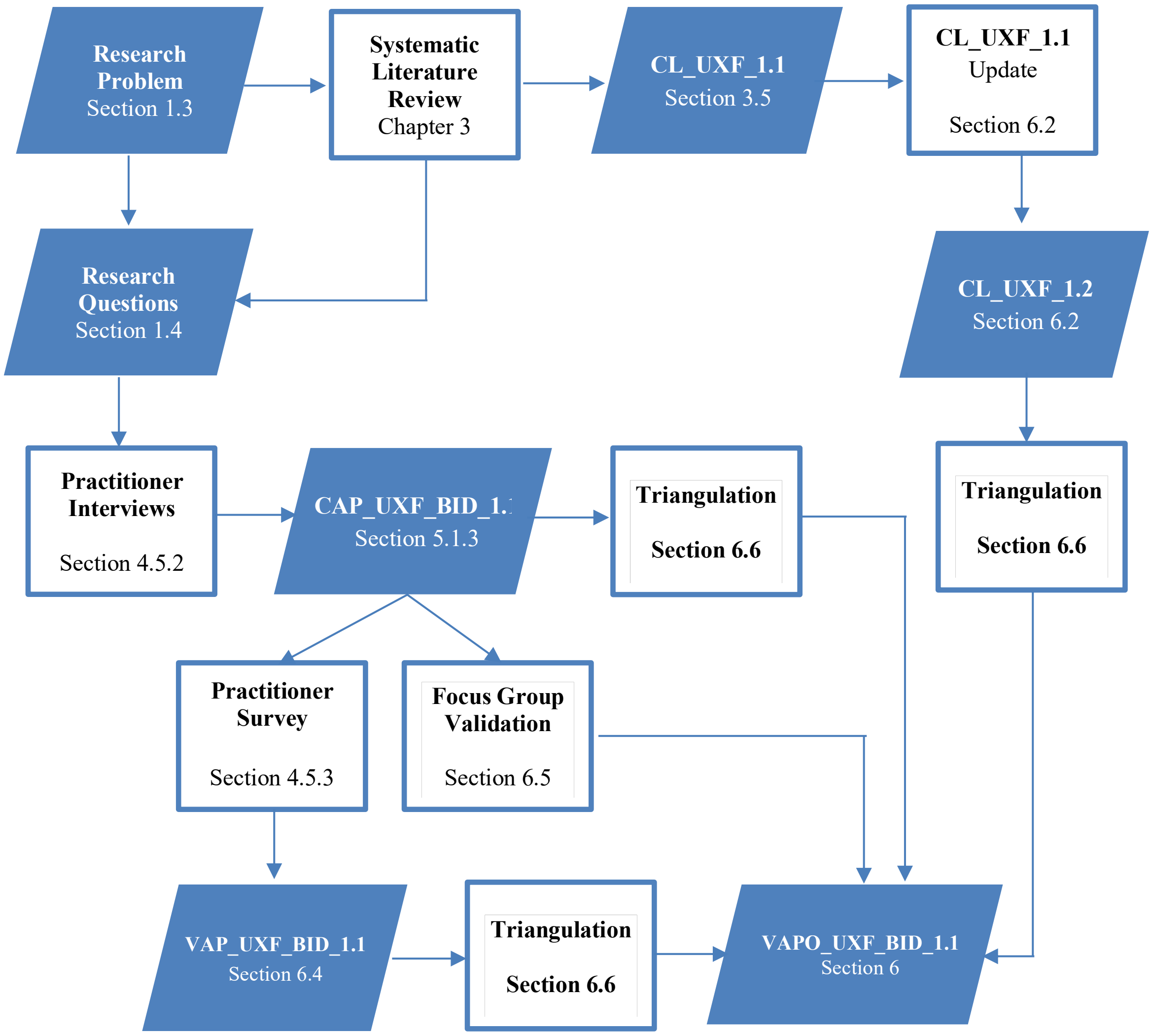

Figure 7.1 Research process overview.

The exploration into the world of practitioners started by asking practitioners about the elements required for the best UX and the answer to that question was much wider than anticipated. The practitioners' view of a connected ecosystem where products are grown and nurtured emerged, shedding light on how, through a collective, carefully coordinated effort, BI products are designed and developed to where users can optimally use and enjoy working with BI dashboards. The multitude of elements identified was then scaled down to make the validation of the elements more manageable. Through triangulation and the focus group session the elements diverged again to provide a multifaceted and dynamic view of the elements required for the best UX of BI dashboards in an agile software development environment. In support of the research questions, Table 7.1 relates the research question and research sub-questions to the chapter in which the relevant investigation was presented:

- the research strategy;
- data gathering methods; and
- data analysis method.

Table 7.1 Research questions by chapter, strategy, data collection and analysis method.

Research questions		**Chapter**	***Research Strategy***	***Data gathering methods***				***Data analysis methodology***	***Data triangulation***
PRQ	*What are the essential elements required for the best UX of BI dashboard interfaces within an agile software development environment?*	Chapters 3, 5, 6	Deductive, Inductive	*Systematic literature review*	*Semi-structured practitioner interviews*	*Structured practitioner questionnaire*	*Practitioners focus group session*	Mixed Method	Data point 1, 2, 3
SRQ 1	What are the essential elements that influence a UX framework for BI dashboards based on **literature** reviewed?	Chapter 3	Inductive	x				Qualitative	Data point 3
SRQ 2	What are the **practitioners' perspectives on the elements** that influence the UX of BI dashboards?	Chapter 5	Inductive		x			Qualitative	Data point 1
SRQ 3	What **elements are essential to a validated** UX framework for BI dashboards?	Chapter 6	Deductive, Inductive			x	x	Quantitative, Qualitative	Data point 2

It is concluded that practitioners identified four principal elements required for the 'best' UX of BI dashboards: (1) the product being built with its inherent elements such as features, functionality, and usability; (2) the design; (3) the development of the product; and (4) the users of the product. Equally important to practitioners were the meta-elements supporting these four constructs, occurring with the primary four constructs, such as (1) the process being used to develop the software; (2) the ability to change and adapt; (3) the roles involved in the process of software development; and (4) ways to work more optimally such as collaboration and communication. These meta-elements were identified to be concomitant elements laterally supporting the four principal elements, and were deemed equally important from the practitioners' view, impacting the quality of the product, the efficiency of work and the overall morale of the team.

The elements identified as required for the "best" (appreciative inquiry term) UX of BI dashboards included four main pillars namely, product, design, development, and user, with supporting and equally important concomitant elements grouped under agile software development which included agile practices and processes, change and adaptability, collaboration and communication, and the agile team members. These results concur with suggestions from previous research to investigate organisational processes as part of the UX framework for BI.

Using an optimistic approach in discovering what works 'best' and 'what could be' (as per appreciative inquiry terms) provides an original perspective in a field where the need to focus on problem solving and critical constraints can limit creativity. Therefore, this strengths-based perspective is suggested to inform the practitioners' UX framework for BI dashboards.

The findings confirm the relevance of existing BI UX framework elements with the addition of supporting concomitant elements which are equally important to practitioners. This study produced a theoretical contribution in the form of an updated UX framework for BI dashboards from an appreciative view of international practitioners. It also contributed methodologically by using an appreciative inquiry approach in the context of researching computer information systems, UX and BI.

The fact that a product is being used does not determine a product's success. The research with practitioners confirmed the literature that usability has been superseded by UX when considering what elements are required for the best UX of BI Dashboards. The best functional tools cannot compete with tools providing the complete experience.

"I think the problem is that so what I have experienced here is that oh well the product is being used so it is successful, that actually means nothing, so how is that product being used, what is it being used for, what value is it actually adding"

~ Participant_A_PO1 ~

From a practitioners' view, the development environment and processes adopted in the environment in which the product is being developed are equally as important as the product being developed. For future research, the institutionalisation of strategic UX to address gaps in UX infrastructure has been identified as a topic for consideration.

7.2 Research contribution

The following contributions were made during the course of the study.

7.2.1 Theoretical contribution

In terms of contributing to the extant academic literature, the study has produced the following theorizations:

- Chapter 3 presented the original conceptual UX framework for BI dashboards based on the systematic literature review conducted (conceptual literature-based UX framework, CL_UXF_1.1 (published as Jooste, C., Van Biljon, J.A., and Botha, A., 2018).

- A contribution has been made to the need for a validated UX framework specific to BI dashboards through the research conducted in this research.

- An original practitioner-based UX framework based on the collection of primary data through interviews conducted with practitioners (practitioner UX framework, CAP_UXF_BID_1.1).

7.2.2 Methodological contribution

In terms of contributing to methodologically, the study has demonstrated:

- The use of mixed methods in the research which provided an example of how an explorative sequential mixed methods design with instrument development was used in a study in an agile software development context.

- The use of appreciative inquiry within the domain of Information Systems.

In terms of contributing methodologically, the study has produced:

- Chapter 4 presented the original theoretical research design framework (TRDF_AAAL_1.1) that was developed to support and guide the research. This framework included interdisciplinary concepts such as the logic model and the use of appreciative inquiry as an underlying philosophy. Incorporating theory in the study through the use of a theoretical framework reinforces the research, providing stability and structure (Savaya & Waysman, 2005).

- The study produced an original conceptual contemporary UX design framework within the philosophy of appreciative inquiry (CAP_UXF_BID_1.1).

7.2.3 Contribution to practice

This research also has value for industry and organisations. This framework can be utilised in practice as a checklist of elements that are needed for the best UX of BI dashboards in an agile software development environment. The elements span across the software development process and pertain to pre- and post-software delivery.

In practice contributing to individual practitioners, the study has produced:

- An original validated practitioner-based UX framework validated by a larger sample of practitioners through the collection of primary data from practitioners (validated practitioner UX framework, VAP_UXF_BID_1.1). These validated elements can be used by UX designers and BI dashboard software developers as a guide to work towards the best UX for BI dashboards.

- A final refined and triangulated framework to guide practitioners on a granular level (VAPO_UXF_BID_1.1), see Appendix I.

These research outputs address the study objective to identify what elements are required for the 'best' UX of BI dashboards within an Agile software development environment. [Table 7.2]

7.3 Limitations and contextual considerations

The study had to navigate the following limitations:

- The interview sample was limited to the three roles: UX designer; product owner; and developer. The agile team comprises of many more roles, such as scrum masters, business analysts, security engineers and quality assurance (QA) testers.

- The sample size for the practitioners' survey is acknowledged as a limitation in the study. The limited number of participants was due to the specialised nature of the research domain, specifically identifying participants who had worked on BI dashboards within an agile environment.

- The sample size of the focus group is acknowledged as a limitation in the study.

- The lack of product representation in the focus group session is acknowledged as a limitation, where the aim was to have a focus group with a balanced representation of all three roles that participated in the preceding stages of the research.

- The COVID pandemic outbreak influenced the way practitioners thought about the work environment, especially the topic of teams having to be co-located to be effective. This was the viewpoint of practitioners before the outbreak. The viewpoint on the necessity of the co-location of team members, started to change during the time of COVID (2020-2021) where teams had no choice other than to work and collaborate in a remote manner; this challenge has enabled teams to develop the practice of agile as still to be effective and remote working is even a preference for some team members. Where teams preferred to be co-located previously, they could now collaborate from anywhere around the globe.

Table 7.2 Research contribution overview per chapter.

Chapter	Objective	Relevance	Contribution
1 **Introduction**	• Introduce the reader to the research. • Provide an overview of the study to the reader.	• Positioning the research within the current disciplinary field.	• *Raising awareness of the UX for BI dashboards.* • *Raising awareness of cross-disciplinary methods of inquiry within Information Systems.*
2 **Domain Orientation**	• Provide the novice reader an orientation to the domain. • Linking the research to existing disciplinary concepts.	• A subject matter expert could skip the second chapter and fast track progress through the document should domain orientation not be required or relevant.	• *Bringing the novice user up to speed with key concepts and supporting literature.*
3 **Theoretical Foundation**	• Present SLR. • Present compilation of conceptual literature-based UX framework for BI dashboards in an agile software development environment.	• The need for a UX framework specific to BI dashboards was addressed.	• *Conceptual UX Framework for BI.* • *Novel Theoretical Framework to guide study.*
4 **Philosophical Viewpoint** **&** **Research Design**	• Present the researcher's philosophical viewpoint and approach to the research. • Present the overall research design, the methodology followed, why it was chosen, what it comprised of who was involved, how and when it was conducted.	• The gap between theory and practice will be addressed through a pragmatic research approach. • The gap between theory will be addressed through collecting data from practitioners in the field.	• *Interviews conducted and data collected with participants in the field.* • *Survey conducted and data collected with participants in the field.*
5 **Data Analysis**	**Qualitative Data Analysis** • Present the analysis of the data collected from the practitioner interviews. • Present the practitioners UX framework for BI dashboards.	• The need for a UX framework specific to BI dashboards as experienced by Agile Practitioners was addressed.	• *A Practitioners Framework for the UX of BI dashboards*

	Quantitative Data Analysis • Present the descriptive factor analysis performed on the data collected from the practitioner survey. • Present the inferential factor analysis performed on the data collected from the practitioner survey.	• The need to validate and ensure rigour is applied in search for a UX framework specific to BI dashboards as experienced by Agile Practitioners was addressed that will add value to practitioners in practice.	• *A Validated Practitioners Framework for the UX of BI dashboards*
6 **Results & Findings**	• Present the validated practitioners UX frameworks for BI dashboards.	• The need for a UX framework specific to BI dashboards was addressed to expand academic knowledge on the topic of UX for BI dashboards. • The practice of Agile in software development is a current reality, the UX framework will enable practitioners to know what is required for the best UX of BI dashboards in practice.	• A Validated Practitioners Framework for the UX of BI dashboards.
7 **Conclusion**	• Conclude the research to the user.	• Provide an overview of the study to the reader.	• Summarise the contribution of the research within the current disciplinary field.

7.4 Recommendations

The following recommendations are made resulting from the research.

7.4.1 The need for strategically driven UX

From the practitioners' interviews the need for strategically driven UX was emphasised, focussing on the establishment of UX design infrastructure, processes, standards, and systems within the organization. This will ensure that design teams are able to spend their attention and energy on doing the UX work focussing on the users and not having concurrently to put in place design processes, secure resources, and motivate for the existence of design and field organisational politics while having to do their design work.

7.4.2 The need for UX to collaborate with cross-functional disciplines

The need for cross-functional, connected, and collaborative disciplines and departments within the organisation was repeatedly mentioned and identified as a critical need for product success. The embedding of roles in the agile team from non-traditional software domains such as marketing and finance bridged historically siloed departmental structures in the company to fast-track product delivery through knowledge sharing, authoritative decision-making representation, and fostering positive cross-departmental relations.

7.4.3 The need for visibility of design and developed products in the company

The need became obvious to make people (team and stakeholders external to the team, such as risk, compliance, etc.) more aware of the impact that the team and the product can have, presenting the feedback to them, showing them the data, how it works and what the product really is doing, what benefit is it adding to customers. The need for increased visibility in the business (even if it might seem unrelated to people) to foster an easier acceptance (firstly) and adoption (secondly) of the process and product through regular companywide product showcases.

7.4.4 The need for customisation

The exact need of the customer for customisation is a requirement to achieve an exceptional user experience. From the practitioner interviews there is a growing need from users and organisations for the customisation or individualisation of a product. Companies are steering away from "stock-standard" solutions to uniquely crafted solutions showcasing their unique user value proposition.

7.4.5 The need for an appreciative perspective

From the interviews with the agile practitioners the appreciative way of looking at a topic brought out what they valued most and what they considered played a part in producing successful software. This change in focus from looking for what didn't work was refreshing and uplifting to practitioners, not having to blame or make excuses, but rather reflect on strengths and look for opportunities.

7.4.6 The need for agility in research design

In the agile software environment, it is evident that practitioners believe that change is expensive and should be controlled through practices utilised in agile, delivering the smallest portion of value to users as soon as possible, incremental quick delivery, etc. Incorporating the Agile model into the theoretical research design frameworks could assist the theoretical framework from becoming obsolete, or irrelevant owing to technological advances in the future, allowing the researcher to adapt or to change the research context or with make changes with regard to the state of the research problem.

7.4.7 The need for expanded quantitative research and validation

Since the quantitative portion of the research was limited only to focussing on two of the major themes (UX Design and Development) that emerged from the qualitative practitioners' research, it is recommended that future research could expand on this research to include the other major practitioner interview themes, such as Product and the User.

7.5 Research insights and reflection on study

Upon reflecting on the research journey, insights were attained, study challenges had to be navigated, discoveries were made, and new perspectives emerged.

7.5.1 Research insights

The validated framework provides a granular, validating view from a larger population of practitioners, focussing specifically on the UX and Development requirements as identified by practitioners in the field. These validated elements can be used by UX designers and BI dashboard software developers as a guide to working towards the best UX for BI dashboards.

Although the various agile executions differ in practice, from the research it is seen that participants follow an iterative way of working and use a people-centric approach to software development that facilitates adaptability and change, collaboration and communication.

Agile methods, therefore, generally follow an incremental continuous improvement process that is built around the agile team, driven by product owners/managers, UX designers and developers who welcome customer feedback to adjust and improve the product continuously. Due to continuous change in the environment (technological, economic, social, etc.) teams, products, tools that cannot adapt, risk becoming obsolete or irrelevant due to misalignment with the environmental requirement.

Measurement is also of key importance to be able to measure the impact of changes made. Welcoming feedback from customers is also essential in measuring the performance of a product. The importance of consulting multiple sources of data to assess UX performance – data from systems and feedback from customers – was recognised. Guiding practitioners to asking the right questions.

7.5.2 The research design's 'Agile' principles are tested

As agile software development environments were central to the study, the effects of Covid on the way of working were witnessed first-hand. Agile advocates for co-located teams, but as waves of covid swept over the globe, it was time for Agile to live up to its name to adapt to these new constraints. Previously co-located teams became digital teams overnight, utilising digital Kanban and Scrum boards to track work and facilitate digital team stand ups. Digital collaboration tools, such as Slack to communicate with team members, Miro to collaborate in digital whiteboarding sessions, and meeting tools like Zoom, Google meet, AppearIn and Microsoft Teams were employed to connect and facilitate effective collaboration. The entire landscape of Agile was changing while the research was being conducted. Simultaneously, people's views were changing on what is possible in the world of agile development.

7.5.3 Gold nuggets emerge from measuring the UX of product features

While the research was being conducted, the researcher employed insights from the research in her own work environment. She heads up a team of UX designers for a large e-commerce company. Firstly, the SUS instrument was used in surveys to measure users' views on the usability of the customer facing website and apps. After a number of months where the data painted the same picture of the general usability of these customer facing interfaces, the lack of an experience angle became clear. An additional survey was introduced, the UEQ, developed by Dr. Martin Schrepp (Schrepp *et al.,* 2017), was workshopped with the design team to select the UX elements contextually relevant to the e-commerce domain. From the initial list of 26, the team voted for the 10 most relevant UX elements. These UX elements were surveyed monthly for 12 months. The outcome was similar to the usability survey, in that the initial visibility of the experience perception was insightful but owing to the general nature of the questions, the data did not provide sufficient direction for experience improvement. The third survey was then engineered by the researcher to ask experience questions pertaining to the experience with specific product features. This survey has been running monthly for 18 months and provides not only a view of user perception of usability and experience on key features but also produces rich user data that point out user issues and provide data-guided design to the UX design team. The value derived from the continuous measuring of user perception of the UX has become a reliable pipeline of design-led initiatives that functions as input into the backlogs of agile teams.

7.5.4 An appreciative perspective

Stemming from the research, the value of the adoption of an appreciative perspective has been refreshing in a software development environment that is normally centred around problem finding. This is true also in design, where concepts like Design Thinking take designers through a process to Empathise, Define, Ideate, Prototype and Test to solve poorly defined or unknown problems in innovative ways. Similarly, approaches like 'jobs to be done' (Christensen, Hall, Dillon, & Duncan, 2016) focus on needs those users have and problems users face that need solving. Taking an appreciative viewpoint turns these approaches upside down and looks at what we have that works already and how can this be improved to be the best. It changes attitudes in the room, not just views on user pain points, rallying teams together for a greater cause to build the best products. In practice the researcher has started to introduce appreciative angles into work to complement the problem focused way of working, enabling team members to build on strengths and balance work with problems faced. This has been enlightening, to not only respond and reflect on problems that are seen, but to also consider what might not be visible to our current perspective. This change in viewpoint has opened up the possibility to view and explore unseen opportunities.

Utilising the appreciative inquiry approach, considering what we know now and what we have *discovered* through the research, the researcher *dreams* about and envisages a future of UX design where dashboards will be individualised for the user needs, highly customisable and user-aware, where BI dashboards will be contextually and situationally aware and adapt to display relevant information to the user to allow for confident decision making and clear associated action. The *design* and the *delivery* of such UX for BI dashboards will be shaped through continuous collaboration with users and, by the hands of the agile practitioners and academics, to inspire the field towards delightful BI UX.

In conclusion, based on the culmination of the research results obtained, presented as VAPO_UXF_BID_1.1 in Section 6.6, the essential elements recommended for the best UX of BI dashboard interfaces from an appreciative perspective within an agile software development environment are: utilising agile software development practices; ensuring user alignment and product clarity; incorporating UX design strategy, practice and process, research and validation, UX characteristics and dashboard design; and an agile approach to technical software development.

-End of Thesis-

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Appendix A: Systematic literature review

Preview of matrix.

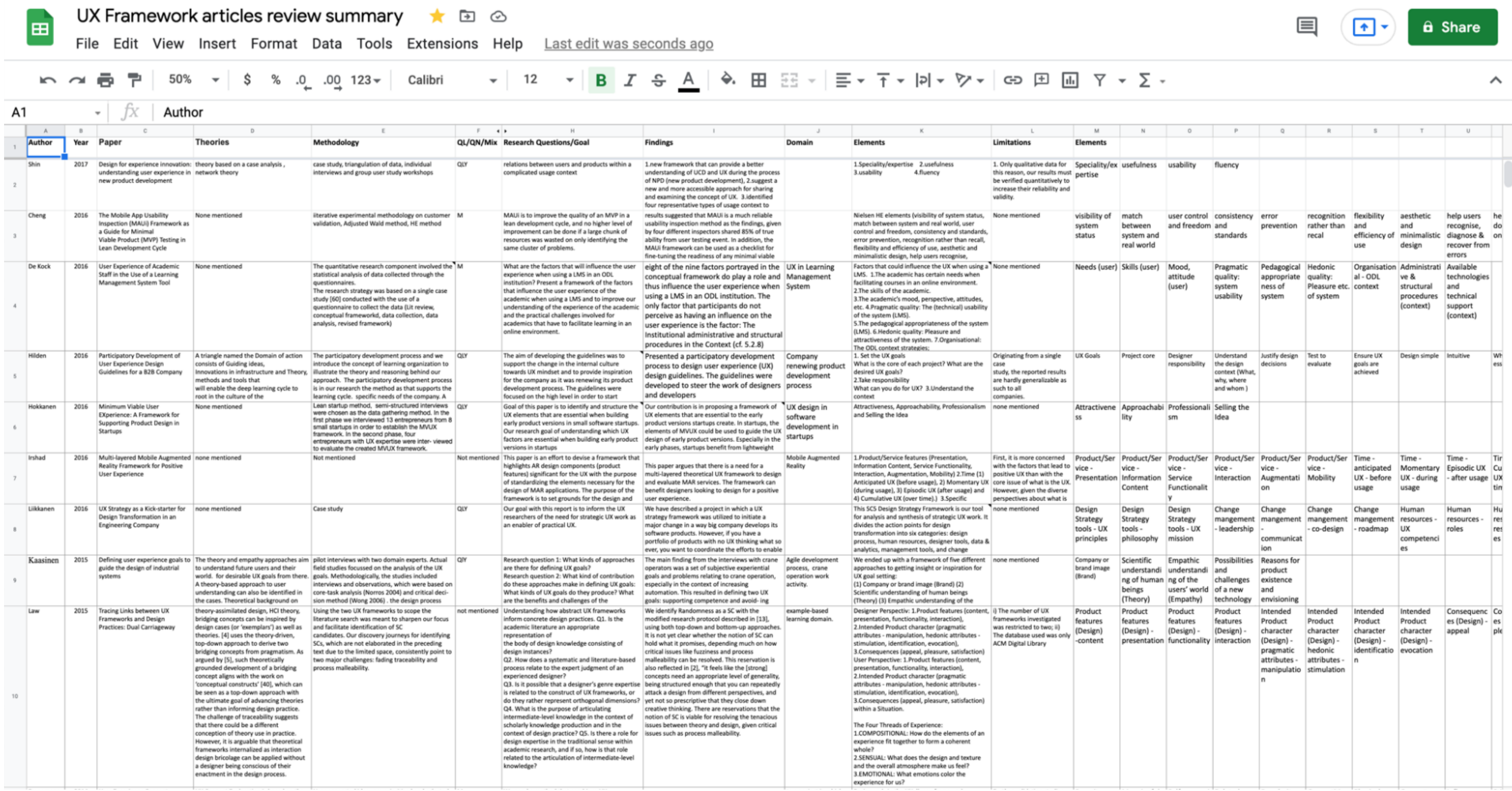

Figure A.1 Systematic Literature Review Matrix Preview.

Matrix can be accessed online here: [Systematic Literature Review Matrix]

The initial conceptual framework produced from the literature study, representing the user experience for business intelligence front-ends (from all literature framework elements) can be accessed here: Conceptual Literature Based UX Framework for BI front-ends.

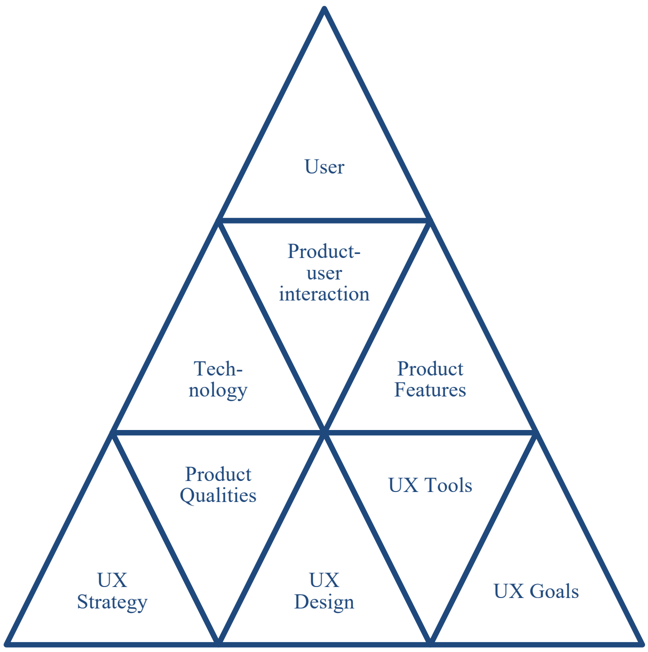

Figure A.2 Conceptual (literature-based) UX framework (CL_UXF_1.1).

Appendix B: Detailed conceptual literature-based UX framework (CL_UXF_1.1)

Updated Conceptual UX Framework for BI Front-ends	
Category	Elements
Product	• Perceivable (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status) • Use (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise diagnose and recover from errors, product use) • Features (meaningfulness, features, qualities, security) (new component: performance) • Support (pedagogical appropriateness, help and documentation) (new component: education/training) • Content (content, content fluency – right data, right time)
Development	• Possibilities (technical possibilities) • Challenges (technical challenges, technical constraints) • Support (technology support – context)
UX	• UX Strategy (brand, UX mission, UX philosophy, principles, accessibility strategy, measuring achievement of UX goals, data and analytics, UX KPIs, design/development processes, UCD process, HR – UX roles/competencies, HR training, change management and communication strategy) (new component: content) • UX Goals (reason for product existence, tech possibilities and constraints, empathy, brand alignment, scientific understanding of humans [theory], understanding design context, simple design, intuitive design, essential design – only what is needed) • UX Tools (processes available such as evaluation process, standardised questionnaires such as SUS, style guide, user representations, interaction flows) • UX Designer (designer responsibilities, professionalism, approachability, selling design ideas) • UX Design (design presentation, design functionality, design interaction, design attractiveness, compositional layout, emotional considerations, sensual, designing of cross-contextual activities, service coherence, minimalistic design (goal coinciding), consistency)
User	• Emotions (mood, concerns, attitude) • User traits (skills/abilities, specialty /expertise, personal, physical attributes, knowledge/experience, competence, physical health) • Motivators (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy) • Association (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal) • Perceptions (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content)
Product/User interaction	• Touch point (product interaction, product use, touch point orchestration) • Context (usage context – experience driven innovation, context-related tasks, context physical, spatio-temporal – effects of place and time of experience) • Experience (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario,

	temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability)
Agile/Lean	• Agile development (new component)

Appendix C: Theoretical research design framework (TRDF_AAAL_1.1)

Appreciative Inquiry

Incorporated as research lens, to find the *best of what is* and the *best of what could be.*

Section 4.3.1

Agile Model

Countering change and unclear requirements through short continuous incremental development cycles.

Section 4.3.2

Affordance Theory

The perceived possibilities (potential) of objects and the (inter) action of objects.

Section 4.3.3

Logic Model

The logic model is typically used for planning, managing and communicating the flow of processes for the desired results.

Section 4.3.4

Figure C.1 Theoretical research design framework (TRDF_AAAL_1.1) developed to structure the research.

Appendix D: Qualitative instrument for interviews

Interview Participation Cover Letter

PARTICIPANT INFORMATION SHEET

UNISA university of south africa

Ethics clearance reference number: 035/CJ/2018/CSET_SOC
Research permission reference number (if applicable):
28 October 2018

Title: A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: A MIXED METHODS STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT

Dear Sir/Madam

My name is Chrisna Jooste and I am a PhD student in Information Systems at Unisa. My study supervisors are Prof Judy Van Biljon, Research Professor at the Department of School of Computing and Prof Adele Botha, Chief Researcher at the CSIR Meraka. We are inviting you to participate in a study entitled A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: A MIXED METHODS STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT.

The information collected during this study will be used to produce a validated user experience (UX) framework for the development and use of business intelligence dashboards. The study aims to fill the gap identified in terms of a lack of business intelligence specific UX frameworks.

You were selected to participate in this survey because of your experience in the development of software including user dashboards in an agile software development environment. You were identified by your role (either developer, designer or product owner).

The study involves individual interviews and an online questionnaire. The questions asked in the interviews are available in the attached Instrument A, the interview questions are exploratory to gather what is required for *the best* UX for the development and use of dashboards. The expected duration of the interview is 60 minutes. The research questionnaire is available as Instrument B, and is not expected to take longer than 30 minutes to complete.

Participating in this study is voluntary and you are under no obligation to consent to participation. Should you decide to take part, you will be given this information sheet to keep and also will be asked to sign a consent (to participate) and non-disclosure form (to ensure the information shared about this study remains secure). You are free to withdraw from the study at any time and without giving a reason.

By participating in this study, you will be contributing to what is required to produce a role specific UX framework for development and use of business intelligence dashboards. This aims to fill the gap identified as a lack of a business intelligence specific UX frameworks. The research also aims to address the gap identified in literature between theory and practice. You will not be reimbursed or receive any incentives for your participation in the survey. You will also not benefit from your participation as an individual, however, it is envisioned that the findings of this study will help the design and development of user dashboards in an agile environment.

Participating in the study should not discomfort you as a participant, and should also not inconvenience you, besides the time expected for participation. There are no foreseeable risks of harm or side-effects to the participants. No individual will be identifiable from the research results.

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and all involvement in the research will be treated confidentially. Your responses will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your responses may be reviewed by people responsible for making sure that research is done properly, including an external coder and members of the Research Ethics Review Committee. Records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Hard copies of your answers will be stored by the researcher for a minimum period of five years in a secure structure at UNISA (Florida campus) for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Thereafter, the answers will be permanently destroyed (hard copies will be shredded and electronic versions will be permanently deleted from all storage locations, hand drive and cloud drive).

This study has received written approval from the Research Ethics Review Committee of the School of Computing, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

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The findings are accessible for 5 years. Should you require any further information, want to contact the researcher about any aspect of this study, or if you would like to be informed of the final research findings, please contact Chrisna Jooste at j.chrisna@gmail.com or 083 447 0960.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. Judy Van Biljon at 011 670 9182 or vbiljja@unisa.ac.za or the research ethics chairperson of the School of Computing, Dr. Bester Chimbo, at 011 670 9105 or chimbb@unisa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

Yours sincerely,

Chrisna Jooste

Interview Consent Form

CONSENT TO PARTICIPATE IN THIS STUDY

I, __________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

Please tick the boxes below that you agree to the following:

- ☐ I have read (or had explained to me) and understood the study as explained in the information sheet.
- ☐ I have had sufficient opportunity to ask questions and am prepared to participate in the study.
- ☐ I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).
- ☐ I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.
- ☐ I agree to the recording of the interview
- ☐ I have received a signed copy of the informed consent agreement.

Confidentiality

Any Proprietary Information related to this research is confidential. By consenting to this agreement, you agree to protect and to hold confidential any Proprietary Information provided, used, or arising in connection with the research. You agree that you shall not use or disclose (except as expressly authorized by this agreement) Proprietary Information.

Without limiting these obligations, you specifically agree to keep in absolute confidence and not to disclose or discuss with anyone:

- Any information about the research until it becomes public knowledge
- Any information regarding any Elements which you are testing, have tested or will test, including the fact that an Element exists

☐ I agree to not disclose any information acquired through participating in the research.

Participant Name & Surname ………………………………………… (please print)

Participant Signature ……………………………………………. Date…………………

Researcher's Name & Surname……………………………………… (please print)

Researcher's signature………………………………………….. Date…………………

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Qualitative instrument – Practitioner Interviews

Q No	Question
Q1(a)	What is your understanding of software development for business intelligence dashboards within an agile environment?
Q1(b)	What is your understanding of UX within Software development?
Q2	**Discover phase** (past achievement focus) Please tell me about a time when you believed you excelled in a software development capacity for the creation of user dashboards. What has been a highlight? Where it took place, why it took place, who was involved, what were they doing, and what were you doing, what technology was used, what practice was used, what process was used, how was it developed, and what was produced that made it a memorable experience? *(Deep story question) (context, actors)*
	Discover phase continued (existing strengths explored) What do you believe you brought to the software development experience that made it a high point (what do you do well)? What have you been successful in/ made a positive impact in?" What are you passionate about?
	What specifically do you value about your past experience and knowledge that prepared you to take on the role described? What was it about the context that helped you to excel? *(Value question)*
	What do you believe you brought to the user experience created through the dashboard that made it a high point? What specifically do you value about your past experience and knowledge that prepared you to take on the role described? What was it about the context that helped you to excel? *(Value question)*
	Discover phase continued (existing software delivery UX elements for dashboards explored) Describe what elements were unique for you about the software development for the dashboards experience. In other words, without these elements, the experience would not have been what it was. (Principal elements question)
	Dream phase (future or miracle question) When thinking about the future, what are your wishes for those who would be part of the best dashboard software development team? What can be done better?
	Design phase Considering what you know now and what you have experienced. When planning for the future, what elements are important for those who would be part of the best dashboard software development team? What would you like to see in the future? What words of wisdom do you have for those aspiring to software development for the best UX for dashboards in an agile environment?
	Delivery phase What (elements, tasks, actions, processes or things) do think is required and should be in place for the delivery of software development for the best UX for dashboards.

Appendix E: Qualitative data

Data from Practitioner Interviews:

- Coded interviews can be accessed here: Coded Practitioner Interviews

- Atlas.ti was utilised to generate network maps of the concepts related to the different interview themes that emerged. The networks can be viewed below and can be accessed online for improved legibility: Atlas.ti Interview Themes Networks

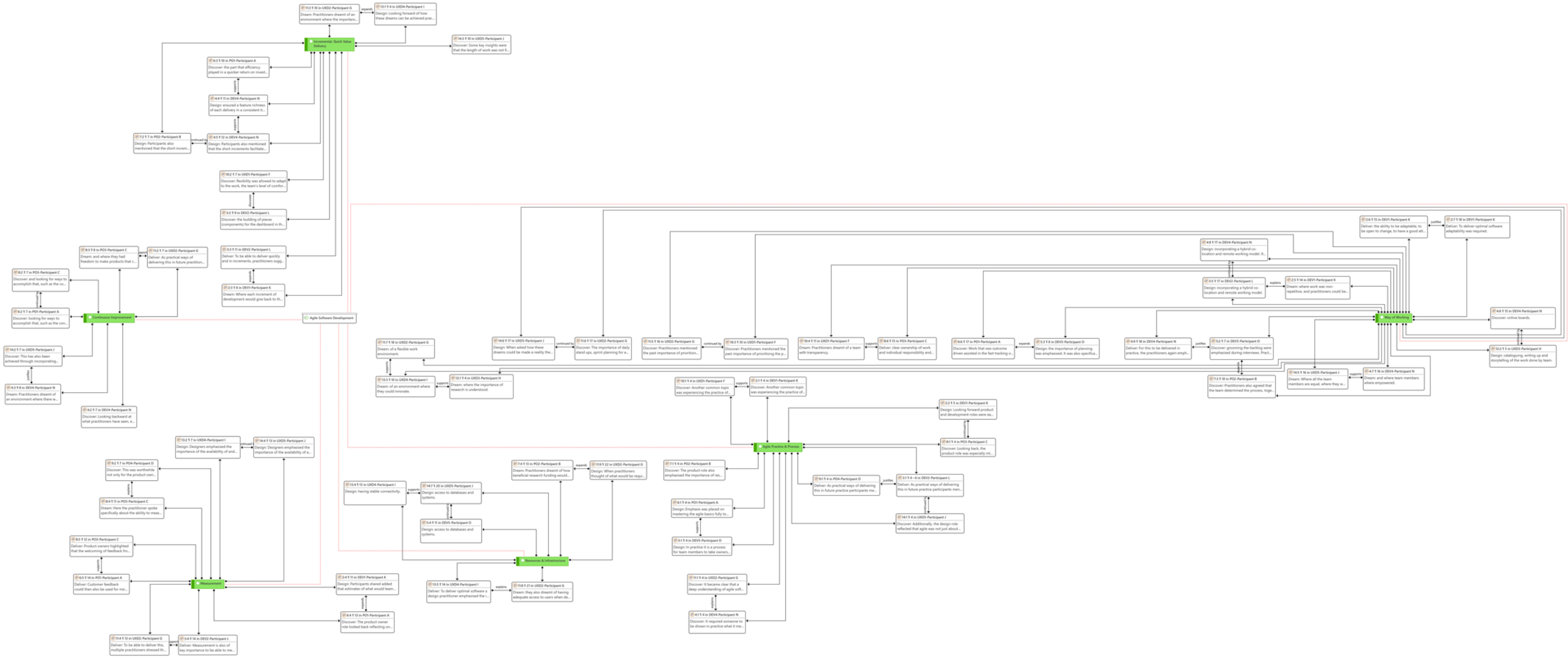

Figure E.1 Interview Theme: Agile Software Development Network.

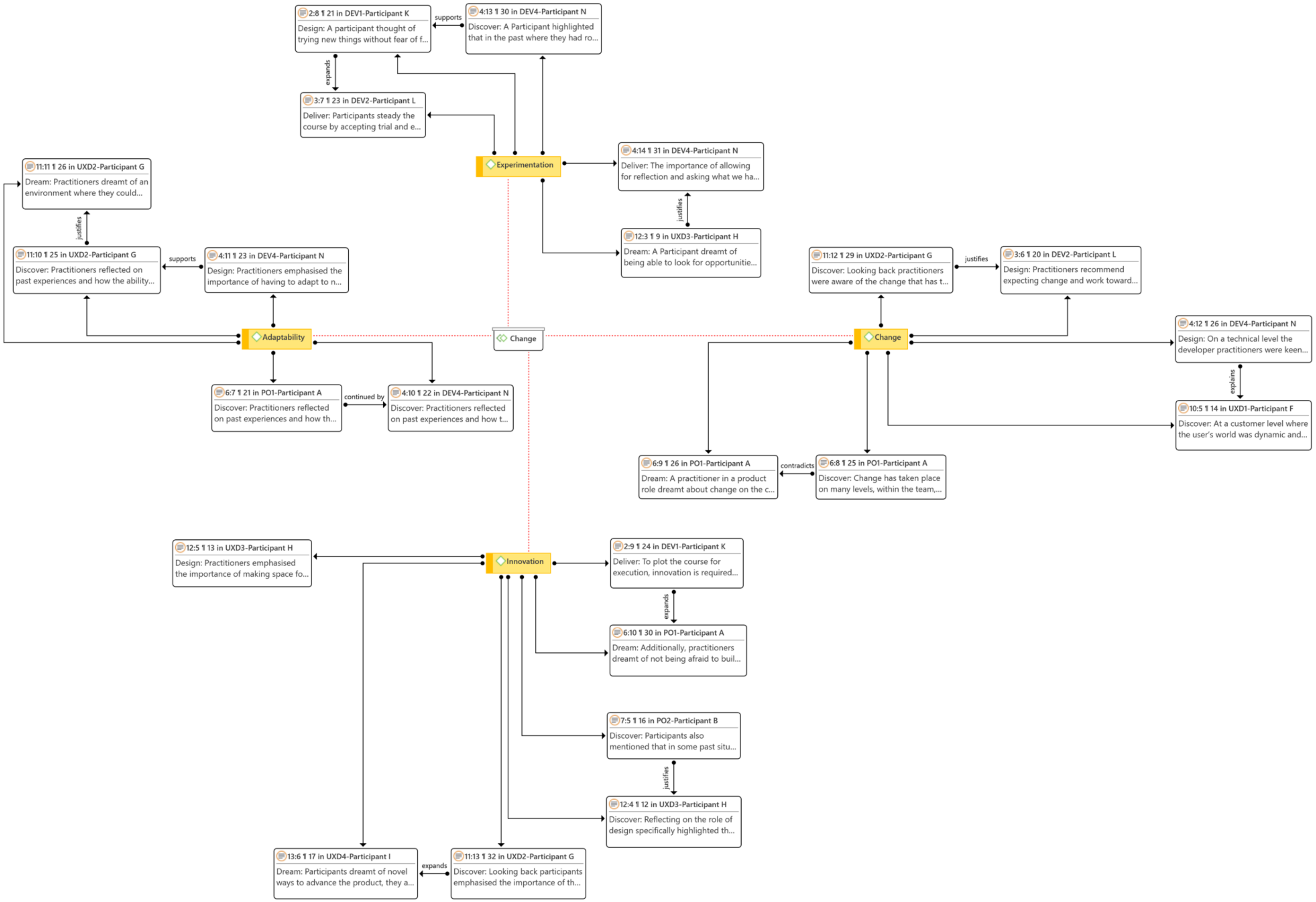

Figure E.2 Interview Theme: Change & Adaptability Network.

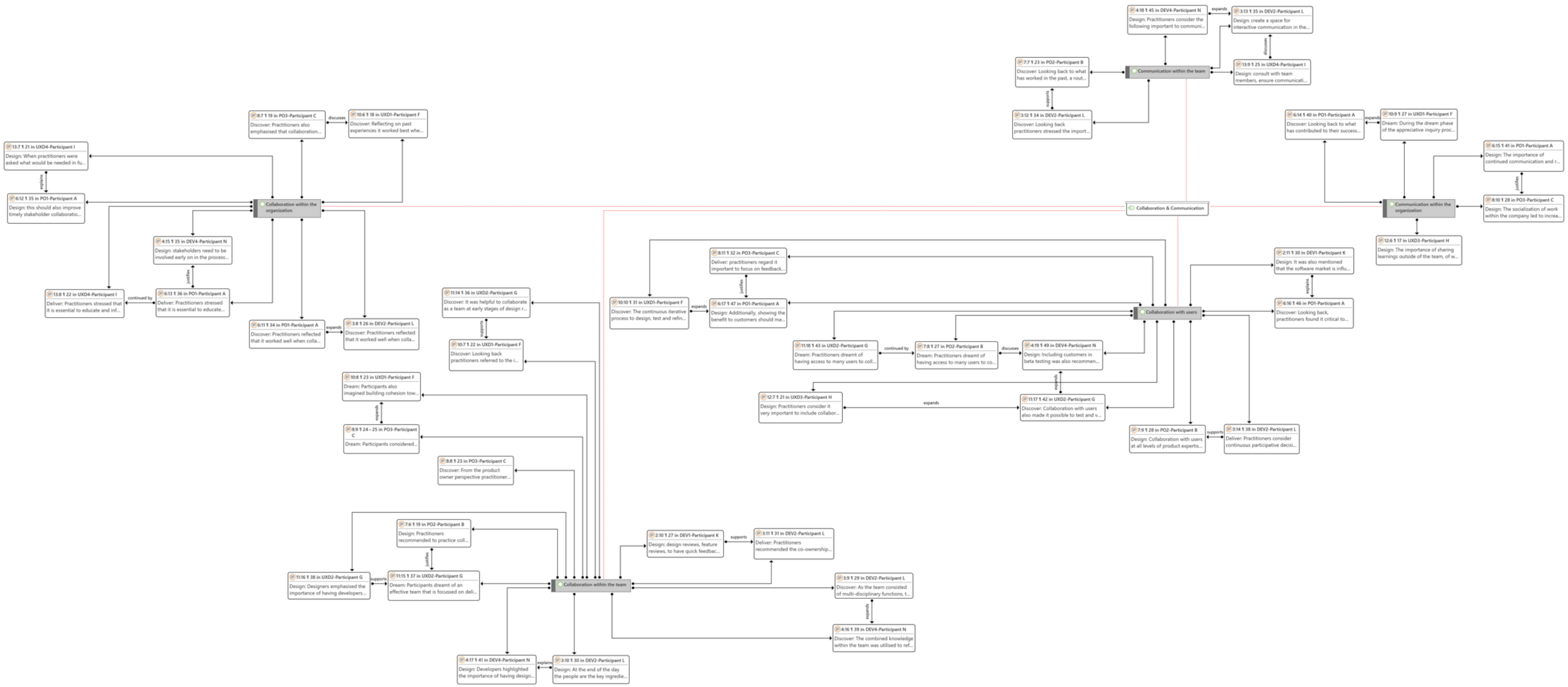

Figure E.3 Interview Theme: Collaboration & Communication Network.

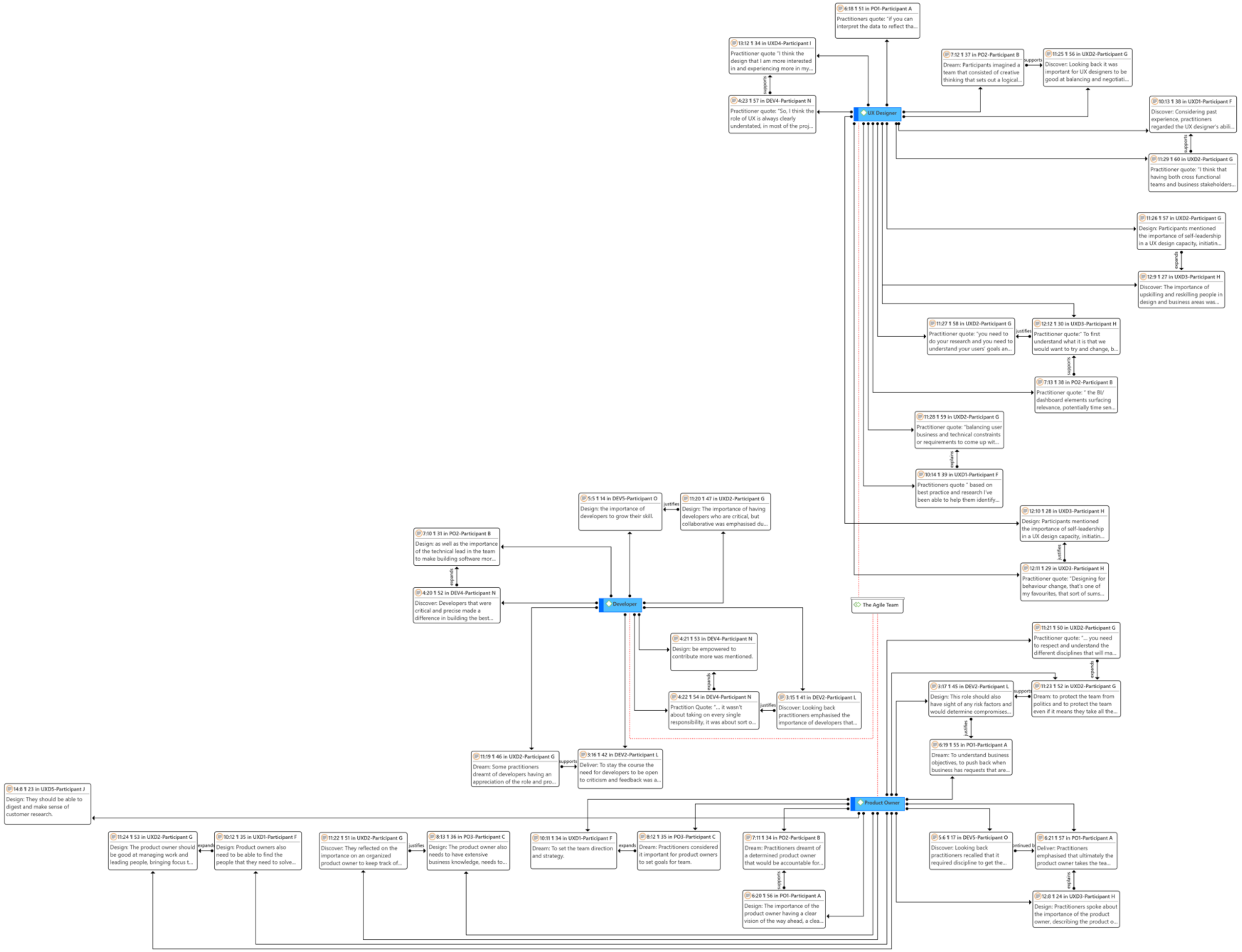

Figure E.4 Interview Theme: The Agile Team Network.

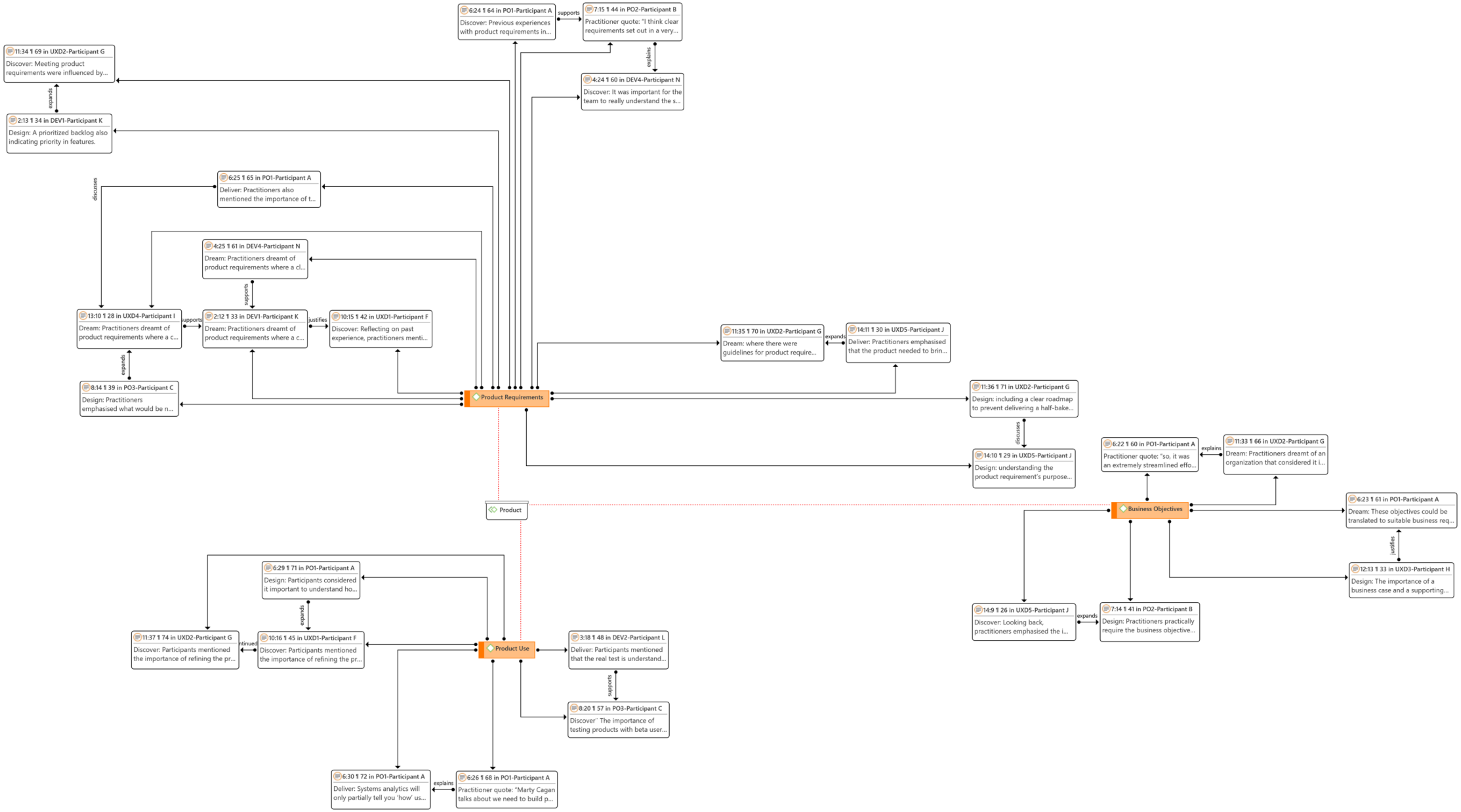

Figure E.5 Interview Theme: Product Network.

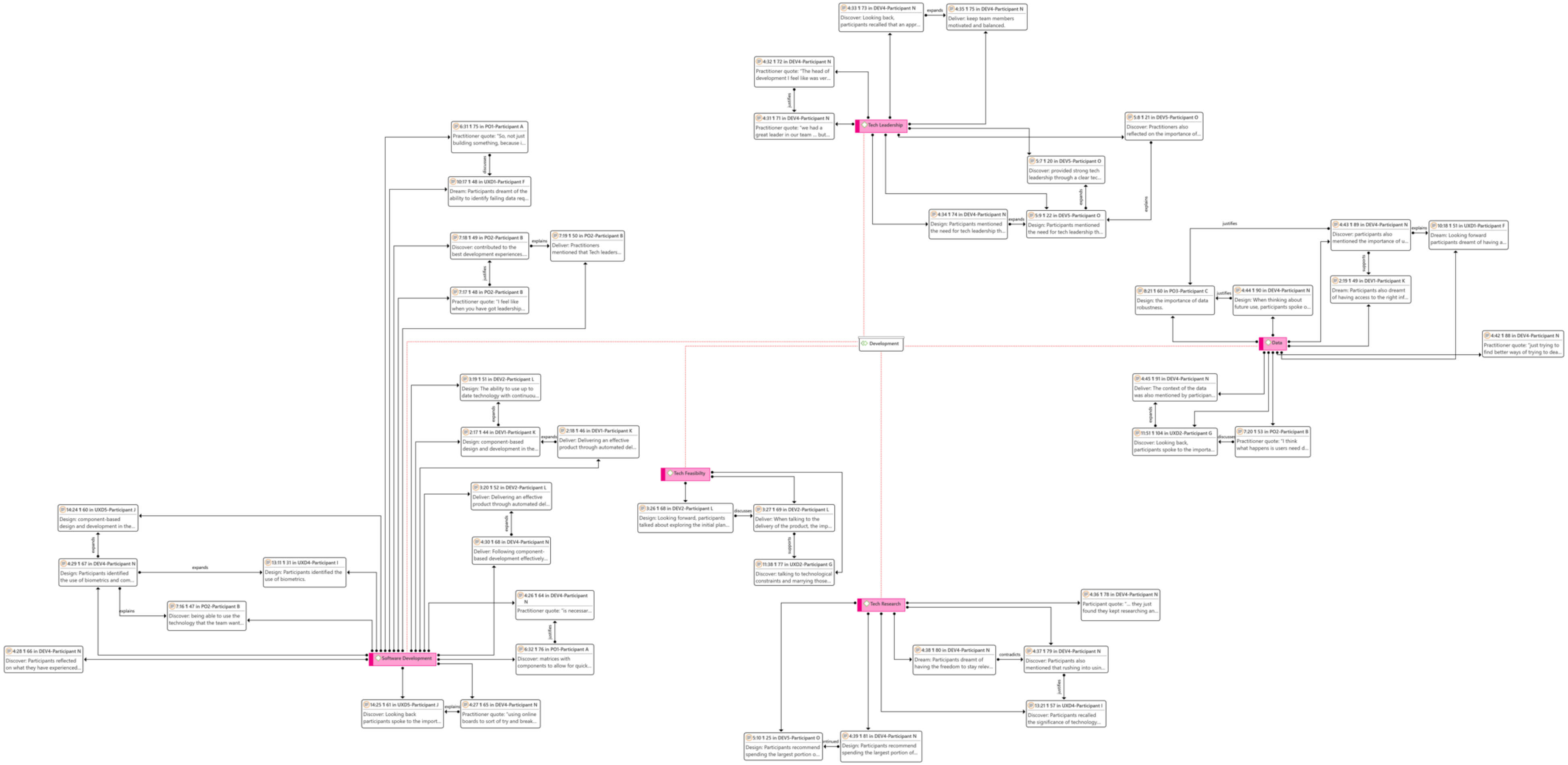

Figure E.6 Interview Theme: Development Network.

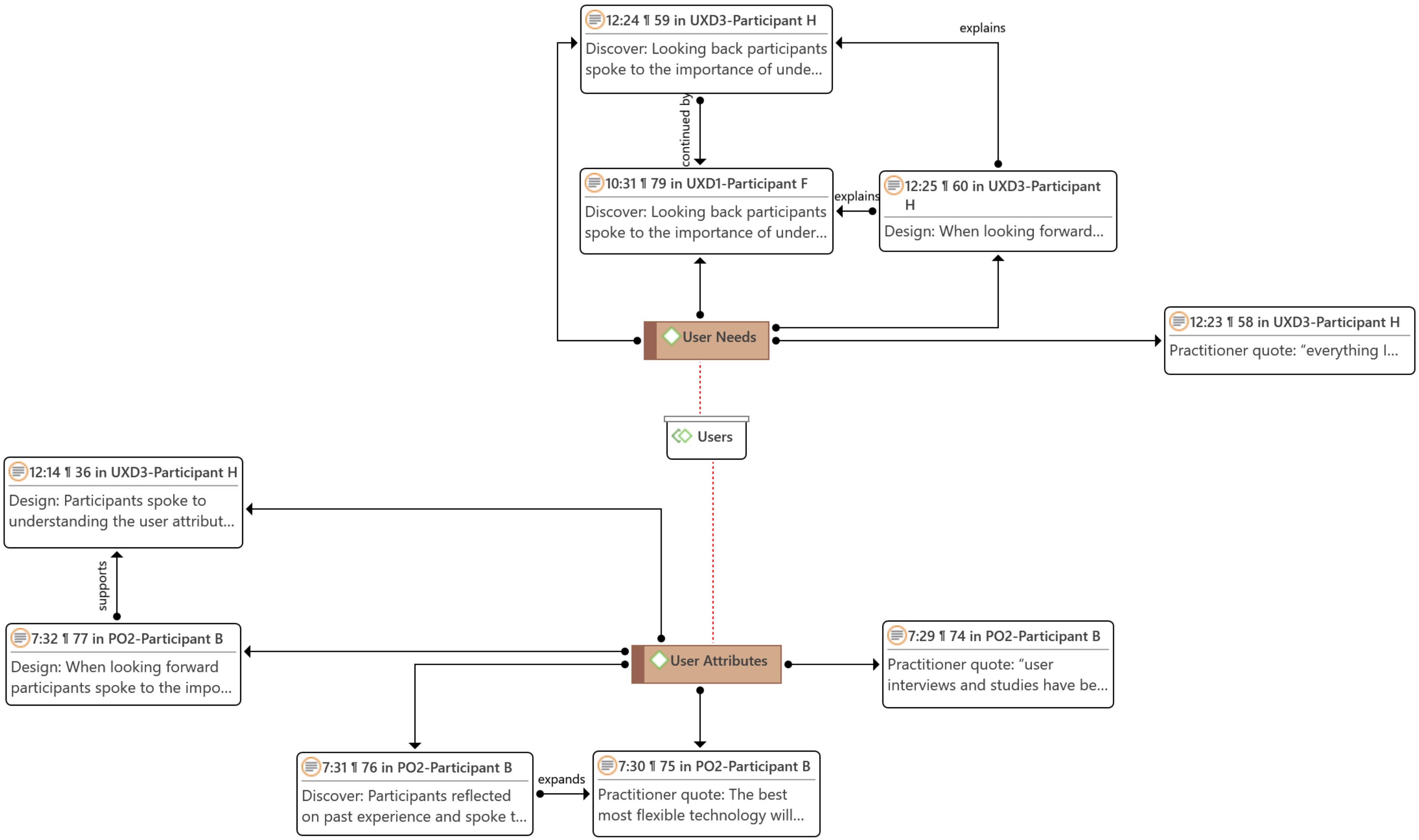

Figure E.7 Interview Theme: Users Network.

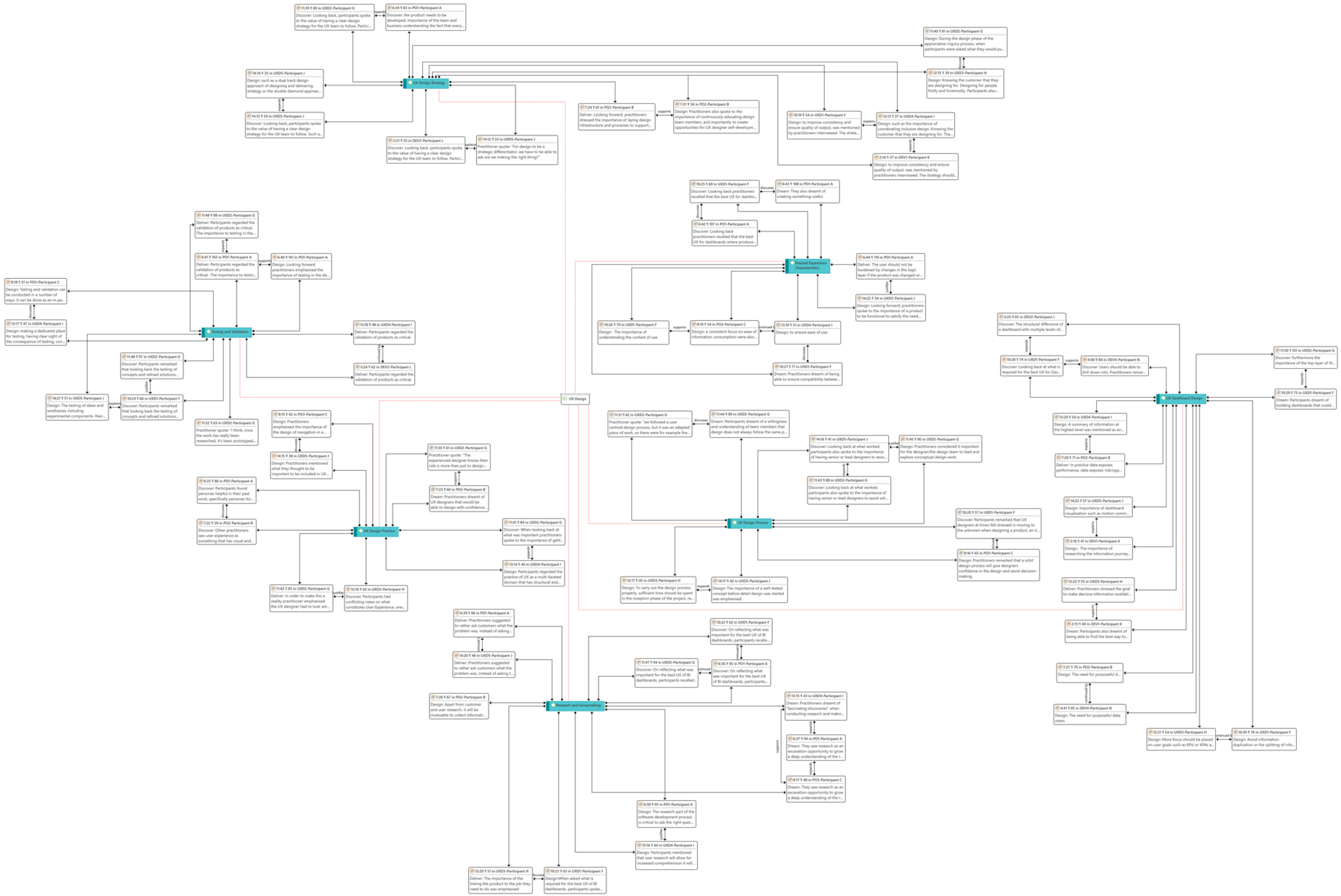

Figure E.8 Interview Theme: UX Design Network.

Appendix F: Quantitative instrument for survey

An agile practitioner's perspective

Hello, I am Chrisna Jooste a PhD Information Systems student at the University of South Africa (UNISA).

Answering the questionnaire should take about 10 minutes.
Survey start date: 20 May 2020, Survey end date: 22 June 2020, 5pm (SAST).
Survey topic: an agile practitioner's perspective

Participation in this study is voluntary. You have the right to withdraw at any point during this survey. At the beginning of the survey information pertaining to your demographics and work experience will be requested, this information will solely be used for statistical analysis. Your information will not be passed on to any 3rd parties and the data will be handled according to the ethical data governance principles of UNISA. You will not be personally identifiable in this study and all data will be anonymised. The survey will ask you to select to what extent you agree or disagree with statements. There is no right or wrong answer, your honest opinion is encouraged. The content of this survey has been created as part of this PhD research and is the property of UNISA, content may not be copied or shared without permission.

Should further information be required you are welcome to contact either myself at j.chrisna@gmail.com or Prof Judy van Biljon the study supervisor at Vbiljja@unisa.ac.za .

By continuing with this survey you agree to participate in this study.

An agile practitioner's perspective

* 1. Do you currently work, or have you worked in an agile software development environment?

- Yes
- No

* 2. Have you been part of a team that build software for dashboard interfaces?

- Yes
- No

1

Preview of Survey, accessible online: An agile practitioners' perspective survey

Appendix G: Quantitative data

Practitioner Survey, Part 1 – Demographics and qualifying criteria

Start Date	Do you currently work, or have you worked in an agile software development environment?	Have you been part of a team that build software for dashboard interfaces?	Please select your current role.	Other (please specify)	Total number of years in curren t role	Total number of years in agile software development environment	In which industry do you work currently?	Other (please specify)	In what country do you work currently?
2020-06-22 12:47:13	Yes	Yes	Other (please specify)	Director	1	10+	IT		United Kingdom of Great Britain and Northern Ireland
2020-06-17 17:03:25	Yes	Yes	Other (please specify)	Design lead	3	5	Finance		South Africa
2020-06-17 14:47:38	Yes	Yes	Product Owner/Manager		2	6	IT		South Africa
2020-06-17 13:30:07	Yes	Yes	UX Designer		2	4	Finance		South Africa
2020-06-10 14:56:37	Yes	Yes	UX Designer		6	5	Finance		South Africa
2020-06-16 17:28:47	Yes	Yes	Developer		10+	5	Finance		South Africa
2020-06-15 13:32:29	Yes	Yes	UX Designer		10+	10+	Finance		South Africa
2020-06-15 11:27:43	Yes	Yes	Developer		2	2	Finance		South Africa
2020-06-11 11:09:25	Yes	No	Developer		10+	5	Other (please specify)	Transport / Fleet Management	New Zealand
2020-06-10 21:14:49	Yes	No	Developer		4	2	Educational		South Africa
2020-06-09 08:15:59	Yes	Yes	Developer		10+	5	IT		South Africa
2020-06-09 11:42:02	Yes	Yes	Other (please specify)	Product Analyst	5	9	IT		South Africa
2020-06-09 01:46:14	Yes	Yes	UX Designer		4	4	Retail		South Africa
2020-06-08 15:44:47	Yes	Yes	UX Designer		9	9	IT		South Africa
2020-06-08 16:28:34	Yes	Yes	Developer		3	3	Finance		South Africa
2020-06-08 13:34:34	Yes	Yes	Other (please specify)	UI Designer	1	8	Retail		South Sudan
2020-06-08 05:23:09	Yes	Yes	UX Designer		7	5	Other (please specify)	Finance, Health, IT & Education	South Africa
2020-06-07 21:32:15	Yes	Yes	UX Designer		5	6	Retail		South Africa
2020-06-03 08:47:29	Yes	Yes	UX Designer		8	10+	Other (please specify)	Software	United Kingdom of Great Britain and Northern Ireland
2020-06-02 21:53:22	Yes	Yes							
2020-06-02 15:13:40	Yes	Yes	UX Designer		9	6	IT		Ireland
2020-06-01 17:14:48	Yes	Yes	UX Designer		5	4	Other (please specify)	Telecommunication	Netherlands
2020-06-01 11:56:36	Yes	Yes	Other (please specify)	UX & UI Designer	3	7	Finance		South Africa
2020-05-31 20:14:46	Yes	Yes	UX Designer		8	8	Other (please specify)	Currently working across several industries	Kuwait
2020-05-29 13:46:03	Yes	Yes	UX Designer		4	6	Retail		Kuwait
2020-05-29 10:00:17	Yes	Yes	Other (please specify)	Design Lead	3	6	Other (please specify)	Work across several industries	South Africa
2020-05-29 09:20:56	Yes	Yes	UX Designer		10+	5	Retail		Israel
2020-05-29 08:14:54	Yes	No	Developer		10+	8	Finance		South Africa
2020-05-28 23:17:41	Yes	Yes	Product Owner/Manager		4	10+	Other (please specify)	Business consulting	United States of America
2020-05-28 22:58:12	Yes	Yes	Other (please specify)	Principal Architect - UX Director	4	10+	IT		United Arab Emirates

2020-05-28 19:21:18	Yes	No	Product Owner/Manager		2	4	Finance		South Africa
2020-05-28 13:58:15	Yes	Yes	Other (please specify)	Customer experience designer	1	3	Other (please specify)	Media and entertainment broadcasting	South Africa
2020-05-28 13:51:08	Yes	Yes	Other (please specify)	Customer experience designer	1	3	Other (please specify)	Media and entertainment broadcasting	South Africa
2020-05-28 11:56:34	Yes	Yes	UX Designer		2	4	IT		South Africa
2020-05-28 09:54:35	Yes	No	Developer		5	5	Other (please specify)	News and media	South Africa
2020-05-28 09:30:21	Yes	Yes	Product Owner/Manager		10+	7	Finance		South Africa
2020-05-28 08:50:48	Yes	Yes	Other (please specify)	Product designer	10+	4	Finance		South Africa
2020-05-27 22:38:41	Yes	Yes	Product Owner/Manager		2	7	Finance		South Africa
2020-05-27 20:02:58	Yes	Yes	Developer		1	5	IT		South Africa
2020-05-27 13:18:22	Yes	Yes	Developer		2	4	Retail		United Arab Emirates
2020-05-27 13:17:48	Yes	Yes	Product Owner/Manager		1	1	Other (please specify)	Unemployed	South Africa
2020-05-27 12:11:28	Yes	No	Developer		7	1	Educational		South Africa
2020-05-26 10:33:23	Yes	Yes	UX Designer		7	5	IT		India
2020-05-22 10:47:53	Yes	Yes	UX Designer		6	5	Educational		South Africa
2020-05-25 21:13:11	Yes	Yes	Developer		6	3	Finance		South Africa
2020-05-25 19:13:45	Yes	Yes	Product Owner/Manager		3	9	Educational		United States of America
2020-05-25 17:36:23	Yes	Yes	Other (please specify)	UI Designer	3	6	Finance		South Africa
2020-05-24 19:01:15	Yes	Yes	Developer		3	3	IT		South Africa
2020-05-24 15:31:39	Yes	Yes	UX Designer		4	4	IT		South Africa
2020-05-23 15:12:14	Yes	Yes	UX Designer		1	3	Other (please specify)	Tourism	South Africa
2020-05-22 17:43:22	Yes	Yes	UX Designer		8	5	Finance		South Africa
2020-05-22 15:36:13	Yes	Yes	Developer		3	3	IT		South Africa
2020-05-22 07:08:51	Yes	Yes	Other (please specify)	BA	3	3	Finance		South Africa
2020-05-22 14:32:51	Yes	Yes	Other (please specify)	Cyber Security Consultant	1	1	Finance		South Africa
2020-05-22 13:57:36	Yes	No	Other (please specify)	Business analyst	10+	10+	Finance		South Africa
2020-05-22 12:30:22	Yes	Yes							
2020-05-22 12:05:45	Yes	Yes	Developer		7	4	Educational		South Africa
2020-05-22 11:13:39	Yes	Yes	Product Owner/Manager		6	3	Other (please specify)	Market Research / Insights	South Africa
2020-05-22 10:33:04	No	No	Other (please specify)	Graphic Designer	4	1	Retail		South Africa
2020-05-22 10:28:52	Yes	No	Developer		10+	9	Finance		South Africa
2020-05-22 09:59:01	Yes	No	Product Owner/Manager		1	7	IT		South Africa
2020-05-22 09:41:42	Yes	No	UX Designer		7	6	Other (please specify)	Life and income insurance	South Africa
2020-05-22 09:29:35	Yes	No	Product Owner/Manager		3	1	Finance		South Africa
2020-05-22 09:26:20	No	No							
2020-05-22 09:15:43	Yes	No	UX Designer		1	3	Finance		South Africa
2020-05-21 09:49:56	Yes	Yes	UX Designer		3	3	Finance		South Africa
2020-05-22 09:05:37	Yes	Yes	Other (please specify)	Design lead	10+	9	Finance		South Africa
2020-05-22 08:51:16	Yes	Yes	Other (please specify)	Scrum Master	4	5	IT		South Africa

2020-05-22 08:06:20	Yes	Yes	UX Designer		3	3	Finance		South Africa
2020-05-22 06:36:32	Yes	Yes	UX Designer		10+	8	IT		South Africa
2020-05-21 22:57:32	Yes	Yes	Developer		8	8	Finance		Australia
2020-05-21 17:25:14	Yes	Yes	Other (please specify)	Service designer	3	6	Finance		South Africa
2020-05-21 12:59:09	Yes	Yes	UX Designer		5	6	Finance		South Africa
2020-05-21 14:21:47	Yes	Yes	Developer		3	3	IT		South Africa
2020-05-21 13:57:39	Yes	Yes	Other (please specify)	UX/UI Practice Lead	1	4	IT		South Africa
2020-05-21 13:45:34	Yes	Yes	Other (please specify)	CX and Service Designer	2	6	Finance		South Africa
2020-05-21 10:44:14	Yes	Yes	Product Owner/Manager		6	4	Finance		South Africa
2020-05-21 13:12:59	Yes	Yes	UX Designer		5	4	Finance		South Africa
2020-05-21 12:23:51	Yes	No	UX Designer		1	1	IT		South Africa
2020-05-21 11:06:49	Yes	Yes	Product Owner/Manager		2	4	Educational		South Africa
2020-05-21 09:59:45	Yes	No	Other (please specify)	Development Team member (Business Analyst)	10+	6	IT		South Africa
2020-05-21 10:35:09	Yes	Yes	Other (please specify)	product designer	10+	10+	Finance		South Africa
2020-05-21 09:43:49	Yes	Yes	UX Designer		4	7	Finance		South Africa
2020-05-21 08:06:42	Yes	Yes	Product Owner/Manager		4	2	IT		South Africa
2020-05-21 07:13:47	Yes	Yes	Other (please specify)	Service designer, UX, UI designer	7	3	Finance		South Africa
2020-05-20 22:13:45	Yes	Yes	Developer		9	6	IT		New Zealand
2020-05-21 07:25:58	Yes	Yes	Product Owner/Manager		3	10+	Finance		South Africa
2020-05-21 06:27:53	Yes	No	Developer		4	7	IT		South Africa
2020-05-21 06:23:15	Yes	Yes	Other (please specify)	Business Analyst	10+	5	Finance		South Africa
2020-05-21 05:23:39	No	No	Other (please specify)	Web designer	9	1	IT		South Africa
2020-05-21 01:08:39	Yes	Yes	Developer		3	3	IT		South Africa
2020-05-21 01:07:09	Yes	No	Developer		1	1	Educational		South Africa
2020-05-21 00:18:29	Yes	No	Other (please specify)	Agile Coach	2	10+	IT		South Africa
2020-05-21 00:04:19	Yes	Yes							
2020-05-20 22:38:53	Yes	Yes	Other (please specify)	Business owner	1	3	Health		South Africa
2020-05-20 22:19:34	Yes	Yes	Other (please specify)	Product designer	1	5	IT		New Zealand
2020-05-20 22:03:55	Yes	Yes	UX Designer		3	5	Other (please specify)	Mixed	South Africa
2020-05-20 21:58:40	Yes	Yes	Other (please specify)	Software Quality Assurance Engineer	1	1	IT		South Africa
2020-05-20 21:57:11	Yes	No	Developer		1	2	IT		South Africa
2020-05-20 21:08:47	Yes	No	Other (please specify)	Agile Coach	1	5	Other (please specify)	Consulting	South Africa
2020-05-13 10:22:36	Yes	Yes	Developer		2	6	IT		South Africa
2020-05-07 15:55:48	Yes	Yes	UX Designer		10+	7	Finance		South Africa

Practitioner Survey, Part 2 – Research Survey Questions

To what extent do you agree with the following statements regarding the development of software within an agile environment?				
Q1. The need for automated delivery to enable the development of an effective product.	Q2. The need for testing the feasibility of the desired functionality.	Q3. The need for exploring the initial UX design plan for data availability.	Q4. The need for clear design artefacts for technical development.	Q5. The need to use tools to chunk user stories for development.
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Slightly agree	Strongly agree
Neither	Strongly agree	Strongly agree	Strongly agree	Agree
Slightly disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Agree	Strongly agree	Slightly agree
Neither	Strongly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Neither	Slightly agree	Slightly agree
Agree	Agree	Agree	Slightly agree	Disagree
Strongly agree	Strongly agree	Agree	Slightly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Neither	Strongly agree	Strongly agree	Neither	Strongly agree
Strongly agree	Agree	Slightly agree	Strongly agree	Slightly agree
Agree	Strongly agree	Agree	Slightly agree	Slightly agree
Agree	Strongly agree	Agree	Strongly agree	Slightly agree
Slightly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Agree	Agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Strongly agree	Agree	Agree	Neither
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Agree	Slightly agree	Slightly disagree	Slightly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly disagree
Disagree	Strongly agree	Strongly agree	Agree	Slightly agree
Slightly agree	Agree	Strongly agree	Slightly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Agree

Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Strongly agree	Agree	Slightly agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Agree	Agree
Strongly agree	Slightly disagree	Strongly agree	Strongly agree	Neither
Strongly agree	Strongly agree	Agree	Strongly agree	Agree
Slightly agree	Strongly agree	Strongly agree	Slightly agree	Neither
Strongly agree	Agree	Agree	Agree	Agree
Slightly agree	Strongly agree	Agree	Strongly agree	Neither
Agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Slightly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Slightly agree	Slightly disagree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Neither	Strongly agree	Strongly agree	Slightly agree	Slightly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Strongly agree	Agree	Strongly agree	Strongly agree
Agree	Strongly agree		Strongly agree	Slightly agree
Slightly agree	Strongly agree	Agree	Strongly agree	Slightly agree
Strongly agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Agree	Slightly agree	Agree
Agree	Agree	Neither	Strongly agree	Agree
Slightly agree	Strongly agree	Agree	Slightly agree	Disagree
Agree	Strongly agree	Strongly agree	Agree	Slightly agree
Agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Agree	Agree	Agree	Slightly agree
Agree	Strongly agree	Agree	Agree	Agree
Agree	Agree	Agree	Slightly agree	Agree
Strongly agree	Strongly agree	Agree	Strongly agree	Agree
Slightly disagree	Strongly agree	Agree	Agree	Agree

Strongly agree	Strongly agree	Agree	Agree	Neither
Neither	Strongly agree	Strongly agree	Strongly agree	Neither
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Agree	Slightly agree	Agree	Slightly disagree
Disagree	Disagree	Disagree	Slightly agree	Disagree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Disagree
Agree	Strongly agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Strongly agree	Agree	Agree	Slightly agree	Agree
Neither	Agree	Slightly disagree	Agree	Disagree
Strongly agree	Strongly agree	Agree	Agree	Slightly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Agree	Agree	Agree
Agree	Agree	Slightly agree	Agree	Agree
Agree	Agree	Strongly agree	Agree	Agree
Agree	Agree	Agree	Neither	Neither
Slightly agree	Strongly agree	Strongly agree	Strongly agree	Neither
Agree	Slightly agree	Slightly agree	Agree	Slightly agree
Neither	Strongly agree	Strongly agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Agree	Agree
Strongly agree	Agree	Agree	Neither	Neither
Strongly agree	Agree	Strongly agree	Strongly agree	Slightly agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree

To what extent do you agree with the following statements regarding the development of software within an agile environment?				
Q6. The need for data relevance when a product is being developed.	Q7. The need for data currency (up to date data) when a product is being developed.	Q8. The need for clean data when a product is being developed.	Q9. The need for accurate data when a product is being developed.	Q10. The need for meaningful data when a product is being developed.
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Slightly agree	Agree	Slightly agree
Agree	Agree	Neither	Neither	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Slightly agree	Neither	Agree	Strongly agree

Agree	Agree	Neither	Agree	Agree
Strongly agree	Agree	Slightly agree	Agree	Strongly agree
Agree	Neither	Neither	Neither	Neither
Agree	Slightly agree	Slightly agree	Agree	Agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Slightly agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Slightly agree	Agree	Strongly agree	Strongly agree
Slightly agree	Agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Agree	Slightly agree	Slightly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Neither	Slightly agree	Neither	Strongly agree
Agree	Agree	Agree	Agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Agree	Slightly disagree	Agree	Agree	Strongly agree
Agree	Agree	Strongly agree	Agree	Agree
Agree	Slightly agree	Agree	Agree	Agree
Strongly agree	Agree	Agree	Agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Slightly agree	Slightly agree
Strongly agree	Slightly agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Slightly agree	Strongly agree	Slightly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Slightly agree	Neither	Agree

Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Slightly agree	Slightly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Agree
Strongly agree	Slightly agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Slightly agree	Slightly agree	Strongly agree	Agree
Agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Neither	Disagree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Slightly agree	Strongly agree	Strongly agree	Agree	Agree
Agree	Slightly agree	Slightly agree	Slightly agree	Agree
Agree	Agree	Agree	Agree	Agree
Agree	Agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Slightly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Agree	Agree	Neither	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Slightly agree	Agree	Slightly agree	Slightly agree	Agree

Neither	Agree	Agree	Strongly agree	Agree
Slightly disagree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Strongly agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Slightly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Agree	Agree	Agree	Agree	Agree
Agree	Agree	Agree	Agree	Agree
Agree	Slightly agree	Agree	Slightly agree	Slightly agree
Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree

To what extent do you agree with the following statements regarding the development of software within an agile environment?				
Q11. The need for processing data at different levels.	Q12. The need to componentise for quick selection by developers.	Q13. The need to isolate code to manage change.	Q14. The need for performance data reporting.	Q15. The need to develop new version of applications in parallel.
	Agree	Agree	Agree	Agree
Slightly agree	Agree	Slightly agree	Agree	Strongly agree
Neither	Neither	Neither	Neither	Slightly disagree
Agree	Strongly agree	Agree	Strongly agree	Agree
Strongly agree	Agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Agree	Neither	Agree	Slightly agree	Neither
Agree	Agree	Agree	Agree	Slightly agree
Neither	Neither	Strongly agree	Neither	Neither
Neither	Slightly disagree	Slightly agree	Slightly agree	Disagree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Agree	Agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Slightly agree	Strongly agree	Slightly agree
Agree	Strongly agree	Strongly agree	Agree	Slightly agree
Agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree

Neither	Strongly agree	Strongly agree	Agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Agree	Neither	Neither
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Slightly agree	Agree	Agree	Agree
Slightly agree	Strongly agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly disagree
Agree	Agree	Slightly agree	Agree	Slightly agree
Agree	Agree	Strongly agree	Agree	Agree
Neither	Slightly agree	Neither	Strongly agree	Slightly disagree
Agree	Agree	Neither	Agree	Neither
Strongly agree	Agree	Strongly agree	Neither	Slightly agree
Agree	Slightly agree	Slightly agree	Agree	Slightly agree
Strongly agree	Strongly agree	Slightly disagree	Agree	Strongly agree
Slightly agree	Agree	Agree	Strongly agree	Slightly agree
Agree	Slightly agree	Strongly disagree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Slightly agree	Agree
Agree	Agree	Agree	Strongly agree	Slightly disagree
Agree	Agree	Agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly disagree	Slightly agree	Strongly agree	Slightly disagree
Strongly agree	Slightly disagree	Agree	Slightly agree	Neither
Agree	Strongly agree	Strongly agree	Agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Agree	Agree	Agree	Agree	Slightly agree
Agree	Strongly agree	Slightly agree	Agree	Agree
Slightly agree	Agree	Strongly agree	Strongly agree	Agree
Strongly agree		Strongly agree	Strongly agree	Agree
Strongly agree	Slightly agree	Agree	Neither	Neither

Agree	Agree	Strongly agree	Strongly agree	Slightly agree
Agree	Agree	Strongly agree	Agree	Agree
Agree	Strongly agree	Neither	Neither	Agree
Agree	Agree	Neither	Agree	Neither
Slightly agree	Slightly agree	Agree	Strongly agree	Agree
Slightly agree	Agree	Agree	Slightly agree	Neither
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Neither
Slightly agree	Strongly agree	Neither	Agree	Agree
Agree	Agree	Agree	Agree	Slightly agree
Strongly agree	Slightly agree	Slightly disagree	Agree	Disagree
Agree	Slightly agree	Agree	Agree	Agree
Strongly agree	Agree	Strongly agree	Agree	Disagree
Neither	Neither	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Agree
Neither	Neither	Neither	Neither	Neither
Disagree	Disagree	Disagree	Disagree	Disagree
Agree	Neither	Slightly agree	Strongly agree	Disagree
Agree	Agree	Agree	Strongly agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Slightly agree	Agree	Slightly agree	Slightly agree	Slightly disagree
Neither	Slightly agree	Slightly disagree	Agree	Agree
Slightly disagree	Neither	Neither	Slightly agree	Disagree
Slightly agree	Agree	Agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Slightly agree	Neither	Slightly agree
Strongly agree	Agree	Agree	Strongly agree	Agree
Agree	Slightly agree	Agree	Agree	Neither
Strongly agree	Agree	Agree	Agree	Neither
Agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Slightly agree	Neither	Agree	Slightly disagree
Strongly agree	Agree	Agree	Agree	Agree
Agree	Neither	Slightly agree	Agree	Agree

Agree	Agree	Strongly agree	Agree	Strongly disagree
Agree	Agree	Strongly agree	Agree	Agree

To what extent do you agree with the following statements regarding the development of software within an agile environment?				
Q16. The need for the developer to stay relevant with tech research.	Q17. The need to get feedback from customers on continuous deploy changes.	Q18. The need for tech vision and foresight.	Q19. The need for time to reflect on the most appropriate approach to the task.	Q20. The need to investigate the new technology (to explore the fundamentals) before starting development.
Agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Slightly disagree	Slightly agree	Slightly disagree	Neither
Strongly agree	Strongly agree	Strongly agree	Neither	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Agree	Agree	Agree	Agree
Agree	Agree	Strongly agree	Strongly agree	Agree
Agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Slightly agree
Slightly disagree	Agree	Slightly agree	Agree	Slightly disagree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Agree	Slightly agree	Agree	Agree
Strongly agree	Agree	Strongly agree	Agree	Slightly agree
Strongly agree	Agree	Strongly agree	Agree	Agree
Slightly agree	Agree	Strongly agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Slightly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree

Agree	Strongly agree	Agree	Agree	Agree
Agree	Strongly agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Agree
Agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Slightly agree
Strongly agree	Strongly agree	Agree	Slightly agree	Agree
Strongly agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Neither	Slightly agree	Agree
Agree	Agree	Agree	Strongly agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Agree	Agree	Strongly agree	Agree	Agree
Strongly agree	Strongly agree	Agree	Slightly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Strongly agree	Agree	Strongly agree	Slightly disagree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree
Strongly agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Strongly agree	Agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Agree	Strongly agree	Agree	Strongly agree	Agree
Agree	Neither	Strongly agree	Strongly agree	Slightly agree

Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Slightly agree	Disagree
Agree	Strongly agree	Agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Agree	Agree
Agree	Agree	Agree	Agree	Agree
Agree	Strongly agree	Agree	Agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Slightly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Slightly agree	Slightly agree
Agree	Strongly agree	Slightly agree	Agree	Strongly agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Agree
Strongly agree	Agree	Strongly agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Slightly agree	Slightly agree	Slightly disagree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Slightly agree	Agree	Strongly agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Neither	Strongly agree	Agree	Slightly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Agree

To what extent do you agree with the following statements regarding the UX design of software within an agile environment.				
Q21. The need for designers to produce clear design artefacts as input to technical development.	Q22. The need for UX to get the conceptual design right through the building of and testing of low-fi prototypes.	Q23. The need to align business objectives with the user needs within the technical constraints that exist.	Q24. The need for UX design to contribute from the discovery phase to the final phase of the product, not just designing wireframes and performing usability testing.	Q25. The need to understand the user's real problems when designing the dashboard interface.
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Slightly agree	Strongly agree	Strongly agree	Strongly agree

Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Slightly agree	Agree
Agree	Agree	Agree	Agree	Strongly agree
Agree	Agree	Strongly agree	Slightly agree	Strongly agree
Slightly agree	Neither	Agree	Strongly agree	Strongly agree
Slightly agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Disagree	Agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Slightly agree	Strongly agree	
Agree	Disagree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Strongly agree	Slightly agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Slightly disagree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Slightly agree	Agree	Slightly agree	Agree
Slightly agree	Slightly disagree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Neither	Neither	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Agree
Agree	Slightly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Slightly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Slightly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree

Agree	Neither	Slightly agree	Neither	Neither
Slightly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Agree	Strongly agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Agree	Agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Strongly agree	Neither	Agree
Agree	Agree	Slightly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Strongly agree
Slightly agree	Agree	Agree	Strongly agree	Agree
Agree	Slightly agree	Strongly agree	Disagree	Strongly agree
Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Neither	Agree	Agree	Agree
Slightly disagree	Slightly agree	Slightly agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree

Agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Slightly disagree	Agree	Strongly agree	Agree
Agree	Agree	Strongly agree	Agree	Agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Slightly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Neither	Neither	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Strongly agree	Strongly agree	Strongly agree

To what extent do you agree with the following statements regarding the UX design of software within an agile environment?				
Q26. The need to surface the essence of information at the top level of the dashboard.	Q27. The need for the surfacing of time sensitive relevant information on the dashboard.	Q28. The need to use user KPIs in task driven environments to focus design instead of using personas.	Q29. The need for linking actions to be initiated by the customer based on the dashboard information (for example timed reminders).	Q30. The need to prioritise dashboard components according to the usefulness.
Strongly agree	Agree	Slightly agree	Neither	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Slightly agree	Agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Strongly agree
Slightly agree	Agree	Slightly agree	Slightly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Neither
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Neither	Slightly agree	Neither	Neither	Agree
Agree	Agree	Neither	Slightly agree	Strongly agree
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Agree	Slightly agree	Slightly agree	Strongly agree
Slightly agree	Slightly agree	Agree	Slightly agree	Slightly agree
Agree	Strongly agree	Slightly agree	Slightly agree	Strongly agree

Agree	Strongly agree	Strongly agree	Strongly agree	Neither
Strongly agree	Agree	Strongly agree	Strongly agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Slightly agree	Neither	Strongly agree
Strongly agree	Strongly agree	Neither	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Agree	Agree	Slightly agree
Slightly agree	Strongly agree	Agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Agree
Strongly agree	Neither	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Slightly agree	Neither	Strongly agree
Agree	Agree	Slightly agree	Slightly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Agree	Slightly agree	Neither
Strongly agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Slightly agree	Strongly agree	Neither	Agree	Agree
Agree	Agree	Strongly agree	Agree	Agree
Agree	Strongly agree	Agree	Agree	Agree
Agree	Agree	Slightly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Slightly disagree	Agree	Strongly agree
Strongly agree	Agree	Strongly agree	Agree	Agree
Slightly agree	Agree	Disagree	Agree	Neither
Strongly agree	Strongly agree	Strongly agree	Agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Slightly disagree	Slightly agree	Slightly disagree	Agree	Strongly agree

Agree	Agree	Agree	Strongly agree	Strongly agree
Strongly agree	Agree	Neither	Slightly agree	Strongly agree
Slightly agree	Slightly agree	Disagree	Agree	Agree
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Slightly agree	Strongly agree
Agree	Strongly agree	Neither	Agree	Strongly agree
Strongly agree	Agree	Agree	Slightly agree	Agree
Agree	Strongly agree	Agree	Agree	Strongly agree
Agree	Slightly agree	Slightly disagree	Slightly agree	Agree
Agree	Slightly agree	Slightly agree	Slightly agree	Agree
Agree	Agree	Slightly agree	Agree	Agree
Strongly agree	Agree	Strongly agree	Strongly agree	Slightly agree
Slightly agree	Slightly agree	Neither	Neither	Agree
Strongly agree	Agree	Neither	Neither	Slightly agree
Strongly agree	Strongly agree	Slightly agree	Strongly agree	Agree
Agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Neither	Neither	Neither
Slightly agree	Neither	Disagree	Disagree	Neither
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Disagree	Slightly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Slightly disagree	Slightly disagree	Slightly agree
Agree	Agree	Neither	Neither	Agree
Agree	Agree	Slightly agree	Agree	Agree
Agree	Agree	Agree	Agree	Slightly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Neither	Agree	Neither	Slightly agree	Agree
Strongly agree	Agree	Disagree	Slightly disagree	Disagree

Agree	Slightly agree	Neither	Slightly agree	Neither
Agree	Strongly agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Slightly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree

To what extent do you agree with the following statements regarding the UX design of software within an agile environment?				
Q31. The need for data to be searchable by users on the dashboard.	Q32. The need for user understandable language when designing dashboards.	Q33. The need to provide for interactivity in dashboard design.	Q34. The need for the user to be able to customise the level of information to be displayed.	Q35. The need for navigation path design.
Agree	Strongly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Neither
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Strongly agree	Strongly agree	Slightly disagree	Slightly agree
Agree	Agree	Agree	Strongly agree	Agree
Slightly agree	Strongly agree	Slightly agree	Agree	Agree
Neither	Strongly agree	Neither	Neither	Slightly agree
Strongly agree	Strongly agree	Slightly agree	Agree	Agree
Slightly agree	Strongly agree	Strongly agree	Strongly agree	Agree
Slightly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Slightly agree	Strongly agree	Agree	Slightly agree	Agree
Slightly agree	Strongly agree	Slightly agree	Neither	Slightly agree
Slightly agree	Strongly agree	Agree	Agree	Agree
Agree	Strongly agree	Slightly agree	Slightly agree	Slightly agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Neither	Strongly agree	Slightly agree	Strongly agree	Strongly agree
Slightly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Agree	Strongly agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree

Agree	Strongly agree	Agree	Slightly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Agree	Agree
Agree	Strongly agree	Agree	Agree	Agree
Agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Agree	Agree	Strongly agree	Agree
Neither	Agree	Slightly agree	Slightly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Slightly agree	Slightly agree	Agree	Slightly agree	Agree
Slightly agree	Strongly agree	Agree	Strongly agree	Agree
Strongly agree	Strongly agree	Slightly agree	Slightly agree	Strongly agree
Agree	Agree	Slightly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Neither	Strongly agree
Strongly agree	Agree	Strongly agree	Agree	Slightly agree
Slightly disagree	Strongly agree	Slightly agree	Neither	Slightly agree
Strongly agree	Strongly agree	Agree	Agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Neither	Agree
Slightly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Slightly disagree	Agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Neither	Agree	Neither	Slightly agree	Agree
Neither	Strongly agree	Neither	Neither	Agree
Strongly agree	Strongly agree	Slightly agree	Slightly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Agree

Agree	Agree	Slightly agree	Neither	Agree
Agree	Agree	Agree	Agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Strongly agree	Slightly agree	Agree	Strongly agree
Agree	Agree	Agree	Neither	Neither
Agree	Strongly agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Strongly agree	Agree	Strongly agree	Strongly agree
Neither	Agree	Neither	Neither	Agree
Neither	Neither	Neither	Neither	Neither
Neither	Strongly agree	Strongly agree	Slightly agree	Agree
Agree	Agree	Strongly agree	Agree	Strongly agree
Agree	Strongly agree	Strongly agree	Slightly agree	Agree
Agree	Agree	Strongly agree	Slightly agree	Slightly agree
Slightly agree	Strongly agree	Slightly agree	Slightly agree	Slightly agree
Slightly agree	Agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree
Slightly agree	Agree	Agree	Slightly agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Agree	Strongly agree	Strongly agree	Slightly agree	Agree
Agree	Strongly agree	Agree	Slightly agree	Neither
Neither	Strongly agree	Agree	Agree	Agree
Slightly agree	Agree	Strongly agree	Agree	Strongly agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree

To what extent do you agree with the following statements regarding the UX design of software within an agile environment?				
Q36. The need for visualising the logical perspective.	Q37. The need for making complex concepts visible.	Q38. The need to represent the same data in different ways.	Q39. The need for motion communicative methods for designs.	Q40. The need for visual cues to improve navigation.
Agree		Slightly agree	Slightly agree	Slightly agree
Neither	Neither	Neither	Neither	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Strongly agree	Agree	Neither	Neither	Agree
Agree	Slightly disagree	Neither	Neither	Slightly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Agree		Agree
Neither	Neither	Neither	Neither	Slightly agree
Slightly agree	Slightly agree	Strongly agree	Slightly agree	Strongly agree
Strongly agree	Agree	Slightly agree	Slightly agree	Agree
Slightly agree	Agree	Agree	Strongly agree	Strongly agree
Agree	Slightly agree	Agree	Slightly agree	Agree
Agree	Agree	Slightly agree	Slightly agree	Strongly agree
Agree	Strongly agree	Slightly agree	Agree	Agree
Strongly agree	Agree	Slightly agree	Slightly agree	Agree
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Slightly agree	Slightly agree
Strongly agree	Slightly agree	Slightly agree	Strongly agree	Strongly agree
Slightly agree	Agree	Agree	Slightly agree	Agree
Agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree
Agree	Strongly agree	Slightly agree	Agree	Agree
Slightly agree	Agree	Agree	Slightly agree	Agree
Strongly agree	Agree	Agree	Neither	Strongly agree
Agree	Agree	Agree	Agree	Strongly agree
Slightly agree	Agree	Slightly agree	Neither	Agree
Agree	Strongly agree	Strongly agree	Agree	Agree
Agree	Slightly agree	Agree	Slightly agree	Strongly agree
Agree	Agree	Neither	Neither	Agree

Agree	Strongly agree	Slightly agree	Agree	Strongly agree
Slightly agree	Agree	Strongly disagree	Agree	Strongly agree
Agree	Strongly agree	Neither	Neither	Slightly agree
Neither	Slightly disagree	Slightly disagree	Neither	Slightly agree
Slightly agree	Slightly agree	Slightly agree	Neither	Agree
Strongly agree	Strongly agree	Agree	Neither	Strongly agree
Agree	Agree	Agree	Agree	
Neither	Agree	Agree	Neither	Agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree
Strongly agree	Neither	Strongly agree	Slightly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
	Strongly agree	Neither		Neither
Agree	Slightly agree	Disagree	Strongly agree	Strongly agree
Strongly agree	Agree	Neither	Agree	Agree
Neither	Slightly disagree	Agree	Slightly agree	Strongly agree
Neither	Slightly disagree	Neither	Neither	Neither
Strongly agree	Strongly agree	Slightly agree	Slightly agree	Agree
Slightly agree	Slightly agree	Slightly agree	Slightly agree	Agree
Agree	Slightly agree	Slightly agree	Agree	Slightly agree
Agree	Agree	Slightly agree	Agree	Strongly agree
Agree	Strongly agree	Slightly agree	Neither	Agree
Agree	Slightly agree	Strongly agree	Slightly agree	Slightly agree
Agree	Agree	Neither	Slightly agree	Agree
Agree	Agree	Neither	Neither	Agree
Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree

Agree	Strongly agree	Slightly agree	Slightly agree	Agree
Neither	Neither	Agree	Neither	Agree
Neither	Neither	Neither	Neither	Neither
Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Agree	Agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree
Agree	Strongly agree	Agree	Slightly agree	Agree
Neither	Slightly agree	Neither	Neither	Strongly agree
Agree	Slightly agree	Neither	Agree	Agree
Agree	Slightly agree	Slightly agree	Slightly agree	Agree
Agree	Slightly agree	Slightly agree	Neither	Strongly agree
Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
Agree	Agree	Agree	Neither	Agree
Agree	Slightly agree	Neither	Slightly agree	Agree
Strongly agree	Agree	Slightly agree	Slightly agree	Strongly agree
Agree	Agree	Slightly agree	Neither	Slightly agree
Agree	Agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree

Appendix H: Expert review focus group survey for the evaluation of the practitioners' framework

Research Framework Evaluation Form

Welcome!

This focus group and accompanying survey is intended to support the evaluation of an UX framework developed as part of a PhD study.

Framework Title: UX Framework for development of dashboards within an agile software environment.

To participate, consider the consent and confidentiality information and tick both boxes to continue.

Attached also find a link to the ethics certificate for this study for your reference:

https://drive.google.com/file/d/1C1Gjmnd42ZM0kyyfvZVUHulJ-ntFydV6/view?usp=sharing

*Required

1. Email *

2. Consent & Confidentiality *

Tick all that apply.

☐ Consent - I agree to participate in this research out of my own free will and understand that I may withdraw from the research at any stage. I understand that other participants could be able to identify me in the focus group. Once the data is recorded and analysed participants will not be personally identifiable from the reported/aggregated data.

☐ Confidentiality - I agree to refrain from sharing the framework or any part of it until the research has been completed or has been published by the researcher.

3. I have read and understood the ethics description and would like to continue with providing feedback on research collaboration.

Mark only one oval.

◯ Yes *Skip to question 4*

◯ No thanks

Skip to question 4

Evaluation Form

4. Occupation *

5. Years experience

6. Work location (country) *

Table 1. UX framework for the development of dashboards within an agile software environment	
MAIN CATEGORIES	SUB-CATEGORIES
Agile software development	
	Agile practice and process
	Continuous improvement
	Incremental, quick value delivery
	Measurement
	Way of working
	Resources and infrastructure
Change and adaptability	
	Adaptability
	Change
	Experimentation
	Innovation
Collaboration and communication	
	Collaboration within the organisation
	Collaboration within the team
	Communication within the organisation
	Communication within the team
	Collaboration with the product users
The agile team	
	Developer role
	Product owner role
	UX designer role
	Extended team composition
Development	
	Software development
	Development/Tech leadership
	Development/Tech research
	Technical feasibility
	Data
UX design	
	UX strategy
	UX goals
	UX tools
	UX designer
	UX design practice
	UX design process
	UX Research and sensemaking
	UX Testing and validation
	Desired experience characteristics
	UX Dashboard design
	Education/Training of user
Product	
	Business objectives
	Product requirements
	Product use
User	
	User attributes
	User needs
Product/User interaction	
	Contextual use
	Temporal use
	Situational consequence of use
	Meaningful experience
	Emotional experience
	Aesthetic experience

Evaluation Instructions

Consider the proposed UX framework in Table 1.

This framework is aimed at providing a high-level view of what elements are required for the optimal development of dashboards within an agile environment. The framework is proposed (to be used) to guide teams/organisations at a high level when developing dashboards within an agile software environment.

Considering the framework presented above, please indicate to what extent do you agree with the statements below.

7. Major Categories

Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
The categories are sufficient to represent, all categories of the domain (Sufficiency)	◯	◯	◯	◯	◯
There is no overlap detected between descriptions of categories (Accuracy)	◯	◯	◯	◯	◯

8. Sub-Categories

Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
The sub-categories are relevant to the respective major category (Relevance)	◯	◯	◯	◯	◯
Sub-categories cover all aspects impacting/involved in the major categories (Comprehensiveness)	◯	◯	◯	◯	◯
Sub-categories are clearly distinct (Mutual Exclusion)	◯	◯	◯	◯	◯
Sub-categories are correctly assigned to their respective Category (Accuracy)	◯	◯	◯	◯	◯

Framework

9. Clarity

Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
The major categories are clear (Clarity)	⬭	⬭	⬭	⬭	⬭
The sub-categories are clear (Clarity)	⬭	⬭	⬭	⬭	⬭

10. Usefulness and Practicality

Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
The framework is useful for assessing gaps in the design and development of dashboards (Usefulness)	⬭	⬭	⬭	⬭	⬭
The framework is practical for use in industry (Practicality)	⬭	⬭	⬭	⬭	⬭
The framework is considered simple enough for the purpose of presenting an overview of major components required in practice (Simplicity)	⬭	⬭	⬭	⬭	⬭

11. Transferability

Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
The framework is transferable to the development of other software besides the design and development of dashboards (Transferability)	⬭	⬭	⬭	⬭	⬭

12. Would you add any major categories? If so please state what and optionally explain why?

13. Would you remove any of the major categories? If so, please state what and explain why?

14. Would you update any of the major category descriptions? If so, please explain what and why?

15. Would you add, remove or redefine any of the sub-categories? If so, please explain what and why?

16. Could the framework be made more useful? How?

17. Could the framework be made more practical? How?

Appendix I: VAPO_UXF_BID_1.1 Detailed framework

VAPO_UXF_BID_1.1 Detailed Framework

Primary grouping	Secondary grouping	Tertiary elements
Agile software development in practice	**Agile practice, ways of working & process**	Agile practice, ways of working & process considerations: ▪ **Research** should be valued; ▪ **UX Design** should be included in process upfront; ▪ **Context** to be considered; ▪ **Experience the practice of agile** first-hand, the adoption of agile practices, to master agile basics; ▪ Practicing **agile as a philosophy**; ▪ **Clear activities**; ▪ **Deliverables** should be accessible to everyone in organisation; ▪ **Outcome driven** work; ▪ **Critical agile ceremonies** (constant sync ups, daily stand-ups, sprint planning ceremonies and retrospectives, backlog; ▪ **Planning and prioritization** of work, backlog grooming.
	Continuous improvement	Continuous improvement considerations: ▪ **Measure** the improvement of the incremental delivery; ▪ Consciously striving towards, looking for ways of **continuous improvement** as an ongoing process and not something that will cease at some point, continuing as software delivery continues; ▪ **Polish**/refine work continuously; ▪ **Support** to team from business continuously; ▪ **Participation** towards progress continuously; ▪ **Research** continuously; ▪ **Learn** continuously; ▪ Allow the **freedom** to make products that customers love; ▪ **Commitment** to continuously improve the product after delivery;
	Incremental, quick value delivery	Incremental, quick value delivery considerations: ▪ **Improvement** of a product through **incremental delivery**. ▪ **Speed** of delivery; ▪ Short **sprints,** deadlines, blocked out time; ▪ Length of **work not fixed**; ▪ **Flexibility** to adapt to work; ▪ The team's level of comfort to **move quickly** through the development phases impact delivery; ▪ **Efficiency** in development of the product for **immediate u**se; ▪ **Building** of pieces (features) for the dashboard;

		▪ **Iterations** in agile work must be understood, each increment of development would give back to the user and where each increment would contribute towards customer value; ▪ **Process order** and manner of execution; ▪ **Feature richness** of each delivery in a consistent iterative way; ▪ **Short increments** facilitate the optimal way for learning to happen, providing contained periods where new knowledge could be applied and tested in the increment; ▪ **Building and releasing the smallest possible pieces** of *value* to customers as soon as possible will speed up delivery and also the rate of continuous customer feedback.
	Measurement	Agile measurement considerations: ▪ **Tracking** of development; ▪ **Measurement** allows the product owner/manager to measure whether what the team has built was worthwhile, beneficial for stakeholders to improve understanding of what they have asked to be built; ▪ The availability of **system analytics** to measure consistently and accurately; ▪ **Success estimates** must be defined and tracked through analytics; ▪ **Measuring the use** of the product through continuous testing and analytics post development and release; ▪ **Tracking** whether people are using what has been built in the expected way (**how it is used**); ▪ Using data to continuously **refine** the product; ▪ Use data to **measure the impact of changes** made; ▪ **Feedback from customers** is essential in measuring performance of a product, what it is used for and what value it is adding.
	Resources and infrastructure (including agile team)	Resources and infrastructure (including agile team) considerations: ▪ Use of white **boards** & stickies, online boards; ▪ **Flexible** work environment; ▪ **Co-location or remote** working where possible; ▪ **Team determines** process, improve agile processes; ▪ **Team ownership** of product, clear ownership of work, commitment from team to own; ▪ Accepting individual **responsibility**; ▪ Team members are **equal, team respect**; ▪ **Empowered** team; ▪ **Focused** team; ▪ **Software developers**: with a specific focus, with a passion for getting software to production phase, that are critical, precise, collaborative, open to constructive criticism and feedback, development team leads to guide and to make building products more effective, to motivate, protect developers, enabling developers to grow their skills, empowering them to contribute more.

		▪ **Product owners**: with discipline to get agile basics right, that understand agile software development, that are organized, that keep track of past and future work, with the ability to lead the team, coordinate events in team, manage work, track work, driving work to delivery, ensure a stable backlog, prioritise work in team, overcome challenges to deliver, manage with fairness, good social skills, ability to sell the UX to the team and stakeholders. The product owner is the face and voice of the product, should understand the product being built, should have a clear vision of way forward, clear product strategy, make work and planning visible to team and stakeholders, keep objectives in scope, make sense of customer research, understand the problems to be solved, protect the team, enable team members to succeed, work towards getting the team on the same page, allow the team to get along, able to talk the same language as developers and designers and translate between them, connecting different roles, needs extensive business knowledge, have sight of risk factors, decide on product compromises, needs autonomy to make decisions without interference from company politics. ▪ **UX Designers**: that can think at high level as well as to focus on detail, that are creative, able to think logically, that balance and negotiate user requirements, business and technical constraints, create and test concepts at speed, promote usability testing, initiating product momentum, run workshops, understand topics in depth, find hidden opportunities, mentor and develop designers in team, upskill and re-skill designers, develop self-leadership, understand basics of other roles in team.
	Experimentation & Innovation	Experimentation and Innovation considerations: ▪ **Innovation** should be encouraged; ▪ **Desire** to want to improve things; ▪ **Experimentation** with ideas, A/B testing, identify what deserves attention, where there is value; ▪ **Look for opportunities** to run experiments; ▪ **Try new things** without fear of failure, accepting trial and error as part of the process towards improvement; ▪ **Space to explore** the unknown and discover new things to generate value that is carried throughout the process; ▪ **Find hidden opportunities** to uncover innovation opportunities; ▪ **Creative problem solving** to find a way forward when there looks to be none; ▪ Find **new ways** to advance the product; ▪ **Reflect** on what has been learnt through experimentation; ▪ **Encourage to innovate**; ▪ **Explore** the characteristics of **products people love**.
	Change & Adaptability	**Change and Adaptability considerations:** ▪ Team members should be **open to change**; ▪ **Positive a**ttitude; ▪ Ability to **adapt and respond to** change;

		▪ **Expect change**, work to limit impact of change; ▪ **Awareness of change** at different levels (team, process, organisation, technology, customer); ▪ Prepared to **adapt processes,** adaption of processes in relation to scenario requirements, Environment should allow for flexibility of practitioners to adapt the process where needed; ▪ **Cultural change** on an organisational level required to accept change and lead from the top; ▪ Change from self-serving to **serving-another** to help achieve other people's goals; ▪ **Search out change** to stay relevant with progress made (by external factors such as technology and changed environment).
	Collaboration and communication	▪ Collaboration and communication within team: promote transparency within team, communication in the team should happen openly, have transparency in the team, separate space for sensitive conversations, people should primarily speak to each other, convey ideas openly, consult with team members, ensure communication channels are open, talk about goals, have a space for interactive communication, practice and grow communication skills. Team should collaborate to move towards clarity together, collaborate at early stages of design reviews, collaborate to utilise combined knowledge to determine workability of ideas, to form effective feedback loops, capture information, coordinate collaboration time, coordinate flow of ideas, coordinate resulting work and discussions, collect as much information as possible early on. Communication should be clear, principles to guide communication and way of working provides a solid foundation for communication in the team. Participative development to deliver quality product, cohesive team, partnership in building products, collaboration with developers to test ideas quickly, design reviews, quick feedback cycles, developer code reviews, design representation in the team from start to finish. Co-ownership of work to ensure durability and maintenance of the product. ▪ Collaboration and communication within organisation: initiate collaboration, collaboration spans across the team, extends to stakeholders, enablers and customers, collaboration during all phases of software development, collaboration is interactive, search for the information needed to continue work, make planning visible, aid communication of work and timeframes, clear roadmaps visible to entire organisation. Collaboration required where legacy dependencies exist. cross-functional collaboration in the organisation, should include but not limited to business owners (from marketing to finance to business), network of stakeholders, involve stakeholders early on to improve quality of discussions, stay close to sponsorship layer, ensure vested interest in product. Educate and inform stakeholders to build an understanding of what they ask from teams, share learnings outside of the team, what has been discovered and how thinking evolves. Socialisation of work in company to increase visibility and improve communication, continuous and regular communication throughout product development iterations. Cross-functional tech to assist delivery better. Understand flow of information in organisation, address challenges of communication

		between business and team, inclusion of design in teams that deal with organisational problems. ▪ Collaboration and communication within users: critical to collect information from users about what they need, collect feedback from users, collaborate with users to design products, continuous iterative process to design test and refine requirements with users, produce authentic user journeys, facilitate critical thinking between designers and users, enable the validation and testing of designs (and sequencing of tasks and screen flows), showing conceptual designs to users before it is worked on further, designer and user together shape and adapt ideas, collaboration with users improves product buy-in and assists in developing a product of value. It is essential to have access to many users to collect information and test with, collaborating to find new innovative ways of addressing user problems, user collaboration allows for insight of what is needed. Collaboration with users at all levels to avoid building for a specific sub-set of customers, including users in beta testing, showing benefits to customers to aid acceptance and adoption. Continuous participative decision making with the user, focus on user feedback, and sharing value delivered with customers continuously.
User	**User attributes**	The user's abilities should be understood to purposefully design the product user's attributes. User attributes to be considered: ▪ **User emotions** (mood, concerns, attitude); ▪ **User traits** (skills/abilities, specialty/expertise, personal, physical attributes, knowledge/experience, competence, physical health); ▪ **User motivators** (needs, expectations, intentions, influence, self-expression/idealism, motivation, anticipation, aspirations, desires, stimulation, autonomy); ▪ **User association** (relatedness, popularity, competition, appropriate, connect, achievement, specific, design consequence – pleasure, design consequence – appeal); ▪ **User perceptions** (perception: thoughts, perception: emotions, interpret, recount, reflect, user value – worth, user value – strategy, user security, user interaction, user presentation, user content).
	User needs	▪ **User needs should be understood** before the development of a product starts; ▪ **Collaborate with users** to gain visibility of user needs; ▪ **Utilise data** from different sources (system generated data and user sourced data) to gain a view of user needs.
Product	**Business objectives**	▪ A thought-through **business case** should be in place; ▪ Understand why something is being built, what is the **purpose of the product**; ▪ Have clear **business objectives**;

		▪ Business objectives should form part of a **product plan or strategy;** ▪ The **business strategy should be aligned to the product strategy**, to inform the product strategy; ▪ The business case and supporting customer case should determine the **real need for a feature before commitments are made** to start up a team to build the feature; ▪ Have clear **success criteria**; ▪ Have clear **customer requirements**.
	Product requirements	▪ Have a clear **product strategy**; ▪ A clear **product vision** is essential to lead the requirements; ▪ Know the **product expectations** from the start to work towards a clear endpoint; ▪ Have clarity on **product support requirements**; ▪ The team should understand the **scope of work** well for development estimates and efficient development timeframes; ▪ Have a clear **product roadmap;** ▪ Have a **stable backlog**, remove blockers to allow for focused work; ▪ Have a **prioritised backlog**; ▪ Have **guidelines for product requirements** (MVP in terms of experience requirements, and functional features); ▪ Be empowered to **change scope if necessary** to bring value to customers; ▪ **Requirement selection** should not be at the cost of experience; ▪ The **product success should be measurable** once delivered.
	Product use	▪ Consider interaction **touch point** (interaction with device); ▪ Consider the **context of use** (usage context – experience driven innovation, context-related tasks, context physical, spatio-temporal – effects of place and time); ▪ **Experience** (momentary UX – during use (time), time cumulative UX – over time, time episodic UX – after use, time anticipated UX – before use, user situation consequence – appeal, user situation consequence – pleasure, user situation consequence – satisfaction, experience of meaning, emotional experience, aesthetic experience, user benefits – in interaction scenario, temporality functional dependency (incorporation phase: usefulness, long-term usability), temporal emotional attachment (identification phase: social, personal), temporality increasing familiarity (orientation phase: stimulation, learnability); ▪ **Perceivable elements** (visual attractiveness, stimulation, augmentation, interaction, manipulation, consistency, match between system and real world, visibility of system status); ▪ **Use** (usability, utility, functionality, mobility, efficiency, flexibility, usefulness, error prevention, recognition over recall, user control and freedom, user to recognise, diagnose, and recover from errors); ▪ Build an **understanding about the use of the product**. Not just through system generated data on the use of the product (what users are doing – systems view of interaction) but also from the user feedback and research on the use of the product, *why* are users using the product in a certain way – user view of interaction; ▪ Understand *how* users are using the product (people engagement needed to understand why users are doing something in a certain way);

		▪ Thoroughly understand the software use by users in the real-world post release; ▪ **Features** (meaningfulness, quality, security, performance), refine the product with users; Test products with beta users; ▪ **Support** (pedagogical appropriateness, help, documentation and education/training); ▪ **Content** (content fluency – right data, timely data, time relevant data).
UX design	**UX strategy & goals**	**UX strategy:** ▪ A clear **UX design strategy** for the UX team to follow. This will guide ***what*** the team works on, and ***how*** the team works (for example how much time is spent on pro-active design work, versus business led work, or the double diamond approach); ▪ Have a common and agreed understanding of the purpose of UX within the organisation; ▪ Have a foundational understanding of what UX is in the organisation, what the expectations of UX practitioners are and having an executive level champion for UX design in the organisation; ▪ The understanding of the purpose of UX should facilitate the inclusion of UX in the entire life cycle of any product work from the initial phases of project inception; ▪ Have an agreed understanding in the organisation that every little decision can have far reaching consequences on the UX. ▪ Ensure alignment with brand strategy. The UX strategy should guide UX designers to produce designs that support a unified brand and consistent user interface; ▪ Design infrastructure should be laid, and processes established to support design work, so that designers can focus on work and not on building design infrastructure; ▪ Have an organizational UX philosophy; ▪ Have a clear UX mission; ▪ Incorporate established UX principles; ▪ Have a UX accessibility strategy; ▪ Provide guidance to the design team by using an established interaction model; ▪ Utilise suitable design methodologies; ▪ Utilise a design system to optimise designer efficiency, to improve consistency and kontroleer quality; ▪ Incorporate UX KPIs, measuring achievement of UX goals, data and analytics; ▪ Understand the technical environment in which the product needs to be developed; ▪ Understand the business landscape and the business objectives. **UX staffing**: ▪ HR – UX roles, competencies, role responsibilities, designer attributes (professionalism, approachability, selling design ideas), in the form of a career framework; ▪ HR training, change management and communication strategy;

		▪ Effectively onboarding designers into the design team and agile teams; ▪ Design team members should be developed, and opportunities created for them to learn and grow their careers; **UX design goals:** ▪ Reason for product existence; ▪ Tech possibilities and constraints; ▪ User empathy; ▪ Scientific understanding of humans [cognition, behaviour and physiology]; ▪ Understanding the context of the design ▪ Design style, for example simple design, intuitive design, essential design – only what is needed; ▪ Continuously learning more about the user to design relevant products.
	UX design practice	**UX design practice:** ▪ Utilise thoroughly tested **conceptual designs**, sketching out many options is helpful during conceptual design stage, designers should be prepared to discard ideas and look at the holistic design of solutions; ▪ UX designers should also be able to work at speed when required to test concepts quickly. ▪ Utilise *personas* where appropriate; ▪ Map out different user flows and user journeys; ▪ Utilise a modular approach to design to make flows flexible; ▪ Make design output (research, testing, flows, wireframes, low fidelity, high fidelity screens) accessible and visible to the design team; ▪ Understand the business environment and balancing the business objectives and goals with user needs, understanding the technical constraints; ▪ Designers should be supported and enabled to design with confidence through the use of data, design tools and stakeholder collaboration; ▪ Designers should be able to work ahead (clear roadmap); **UX tools:** ▪ Design software available (for designing, collaboration, user representations, interaction flows, prototypes, etc. for design functionality, design interaction, emotional considerations, service coherence); ▪ Use of standardised questionnaires such as SUS; ▪ Use of design style guide, design system, etc. for guidance on design presentation, design attractiveness, compositional layout, sensual design considerations, designing of cross-contextual activities, minimalistic design [goal coinciding], consistency.
	UX design process	▪ Institutionalise UX design processes within the UX team; ▪ Utilise recognised design process as the foundation of the process, such as a UCD process; ▪ Utilise senior or lead designers when designing; ▪ Utilise an iterative design process to get to a fit-for-purpose design;

		▪ Include users in design iterations, for users to articulate wants and needs; ▪ Inclusion of demonstrative (visual/audio) designs in user collaboration sessions; ▪ The design process should include requirements gathering, specifications, initial research, conceptual design, refined design elements, prototyping, testing and development to produce a minimum viable product; ▪ Awareness that, in reality, design does not always follow the same linear process; ▪ Ensure the concept is well-tested, sufficient time should be spent on research, having a refined problem statement, validation of pain points, evolution of solutions, assurance that right user problem is being addressed in the right way; ▪ Continuous testing and validating of work at different stages of process; ▪ The design process to provide designers with confidence in decision-making within design.
	UX research & sensemaking	Research is required for deep understanding of the root problem: ▪ Research to provide clarity of the problem being solved; ▪ Research to provide clarity of the product requirements; ▪ Collect information from users and internal customers (business or technical stakeholders) for clarity; ▪ Research to provide clarity about the reason for design decisions; ▪ Research is required for alignment between user needs and 'jobs to be done' by the product (understanding the user needs and problem before designing); ▪ Understanding unique customer needs; ▪ Understanding customer needs for different experience levels (novice to advanced users); ▪ Researching as much as possible, even the smallest robust amount of research is valuable; ▪ Multiple iterations of research are required (to improve understanding of user, business, technical); ▪ Continuous research by the design team as a way of working; ▪ Fieldwork to provide clarity and certainty; ▪ Content is required to allow for sensemaking; ▪ Product familiarity is beneficial for researching; ▪ Articulation of real user needs in clear language; ▪ Research includes: identifying the data needed, collecting the data, synthesising the data, identifying connections within the data to support the sensemaking of the data, supporting user needs for customised products. ▪ Share research findings with team and stakeholders.
	UX testing & validation	▪ Test all conceptual designs; ▪ Conduct continuous incremental testing also during delivery of product (pre- and post- delivery testing) to refine product; ▪ Use the right level of UI fidelity for the stage of testing (for example, low fidelity testing for concepts and high fidelity for detailed and refined designs) visual/prototype-based testing to aid user understanding;

		▪ Conduct proper participant selection; ▪ Have clear testing criteria (for example ease of use, learnability, etc); ▪ Test towards clarity of design; ▪ Test towards certainty of requirements; ▪ Allow for experimental testing of ideas; ▪ Have a dedicated place for testing; ▪ Test in the intended environment of use (if possible); ▪ Utilise analytics when testing; ▪ Include the testing of non-users for additional perspective on products. ▪ Allow for mindfulness and consideration of consequences of testing; ▪ Have structured channels to feedback testing results.
	Usability & experience characteristics	▪ Design towards an predefined experience; ▪ Training of the user is not required for use of product; ▪ Simplicity of the interface; ▪ Complexity should be hidden; ▪ Product to be perceived as usable (including usability elements such as ease of use); ▪ Product to be perceived as useful; ▪ Product to be appreciated by user; ▪ Product to be perceived as friendly; ▪ Product to be perceived as enjoyable; ▪ Product to be perceived as exciting; ▪ Product to be perceived as meaningful; ▪ Product to be perceived as pleasurable to use routinely; ▪ Product aesthetics to be considered; ▪ Emotional considerations of interface. ▪ Ensure alignment between team and end user of contextual use of product and at conceptual design stage to create something useful, functional, that satisfies the need of the user, ▪ Design for the user to have control;
	UX Dashboard design	Dashboard design considerations: ▪ Research product user journey; ▪ Research dashboard navigation strategies; ▪ Research use of language (contextual, systems/organisational legacy and user); ▪ Utilise user goals (KPIs or KPAs) for design direction as opposed to a user *persona* focus; Presentation of data: ▪ Surface the essence of (relevant) information at the top level of the dashboard; ▪ Make decisive information available to the user; ▪ Surface potentially time sensitive information; ▪ Surface potentially high impact information; ▪ Link time management functionality of information presented on the screen to user need to initiate information driven action;

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- Surfacing important lower-level info on the dashboard, when relevant;
- Ability to customise solution/level of information displayed;
- Ability to drill down into information of interest;
- Have different data level views, users need to be able to move up and down, forward and backward (historical data) in data structure;
- Design to be fit for context of use;
- Utilise visualisation for important information;
- Represent the same data in different ways to aid understanding of data;
- Utilise visualisation to improve understanding of complex concepts;
- Utilise motion communicative design;
- Visually organise data for mobile interfaces;
- Have purposeful data views;
- Utilise of comparative features;
- Component based design.

Designers:

- Designers should have experience and an understanding of data structures when designing dashboard interfaces;
- Understand relationships between data;
- Look for ways that the dashboard can support complex data more effectively;
- Prioritise features based on usefulness to the user, improve usability incrementally;
- Gauging the ability of the user to consume the information presented;
- Allow for reflection by team members on dashboard design.

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<td>Technical product development</td>
<td>Software development – technical</td>
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Software development considerations:

- Technical possibilities;
- Technical challenges, technical constraints;
- Technology support (context dependent);
- Developing new versions of software in parallel;
- Developing with version control;
- Development of feature toggles;
- Use of tools to chunk stories;
- Making use of the development of individual components (modular approach);
- Component matrices to allow for quick component selection;
- Using technology the team prefer;
- Identify problematic data requirements;
- Accurate data visualisation;
- Optimal data rendering on dashboard;
- developer knowledge;
- Thought through use of biometrics;
- Code isolation;
- Use of up-to-date technology;
- Automated delivery where possible;
- Making design assets available to developers;
- Continuous feedback from customers;
- Tacking performance improvements

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		▪ Use of DevOps practices; ▪ Continuous deploys ▪ Continuous integration systems ▪ Continuous monitoring.
	Development leadership	▪ An appreciative leader; ▪ Strong tech leadership through clear tech vision; ▪ A leader that executes with foresight; ▪ Leadership in step with tech trends; ▪ Leaders that encourage developers to learn new technologies and try new technologies; ▪ Technical mentorship to develop and grow developers; ▪ Tech leadership that mentors more junior developers and keeps an eye over team members; ▪ Leadership that protects team members from burnout; ▪ Leadership to keep team members motivated and balanced; ▪ Tech leadership to lead the team to develop software in the team effectively and to deliver working software on a continuous basis.
	Development research	▪ Significant technology exposure in past projects; ▪ Avoid rushing into using new tech without exploring it properly first; ▪ Have the freedom to stay relevant with new tech through continuous research; ▪ Spend the largest portion of time on actual development of software, but have time to reflect on work, to explore how and with what developers work.
	Technical feasibility	▪ Check compatibility of tech to designs; ▪ Match technological constraints to design concepts in the most effective ways; ▪ Explore the initial plan of the design for data availability and ideal data format; ▪ Understand the technical viability of the product; ▪ Test the feasibility of the desired functionality.
	Data	Data considerations: ▪ Data quality; ▪ Up-to-date data; ▪ Accurate data in end product; ▪ Data relevance; ▪ Meaningful data; ▪ Useable data; ▪ Clean data; ▪ Data performance; ▪ Reporting on data performance; ▪ Data that reflect the logical perspective;

		▪ Access to the right systems and information for team members to do their jobs; ▪ Retrievable data; ▪ Analysis of the data; ▪ Understand the data; ▪ Ability to process data at different levels; ▪ Process data at different speeds; ▪ Have robust data.
	DevOps	DevOps considerations: ▪ Contextual adaptation

Appendix J: Thesis overview

Thesis Overview

- **Chapter 1** Introduction
- **Chapter 2** Domain Orientation
- **Chapter 3** Theoretical Foundation
- **Chapter 4** Philosophical Viewpoint & Research Design
- **Chapter 5** Data Analysis
- **Chapter 6** Results and Findings
- **Chapter 7** Conclusion
- **APPENDIX A** Literature Review Matrix
- **APPENDIX B** Conceptual UX Framework (CL_UXF_1.1)
- **APPENDIX C** Theoretical Framework (TRDF_AAAL_1.1)
- **APPENDIX D** Qualitative Instrument
- **APPENDIX E** Qualitative Data
- **APPENDIX F** Quantitative Instrument
- **APPENDIX G** Quantitative Data
- **APPENDIX H** Expert Review Focus Group
- **APPENDIX I** Practitioner checklist (VAPO_UX_BID_1.1)
- **APPENDIX J** Thesis Overview
- **APPENDIX K** Ethical Clearance Certificate
- **APPENDIX L** Originality

Appendix K: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) RESEARCH AND ETHICS COMMITTEE

23 November 2018

Ref #: 035/CJ/2018/CSET_SOC
Name: Mrs Chrisna Jooste
Student #: 32510292
Staff #:

Dear Mrs Chrisna Jooste

Decision: Ethics Approval for 5 years (Humans involved)

Researchers: Mrs Chrisna Jooste, P.O. Box 51852, Wierdapark, 0149, j.chrisna@gmail.com, +27 83 447 0969

Project Leader(s): Prof Judy van Biljon, vbiljja@unisa.ac.za, +27 11 670 9182
Prof Adele Botha, abotha@csir.co.za, +27 12 841 3265

Working title of Research:

A User Experience Framework for Business Intelligence Dashboards: A Mixed Methods Study Within an Agile Software Development Environment

Qualification: PhD in Information Systems

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee for the above-mentioned research. Ethics approval is granted for a period of five years, from 23 November 2018 to 23 November 2023.

1. The researcher will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee. An amended application could

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be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date (23 November 2023). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
8. Field work activities may only commence from the date on this ethics certificate.

Note:

The reference number 035/CJ/2018/CSET_SOC should be clearly indicated on all forms of communication with the intended research participants, as well as with the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee.

Yours sincerely

Dr. B Chimbo

Chair: Ethics Sub-Committee SoC, College of Science, Engineering and Technology (CSET)

Prof I. Osunmakinde

Director: School of Computing, CSET

Prof B. Mamba

Executive Dean: CSET

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Appendix L: Originality

Turnitin Originality Report

Thesis Submission: A USER EXPERIENCE FRAMEWORK FOR BUSINESS INTELLIGENCE DASHBOARDS: AN APPRECIATIVE INQUIRY STUDY WITHIN AN AGILE SOFTWARE DEVELOPMENT ENVIRONMENT

ORIGINALITY REPORT

16%	12%	7%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Chrisna Jooste, Judy Van Biljon, Adele Botha. "A Conceptual Framework Representing the User Experience for Business Intelligence Front-Ends", 2018 International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD), 2018 Publication	2%
2	uir.unisa.ac.za Internet Source	2%
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