The Awareness of Biases in our Intuition: Understanding Influences on Decision-Making in User-Centred Agile Requirements Engineering

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Declaration

I hereby declare that the work presented in this thesis has not been submitted for any other degree or professional qualification, and that it is the result of my own independent work.

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Abstract

During recent decades, software development in all industries has experienced an impactful change from feature focused and sequentially planned to user-centred and agile approaches. Reasons are continuously evolving technologies and with it fast changing markets and customer expectations to receive products fitting latest standards and their needs. To cope with this unstable environment and high expectations, organizations must adapt using user-centred and agile frameworks, methodologies and processes. Due to correlated changes in organisational structures, role expectations including responsibilities and needed skill sets change. Classical roles adapt and new roles emerge, trying to fulfil all expectations from organisations as well as from customers.

An observed phenomenon is irrational decision-making (DM) in this complex, timely and stressed environment, which contradicts rational decisions to maximize outcomes. What triggers this observed irrational DM and is it possible to become aware and handle it? The aim of this study is to understand influences that cause irrational DM in user-centred agile requirements engineering (UCA-RE) with the motivation to avoid inefficient or even harmful and emotionally loaded collaborations due to subjective discussions.

Literature on RE and psychological DM got reviewed to create a conceptual framework for understanding this phenomenon. Insights from the literature review uncovered gaps and left open questions: Why do identified processes and roles influence thinking processes and why do resulting heuristics influence DM? To answer the questions, the results of a thematic analysis of semi-structured interview data got used to extend the conceptual framework. Analysis results revealed new insights on influences of time and available knowledge as cause for irrational DM. Based on those insights, a reviewed approach to support awareness of influences got introduced. As conclusion, it was acknowledged that heuristics and intuitive DM is a necessity to cope with today's expectations. However, awareness of potential for biases is important to guide evolvements of processes or models through future research and manage their influences on DM in practice.

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Abbreviations

ASD ..... *Agile Software Development*
CRT ..... *Cognitive Reflection Test*
DM ..... *Decision-Making*
DT ..... *Design Thinking*
EDT ..... *Enterprise Design Thinking*
HCD ..... *Human-Centred Design*
PO ..... Product Owner
RE ..... *Requirements Engineering*
UCA ..... *User-Centred Agile*
UCA-RE ..... *User-Centred Agile Requirements Engineering*
UCD ..... *User-Centred Design*
UC-RE ..... User-Centred Requirements Engineering
UX ..... User Experience
XP ..... *Extreme Programming*

Glossary

Terminology	***Definition***
Agile Software Development	An iterative development approach including frequent inspections and adaptions for an incremental delivery of requirements and solutions which can evolve throughout the development process based on cross-functional team collaboration and continuous stakeholder feedback (International Organization for Standardization, 2021).
Human / User-Centred Design	HCD focuses on a holistic UX which is defined to represent a perception or response of a person from the use of a product, system or service including emotions, beliefs, preferences, physical or psychological responses and is a consequence of brand image, functionality, system performance and interactive behaviour (International Organization for Standardization, 2018). UCD focuses on how a specific user can use a system or service to achieve an intended goal in effective, efficient and satisfactory manner in a specific context of use. It is interpreted from users' personal goal perspectives, which include perceptual and emotional aspects associated with UX (International Organization for Standardization, 2010).
Requirements Engineering	RE is the science and discipline of analysing and documenting requirements, which are defined as conditions or capabilities that a user needs to achieve an objective and must be met by a system, component or service to fulfil a contract or other

	specification document (International Organization for Standardization, 2010).
User-Centred Agile Requirements Engineering	UCA-RE represents an RE approach which includes user-centred and agile frameworks, methodologies, and methods to address user needs in an incremental and iterative way with strong focus on the value of the product.
Design Thinking	A framework for a dedicated focus on user outcomes. DT follows the phases of understanding, exploring, prototyping, and validating in an iterative approach.
Scrum	Scrum is defined as “lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems” (Schwaber & Sutherland, 2020).
Product Owner	A stakeholder responsible for the capabilities, acceptance and use of a product by sharing the product vision, required features and their priorities and acceptance criteria (Standardization, 2021).
Usability Specialist	A user-centred design expert who is trained in human factors and ergonomics, usability, accessibility, human-computer interaction, user research, user interface, visual and product design (Standardization, 2010).
Decision-Making	“The act or process of choosing a preferred option or course of action from a set of alternatives. It precedes and underpins almost all deliberate or voluntary behaviour “ (Colman, 2015, p. 189).
Intuition	Informal and unstructured reasoning that includes no analytical or deliberate information processing, quick thoughts or preferences involving not much reflection (Kahneman, 2002; Kahneman & Tversky, 1982).

Heuristic	"The technical definition of heuristic is a simple procedure that helps find adequate, though often imperfect, answers to difficult questions." (Kahneman, 2011, p. 98)
Bias	Cognitive bias is defined to be a misstep in thinking and causes a pattern of deviations in judgement while creating inferences without proper reasoning (Haselton, Nettle, & Andrews, 2015).

Chapter 1: Introduction

1.1 Introduction

The introduction chapter will give the reader a better understanding of the research context of this study in Section 1.2, which will clarify the authors intention and motivation to carry out this study with its positioning in business as well as academic context. The business context is described using scope clarifications and trend explanations. Furthermore, the active participation of the researcher in the business context leads to the described intention and motivation to gather insight from the introduced academic context to target the research aim and objectives (Section 1.3) for explaining observed phenomena. However, in the context related to the aim and objectives exist boundaries for the research, which are described in Section 1.4. At the end of the introduction chapter, the structure of this thesis (Section 1.5) is introduced on chapter level with a brief description of the individual content and focus.

1.2 Research Context

The research context introduces the contextual setting of the research in business and academia for a clear understanding of the discipline as well as knowledge domain underpinning the study. Additionally, as the research intends to have an impact in the business as well as in the academic context, the intention and striving motivation to create awareness how role expectations, processes and psychology impact the DM in UCA-RE according to academic research and lived experiences is explained in more detail to give the reader an idea why the research context got chosen and how it guides the research.

1.2.1 Business Context

The business context of this study lays in the consultancy sector, more specific in requirements engineering (RE) consulting, specialised on digital product (software or service) design and development. RE is a process of identifying and deciding on a purpose of a product and how a product is delivering its purpose

(Richter et al., 1976). Today, to have a competitive advantage, it is important to change as quickly as requirements in an increasing complex digital business world. While reducing time to market for digital products to cope with the fast-changing and uncertain market requirements, those fast-innovating products must appeal to customers and users. Therefore, a focus on the actual experience of a digital product became more important and a market differentiator among competitors. To address the fast pace of the market needs and at the same time keep high customer satisfaction, agile software development (ASD) seems to fulfil those requirements according to Dybå and Dingsøyr (2008). With ASD, requirements and the purpose of a digital product can be changed and adjusted immediately when a need is identified, because the process of specification and development is carried out incrementally and empirically. On top, actual human and more specific user interactions are a base for identification of necessary adjustments to the digital product specification (Beck, 2001a). User-centred design (UCD) approaches got included into processes of ASD to target customers directly and find their place in the specification phase together with RE. With this introduction of user-centred approaches to RE came a specific focus on user-research and user experience (UX) focused requirements gathering methods such as Design Thinking (DT), which got adapted and optimized by leading consultancy companies such as IBM with their own Enterprise Design Thinking (EDT). (Studios, IBM, 2018) With the shift into more user-centred approaches in digital product design and development to address required UX, business consulting evolved as well. The role of experience consultants emerged with a strong focus on UX in RE, which in its definition is a professional who provides strategic direction for all aspects of UX, which is the actual goal of user-centred requirements engineering (UC-RE). Experience consultants work across teams and clients to understand business objectives, user goals or customer targets, technical platforms with their capabilities and translates that into a UX strategy and framework. An experience consultant must be a subject matter expert with skills in DT, experience mapping, research and evaluation, service design, system thinking and mental models. The description may vary from one consulting company to another, the base for this informal description comes from the consulting company of the researcher. It reflects the

actual business environment and context in which the researcher is active and where the motivation emerged, as described in the next section.

1.2.2 Motivation and Intention

As mentioned in the previous section, the researcher is active as experience consultant and therefore involved across teams and clients due to the role. However, the focus of the role is on strategy creation and RE, so especially during a specification phase, a very intense and close collaboration with the product owner (PO) and the UX designer is necessary for deciding on purpose, features and design of a digital product. Due to the strong involvement in DM processes of POs and UX designers during specification phases and with the role to keep the overall feasibility and experience of the product in mind, the researcher developed a high interest in DM processes. With experience in facilitating DT workshops, managing RE phases, strategizing and creating roadmap, the researcher experienced phenomena concerning agreements on decisions regarding product experience. DM seems to be highly dependent on processes applied, roles lived by project stakeholders and other influences from psychological perspective. With an extensive experience in both, DM for business as well as experience requirements, the researcher is highly interested in optimizing the relationship between POs and UX designers due to bad experiences based on misunderstandings of role expectations and psychological influencers during DM. The researcher is therefore knowledgeable about the circumstance, that POs and UX designers have the same overall goal of creating a product serving the best utility and usability, but different drivers for their individual missions and focus on either of those two main characteristics of the digital product.

The motivation of the researcher is therefore grounded in understanding repeating project experiences as well as in intense knowledge gathering on the UCA-RE domain to become better as experience consultant by understanding influences on especially PO’s and UX designer’s DM. As the researcher is continuously engaged with mentioned business roles, there is an additional strong motivation in avoiding frustrating and destructive discussions due to missing understanding of roles, processes and DM psychology. The final trigger

for conducting the research was the active involvement of the researcher in a long-term project for creating a digital product in the automotive industry including RE following a user-centred approach in an agile development environment and experiencing once again exactly those frustrating and destructive conversations.

The self-questioning and need for understanding phenomena behind experienced situations (Table 1.1) became intense and urged the researcher to find answers.

Observed Phenomena	***Self-Questioning (Why are we…)***
Request to get more insight for making a decision is rejected…	… not fully aware of the impact of our decisions, especially on others?
You cannot understand how somebody can make such an uninformed decision…	… making decisions even if we are not really capable of doing so?
Accessible insights on information necessary for a decision is ignored or neglected…	… rarely really changing perspectives when making decisions?
Somebody is really convinced of his opinion with no valid reason…	… really convinced by our decisions even if there are no valid bases for them?
Risks of taking a decision are not even considered…	… sometimes not evaluating or ignoring the risks of our decisions?
You are taking a decision because you have to and are not really feeling good about it…	… making decisions even if we have bad gut feelings?

Table 1.1: Self-Questioning about Observed Phenomena

The project experiences strongly influenced the scope of the literature review and research discussion and serves as a guiding example to follow along in the research and help connecting the academic and business world. Due to the mentioned working environment of the researcher as experience consultant, the

main stakeholders for this study are POs and UX designers, who share the same motivation and have experienced similar phenomena which they want to understand and approach in their daily business live or simply out of personal interest. Therefore, the research will cover important knowledge about roles, processes and psychology for those stakeholders as shown by the academic context in the next section.

1.2.3 Academic Context

The academic context is necessary to underpin the business context for explanatory purpose and making sense of research findings. Moreover, without suitable academic context, the discussion as well as the answers to the research questions cannot be linked back into academic knowledge domains and consequently cannot serve as academic contribution. Even though the research context mainly evolved from the introduced business context and the researchers practical experiences, important definitions, process and approach descriptions and related theories are covered in the academic knowledge domain and need to be investigated. Therefore, the research will have its academic context in the digital product (software or service) design standards, guidelines and insights from field research. More precisely, the focus of the research is spread across frameworks, processes and roles in UCA-RE. For acquiring necessary academic knowledge in relation to the business context, acknowledged standards for definitions as well as widely accepted literature on user-centred approaches and processes with their methods are part of the academic context of this study.

In more detail, the UCA-RE approach is covered in its definition including frameworks, methodologies and processes, mainly focusing on EDT from IBM (Studios, 2018) as user-centred data gathering method and Scrum (Schwaber, 2004) for ASD. Additionally, role definitions of a PO and UX designer are investigated to either approve lived roles and responsibilities in the business context or explore a need of adapted views on role expectations. As already indicated, all academic domains needed for the theoretical underpinning of the study will be selected using a spotlight approach based on the professional focus of the researcher as experience consultant. The main reason is the described motivation and intention of the research and the researcher’s profound

knowledge in the chosen domains due to certifications as Agile PO, Scrum master and SAFe agilest for scaled agile frameworks. Furthermore, the intense training in the IBM EDT method while executing the role of experience consultant for more than 10 years.

However, despite the experience of the researcher and knowledge in academic context of UCA-RE, further explanatory academic context is necessary to engage with observed phenomena of missing patterns in DM during RE and provides explanations to potential research results. The original concept of this study was based on an idea of solving problematic phenomena by introducing rising technology such as artificial intelligence and cognitive computing to support POs and UX designers in their DM by filling missing gaps of information that is needed for substantial DM. However, the pilot study revealed that the initial approach to this study concerning a solutioning approach to the phenomena may be covering an idea how to decrease certain risk of failure linked to flawed DM. However, it would not cover the cause and awareness of flawed DM, which seemed to be the main problem as the pilot study revealed. Consequently, the provisional findings of the pilot study had a huge impact on the academic context. A whole knowledge domain of the initial research concept got eliminated due to the pilot study results, as described in the report (Appendix B). The focus of the whole research shifted from researching a solution using artificial intelligence technology for better DM to an understanding of DM processes by raising awareness for potential psychological influences related to processes, roles and responsibilities impacting DM on user-centred requirements. With that shift, a whole new academic context of psychology has become a base for explanations of researched phenomena, especially focusing on the specific knowledge domain of DM processes including heuristics and intuition. Even though DM psychology itself is already a key domain in RE, it becomes a special focus when it comes to UCA-RE, as this study shows.

For a better understanding of both knowledge domains, RE and DM psychology, and the related critical discussions, an extensive review of the literature is necessary, which is covered in Chapter 2. With approaching the introduced academic context for explanations, using the experience from the business

context and being guided by the motivation and intention of the researcher, the study strives to reach the aim and objectives covered in the next section.

1.3 Research Aim and Objectives

The aim of this study is **to understand influences on DM in context of UCA-RE by investigating influences of UCD and ASD processes including involved roles and human thinking processes.** For achieving this aim, the following objectives need to be addressed:

Research Objective 1: To collect information on DM psychology, UCD, ASD, RE processes as well as participating roles from the literature in order to identify and critically discuss theoretical issues. The information from the collected literature will be used to create a conceptual framework which incorporates themes that build the base for the primary research in order to answer the research questions covering identified gaps from the literature review.

Research Objective 2: To make use of a qualitative data collection method as well as analytical techniques to investigate lived experiences during DM processes of decision makers in UCA-RE processes.

Research Objective 3: To identify and discuss the awareness of influenced DM in UCA-RE due to heuristics and intuition during thinking processes.

Research Objective 4: To develop an approach for DM in UCA-RE in order to create awareness for biases in intuition and potential flaws in product specification and experience design.

1.4 Research Boundaries

In order to achieve the aim of this study, the literature review, research execution as well as analysis and discussions on the results are done within the following boundaries related to the objectives.

As mentioned in the research context Chapter 1.2, most of the boundaries to collect information for this study via literature review is based on the profession of the researcher and the business context. Therefore, only a specific choice of agile RE and UCD processes are covered in this study for abstracting the general idea of DM approaches in user-centred digital product design. Different available processes are mentioned in the literature review. However, a spotlight approach identifies the most established ones related to the business context of this study. Due to the variety of frameworks and processes, different roles and responsibilities may apply and vary accordingly. In this study, only two main roles of the PO and UX designer are investigated due to the overarching involvement in both, ASD and UCD processes. Even though more roles take part in DM, they will be mentioned in the literature review, but neglected via spotlight approach for the purpose of keeping the extent and boundaries of this study.

The covered knowledge domain of psychology is a broad field of expertise in which this study focuses on a DM processes including heuristics and intuition to explain observed phenomena. DM processes are continuously researched and explained in the psychology domain following various concepts. However, most of this study is based on the comprehensive work of Kahneman (2011), which covers dual thinking processes including intuition as well as a heuristics and biases program for explanations of DM patterns. Other theories to DM will be introduced in the literature review, the spotlight approach however will focus on Kahneman’s theories.

Regarding the methodology, constructivism is a critical philosophical stance, but will be used for explaining the focus on constructed knowledge during RE and DM as well as for using qualitative methods as best approach to collect data for answering research questions and filling identified gaps. The psychological

stance itself is not part of the research and will neither be questioned nor analysed.

The identification and discussion of thinking processes during DM is based on sampled individuals and therefore strongly restricted by the boundaries on their experiences with frameworks, processes and roles of interest for ASD or UCD.

The research aim focuses on understanding influences on DM in UCA-RE. Therefore, the introduced approach is for becoming aware of biases in intuition, not handling biases. Even though examples will be included on how to proceed with DM after becoming aware of biases, the scope of this study does not allow for further investigation of de-biasing or dealing with potentially flawed DM.

Other unintended boundaries, which occurred during the research process, will be covered in the limitations in Section 6.5 of the Conclusion Chapter 6. Some of the boundaries may be addressed in the implications for further research in Section 6.6.

1.5 Thesis Structure

Chapter 1 gives the overall introduction to the context of this study including intention and motivation of the researcher and the aim and objectives. Furthermore, research boundaries related to the aim and objectives as well as to the research context are introduced as frame for this study.

Chapter 2 focuses on the relevant literature following a thematic path through UCA-RE, covering ASD frameworks and processes including their roles, and psychological aspects of DM to identify and discuss relevant academic as well as practical knowledge, which is needed for constructing a conceptual framework supporting the understanding of influences. The conceptual framework incorporates all literature findings as well as the empirical knowledge and experiences of the researcher. With support of the conceptual framework, gaps are identified which are the base for the emerging research questions.

Chapter 3 covers the research methodology which is applied in this study based on the philosophical underpinning including ontological, epistemological, and

axiological perspectives. With the research position as constructivist, the methodology and its applicability are justified and other approaches, on the other hand, shown as incompatible for this specific study. Following the philosophical underpinning, data collection including its analysis method is described. Also, limitations of the chosen and applied research methodology, including ethical considerations, are explained in Chapter 3 for a comprehensive coverage of all necessary insight into the overall research approach.

Chapter 4 presents initial expectations and thoughts during familiarisation with the data, the initial coding structure and theme refinement as well as the results from the thematic data analysis. Moreover, the conceptual framework is extended based on the thematic analysis. With answering research questions one and two during the theme analysis and interpretation, the chapter lays the foundation for understanding the influences on DM in UCA-RE and supports the creation of an awareness approach which addresses the third research question.

Chapter 5 builds on Chapter 4 and introduces an approach on how to become aware of biases considering the findings from the theme analysis and their interpretations. With the extension of the conceptual model while answering the first two research questions, the understanding of influencers is transferred into a two-step awareness approach including checking lists for the project / decision environment and a matrix for knowledge categorization. Furthermore, a recommended approach to the introduction of the approach into projects is presented for smooth adoption into DM in UCA-RE. Finally, a report on an expert group review including interactive discussion session is presented before concluding the study.

Chapter 6 finalizes this thesis and summarizes therefore all highlights including answers to the research questions as well as how the research aim and objectives are met. Furthermore, the contributions to knowledge and practice are presented to show and evaluate the value of this study for the academic and business world. However, as this study is conducted in its explained boundaries, there are limitations that need to be kept in mind when using and building on this study, which will be clearly stated before implications on further research are considered and briefly explained.

Chapter 2: Literature Review

2.1 Introduction

The literature review follows a thematic structure as described in Section 2.2. In Section 2.3, different frameworks and process related to UCA-RE as well as best practices are explained, and corresponding literature reviewed. The focus is mainly on characteristics of frameworks and processes that influence DM. Additionally, involved roles and their expected skill sets, knowledge and responsibilities are explained and reviewed. Section 2.4 discusses DM from an organizational and psychological point of view with focus on its essential elements as well as DM processes or systems and their interoperations. Furthermore, intuition and heuristics are explained to gain a deep understanding on how the two systems affect each other and how that influences DM. Insights gathered in Section 2.3 and Section 2.4 result in a conceptual framework clarifying independent and dependent concepts with their potential moderators as well as mediators, which is described in Section 2.5. With the insights from the literature review visualized in a conceptual model, all relations are discussed. The modelled insights are considered for identifying gaps that are described in Section 2.6, followed by derived research questions in Section 2.7.

2.2 Literature Research Approach and Thematic Structure

The literature research consisted of integrative reviews with focus on past research of separated studies and critical reading of available literature. The review or examination of the literature mainly focused on monographs and peer reviewed journal articles. The literature was accessed using the Edinburgh Napier University Library Search online services including databases such as ScienceDirect, ProQuest, Springer Link, IEEExplore and BSOL mainly limited using abstracts, titles and keywords of the literature. Full text search was mainly used with Google Scholar. Various search key words and search string combinations were used depending on the thematic focus on either UCA-RE or DM. Furthermore, a holistic search on both knowledge domains with an all

including key word search string was used to identify available literature on observed phenomena. Additionally to academic literature, online articles of established academic or business online publishers served as information sources. All sources were organized and described by metainformation using EndNote 20, including the Microsoft Word integration for reference management.

The literature review itself follows a funnel approach based on the knowledge domains of UCA-RE and DM. The review of the literature gradually zeroes-in to specific concepts of both knowledge domains as shown in Figure 2.1.

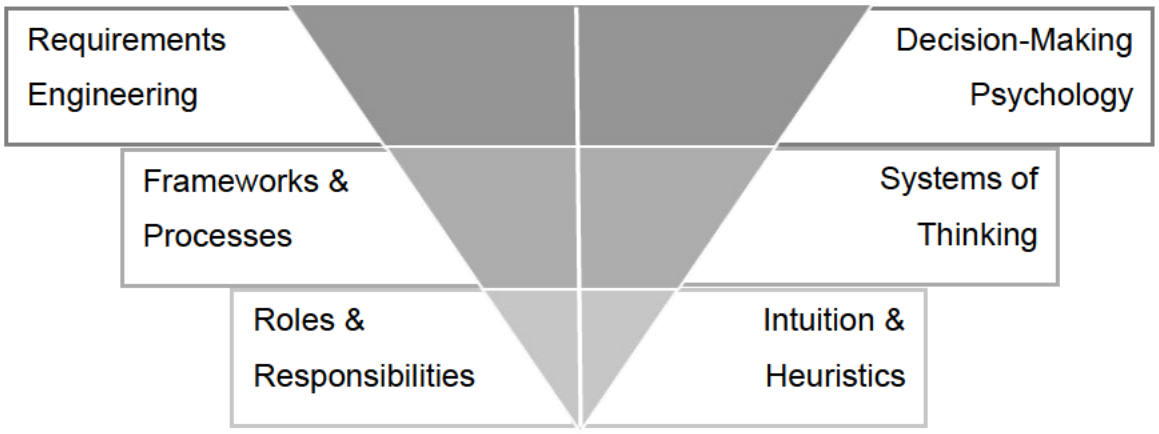

Figure 2.1: Funnel Approach

Furthermore, because each knowledge domain is broad and extensive in concepts, a spotlight approach is used to identify and cover only topics within the boundaries of this study and its research context. The chosen concepts, and explanations of the elimination processes of others, are covered in the individual sections of the literature review.

Summarized, the literature review follows a thematic structure covering two knowledge domains for critical reviewing, defining, describing and explaining concepts that give insights into the environment of the observed phenomena and their potential explanations.

2.3 Requirements Engineering

The first field of interest is the RE process. The broader literature discussing and explaining RE and its historical change leads into more granular topics covering processes and roles.

According to ISO/IEC IEEE 24765:2010, RE is the science and discipline of analysing and documenting requirements. Those requirements are defined in the same ISO as conditions or capabilities that a user needs for achieving an objective and which must be met by a system, component or service to fulfil a contract or other specification document (International Organization for Standardization, 2010). As mentioned already in the introduction, the term of RE appeared already in the 1970s (Richter et al., 1976).

Waterfall Model The early processes for RE consist of a requirements specification process, which is conducted before the actual development of the product starts and is persisted in a specification document, which is the base for the whole development process. At the time the development process starts, RE is finished, and no changes are easily accepted during development. If changes occur, long lasting and approval heavy processes must be fulfilled to get a change worked into the requirements specification for realization. One of the sequential processes of product development was introduced by Royce and is known as Waterfall Model (Royce, 1970). It consists of 5 phases, as visualized in Figure 2.2.

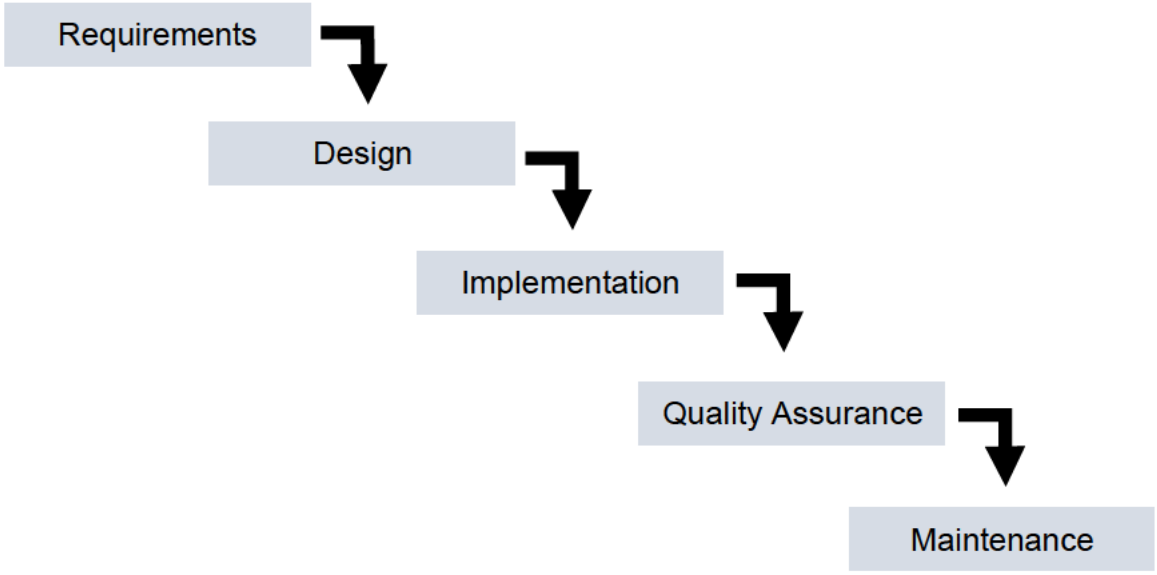

Figure 2.2: Traditional Development Process Phases

A specification documentation as result of the requirements and design phase is used in the implementation and quality assurance phase. Even though Royce (1970) mentioned the iteration of the whole development process to keep up with changes in a market, he argued that all requirements are consolidated into one specification document before the development and that a requirement specification must be finished and needs to be completely developed before further enhancements. All decisions on product specifications are therefore done by the involved stakeholders before and only hard to change during development (Royce, 1970). In summary, RE is incorporating all activities on discovering, documenting and maintaining requirements for development of products. However, it needs systematic and repeatable techniques to make sure the specification of the product stays complete and consistent as well as relevant (Sommerville & Sawyer, 1997). Consequently, the documented requirements specification needs to be enhanced and details added throughout the development process.

Agile Development Coming back to the statement from the introduction that traditional product development is not keeping up with a fast-changing business world and its quickly changing market requirements, a sequential process is not sufficient to cope with fast pace and uncertainty. The missing flexibility of a sequential process was already mentioned in the 1980s by Takeuchi and Nonaka (1986). An agile approach to software development is

capable of such flexibility and enables faster time to market to deliver changes whenever needed and at the same time possibilities to react to changing customer needs for delivering products they desire (Dybå & Dingsøyr, 2008). Agile development itself is defined in ISO/IEC TR 24587:2021 as an iterative development approach including frequent inspections and adaptions for an incremental delivery of requirements and solutions which can evolve throughout the development process based on cross-functional team collaboration and continuous stakeholder feedback (International Organization for Standardization, 2021). The faster time to market and increased value for the customer, because their needs are at the centre of continuous improvement of specifications through repeating RE and design phases during development, is the reason for a rising popularity of iterative and agile methods, which will be introduced in more detail in Section 2.3.1. The general idea is to focus more on a value driven than a plan driven development which shifts the focus from feature development based on resources to an experience development based on customer needs. The aim is to ensure a product achieves its core business objectives whilst providing a best usability possible, which is defined as the concept of three factors covering effectiveness and efficiency as well as enjoyable experience of use (Kurosu, 2009).

To cope with the introduced change in development purpose and the complexity that comes with it, a finished upfront RE phase before the development is not sufficient and should be iterative, to ensure relevance of the requirements (Pohl, 2010). Instead of the finished document of requirements, a prioritized list is created, which incorporates rough requirement hypotheses instead of finished specifications. A well-established concept of such a list is for example a Product Backlog in Scrum (Schwaber, 2004), which will be introduced in Section 2.3.1. A list of hypotheses however, needs to be continuously evaluated through feedback from users and other stakeholders (Olsson & Bosch, 2015). DM on such requirements is therefore not only a task of a PO, it is supposed to be shared with users and stakeholders and even described from their perspective (Cohn, 2004), which is further explained in the process Section 2.3.1. To manage such a complex RE phase, it needs to be separated and adapted to an activity stream that can be iteratively executed: discovery, refinement, prioritization, review and

documentation (Schön et al., 2017). Due to an iterative approach to RE and product development, only most required information is needed for specifying requirements, which enables a just in time finalization of requirements developed in every iteration. A combination of just in time iterative requirement specification and a value driven product development leads to a continuous focus on the user with only a Little Design Upfront (Adikari et al., 2009), which later led to the incorporation of well-established approaches such as DT (Adikari et al., 2013). An iterative and continuous gathering of new information and knowledge has an impact on DM of a PO, because it is in favour to appoint that role to a single, knowledgeable person who is always available and capable of making decisions for a product quickly to not waste time and effort, which is also mentioned in ISO/IEC TR 24587:2021 (International Organization for Standardization, 2021). To make sure decisions on requirements are valid related to an expected value delivery by a product, a high frequency of usability testing is needed to validate assumption of a PO against actual user needs (Larusdottir et al., 2010).

Human / User Centred Design The change in requirements validation through user research and usability testing to emphasize on the importance of values for users resulted in an integration of human-centred design (HCD) and UCD approaches. First definitions of HCD and UCD were introduced in ISO 13407:1999 by the International Organization for Standardization (1999) and later refined in ISO 9241-210:2010 emphasizing on the difference, that HCD incorporates a bigger focus than UCD. Whereas UCD focuses on direct needs of users and concentrates mainly on usability of a product, HCD involves more stakeholders and encourages a broader view by focusing on a whole system and UX overall. ISO 9241-210:2010 states as well that both terms are used as synonyms in practice (International Organization for Standardization, 2010). However, because this study focuses on UC-RE, it is important to notice the difference. As mentioned, HCD focuses more on a holistic UX which is defined in the current ISO 9241-11:2018 to represent a perception or response of a person from the use of a product, system or service. This includes emotions, beliefs, preferences, physical or psychological responses and is a consequence of brand image, functionality, system performance and interactive behaviour (International Organization for Standardization, 2018). Usability on the other hand is defined in

the same ISO as how a specific user can use a system or service to achieve an intended goal in effective, efficient and satisfactory manner in a specific context of use. It can be used to assess aspects of UX, if interpreted from users' personal goal perspectives, which include perceptual and emotional aspects associated with UX (International Organization for Standardization, 2010). An introduction of HCD/UCD in organisations is usually a hybrid approach with agile RE due to the iteration of processes. As in ASD, UCD follows an iterative approach to make sure a design based on user-centred requirements fulfil actual needs of users as well as enable continuous improvement whenever a need for specific outcomes arise, as described in ISO 9241-220:2019 (International Organization for Standardization, 2019).

In summary, an agile approach consequently deals with the fast-changing pace of requirements by incremental completion of a product while dealing with missing information by gaining more insights to cope with uncertainty throughout development of a product. The more information gained and processed; the less uncertainty remains (Galbraith, 1973). However, as the values to customers are the centre of user centred agile approaches, ambiguity of requirements is a challenge next to uncertainty, because value is subjective and may be interpreted differently by involved stakeholders. Even if information is available to reduce uncertainty, it can convey multiple meanings depending on the interpreter and in some cases even strengthen ambiguity. To reduce ambiguity, human and user centred design approaches and methods are used to support DM with rich information gathering. Information richness is defined in how fast certain information can change someone's understanding of something (Daft & Lengel, 1986). Uncertainty and ambiguity are two main concerns of decision makers in organisations, which is why further elaborations on agile as well as UCD frameworks and processes including their roles follow in the next sections, to understand how both are approached. It seems that historical change from feature driven to value driven development triggers a change in methodologies and consequently in processes and roles, which have an impact on the DM. Unfortunately, the reviewed literature does not cover any extended elaboration how dealing with uncertainty and ambiguity in an UCA-RE environment impacts DM of stakeholders from a psychological point of view.

2.3.1 Frameworks, Methodologies and Processes

Scrum Framework As mentioned in the previous section, Takeuchi and Nonaka (1986) stated already in the 1980s that sequential processes in RE and development lack flexibility. As a consequence and due to faster changing market requirements, first conversations and discussions around more lightweight and flexible product development processes came up in mid to end 1990s. Schwaber (1997) introduced the Scrum Development Process and defined it as an enhancement of iterative development cycles, which were introduced before Scrum as alternatives to the waterfall model mentioned in the last section. More precisely, the initial process of Scrum was introduced as development process which treats “major portions of systems development as a controlled black box” (Schwaber, 1997, p. 117). The introduced Scrum process provided a first idea of no full initial planning phase with predetermined requirements that have to be developed, the black box represents an area of potential unknowns which need to be identified and answered throughout the development process and therefore give more flexibility in reacting to changing initial or additional requirements. Schwaber (1997) furthermore states that smaller but high performance teams were observed by Takeuchi and Nonaka (Takeuchi & Nonaka, 1986) at Canon, Honda and more well established engineering companies, which shows that Scrum was one of the process adaptions as response to the identified gap of flexibility in a development process. As already mentioned, other types of process enhancements of the sequential process from the waterfall model from Royce (1970) got introduced before Scrum. To mention one, an iterative and incremental approach of object-oriented software delivery, introduced by Pittman (1993), explains an idea of delivering a product in a series of chunks adding to each other instead of delivering a system in one big bang, which would require making decisions when least information is available (Pittman, 1993). To mention another preceding process which refined the waterfall model a couple of times is The Spiral Model, introduced by Boehm (1988). It described iterations as rounds or cycles of activities to develop a product or system which encourages prototyping, re-work and validation through each round. It is basically an introduction to easier change than in the waterfall model, but still involves full upfront requirements specification (Boehm, 1988). There are more process adaptions preceding

Scrum, but all examples got chosen on purpose, because they build an enhancement base for the initial Scrum process, which uses all waterfall phases but adds benefits of iterative object-oriented software delivery and The Spiral Model. Therefore, it helps to understand the change in processes and consequently the required change in DM. Next to Scrum, more process enhancements followed shortly after, such as Extreme Programming (XP) (Beck, 2000) or Feature-Driven Development (Palmer & Felsing, 2001). With an importance gain of flexibility in development processes, all mentioned and more members of the flexibility embracing community came together to create a common understanding which resulted in the Agile Manifesto (Beck, 2001a) including its 12 principles of agile software (Beck, 2001b) in 2001. The manifesto gained popularity right from start and encouraged a lot of process enhancements towards flexibility and agility in software development. Till today, the agile values and principles guide projects and their adopted processes to embrace and enable immediate change in product specifications depending on user and market needs. The Scrum process got revised in 2004 (Schwaber, 2004), shortly after the release of the manifesto and together with another agile framework, covered in a symposium paper (Anderson, 2004) and later named and published as Kanban (Anderson, 2010). Again, there are more agile frameworks, methodologies and processes besides the mentioned examples. However, this study is not aiming to compare processes, the focus is on understanding potential impacts of the processes on DM in UCA-RE. An introduction to preceding processes to Scrum is important to understand the base for the development of the Agile Manifesto, which is again important to fully understand the foundation of modern agile frameworks and how DM changes with process and culture changes. To understand how exactly agile processes influence DM, Scrum is briefly defined and explained due to its popularity as most used agile framework, with 66% of all used agile frameworks including variations, according to the 15th State of Agile Report (Digital.ai, 2021).

The following definition and short explanation of Scrum is based on the latest available Scrum guide developed by Schwaber and Sutherland (2020). The aim is not to present the Scrum process in detail. A brief introduction to the purpose and short summary of the process is sufficient for later reuse during identification

of influences on DM processes. The latest version of the Scrum guide is based on the initial introduction in the 1990s and evolved ever since based on new insights or feedback. Scrum is defined as “lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems” (Schwaber & Sutherland, 2020). The elements of Scrum are intended to guide relationships and interactions of involved people and do not serve a purpose of detailed instructions. Therefore, it is incomplete on purpose, to leave space for creativity and adaptions related to project environments. However, Scrum requires an environment where a PO prioritizes work in a Product Backlog, a Scrum Team realizes a selective part of work during a Sprint and stakeholders inspect results at the end of a Sprint and adjust for a next Sprint, which will repeat the process. According to the Scrum theory, it is based on empiricism and lean thinking. Empiricism means that knowledge used in the process comes from experience or implicit information and decisions are made on observations whereas lean thinking focuses only on essential, mostly explicit information. Furthermore, the iterative and incremental approach optimizes predictability, which is realized through 4 formal events which enforce inspection and adaption to cope with uncertainty and ambiguity. The events Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective are based on the Scrum pillars of transparency, inspection, adaption, and encapsulated in the main event of Scrum, the Sprint. The self-managing Scrum team, consisting of one PO, one Scrum Master and Developers, is responsible for stakeholder collaboration, verification, maintenance, operation experimentation, research and development of a valuable and useful Increment every Sprint that serves towards achieving a Product Goal. Such an Increment is one of three Artifacts in Scrum, along with a Product Backlog and Sprint Backlogs and gets created when a Product Backlog item is fulfilling a Definition of Done, a quality measure required for a product. All planned Increments for a Sprint are collated in a Sprint Backlog, which is a subset of a Product Backlog giving an objective for a single iteration, a Sprint Goal. A Sprint Backlog is filled during a Sprint Planning using listed items in a Product Backlog, which get refined until they are clear to Developers realizing them. Product Backlog items are created, refined and developed until a Product Goal is achieved, which serves a long-term objective for a Scrum team to realize a final product. “A product is a vehicle to deliver value. It has a clear boundary, known

stakeholders, well-defined users or customers. A product could be a service, a physical product, or something more abstract" (Schwaber & Sutherland, 2020).

The Scrum process explanation shows very well a need for continuous and iterative DM on incremental completion of a product. Even though a whole Scrum team is involved in decisions on the actual realization of a product, initial purpose and specification of a product as well as the responsibility for the outcome stays with a PO. The role itself is covered in Section 2.3.2, however, the Scrum guide does not include any information on actual DM processes of a PO, only responsibilities towards a product goal and that the entire organisation must respect their decisions. Mentioning observations and coming back to responsibilities for a product goal, a PO must understand values that a product must deliver as well as define users and customers according to a definition of a product. To fulfil responsibilities and specify valuable requirements for a product, user needs must be identified. According a survey from Hussain et al. (2009), over 60% of 92 participants believe that an adoption of an agile UCD process improved the usability and quality of a product and that better quality of a product increased customer value and satisfaction. Less than 10% disagree with those statements. The result shows benefits of UCD in ASD, which supports a need of its involvement and further review.

Usability Methods UCD definitions and explanations are covered in Section 2.3 on RE, but can be summarized in four phases, which reflect the USD process introduced in ISO 9241-210:2010 (International Organization for Standardization, 2010). First phase is to specify a context of use including identification of users, for what it is used and under what conditions. Second phase is requirements specification, an identification of business requirements or user goals, which are needed for a successful product. Third phase covers creations of design solutions, all steps from an initial concept to final designs. The final phase is a design evaluation through usability testing with actual users. The introduced phases are used for many UCD methodologies, but do not enforce or specify any exact methods. The ISO 9241-210:2010 references however to the technical report ISO 16982:2002 (International Organization for Standardization, 2002), which introduces usability methods for HCD/UCD to support project managers or POs in making informed decisions on a choice of usability methods

for including a UCD process in RE, but at the same time does not aim to turn them into human-factors specialist. A method strongly depends on an individual phase of a design process, which is why their applicability is covered in the ISO as well. In general, usability methods are used for design or evaluation. Design provides requirements, limitations or suggestions for product development as well as discovery of unanticipated insights on user behaviours or needs. Evaluation allows for an assessment of the degree of achievement of usability objectives based on data concerning users' performances or preferences. In summary, usability methods serve the purpose to understand situations and contexts around users. The following Table 2.1 shows examples from ISO 16982:2002 (International Organization for Standardization, 2002) including brief descriptions of methods with focus on involvement of actual users or usability specialists.

Name of the Method	***Short Description***
Observation of Users	Collection of information about behaviours and performances of users in specific contexts during task executions.
Questionnaires	Predefined questionnaires for getting indirect information from users about a specific user interface.
Interviews	Questionnaires with more flexibility during face-to-face involvement with interviewees.
Thinking Aloud	Users need to continuously verbalize thoughts, ideas, expectations, doubts while using a system in a predefined test.
Document-based Methods	System documents are examined by a usability specialist for a professional judgment.

Expert Evaluation	An evaluation of a solution based on knowledge, expertise and practical experience of a usability specialist.

Table 2.1: Usability Methods

The introduced methods can be used together or individually, limitations to one preselected method are not sufficient, the more methods are used to achieve usability objectives, the better is a final product (International Organization for Standardization, 2002). Project environments can however limit usage of methodologies as well as possibilities to involve users. Direct involvement of users is a key factor. Methods with no user involvement should only complement ones with active user involvement. Bevan (2009) introduced criteria for selecting methods in UCD in relation to their efficiency depending on an organizational and project environment. Main criteria for selecting appropriate usability methods are environmental constraints and user characteristics. Examples for environmental constraints include project characteristics of very tight timescales or cost/price controls. Interpreted from those criteria (Bevan, 2009), Thinking Aloud is not recommended in relation to time and cost, because it takes too long and comes with higher expenses. Expert Evaluation on the other hand is recommended due to fast results during development processes and lower expenses, especially if experts are already part of a project. In addition, if user characteristics criteria indicate that they cannot be involved or accessed, for whatever reason, Thinking Aloud is immediately disqualified as an option and Expert Evaluation the chosen alternative. This is one example to show how selection criteria from a managerial and organizational point of view defines an appropriate usability method. The example was chosen on purpose to show and discuss how a method selection and consequently processes influences DM in UCA-RE. Based on empirical knowledge of the researcher, availability constraints of methods for data gathering have a direct impact on product quality and usability, no matter if decided by an organisation or directly by project management / PO.

Design Thinking To avoid random qualification or disqualification of methods, it is possible to use them concurrently or sequentially as part of a larger framework or UCD methodology for guidance on a proven process or best practice to achieve best usability (International Organization for Standardization,

2002). The technical report does not cover any framework or methodology. The idea of frameworks, methodologies and processes around designing products with high user value is not new. In the 1980s, Rowe (1987) published his book with the term Design Thinking as title. After first big discussions on DT in 1992 during a symposium (Cross et al., 1992) as well as in journal articles (Buchanan, 1992), the concept of DT got extended and enhanced through design methodology, psychological and educational knowledge domains. Today, especially companies are strongly encouraged to build such frameworks or methodologies for a possibility to establish a common process to reach high usability in own products or, in case of consultancies, build a branded and sellable process to clients for creating higher customer satisfaction through better usability. The global technology and consultancy company International Business Machines (IBM) introduced their EDT framework in 2015 to apply DT in enterprises for enabling innovation and brand differentiation (Lohr, 2015). The framework should support team collaboration on large scale projects with a dedicated focus on user outcomes. EDT follows the earlier introduced phases of understanding, exploring, prototyping and validating with a wrapping concept of a loop that includes the steps Observe, Reflect and Make. **Observe** is for learning about users and includes the usability methods of interviews and observations. **Reflect** is an intermediate step of synthesizing all gathered data for planning next actions and **Make** executes the actions to realize ideas and validate with actual users using prototypes until a final design of a product (Studios, 2018). The loop was not included from the beginning of EDT's existence, it was a result of feedback for improvement by an agile community within IBM. The upfront DT approach was felt to be a throwback to the waterfall model and not welcome (Schmiedgen & Rauth, 2019). With an introduction of the loop, the iterative approach of agile frameworks, methodologies and processes could be adapted so that agile and user-centred approaches could be adopted in the same project.

The combination of agile and user-centred frameworks, methodologies and processes gains significance due to the needed flexibility in RE and differentiation in usability. Hybrid models including RE, UCD and ASD become popular, which results in various combinations of user-centred and agile methodologies. DT is only one of many possible frameworks, such as Contextual Inquiry or

Participatory Design, to enable ASD becoming more user-centred and deliver product with high user satisfaction. However, the combination of agile and user-centred comes with important questions such as how to integrate user research into tide timelines of ASD, when to create designs and when to evaluate them with the actual users (Salah, 2011). Using the term of Agile and User Centred Design Integration (AUCDI), Salah et al. (2014) published a systematic literature review on challenges of integrating agile and user-centred design. The result introduced 7 main challenges with corresponding practices and success factors, such as lack of time for upfront activities due to flexible requirements specification during development, which resulted in an upfront design approach to set a foundation for further user-centred DM of POs during ASD. Another challenge is the difficulty of prioritizing UCD activities due to focus on delivering product increments by developers which resulted in assigning responsibilities for agile UCD increment delivery to designers and separate the Sprints in Scrum to have individual backlogs. A more general integration problem of UCD and ASD is the modularization and documentation concepts behind the approaches, whereas UCD is not working with chunks of design as increments and relies on profound documentation, ASD strives to achieve minimal documentation and delivering a whole product in increments (Salah et al., 2014). Those examples give just an idea about the complexity in aligning user-centred and agile approaches on process level, impacts on roles responsible for either of the approaches is even higher and influences their DM in ASD and ability to fulfil UCD standards. The next section covers roles and their responsibilities as well as skills expected in highly complex agile and user-centred environments.

2.3.2 Roles, Responsibilities and Skills

Following the funnel approach in the literature review on UCA-RE, the most granular level necessary for this study is the practitioner level in the previously explained framework, methodology and process environments from UCD and ASD. The research investigates the role definitions from the introduced ISO standards as well as frameworks and methodologies with the aim to find the main responsibilities for agile or user-centred topics and their expected skill sets.

Product Owner The technical report on agile development ISO 24587:2021 defines a PO as a stakeholder responsible for capabilities, acceptance and usage of a product by sharing a product vision, required features and their priorities and acceptance criteria. Furthermore, the technical report states that a digital product customer usually appoints a single, knowledgeable person, a PO, who is always available to react in timely manner and acts as a customer representative with DM authority (International Organization for Standardization, 2021). DM by a group of experts is also mentioned as alternative, but slows down a development process and moreover is denied by frameworks such as Scrum, which sets an explicit limit to one person according to the Scrum Guide, even though the one person might represent needs of many stakeholders (Schwaber & Sutherland, 2020). The guide describes responsibilities of a PO in more detail related to the Scrum framework. According to this description, a PO is accountable for reaching a maximum value of a product that gets developed by a Scrum team. The guide is not mentioning how it needs to be done, only that it may vary depending on organizational standards, team dynamics or individual preferences. Specific accountabilities however include effective management of a Product Backlog by developing and explicitly communicating an underlying product goal, creating its items including ordering them according to their priority as well as making it transparent, visible and understood. Even if all those responsibilities are delegated by a PO to other project members, a PO stays accountable. The accountability is underpinned by an absolute DM power when it comes to content and priority ordering of a Product Backlog. Therefore, a whole organisation must respect a POs' decisions and those who want to change a Product Backlog need to convince a PO. All final decisions on a product and its value are consequently in total responsibility of a PO, which the name implies already. What skill sets are expected from a PO to make those decisions is not stated in either, the ISO standards nor the Scrum guide, except knowing the agile methodologies, which is important to understand how to make decisions in agile environments. Kelly (2019) describes in his book "The Art of Agile Product Ownership" a necessity of a mixed skillset portfolio for a PO as shown in the representative Figure 2.3.

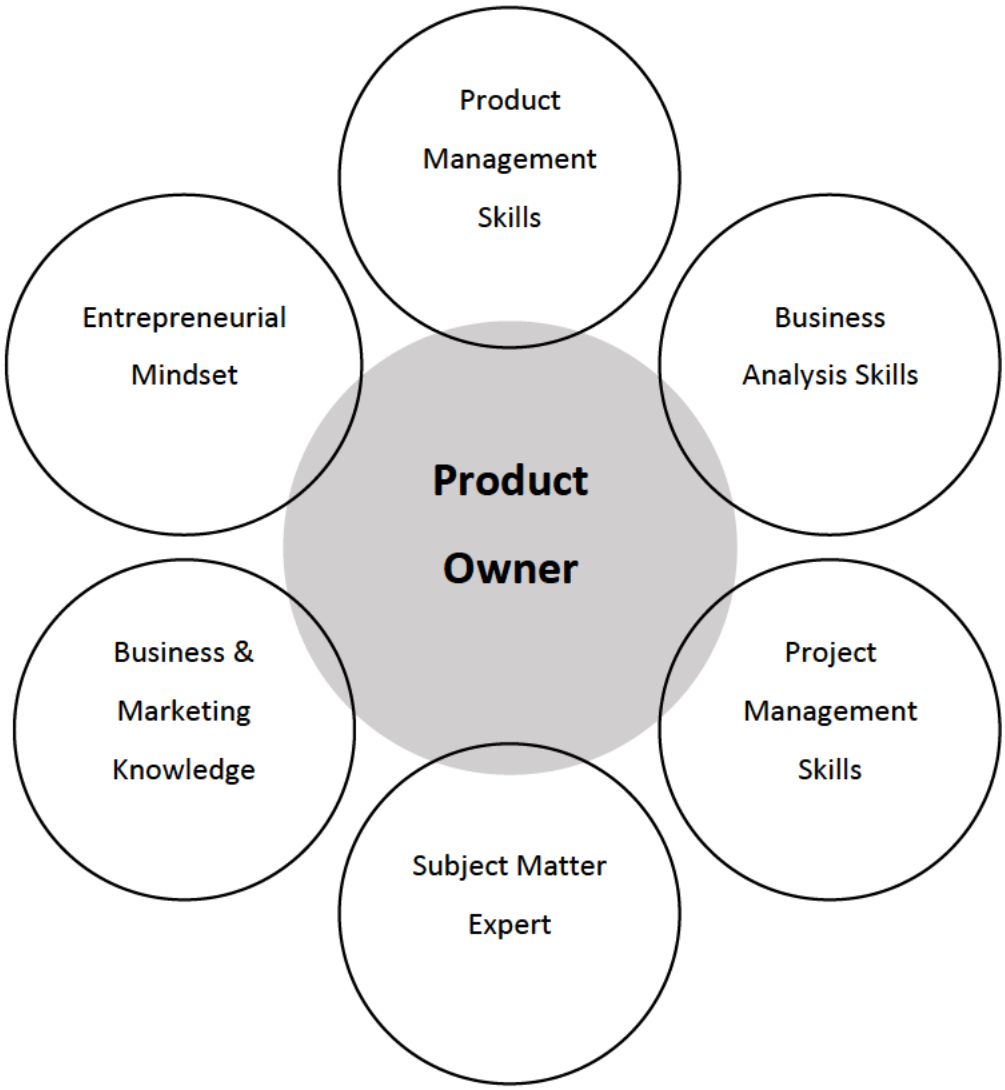

Figure 2.3: Product Owners' skillsets (Kelly, 2019, p. 28)

The mixed skillsets enable POs to adapt to project needs for developing differentiating and successful products, but consequently the exactly needed skills vary depending on the team and position.

Usability Specialist However, as this study covers UCA-RE, skills on UCD are necessary to fulfil introduced requirements of UC-RE and aiming for high value creation during ASD. Therefore, a broad skill portfolio of a PO must be complimented by UCD experts to build a team addressing the requirements of ISO 9241-210:2010 describing the multidisciplinary skillset and perspectives needed for collaborative DM on design or implementation trade-offs. Next to skills and perspectives from ISO 9241-210:2010, which are covered by operations or developers, following examples (Table 2.2) are important to be covered by POs and usability specialists.

Product Owner	***Usability Specialist***
• Application domain expertise, subject matter expertise • Marketing, branding, sales • User management, service management, corporate governance • Business analysis, system analysis	• Human factors and ergonomics, usability, accessibility, human-computer interaction, user research • User interface, visual and product design

Table 2.2: Comparison Product Owner and Usability Specialist

The table shows that only a joint skill set of a PO and usability specialist fulfils the requirements on a UCD team, which needs to be considered during identification of responsibilities for introduced UCD phases with their usability methods. To make sure user-centred approaches for value creation are followed and user needs are considered, an experience consultant role can be established in projects, as explained by Kropp and Koischwitz (2016). They describe the role as comparable to a UCD specialist but with more focus on assisting a PO during DM. An experience consultant is therefore strongly involved in all conversations about product specifications and knows all requirements, which enables the role to question them and discover potential weaknesses in existing solutions. This unpleasant task is very important to extend a PO's fast solution-oriented thinking in an agile environment and adds a user-centred perspective and knowledge. As discussed earlier, the term UX is bigger than just usability, which fits the holistic view of a UX consultant to support the broad responsibilities and knowledge of a PO. However, a UX consultant is only allowed to give advice to product management, PO or developer as well as design team, if asked for. The final DM for a product, due to the accountability, stays with a PO (Schwaber & Sutherland, 2020). The role can be adopted by different project members, but usually is best allocated to an external outside of a product development team to avoid conflict of interest with the actual role in a project and feeling more comfortable in challenging solutions. The importance is on an extensive training and knowledge in UCD methods and practices as well as constant availability as user-centred

support in highly flexible and changing agile environments (Kropp & Koischwitz, 2016). Special trained consultants, such as experience consultants, delivering exactly the explained support to agile customer project environments and POs are an important ingredient to successfully combine user-centred and agile approaches to deliver highest possible product value. Unfortunately, reviewed literature on role definitions resulted in insights on responsibilities and expectations, but not on influences on DM from a psychological point of view. The next section covers a literature review of another knowledge domain with the aim to gather insights on thinking processes during DM in highly complex UCA environments.

2.4 Decision-Making

The second field of interest is DM. As in the previous section, this section is following a funnelling approach by starting with broader literature on theories around DM. While getting into more granular subtopics, theories around thinking processes are reviewed, defined and characterized to get an understanding of different concepts to elaborate on psychological phenomena such as intuition, heuristics and biases.

Organisational DM When reviewing literature about DM in organizational or project environments, the knowledge domain of managerial DM is an essential part of it. RE represents both, an organizational activity regarding decisions on which requirements must be implemented and a project activity with decisions on how they get implemented. RE is therefore based on DM related to specifications of a product, as described in the previous section. The introduced RE processes give guidance on what decisions must be made at which time but have less focus on how. Because product quality represents the quality of its development process, an efficient but also effective DM is crucial, which is why it is also important to know how decisions should be made. Even though RE processes are designed to deliver high quality products, in reality it is a political process of negotiating about conflicting requirement specifications, which are based on manager preferences or intuitions on product value that has to be delivered

(Andriole, 1998). The result of this negotiation needs to be a decision for a problem solution for moving forward with development. According to Simon (1960), problem solving involves either structured or unstructured decisions, depending on how a decision maker is approaching DM. In general, a DM process consists of an intelligence, a design and a choice phase. If a decision is repetitive and its process clearly identified, it is structured. If a decision however is novel and its process is ambiguous, it is an unstructured decision (Simon, 1960). This differentiation of decision types matches a problem classification from Shapiro and Spence (1997), which separates problems into well-structured and ill-structured. Bothe types of problems identify themselves by the possibilities to apply decision rules. The structured problem can be solved by strictly applying decision rules, whereas no clearly defined or general acknowledged decision rules exist for ill-structured problems. Simon (2013) includes a similar concept of problem classification but calls it well-defined and ill-defined. However structuredness of problems and decisions are named, the differentiation into analysable and non-analysable problems with more or less rule-based DM is important to understand in context of UCA-RE, because both exist in UCA environments. An example for structured decision problems is agile development itself following agile frameworks, which give rules for making repeatable decisions on how product features need to be realized from an operational point of view. The user-centricity gives examples on ill-structured decision problems, because they represent subjectiveness in deciding for an optimal solution to deliver high value with no clearly defined or widely acknowledged decision rules. To understand how structured or unstructured decisions on broad organizational level (macro) and detailed operational (micro) level are generally approached, two major models are investigated broadly. The Anthony's organizational DM model (Anthony, 1965) covers macro decisions by separating organizational decisions depending on management activities into strategic decisions, management control and operations control. Strategic decisions cover organizational goals, management control deals with resource allocation, operational control assures effective operation in an organisation. All three levels of macro decisions build an environment for making micro operational decisions, which concentrate on actual activities in an organisation. The Mintzberg's process model (Mintzberg et al., 1976) explains process-oriented micro decision

based on three main phases and related to a categorization into opportunities, crisis and problem decisions. First is a problem identification phase covering recognition and diagnosis for awareness as well as categorization of what needs to be decided on. Second is a development phase including searching for already existing solutions and design for adapting or creating new solutions. Third is a selection phase incorporating a screening of potential solutions, an evaluations and choice of a solution and finally an authorization, which represents a decision how to move forward. Relating those introduced phases to the RE phases from Section 2.3 shows how the phases overlap and clarifies that a RE process is a micro decision process in an organizational environment determined by macro decisions. In summary, both types of organisational decisions have an interdependency. Macro decisions set an operational environment for micro decision, whereas micro decision determine how macro decisions are executed and realized. No matter which level and if structured or unstructured decision problems, organisational decisions are influences by two factors, equivocality and uncertainty (Daft & Lengel, 1986). As mentioned in Section 2.3, agile RE deals with uncertainty due to partial availability of information and fast changes of market requirements during product realization. Daft and Lengel (1986) also relate variety of tasks for DM to uncertainty, as the frequency of unexpected events during completing a task is directly impacting the certainty about an optimal solution. An iterative agile approach is dealing exactly with this definition of uncertainty and task variety. If a decision problem is structured and analysable, uncertainty can be reduced by gathering more information (Galbraith, 1973). In agile environments, gathered information during a realization process can be incorporated iteratively. If a decision problem is hardly analysable and DM unstructured, such as subjective perception of high product value in user-centred RE, more information to reduce uncertainty could lead to more equivocality. The higher equivocality for a certain decision problem, the less straight forward is solutioning (Daft & Lengel, 1986). If equivocality is high, multiple interpretations of a problem and its potential solution exist, which makes DM complicated due to conflicting viewpoints (Putnam & Sorenson, 1981). However, complicated DM due to high equivocality should not be confused with complex problems and solutions, because complexity is perceived to be structured in essence (Zack, 2007). Conflicting viewpoints which lead to equivocality can be caused by

differences in interpretation of the individual to the collective level due to different backgrounds, roles or cultures (Sjödin et al., 2016). Such circumstances also affect decision makers on individual level when various interpretations must be considered for deciding on value of a product. On top, as interpretations are always subjective and personal, the decision maker enforces as certain equivocality during inference creation through individual perceptions (Felin et al., 2017). Next to the socially enforced equivocality, the problem itself can also involve contradictory but interrelated aspects at the same time (Smith & Lewis, 2011). Summarized, structured problems that are analysable with low equivocality can be solved following clear DM rules including uncertainty reduction through information gathering to keep task variety low. If an unstructured problem with high equivocality is not analysable and no DM rules are applicable, more information may lead to increased equivocality, which can be reduced by direct communication (Daft & Lengel, 1986; Zack, 2007) or group supported interpretations (Crossan et al., 1999). As all stakeholders in organisational DM encounter structured and unstructured DM environments with various information needs, it is necessary to understand psychological DM for suitable information processing to ensure effective inference creation.

Psychological DM Next to strategic and model-based approaches to DM, literature on psychological DM is investigated for insights on how thinking processes and heuristics influence DM in UCA-RE. According to “A Dictionary of Psychology” from Colman (2015), DM is “The act or process of choosing a preferred option or course of action from a set of alternatives. It precedes and underpins almost all deliberate or voluntary behaviour“ (Colman, 2015, p. 189). Simply described, a decision is a choice of what to do or not to do. With a choice of actions what to do and how, decision makers aim to achieve certain goals. A decision is based on beliefs how to achieve those goals, which can be based on selfish purpose for an individual decision maker or they can be important for a community which can be part of actions to reach those goals. Furthermore, decisions can be related to small or very important matters which usually also reflects the complexity or difficulty of those decisions. This complexity and difficulty can reach from simple and clear goals, mostly single goals with few options and strong belief which actions reach those goals, to highly complex or

ambiguous decisions involving many dependent goals and options based on uncertain beliefs (Baron, 2000).

Rational DM Taking those ingredients for DM into account, it becomes clear that decisions are results of thinking processes around a choice that must be made. Those choices can be rational, which in classical economics is defined as humans making choices resulting in the best outcome for themselves through careful considerations of costs and benefits. This understanding is following the rational choice theory, which is based on the theory of the invisible hand by Smith (1776) and assumes self-interest of an individual to achieve best outcomes for an individual as well as for society. The idea of rational choice theory assumes that all actions are rational, and humans consider all costs and benefits for any action before deciding on the best outcome (Scott, 2000). To achieve the best outcome possible, accessing long-term effects of decisions is needed, which requires a strong fact based validation of options (Russ et al., 1996). For an effective validation of options using correct facts, rational DM is following a structured and controlled orientation (Rotter, 1966). Such structures are reflected in various models for evaluating alternatives in a multi-step decision-process using logic, objectivity and analysis. Some common steps are explained in Table 2.3 with short explanations (Uzonwanne, 2016).

Step	***Explanation***
Identifying the problem that requires a solution	The problem must be identified properly to avoid too much or too less effort in solving it.
Identifying a solution scenario	A solution to the problem must be identified to define success factors which can be observed or measured.
Carrying out a gap analysis	A gap analysis determines which steps are necessary to get from the problem state to the solution state.
Gathering facts, options and alternatives	For enough information as foundation for DM, facts must be gathered which are necessary for carrying out the identified steps.

Analysing option outcomes	Each alternative must be carefully analysed using gathered information to determine most suitable options and precisely predict outcomes.
Selecting best possible options	Select the most effective and functional option with the best outcome as final decision.
Implementing decision for solution and evaluate final outcome	The selected option must be implemented exactly according to the determined steps for an effective and functional solution. The outcome must be evaluated to match the predictions.

Table 2.3: Rational DM Steps

Rational models come however with assumptions that need to hold to execute rational DM. First and already introduced assumption is that people always make decisions to maximize benefits and minimize costs, so choosing whatever brings greatest reward at lowest cost. Second and important assumption is completeness of perfect information, which is necessary to make the best decision to achieve the best outcome. Furthermore, to proof completeness of information, rational DM assumes that measurable criteria exist on what data can be collected and consequently analysed. With the willingness to achieve the best outcome and with perfect information in place, another important assumption is the belief that every individual has cognitive abilities as well as time and resources to critical evaluate all potential options (Simon, 1957). Considering all assumptions, rational DM depends on objective data and an analysis process for making decisions that maximize benefits. However, complete and perfect information is mostly not possible due to availability, accessibility or high cost on time and resources to acquire missing data. Next to limits on perfect information, cognitive abilities of decision makers to analyse and compare alternatives is also limited in relation to the complexity of the rational choice. The higher the complexity of a choice, the higher the demand on necessary information and cognitive ability to analyse the data. In such cases and with the assumption of always seeking for optimized benefits while minimizing the cost, an acceptable option is chosen in favour to the optimal one (Gigerenzer & Selten, 2002; Simon, 1955).

Bounded Rationality An alternative theory to pure rationality is bounded rationality, which takes into account considerations on the assumptions from the previous paragraph. Simon (1955) explains that the simplified model of rational DM is not reflecting the complexity of reality, especially in an organizational setting. The capability of making a rational decision is bounded to the cognitive capability of decision makers depending on the context of an environment where decisions are made. Those internal and external constraints lead to approximate rationality where decision makers are intentionally rational. If decisions can only be partly rational, the other parts need to be irrational. If no full rational decision can be made because of cognitive or other environmental limitations, decision makers compensate limitations with known structures and heuristics. Using simple heuristics can lead to even better outcomes than theoretically optimal procedures when adapting to an environment or cognitive limitations, which is covered in more detail in Section 2.4.2. What defines better outcomes strongly depends on the cognitive styles of decision makers. Maximizers are searching for a best possible option within limitations, which usually takes longer due to more data gathering and analysis. Satisficers are looking for a first option that is good enough by diminishing choices on purpose to make a fast and effective decision for a satisfying solution within chosen limitations (Gigerenzer & Selten, 2002; Simon, 1955). Concluding, bounded rationality shares the opinion on DM to be rational, but only in limits of an environment and cognitive abilities. At the same time, it does not emphasize that it is less effective.

Different theories on mapping conditions of partial rational or irrational DM try to understand what compensates missing information or limited cognitive abilities. Based on the research from Herbert A. Simon and Gerd Geigerenzer, Daniel Kahneman and Amos Tversky expanded the theory of bounded rationality with a focus on cognitive mechanisms during irrational DM. The research mainly focused on three topics of their joint work: heuristics in judgement, risky choices and framing effects (Kahneman, 2003). All three domains included intense studies on intuitions, thoughts and preferences according to Kahneman (2003). This study is primarily interested in heuristics in judgment, which is based on researching accessibility of thoughts depending on intuitive or deliberate thinking processes during DM.

With expansions of bounded theory related to cognitive mechanisms during DM, theorises on information processing change as well. Simon (1978) describes DM as one sequential analytical information processing system. Following the Dual Process Theory, Kahneman (2011) describes two systems with different approaches to information processing. The difference to the concept of bounded rationality is the acceptance of two separate but correlated processes of thinking, intuitive and analytical.

2.4.1 Processes (Systems) of Thinking

Dual Process Theory Stanovich and West (2000) introduced the theory of two systems which represent two types of cognitive processes. The two-system theory is based on the theory of dual processes, which differentiate thinking into fast intuitive and slower deliberate processes. According to theories based on the initial introduction of dual processes by Wason and Evans (1974), two distinct types of processes exist, the heuristic and the analytic process. Information relevant for the judgement is selected by the heuristic process and the actual analysis of information is done by the analytic process. The heuristic process is categorizing the relevance of information related to the issue that needs to be solved. It decides which information is categorized as irrelevant and not further processed, whereas the relevant information functions as input for the analytic process, which generates a final judgement based on the chosen information. Information can be implicit or explicit and differs in their source and access. Implicit information is gathered through experience over time and accessible in long term memory, whereas explicit information is gathered purposefully and topic specific from external sources. The term heuristic in the sense of a heuristic process refers to the selection of relevant information, whereas the term heuristic used by Tversky and Kahneman (1974) indicates potential flaws in judgement due to short cuts in reasoning (Evans, 1984). Theories around dual processes evolved in the 1980s and 1990s until the labelling into System 1 and System 2 (Stanovich & West, 2000). Even though the labelling into systems including their definitions is subject of criticism, it is still acknowledged in a wide range of psychometric or neuroscientific methods (Evans & Stanovich, 2013). The reason for the criticism is the granularity and explanatory strength of the definitions as

well as the oversimplification by separation into only two systems. The labelling indicates that two individual single systems and therefore two separate minds participate in DM, whereas actual System 1 should be plural and represents a set of systems. For that reason, Stanovich (2011) discontinues the use of the labels and refers to Type 1 and Type 2 terminology. The research uses the labelling into System 1 and System 2 the same way as it is used by Kahneman (2011) for describing not more than two types of information processing (Evans & Stanovich, 2013) for explaining intuition, heuristics and analysis. A deeper elaboration on the labelling is not in scope of this study, the introduced discussion serves the explanation and understanding of the general concept, which is experiencing continuous renaming and refinement. Even though the concepts of information processing vary in their terminology, there is an agreement on the differentiation into intuitively and analytical operating systems which interact (Sadler-Smith, 2016). It is also assumed, that the intuitive system processes implicit information holistically (Brunsson & Brunsson, 2017) and that explicit information is getting processed rule based by the analytical system (Baldacchino et al., 2015). Although the information processing differ between the systems, they may interact for inference creation.

Interaction Styles of Systems Two interaction styles of the two systems can be differentiated, the default-interventionist and the parallel-competitive view (Evans, 2010). The parallel-competitive view gives insights on how intuitive and analytical inference creation functions based on differences in information processing. One is the intuitive information processing system, which processes implicit information holistically, and the other is the analytic information processing system, which processes explicit information sequentially (Smith & DeCoster, 2000). The default-interventionist view describes operations of the two systems as sequential processes. Inference created by the intuitive system needs to be checked by the analytical system for flaws which may get corrected if needed (Stanovich & West, 2000). Both interaction styles describe the difference of the systems in relation to intuition and analysis but differ in their acknowledgement of successful inference creation due to their individual processing approach. The parallel-competitive view gives the intuitive system more credit in solving ambiguous problems holistically, whereas the default-

interventionist view describes the intuitive system as faulty. As this study is investigating the potential biases in intuition and how to become aware of them, the default-interventionist view is adopted. However, as UCA-RE environments consist of structured as well as unstructured decision problems involving uncertainty and equivocality, the intuitive system might be as important as the analytical system. Consequently, this study does not assume that intuition, and heuristics, are entirely disadvantageous and acknowledges that they may outperform deliberate thinking and analytical information processing depending on DM environments.

Default-Interventionist View The two systems are introduced by Kahneman (2011) as two characters which can work together or stay in conflict to each other related to inference creation. The characterization of the two systems leads to an anthropomorphic or homunculus style when relating to them. However, they are defined to make up the mind and can therefore not be independent agencies from a person. The style is used throughout this thesis to acknowledge the initial description and intentional use of the systems by Kahneman (2011). Kahneman (2011) describes unease and conflicting interactions of both systems because System 1 may operate on inaccurate heuristics whereas System 2 must evaluate those heuristics and is error prone. For understanding why the two systems need to work together, both systems must be characterized. System 1 represents fast and automated thinking processes with almost no effort and no sense of thought control. It is also referred to as automated system. System 2 represents the slow thinking processes, responsible for the effortful activities like computational tasks or analysis, which need attention or concentration. It is also referred to as effortful system (Kahneman, 2011). When relating the two systems to the differentiation of intuitive and analytical DM, System 1 represents the intuitive DM using associative reasoning and System 2 the analytical DM using rule-based reasoning. Gilovich et al. (2002) summarized the characteristics of the two systems according to their reasoning approaches in the following Table 2.4. Relating the two forms of reasoning to the individual systems supports the understanding of their individual approach to inference creation using intuition or analysis including their focus on implicit and explicit information.

	Associative System	***Rule-Based System***
Principle of operation	Similarity and contiguity	Symbol manipulation
Source of Knowledge	Personal experience	Language, culture, and formal systems
Nature of representation		
Basic units	Concrete and generic concepts, images, stereotypes, feature sets	Concrete concepts, generic, and abstract concepts, abstracted features, compositional symbols
Relations	a) Associations b) Soft constraints	a) Causal, logic and hierarchical b) Hard constraints
Nature of processing	a) Reproductive but capable of similarity-based generalization b) Overall feature computation and constraint satisfaction c) Automatic	a) Productive and systematic b) Abstraction of relevant features c) Strategic
Illustrative cognitive functions	Intuition Fantasy Creativity Imagination Visual recognition Associative memory	Deliberation Explanation Formal analysis Verification Ascription of purpose Strategic memory

Table 2.4: Characterization of Two Forms of Reasoning (Gilovich et al., 2002)

The compared characterizations of the two systems show their differences and indicate their individual purposes. Both systems with their forms of reasoning correspond to using intuition and analysis as DM tools (Sinclair & Ashkanasy, 2005), which work together in an interactive mode to cope with various situations in real life by leveraging their different capacities. Each of the systems is acting

as expert for dealing with structured and unstructured decision problems in an UCA-RE environment. The associative system uses implicit information (experience) for reasoning holistically on unstructured decision problems with high equivocality using similarity or coherent pattern recognition (Dane & Pratt, 2007). The rule-based system uses explicit information for reasoning on analysable structured decision problems with low equivocality but potentially uncertainty, which can be reduced through more explicit information gathering. They can cooperate to solve sensible problems, which is however effortful and potentially inefficient or not reliable. If given a certain problem, the individual systems may act on their own and come up with answers or solutions which contradict each other (Gilovich et al., 2002). Both systems are eager to give responses and may also contribute partially to a response. Because not every problem or situation can be categorized to be in the domain of System 1 or 2, it is up to decision makers to decide which inference is best suited for the problem. However, because System 2 is reluctant to invest more effort than necessary, fast and impulsive responses from System 1 are the first inferences to most problems. Some tasks are directly taken over by System 2, independently of System 1, due to necessary effort or needed self-control to keep impulsive responses from System 1 under control. Because System 2 takes a lot of effort and is limited in capacity, it is selective if too much load is on the system and allocates free capacity to parallel tasks as soon as available (Kahneman, 2011). Additionally, System 1 uses heuristics, mental shortcuts, to keep load from System 2 and concludes on a given problem in a reliable way. System 2 can also teach System 1 over time to know answers to recurring questions, but it is still responsible for monitoring System 1 and allow or modify information processing and inference creation. However, Kahneman (2011) mentions, that the laziness of System 2 to make effortful checks of System 1 follows the law of least effort and can result in inappropriate use of heuristics to form beliefs about optimal solutions to problems. Especially structured decision problems are prone for potential flawed inference creation by the intuitive System 1, even though System 2 would be appropriate to operate rule-based on explicit information for inference creation.

Cognitive Reflection Test The Cognitive Reflection Test (CRT) shows for example fast and intuitive responses from System 1 and at the same time triggers System 2 to override those responses (Frederick, 2005). The CRT indicates that intuition causes biased DM and System 2 usually fails to recognize and correct flaws for less complex structured problems such as the CRT calculation task, which can be solved using rule-based explicit information processing. Keeping System 1 always under control through self-checks is however not feasible, because it would increase mental load on System 2 and take capacity which may be needed for more complex tasks. The goal is to ”learn to recognize situations in which mistakes are likely and try harder to avoid significant mistakes if the stakes are high“ (Kahneman, 2011, p. 28). However, just because CRT results support the statement from Frederick (2005), that there are analytical structured problems that offer no intuitive solution, does not mean that there is no possibility to learn intuitive inference creation on complex analytical problems. Yuliya et al. (2022) state that in the field of mathematics education, intuition is the ability to create rapid solutions to problems based on creative thinking using logic instead of memorized mathematical operations. This however needs practicing in complex problem-solving scenarios to benefit from the possibility of System 2 teaching System 1, allowing scholars to comprehend mathematical operations, facts, principles, and ideas in an intuitive as well as analytical way. Next to learning mathematics intuition, Resnick (1986) argues that mathematical intuition can even function without any formal analytical reasoning, because it is perceived as cognitive primitive. Another understanding of intuitive inference creation in mathematics is the perception of a complex analytical problem as mental representation of facts which are viewed as self-evident and can be solved without formal instructions (Dreyfus & Eisenberg, 1982). Moreover, the representation can be uncovered using estimations (Dixon & Moore, 1996). The CRT can consequently be solved using intuitive inference creation, which however is dependent on the ability of mathematical intuition. In any case, the CRT shows the interrelation of System 1 and System 2, however effort might be balanced between them to solve the analytical problem using intuition or reasoning. More details on various viewpoints what intuition represents and how it functions including potential usage of heuristics are covered in the next section.

2.4.2 Intuition, Heuristics and Biases

Intuition Definitions depend on the perceptions of information processing and what constitutes to successful inference creation. Following the perception from Simon (1983) and bounded rationality, intuition is instant pattern recognition during subconscious information processing. The only difference to analysis is the subconscious processing, the essential thinking process itself is the same (Simon & Gilmartin, 1973). Pattern recognition skills are gathered through experience over time and are stored as implicit knowledge if associations lead to successful inferences following analytical processes (Prietula & Simon, 1989). Consequently, decision makers gain more intuitive expertise, the longer successful inferences are created and stored for more comprehensive pattern recognition and solutioning. Summarized, intuition is defined as recognition during analysis for rapid responses, which become a habit over time (Simon, 1987). A similar perception is shared by Hammond et al. (1987), who define intuitive thinking as automatic, fast, effortless unconscious and based on experiences in relation to expert judgement. Other perceptions separate intuition from analysis and define it simply as knowledge of a solution to a problem without reasoning, sometimes referred to as gut feeling (Horstmann et al., 2009). The separation of intuition from analysis implies an existence of dual processes, which operate separately from each other. Kahneman and Tversky defined intuition different throughout their research on DM until the introduced separation into System 1 and System 2. Intuition had been defined as informal and unstructured reasoning that includes no analytical or deliberate information processing, intuition were quick thoughts or preferences involving not much reflection (Kahneman, 2002; Kahneman & Tversky, 1982). Other definitions which acknowledge dual processes define intuition as rapid and subconscious judgments drawn from holistic associations which are fundamentally different from analytical information processing (Dane & Pratt, 2007). Definitions of intuition following the dual process theory matches growing acceptance that intuitive and analytical information processing are two distinct systems (Dane, 2011; Dane & Pratt, 2007; Evans, 2010). However, no matter what exact definition of intuitive or analytical information processing and underlying theories of dual processes are used, they all distinguish thinking processes that are fast

and associative from other which are slow and rule based (Gilovich et al., 2002). Consequently, processing cost of intuitive thinking is less than for deliberative thinking (Hogarth & Karelaia, 2007). Even though characteristics of intuitive thinking fits System 1 and deliberative thinking fits System 2, it is not correct to assume that they are exclusively done by either of the systems (Horstmann et al., 2009). It is also not correct to state that intuition cannot be rational, just because it is defined to be fundamental different from analysis, which is usually related to rationality (Griffin et al., 2012). According to Gilovich et al. (2002) and the default-interventionist view, intuition is only perceived as effective if analytical reasoning based on formal models is facing uncertainty. Taking that statement into account and according to the parallel-competitive view of system interaction, intuition can be perceived as more effective in unstructured environments with uncertain and ambiguous conditions. If a problem cannot be approached sequentially because it cannot be successfully decomposed into explicit information due to high equivocality, intuitive DM becomes more effective (Dane et al., 2012). If rationality refers to the degree of how well a DM approach suits the decision problem environment (Gigerenzer & Gaissmaier, 2011), intuition may be rational in unstructured decision problem environments with high equivocality, because analytical rule-based DM approaches do not fit, resulting in analysis to be irrational. No matter if rational or irrational, intuitive information processing is essential in dual process theories. Following the definition of System 1 by Kahneman and Frederick (2005), intuition uses heuristics for quick responses to decision problems, which however get overwatched by System 2.

Heuristics "The technical definition of heuristic is a simple procedure that helps find adequate, though often imperfect, answers to difficult questions." (Kahneman, 2011, p. 98) They can be used as rule of thumb for fast decisions in uncertain environments by reducing complexity for efficient and effective assessment of probabilities and outcomes (Cristofaro, 2017). Reducing complexity may include different possibilities for effort reduction, such as examining fewer cues, reducing effort of retrieving cue values, simplifying weighting of cues, integrating less information or examining fewer alternatives (Shah & Oppenheimer, 2008). Gigerenzer and Gaissmaier (2011) state that heuristics are strategies which partially ignore information to make faster, frugally

or more accurately decisions than complex methods. Consequently, heuristics may contribute to successful inference creation depending on the complexity of the decision problem, situational circumstances, and cognitive style of the decision maker. Daniel Kahneman and Amos Tversky introduced three first heuristics as part of their decision theories related to the topic of heuristics in judgement, which focus on compensating missing information or limited cognitive abilities, as introduces earlier in this chapter (Kahneman & Tversky, 1972, 1973; Tversky & Kahneman, 1974). First is availability, which is a heuristic making frequency or probability judgments based on "the ease with which instances or occurrences can be brought to mind" (Tversky & Kahneman, 1974, p. 1127). Second is representativeness, which described classifications of objects and an evaluation of probabilities based on comparability of objects to those classifications. If object comparisons result in similarity, the potential that those objects belong to a class is judged as high, even that judgement may be flawed (Tversky & Kahneman, 1974). Third is anchoring and adjustment, which refers to the process of estimating an initial value as anchor for a judgement and adjusting that estimation by increasing or decreasing the value in relation to that anchor, as described by Tversky and Kahneman (1974). Another heuristic, introduced later, describes the replacement of attributes which need to be assessed by other ones based on availability and speed they come to mind (Kahneman & Frederick, 2002). All introduced heuristics as intuitively used short cuts can be "quite useful, but sometimes they lead to severe and systematic errors" (Tversky & Kahneman, 1974, p. 1124). Heuristics potentially lead to biases, because they are used unconsciously and intuitively by System 1, which contradict the logical and probability-based thinking and indicates error in judgement due to short cuts in reasoning (Tversky & Kahneman, 1974). Heuristics can cause biases individually depending on the contextual situation and environment or also in combination, according to Sibony (2020). In Sibony's book "You're About To Make A Terrible Mistake" (Sibony, 2020), combinations of heuristics are called traps and represent heuristics triggering each other to combine a bias. An example would be the Storytelling Trap, which constructs a coherent story based on Confirmation Bias, which can trigger a Champion Bias by supporting our confidence and finally the Experience Bias for the high relevance of our experience, which lets a story become true (Sibony, 2020).

Biases Cognitive bias is defined to be a misstep in thinking and causes a pattern of deviations in judgement while creating inferences without proper reasoning (Haselton, Nettle, & Andrews, 2015). Consequently, cognitive biases can cause inaccurate judgement or illogical interpretations (Tversky & Kahneman, 1974). Biases examples in Table 2.5 got selected purposeful, based on the research context and their contribution to data analysis, interpretations of findings and discussions of results in this study. All biases explanations are abstracted from descriptions by Kahneman (2011) and should not be referred to as universal definitions. They serve the purpose of differentiating types of biases and as potential explanations for the introduced observed phenomena later in this study.

Biases	***Explanation***
Affect	Emotional preferences influence judgment.
Intuitive Predictions	Intuitive conclusions from System 1 feel overconfident, System 2 does not evaluate.
The Illusion of Validity	Strong confidence in opinions and predictions, even though counter information are available.
Confidence over Doubt	Confidence on System 1 story, which System 2 is not doubting due to high effort of disbelieve.
Trust Expert Intuition	Overconfidence when a solution comes easy to mind and no contradicting information is available.
Cognitive Ease	Information that is easier to comprehend seem more true than complex information.
Associative Coherence (Coherent Stories)	Storytelling and association for explanations of situations, not fitting information gets adapted.
Confirmation Bias	Active search for confirming information while overlooking counter examples.
Substitution	If a problem or question is to complex, it is replaced by an easier version for estimations.

Ignoring Algorithms	Relying on intuitive DM, even though algorithms are available for inference creation.
Overlooking Statistics	A story is presented around statistical data and the belief is stronger in the story than the actual data.
The Planning Fallacy	Making a decision based on best case scenarios without evaluating the worst cases.
Representativeness	Making decisions in favour of how similar the alternatives are to something already known or preferred, not considering other factors.
Overlooking Luck	Giving reason and causal interpretations to random situations.
The Optimistic Bias	Neglecting the possibilities of unfavoured or negative outcome due to strong optimism.
The Focusing Illusion	The focus on a situation makes it more important than it actually is.

Table 2.5: Selected Biases

According to Artinger et al. (2015), if heuristics are perceived as short-cut strategies for inference creation that coexists to an optimal solution, which represents a rational choice, heuristics become the mentioned misstep that cause deviations and are consequently perceived as biases. However, an optimal solution depends on the structuredness of a decision problem environment. In case of a structured decision problem, if System 1 follows intuitive heuristics to create inferences and System 2 misses to check the outcomes of System 1 through analytical reasoning, systematic errors may result, which in return can lead to biases due to discrepancies between correct and actual answers (Montibeller & Von Winterfeldt, 2015). Consequently, if complexity of a structured decision problem needs to be reduced due to missing information gathering possibilities to address uncertainty and existing environmental constraints that enforce DM, consciously applied heuristics may be appropriate for inference creation. On the other hand, if intuitive heuristics are used unconsciously, the potential of flawed DM and biased intuition is high due to missing deliberate

analytical information processing. Also, if heuristics are applied to unstructured decision problems with uncertainty and high equivocality, potential optimal outcomes using holistic implicit information processing might be limited due to analytical short-cuts of not analysable DM environments, which causes biased analysis. In any of those cases, inappropriately applied heuristics may cause biases. To become aware of and understand heuristics which may contribute to biased DM, it is possible to individually de-bias, but it is effortful and needs training (Kahneman et al., 2021). Another approach is the support of a decision observer, who is nominated to identify signs of biases (Kahneman et al., 2021; Sibony, 2020). If awareness of intuitive heuristics and understanding of conscious use of heuristics is high, biased intuition or analysis can be reduced and flawed DM avoided. As Gigerenzer and Gaissmaier (2011) states, in some business situations and depending on the underlying information quality, heuristic and intuitive DM can be more accurate than complex analytical strategies.

2.5 Conceptual Framework

This section introduces a conceptual framework representing all researched knowledge domains, focusing on their relationships for understanding observed phenomena (Fain, 2020). It represents a conception of what this study intends to investigate to find an explanation of what is experienced in the introduced business context. Consequently, it is a tentative theory of phenomena that this study is investigating (Maxwell, 2013). Even though the representation is only a very simplified form of visualizing the interrelations of areas of interest (Green, 2014), it is suitable to explain main elements for investigation. Elements are key factors, concepts, phenomena or variables as well as presumed relationships among them to underpin the purpose of qualitative research in this study (Miles et al., 2018). Representation and interrelations are based on the understanding and experience of the researcher, which is valid to be considered (Regoniel, 2015).

The conceptual model in this study works with different concepts for explanatory purposes of cause-and-effect relationships. The model elements, representing

concepts and interrelations, are inspired by variable definitions (Regoniel, 2015; Scribbr, 2021). However, instead of using variables, which usually represent measurable elements of a model, concepts from the literature review are used to build a framework for explaining observed phenomena (Imenda, 2014). Even though literature covers theories on DM, underlying concepts in theories are of interest in this study, not the validity of theories. Because of the interest in the concepts underlying theories, a conceptual framework instead of theoretical framework is appropriate according to Imenda (2014).

Following concepts in Table 2.6 are used for conceptualising the literature review in this chapter and findings from research in Chapter 4:

Element	***Explanation***
Dependent Concept	A concept that is influenced by causal relationship to another concept in the model. It is changing in itself which is caused by another concept in a framework.
Independent Concept	A concept which influences a dependent concept through a causal relationship. Even though it is a concept, it is not dependent on any other concept in a framework.
Causal Relationship	A causal relationship is the influence or impact of an independent concept on a dependent concept. It can be altered by a moderator concept and explained in more detail by a mediator concept.
Mediator Concept	A mediator concept explains how or why an independent concept affects a dependent concept. It is affected by an independent concept and affects a dependent concept.
Moderator Concept	This concept alters and moderates an effect of an independent concept on a dependent concept. It is not affected by an independent concept but has effects on a dependent concept.

Control Concept	A concept that is not relevant to research questions but needs to be kept or considered constant.

Table 2.6: Elements of Conceptual Framework

The first part of the dependent concept is RE in digital product development, which changed during last decades from sequential to very agile environments. With the understanding of the change from a historical perspective as well as from a cultural point of view, the business environment of the phenomena is clear. Furthermore, it helps to understand a rising importance of frameworks, methodologies and processes such as Scrum for ASD or EDT for UCD. As this study is about psychological DM, the roles of POs, usability specialists and experience consultants got investigated to understand potential influences causing the phenomena. Summarized, this part of the dependent concept introduces the organizational environment of UCA-RE.

The second part of the dependent concept is DM, which emphasizes that RE basically represents a DM process adhering to DM models. Next to organizational DM, insights on psychological DM reveal underpinning thinking processes which are applied during RE. The reviewed literature covers insights from rational to intuitive DM including their influencers such as heuristics and potential biases. This part of the dependent concept represents the DM processes in the environment of UCA-RE.

Both parts combined represent the full dependent concept of DM in UCA-RE, which represents the environment for the observed phenomena. It is important to understand the complex environment and all included elements to research on influences and dependencies between the elements and contextualise research results within the environment for explanations of the observed phenomena. Consequently, both concepts build the underlying thematic framework for zeroing down on more specific sub-areas to understand the conceptual framework around the phenomena. How the independent sub-areas influence the dependent environment is discussed theoretically in literature, the dependent concept represents the DM environment of UCA-RE.

The first independent concept are processes and roles in RE, which are specific sub-areas for UCD and ASD and differ from traditional sequential feature focused RE processes. Taking the example of Scrum, it shows that iterative approaches to all stages of the development process have an impact on timing and extent of DM in RE. DM is not upfront, as in traditional RE processes, and not all information is available, but gathered throughout development. Also, information needed for DM changed from logical structured feature specification to a general abstract value, which represents customer satisfaction. This change in focus and timing of DM needs an expectation adaption of involved roles, especially POs and usability specialists. Both need to collaborate to fulfil expectations, which changes final DM of POs to be inclusive and dependent on external skills. Even the introduction of new roles may be necessary, an experience consultant, taking over overarching responsibilities to combine UCD and ASD processes and keep value creation as priority. Concluding, the independent concept represents theoretical process and role descriptions within UCA-RE in the conceptual framework.

The second independent concept covers thinking processes as sub-area of DM, as introduced and explained in Section 2.4.1, including intuition, heuristics and potential biases. Because DM is based on inference creation through thinking processes on alternatives, it is important to understand that beliefs about alternatives are strongly influenced by available information and cognitive capabilities of decision makers. The concept includes discussed variations of thinking processes divided in two systems or types of thinking. Within those thinking processes, intuition and heuristics are also included, which consequently influence DM as outcome. Extracted heuristics and potential biases from literature show why the independent concept of thinking and heuristics change and influence other concepts in the model due to altered thinking processes including impacted intuition. This independent concept reflects underlying psychological functions of DM, thinking, cognition, intuition and reasoning in user-centred agile (UCA) environments, which act as key for explaining the observed phenomena.

The visualization of the conceptual framework (Figure 2.4) shows the introduced concepts and represents causal relationships. For the independent as well as for

the dependent concepts, rectangle shapes are used. The moderator concept is shown in oval shapes and is connected to interrelations between the dependent and independent concepts. For the interrelations, arrow shapes are used and represent causal relationships including influential or affecting directions. The frame of the figure is not a stylistic element but is needed to indicate the overall big picture and understanding of interrelations of all concepts, which will become more important when looking at gaps and research questions.

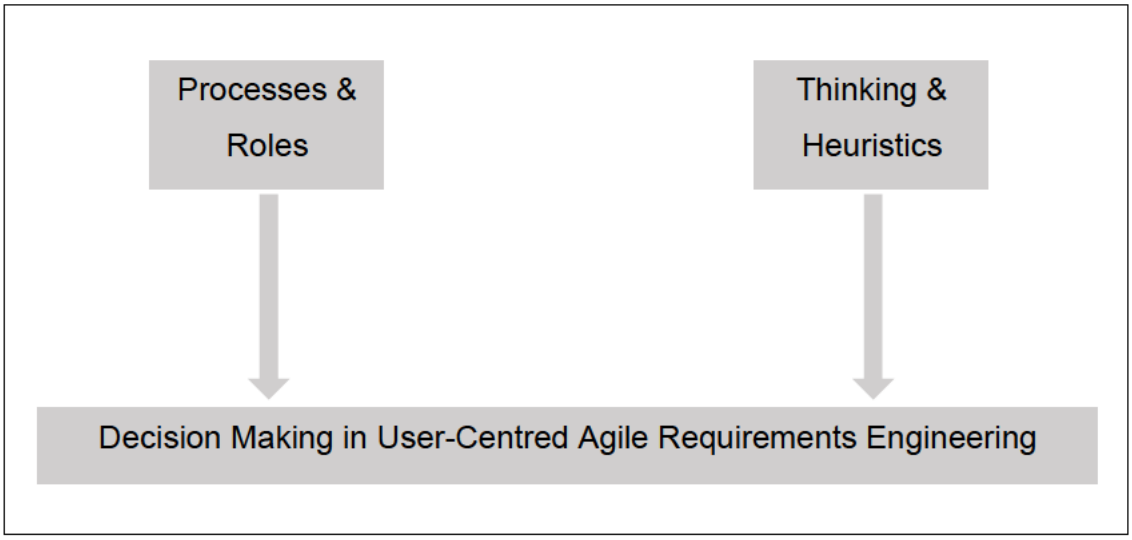

Figure 2.4: Initial Conceptual Framework

The causal relationships in the conceptual framework represent interrelations of the introduced concepts, in this case between the two separate ones. The dependent concept of DM in UCA-RE is affected by processes and roles as well as by thinking and heuristics. The two separate causal relationships reflect the thematic framework of the literature review, which is separated in two fields of interests as well. Due to necessity of understanding influences on DM in an environment of UCA-RE, both influential sub-areas affect the specific environment of the observed phenomena.

Processes and roles come with theoretical definitions and regulations to comply to, which impact DM in UCA-RE directly through enforcement of structures. Additionally, organizational decisions set boundaries for project environments including processes and consequently involved roles. The fusion of UCD and ASD is challenging. Even though the iterative approach of ASD is appreciated in UCD for continuous improvement, upfront research for information gathering is

needed because qualitative data gathering is time consuming. Such conflicting characteristics of the two different approaches influence DM in UCA-RE. Those influences are objectively defined and explained by literature. The causal relationship consequently represents the structural effect of process definitions and role expectations on DM in UCA-RE. Thinking and heuristics are underpinning theories to DM, which consequently directly influences DM in UCA-RE. The independent concept of thinking and heuristics affect the dependent concept of DM in UCA-RE by its theoretical definitions of thinking processes and introduced concepts of heuristics and biases. This causal relationship is answered according to literature. However, roles and processes impact thinking and heuristics as well due to introduced changes in processes and roles reflecting those changes in the business environment of RE. Consequently, thoughts for DM change within boundaries of processes and roles, which results in changes in the causal relationship of thinking process to DM in UCA-RE. Summarized, processes and roles influence DM in UCA-RE directly through theoretical boundaries and indirectly through influences on thinking process underpinning DM in UCA-RE. The additionally identified causal relationship is shown in Figure 2.5.

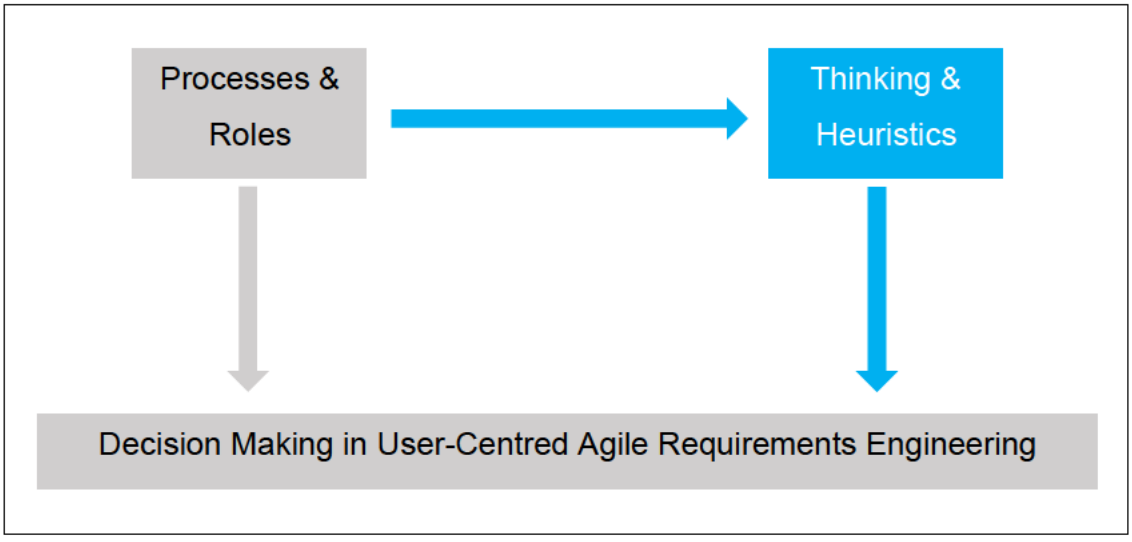

Figure 2.5: Adapted Conceptual Framework

The mediator concept represents the explained indirect causal relationship of processes and roles through thinking and heuristics to DM in UCA-RE. The key to the phenomena explanations is the theory of processes & roles affecting

thinking processes which underpin and therefore affect DM in UCA-RE. Simplified, irrational DM of POs, which is observed as negative phenomena in UCA-RE, is based on influences from processes & roles on thinking & heuristics. Consequently, the independent concept of thinking & heuristics serves as mediator concept in the conceptual framework, explaining further how processes & roles influence DM in UCA-RE next to their theoretical structural regulations and expectations. The understanding of thinking & heuristics supports the affect as mediator concept but can be neglected due to extensive coverage in theory.

As explained by Godfrey (2010), use of frameworks helps to gather information on casual relationships between concepts, guide and extend search strategies as well as represent and clarify the outcomes of the literature review in a structured way. However, the critical reviewed literature shows gaps that cannot fully explain the interrelations of concepts in the conceptual framework, especially the effects of the mediator concept. Consequently, the literature is not giving the whole picture to understand the phenomena under investigation and further research is needed. What open questions need to be answered through research to fill the gaps is introduced in the next sections.

2.6 Identified Gaps

The conceptual framework represents the underlying thematic structure of the literature review. Gathered insights identify concepts in the model and their interrelations. The initial conceptual framework shows causal relationships which got identified during the literature review. It shows separated influences of processes & roles as well as thinking & heuristics on DM in UCA-RE. The individual causal relationships are comprehensively explained in theory and covered by the literature review. However, with the introduction of the mediator concept as explanation of the observed phenomena, the individual definitions contribute only with theoretical underpinning knowledge. This theoretical knowledge is not sufficient for describing the indirect influence on DM in UCA-RE by processes & roles through thinking & heuristics. Consequently, on the one hand, the influences of processes & roles on thinking & heuristics need further

investigations. On the other hand, the influenced thinking & heuristics effect on DM needs further investigation to complete the understanding of the conceptual framework. Summarized, the causal relationship from processes & roles to thinking & heuristics and resulting influences on DM is not covered in the specific context of UCA-RE. The following gaps are identified and visualized in the conceptual framework (Figure 2.6).

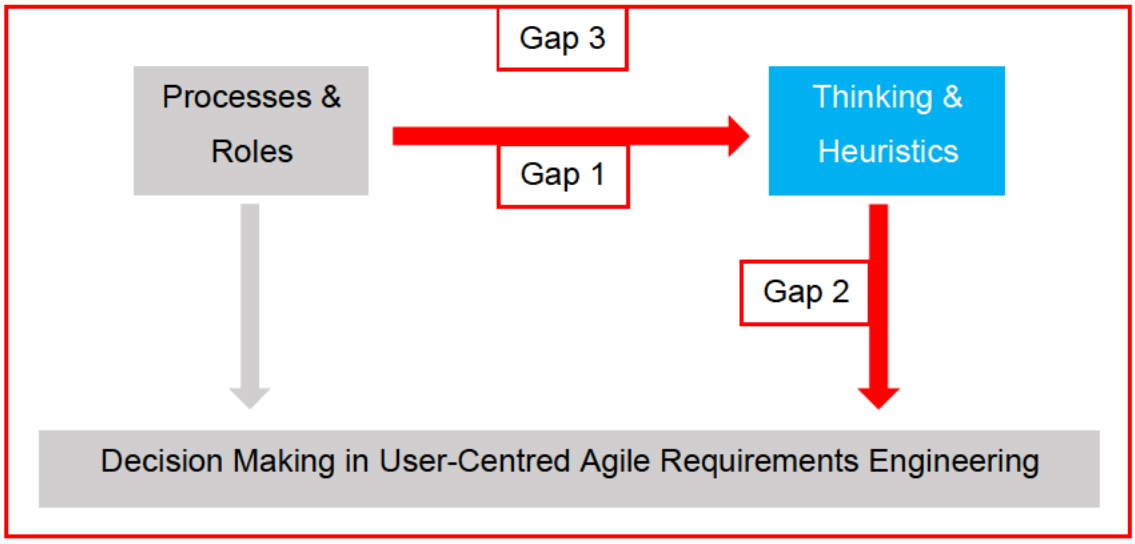

Figure 2.6: Gap Identification

Gap 1: Influences of UCD and ASD processes and roles on thinking & heuristics is not covered by literature in the specific context of UCA-RE environments. Not only that heuristics influence thinking processes for psychological DM as explained in literature, but they are also potentially on top enforced or triggered by influences of processes & roles.

Gap 2: How potentially enforced and triggered heuristics during thinking processes impact DM especially in context of UCA-RE is not discovered in literature. Literature implies potential influences for general RE, but no clear explanation can be found for UCD and ASD influenced thinking processes. Moreover, it is lacking explanations by observing and experiencing humans. Furthermore, the phenomena tend to be not taken seriously and lead to wrong long term evaluations of costs and benefits when making decisions, which are influenced by heuristics and potential biases triggered by processes and roles. Misleading validity of decisions leads to understating the importance of data

gathering through usability methods. Literature covers decline of usability methods due to organizational limitations, but not sufficiently through biased DM.

Gap 3: The awareness of influences on DM in context of UCA-RE is not explored, described or sufficiently explained in literature. Not knowing influences of processes & roles on thinking & heuristics and resulting influences on DM potentially leads to flawed subjectively decided requirements with high risk of failure. Literature mainly covers influences of DM psychology during RE, but not how specific UCD and ASD processes and role expectations influence DM.

From the identified gaps, open questions for research evolve that need to be answered to fill those gaps in literature and contribute thereby to knowledge as well as practice for understanding the phenomena. The next section introduces the research questions addressed with this study.

2.7 Research Questions

Literature answers questions about definitions, discussions, evolvements through time of concepts. Insights on direct interrelations and influences of processes & roles on DM in UCA-RE are mentioned and elaborated on in literature, mainly on organizational and structural level. An exploration and a description of interrelations are consequently available as knowledge and serve as base for further explanations to answer the questions regarding their specific influences on psychological DM in UCA-RE, which remain uncovered after a comprehensive literature review. Identified and introduced gaps during the literature review and corresponding open questions remained uncovered and get addressed by this study. With addressing those research questions, gaps in literature are closed and contribution to knowledge and practice accomplished by extending the existing knowledge on influences from processes and roles on DM in UCA-RE with explanations for its interrelations with the psychological domain of thinking processes including intuition, heuristics and biases. Following the three identified gaps, the focus of the research questions is to complete the influential and causal relationships of the conceptual framework. Figure 2.7 shows the research questions based on the identified gaps in the conceptual framework.

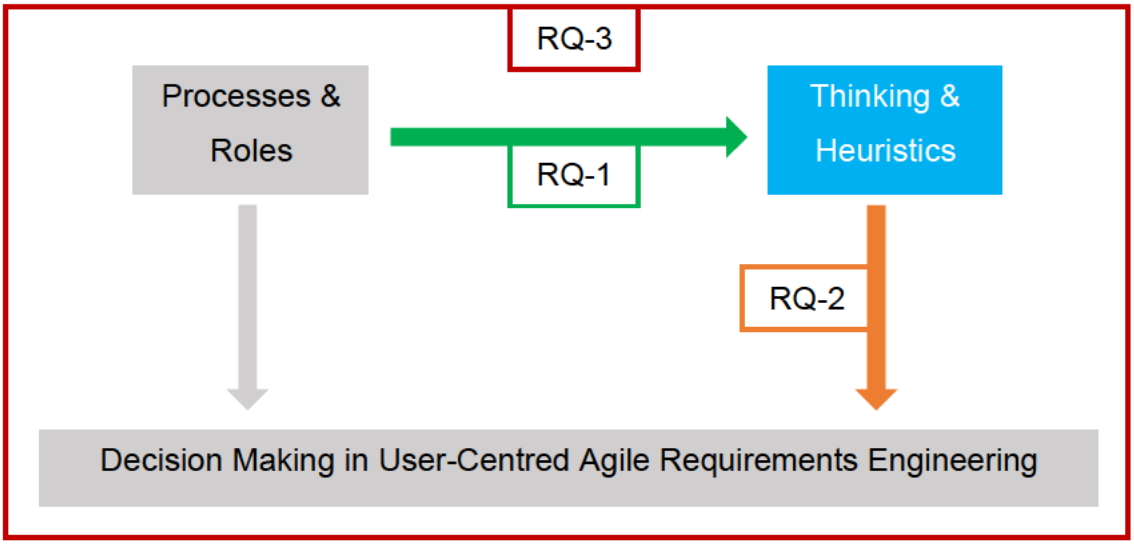

Figure 2.7: Research Questions

RQ-1: Why do processes and roles in UCA-RE have an influence on thinking and heuristics?

RQ-1 focuses on influences of processes & roles on thinking & heuristics. Those influences are already explored and descriptive answers on "how" are retrieved from literature. Qualitative data on lived experiences regarding influences is important to get an appropriate answer "why" those influences exist. This question is not answered by literature in context of UCA-RE. The answer to this RQ shows actual influences exist, which is so far only assumed due to empirical knowledge of the researcher, the initial results from the pilot study and underpinned by insights from the literature review. Furthermore, an answer to this question reveals insights on the general influence of processes & roles on DM, no matter which organizational environment. Answering this RQ will help to understand which characterizations of the processes & roles lead to changed thinking and give explanations why this is the case. Finally, characteristics of processes or expectations on roles identified during answering the RQ can be used to identify common heuristics which get triggered and influence thinking. The gathered insights are used to underpin the answers to RQ-2.

RQ-2: Why is DM in UCA-RE influenced by intuition and heuristics?

RQ-2 focuses on influences of thinking processes including heuristics in the specific environment of UCA-RE. In combination with RQ-1, the focus is on indirect influences of processes & roles on DM through triggered heuristics in

thinking processes which could lead to biases in intuition. Answers to the RQ will clarify which heuristics cause biases in intuition, or general in thinking processes for DM in context of UCA-RE. Moreover, answers will clarify a potential necessity of intuitive DM and potential consequences if it is biased, especially in UCA-RE. Reasons for potentially biased intuitive DM in UCA-RE will be covered and serves the understanding of the observed phenomena. Answers will clarify “why”, not “if” or “how” thinking processes & heuristics influence DM in UCA-RE. Influences on DM by thinking processes, intuition, and heuristics are always present and already explored and described by existing literature. However, why those influences are especially present in UCA-RE is not explained. Furthermore, how is it possible to become aware of those influences in UCA-RE? A question that is covered with RQ-3.

RQ-3: How to become aware of biases in intuition due to heuristics and their triggers during DM in UCA-RE?

RQ-3 focuses on the awareness of influences in DM in context of UCA-RE, which is observed by POs and usability specialists, but not questioned or covered in literature. RQ-1 and RQ-2 answer the questions why certain influences exist in the conceptual framework and close the gaps with explanations that support the understanding of the phenomena. Answers to RQ-3 will clarify how it is possible for POs and usability specialists to gain awareness of the influences during UCA-RE. Awareness is important to deal with unintentionally biased intuitions or at least understand and acknowledge them. Answers to this RQ are therefore fundamental to understand the whole conceptual framework and make use of insights from answering RQ-1 and RQ-2. Without awareness, RQ-1 and RQ-2 might still be answered for contribution to closing gaps in literature and complete the conceptual framework. The contribution to practice however is accomplished by answering RQ-3 and exploring possibilities to work with the gathered knowledge. Summarized, the awareness of triggers of heuristics and their influences on DM in context of UCA-RE is not covered by reviewed literature and will be covered by RQ-3.

2.8 Chapter Conclusion

The introduction to the funnel approach of the literature review presented two knowledge domains which got reviewed in this chapter. On the one hand, the knowledge domain of RE with primary focus on user-centred and agile processes, such as Scrum and EDT, was discussed before identifying the roles and responsibilities of POs and UX designers as primary focus in this study. Furthermore, the knowledge domain of DM with its separation into organizational and psychological DM was discussed before deeper investigation of the dual processing or two-systems theory of thinking. Finally, theories about intuition, heuristics and biases concluded the actual review. Both knowledge domains got contextualised in a conceptual framework showing their relationships and interdependencies. The conceptual model supports the identification of gaps within the reviewed literature, which can be summarized to following two statements.

1. Lack of qualitative research on influences on DM in UCA-RE, which are caused by specific processes and roles through triggers of heuristics in thinking processes.
2. Lack of understanding how to become aware of biased DM in UCA-RE and how to handle or at least acknowledge them in business context.

The investigation of the emerged research questions from the gaps will reveal explanations for influences on psychological DM by processes and roles as well as triggered heuristics in UCA-RE environments. Furthermore, they will cover the awareness of potentially biased DM in order to ensure an efficient and qualitive RE for valuable product development. With insights of the primary research, the extension of the conceptual framework will clarify those interrelations and close identified gaps. To gather necessary knowledge for closing the gaps, the methodology, which is underlying this study and driving the primary research, is presented in the next chapter.

Chapter 3: Methodology

3.1 Introduction

This chapter presents the philosophical framework and underlying methodology of this study which is described in a summarized way in Table 3.1 showing the overall philosophical stance as well as detailed methods with their applications. As Eriksson and Kovalainen (2015) stated, research methods and research philosophy are in close connection and are defined by a possible way of creating new knowledge through research. The sections follow a top-down approach of interrelated philosophical clarifications to describe the philosophical stance and its impact on methods for data collection and analysis. Starting with research position to constructivism and its ontological, epistemological and axiological dimensions in Section 3.2. Continuing with research nature (Section 3.3) and research approach (Section 3.4), which explain the choice of the explanatory nature and retroductive approach as most suitable. Following research approach, research design (Section 3.5) and strategy (Section 3.6) are described, giving more details on the qualitative design and phenomenological research strategy and why it is the choice for this study guiding data collection as well as data analysis. Section 3.7 presents the approach to data collection and how available data sources are used through applying the qualitative method of semi-structured interviews followed by Section 3.8 describing the selection of appropriate participants using purposeful sampling in combination with discriminative snowball sampling. The analysis of collected data is described and explained in Section 3.9 covering the reflexive thematic analysis approach and how it is applied step by step. Finally, limitations (Section 3.10) of the chosen methodology as well as important ethical considerations (Section 3.11) related to this study are reflected on.

Theme	***Characteristics***	***Application***
Research Position	Constructivism	Ontology: Constructivism Epistemology: Radical Constructivism
Research Nature	Explanatory	Taking theory of business and psychology and applying it to explored phenomena

		during DM in UCA-RE, explaining why they are happening.
Research Approach	Retroductive	Combine deductive and inductive approach to test constructed insights from psychological DM and constructing new insights by explaining related phenomena during DM in UCA-RE.
Research Design	Qualitative	Use of qualitative data (words) to examine and understand human behaviour, opinions and experiences.
Research Strategy	Phenomenological	Identifying phenomena during DM in UCA-RE and using subjective experiences to understand underlying structures of lived experiences.
Data Collection	Interviews	Semi-structured interviews with participants having different roles, responsibilities and experiences in UCA-RE processes
Sampling Procedure	Non-probalistic	Purposeful sampling for initial participants and follow up Discriminative Snowball Sampling
Data Analysis	Thematic	Reflexive Thematic Analysis for explaining phenomena by contextualising and interpreting coded and themed data within a conceptual framework of reviewed literature

Table 3.1: Overview of Methodology

3.2 Research Position

This research is based on the belief that all knowledge and perspectives on the world are constructed by humans through experiences, beliefs and interactions

with our social environment. Furthermore, the business context of this study in the consulting environment consists of constructing new knowledge and views on the world which support the belief. Consequently, linking the beliefs in what can be researched, which is the ontological position, to what is known about the researchable domains, which is the epistemological position, lays the foundation of the academic research (Grix, 2010). The beliefs are based on constructed environments and knowledge, which is the reason for applying constructivism as ontology and radical constructivism as epistemology to this study. The choice and both approaches are explained further in the next subsections of the research position. Axiology, as underlying value commitments, is closely connected to the nature of a DBA and the research context. The value of this study is to help changing unsatisfying situations in the experience consulting practice.

3.2.1 Ontology

Starting with the mentioned top-down approach to describe the philosophical stance and following the words of Jonathan Grix: "Ontology is the starting point of all research, after which one's epistemological and methodological positions logically follow" (Grix, 2002, p. 177). As explained earlier, ontology states what exists in real world and consequently what reality is emerging from it (Goodin & Tilly, 2008). The view on reality is separated in two opposing ontological positions, objectivism and subjectivism. Whereas objectivism defines reality consisting of entities that exist externally to social actors, subjectivism defines reality as constructions from those social actors build on perceptions of these entities (Bell et al., 2018). Critical Realism is positioned in-between those ontological approaches and accepts the existence of entities external to the social actors, but states the necessity of their interpretations by social actors to make sense of their existence and understand causes for experienced phenomena (Easton, 2010). The following Table 3.2 explains which ontologies are not applicable for this study and why according to their definitions.

Ontology	***Application***
Objectivism	Knowledge is based on objects and events, that can be perceived and is not influenced by subjects, the perceiver. As

	the theme of study is about experience engineering, it is very unfitting to choose a philosophical approach which negates the existence and relevance of subjective influences.
Subjectivism	Reality is described as definition of social actors and their experience with a surrounding world. Negations of external structures and characteristics of objects lead to constant reinterpretations of knowledge and reality. However, experience engineering needs the acknowledgement of predetermined structures in engineering and thinking processes during DM as psychological and explainable structured behaviour.
Critical Realism	Critical Realism considers scientific knowledge, and knowledge in general, as independent from social interactions or any kind of constructive influences. It acknowledges the contextuality, which only refers to the truth about knowledge in context, but not that it might be constructed for this specific context. Therefore, simply the acceptance of knowledge as given in certain context and time bound is not sufficient for this study. The continuous reconstruction of knowledge is not appropriately addressed by this ontology.

Table 3.2: Reasoning Deselection of Ontologies

A philosophical approach which accepts the idea that knowledge is constructed and will always be reconstructed depending on already constructed knowledge, context of application of knowledge and subjectivity of individuals or groups of social actors explaining a view on reality is more suitable for this study. Constructivism appreciates construction of knowledge and accepts multiple truths of subjectivism and therefore positions itself in opposite to objectivism, which fits to the earlier introduced deselection of objectivism and clarifies the field of subjectivism in relation to knowledge creation (Mills et al., 2006). Constructivism is comparable to the introduced critical realism with the statement, that truth and knowledge are not representing reality independent of experience but differs as it denies that social actors only explain the existence of objects, but create their meaning and all knowledge around them (Matthews, 1998).

Constructivism is evaluated as valid philosophical approach for this study, even though it is a hard to define philosophical approach and has many different variations. Moreover, it tends to mix the dimensions of the view on reality and the view or acceptance of knowledge, as both interrelate constantly and depend on each other. More precisely, knowledge is constructed by social actors and their interactions with environments. Environments are consequently influenced by knowledge creation of those actors and in return influences them in further knowledge creation due to their interactions with environments, which is also including the researcher as a strong influencing factor in this study (Collins, 2018). Constructivism states, that knowledge and reality is constructed by social actors and in human minds, but at the same time still acknowledges that a real world exists, which makes it a suitable approach for the theme of this study. In the field of UCA-RE, the main goal is to construct a product experience for a user, which shapes the reality with which a user is interacting in a specific context. In other words, a decision maker is creating a world based on already constructed or self-constructed knowledge which experiencing users will have to accept as reality and will use for reconstructing the constructed knowledge depending on context and individual subjectivity. Individual humans consequently play a big role in the creation of knowledge and the view of the world in constructivism. As this study is aiming to understand the impact of individual thinking processes on DM for creating experiences for other individuals, constructivism is a suitable ontological stance.

3.2.2 Epistemology

Following the introduced ontological approach of Constructivism, suitable epistemologies must focus on knowledge which is based on experiences, feelings or thoughts. The epistemology reflects the criteria for what does and does not constitute knowledge (Hallebone & Priest, 2008).

The constructivist epistemology emphasizes that knowledge is constantly constructed by humans through social interaction and cognitive recognition. The essence of radical constructivism is acceptance of a world independent and beyond of the human mind, but the focus is on a “knowers” explanation and knowledge of a world as an individual construction (Von Glasersfeld, 1984).

This approach fits well with the ontological viewpoint of constructivism and can be represented using an example from business context in which this study is conducted. Knowledge that is used to decide in UCA-RE is constructed either by deciding stakeholders or by a professional / scientific community. This knowledge is also gathered and interpreted by experts and is constantly extended and reconstructed by every expert seeking for explanations of reality to make decisions.

As shown in the example, nature of reality might be independent of human minds, but needs interpretation to be understood, which is based on knowledge that is constructed by “knowers” using their experiences and individual thinking processes, including potential biases (Von Glasersfeld, 2013).

Creation of knowledge and understanding of reality is important for the theme of this study because thinking processes during DM in UCA-RE create inferences based on knowledge, which is strongly influenced by “knowers”. Consequently, methodology and methods are very qualitative and focus mainly on understanding the introduced subjective characteristics of this study (Dudovskiy, 2018).

3.2.3 Axiology

Axiology is part of a philosophical approach and represents values underpinning this study and its commitments. It is the part of the philosophical stance, which identifies how values impact the way of approaching the research objectives and reasoning behind answering the research questions (Saunders et al., 2009). The axiology of this study and underpinning value is to understand a common process. The common process is part of the topic and described as the DM process in UCA-RE. This is a managerial controlled process of specifying requirements and designing experiences, which is influenced by PO and UX designer roles as well as agile RE process steps. Influences on that DM process are phenomena that need understanding and explanations. This research is not aiming to change influences on DM processes but pursues an awareness for influences through clarification of the conceptual framework around the phenomena. With an extension and clarification of the conceptual framework

around the phenomena, this study results in constructed knowledge which benefits practice by achieving a more efficient use of time and resources for better business results. The conclusion will show if the explanations of the experienced phenomena are true for the specific knowledge domain and field of expertise of this study context.

3.3 Research Nature

According to Dudovskiy (2018), there are three types of research natures that apply to science, exploratory and descriptive as well as explanatory. Exploratory research is exploring phenomena and building a theory around **"What"** is happening. For creating that theory, already known and well-defined theories are gathered and applied to a focus area in which phenomena occur, or the researcher can build a very own theory from scratch. In both cases, the research goal is to explore without any deep understanding and description (Dudovskiy, 2018). A descriptive research is building on top of an exploratory research and taking results from exploration and adds additional information for describing not only what is happening, but also **"How"** something is happening (Dudovskiy, 2018). Explanatory, also known as causal research, is the highest order of research nature, and it builds on exploratory and descriptive research results. It intends to explain certain phenomena in detail and is focusing on **"Why"** phenomena are occurring by identifying reasons for influences on concepts. Explanatory research without results of exploratory and descriptive research is not possible as phenomena need to be explored and described as well as understood before they can be explained (Dudovskiy, 2018). This research is of explanatory nature for explaining specific observed phenomena based on already explored and described knowledge from literature, which got summarized in a conceptual framework for further research on interrelations to answer why they exist in the environment of UCA-RE. The awareness approach based on the understanding from those explanations is exploratory in its nature to answer the question how to become aware of the explained interrelations. The explanation of phenomena before exploring possibilities for awareness follows the research approach introduced in the next Section 3.4.

3.4 Research Approach

Research approach describes a process of finding explanations to observed phenomena by going through research steps from assumptions to methods of data collection, analysis and interpretations as well as incorporating theory. The concept of working with theory and data strongly influences the type of approach by going either from theory to data for testing or from data to theory for creating insight. Main types that can be distinguished are inductive or deductive approaches, which are mostly used in social science (Bell, 2019).

According to Collins (2010), the deductive approach follows more scientific principles to get from theory to data and with emphasizes on quantitative data. The researcher is separated from the actual research, which follows a very structural approach and needs to be generalisable by using samples of sufficient size. On the other hand, Collins (2010) also explains the inductive approach to focus more on the meaning of a certain context and how it is understood by people. Consequently, the approach must give an understanding of the research context and therefore emphasizes strongly on qualitative data. Because the understanding must be gathered throughout the research, a flexible approach is needed to allow for change of scope as the research continues, a structured approach as in the deductive approach would otherwise lead to a deadlock as soon as results from data do not build meaningful theory. As qualitative data needs to be interpreted for understanding, the researcher is part of the research process and focuses on giving an explanation and understanding of specific phenomena with no need to generalize. Summarized, the inductive approach aims to combine theory and data to create insights instead of testing them, as for the deductive approach the aim is testing of insights (Bell, 2019).

Both approaches, deductive as well as inductive, have reasons to be considered to get appropriate answers to research questions which address the exploratory and descriptive characteristic of this study. As this study considers to be of explanatory nature as described in Section 3.3, no sequential research from theory to data or data to theory is appropriate. Additionally, as constructivism

seeks knowledge creation through development of an explanation of phenomena by application of already constructed knowledge and observations, and knowledge is constructed and can be reconstructed, a sequential pure inductive or deductive approach for analysis is not appropriate. Following the research position of constructivism, phenomena must be explained using existing knowledge and observations by analysing theory and qualitative data. Results need to feed back into insights from literature for adaption of theory.

A third type is introduced, a retroductive approach is used for reiterating between testing and creating insights. Instead of following a sequential research approach, as known from deductive and inductive approaches, it is replaced by a complementing approach. Reduction positions itself as a combination of deduction and induction for explaining observed phenomena using theory, but also accepts an extension of existing literature and theory with observations and interpretations from a research (Poole et al., 2000). In other words, qualitative exploratory data can enrich theory with meaning, and vice versa, insights from literature review reveals basic concepts needed for descriptions after analysing, interpreting and understanding data. The growing understanding of phenomena is consequently realized by testing theory and at the same time gathering data for analysis and interpretation. This whole process according to Ragin and Amoroso (2010), shown in Figure 3.1, is recursive to ensure continues insight gathering throughout the research process.

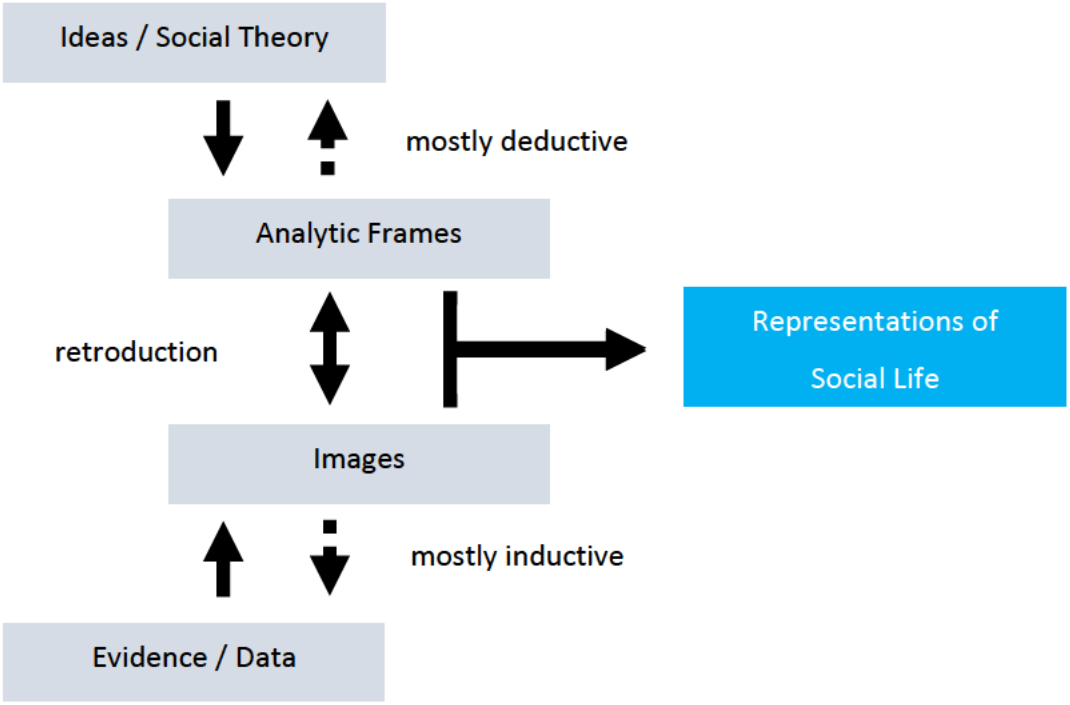

Figure 3.1: The Interpretive Model of Social Research (Ragin & Amoroso, 2010)

The base of the model is evidence or data, in the case of this study gathered from qualitative analysis. The top of the model shows ideas, which are in essence literature theories and concepts. Analytic frames are created deductively from theory to incorporate and represent ideas around phenomena with an intention for clarification of casual relationships, such as the introduced conceptual framework in Section 2.5. Ideas on the other hand emerge from evidence / data and get synthesised to inductively constructed images for interpretations as shown in the thematic analysis in Chapter 4. The retroduction happens right at the point when images from evidence are contextualized with analytic frames. Analytic frames deliver context explanations for images. At the same time images add to analytic frames with insights from evidence that extends them and consequently also related theory as presented in Section 4.5. This cycling retroductive approach is continued until explanations are found for phenomena, which will answer the research questions and fill the gaps.

3.5 Research Design

The research design works as a framework for data collection and analysis and ensures that the research questions get answered properly (Bell, 2019). This research is from explanatory research nature and therefore tries to find explanations by asking research questions which focus on finding answers to “Why” something is happening as discussed in Section 3.3. Phenomena under investigation are situated in the psychological knowledge domain and the research questions can be answered by understanding lived experiences and observations. Consequently, data describing and expressing those experiences and observations need to be collected and analysed, which is realized by collecting qualitative data such as spoken words. The research design has therefore to be a qualitative framework to incorporate data collection and analysis methods suitable for qualitative data. Another reason for using a qualitative and not quantitative design is the choice of the research approach discussed in Section 3.4. Because quantitative research design makes primarily use of numerical data to test theory, it is very suitable for deductive research approaches whereas inductive research approaches work better with qualitative research designs due to working from “soft” but rich data, which gets analysed, towards theories on explanations. Even though the approach of this study is chosen to be retroductive, the research questions must be answered by working from qualitative data towards theory, which supports the choice of a qualitative research design as framework for explaining phenomena following the research strategy explained in the next section. Furthermore, reduction is positioned closely to induction, which supports the research design choice and goes along with the research approach (Poole et al., 2000).

3.6 Research Strategy

As explained in the previous sections by research position, nature, approach and design, the goal of this study is to explain observable phenomena by fulfilling the objectives and achieving the aim using qualitative data and theory on psychology. A suitable research strategy is therefore phenomenological research, because it

originated in the psychological knowledge domain and relies on analysis of lived experiences (Moustakas, 1994). Consequently, the main sources of evidence / data are participants reporting on experiences and delivering qualitative data that can be analysed for creating new insights (Creswell & Poth, 2016). The most used and valued data collection method in phenomenological research is the interview (Dudovskiy, 2018). After data collection, as further described in Section 3.7, a thematic analysis of collected qualitative data is delivering results that can be interpreted and discussed for answering the research questions and achieving the research aim of this study by explaining observed phenomena.

3.7 Data Collection

The scope of research for this study is on lived experiences of participants in certain business situations. As phenomenology is considered to go along with qualitative methods, interviews were used in the main study as already proved appropriate in the pilot study. For addressing the objectives and research questions, “soft” data needs to be collected, which is non-numerical information that describes feelings, opinions and expectations as well as motivations or aspirations. As there is no intend and need for any numerical data and information, no quantitative research aspects were considered. Data got collected using semi-structured interviews.

This choice is based on requirements to gather inner experiences of interviewees for very specific outer world situations. A contextual structure makes sure the thematic focus on those situations of interest is not lost. However, as the semi-structured format of the interview leaves room for interpretation and thought evolvement, the freedom for expressing thoughts and experiences is kept. Overall, appreciated advantages of semi-structured interviews are flexibility to alter a conversation depending on emerging topics or extensive deep dives and even skipping questions if not necessary (Kvale & Brinkmann, 2009).

The pilot study interview guide (Appendix A) consisted of an introduction to a scenario and a clearly defined focus for answering a set of questions extended by probes if needed. This semi-structure was appropriate for a pilot study to

gather insights on potential phenomena in a specific project setting. However, as the pilot study report (Appendix B) shows, the phenomena are not bounded to a specific situational context, which is why the semi-structure for this main study interviews changed.

The guide for the semi-structured interviews of this study is attached in Appendix E. It consists of a core group of questions, which structures the interviews in focus areas. Three of the focus areas target directly insights gathering for answering the research questions and filling the gaps identified in the conceptual framework with information which could not be drawn from the literature review. Therefore, the focus areas match the thematic structure of the literature review covering UCA-RE with its processes, roles and responsibilities as well as DM including intuition and heuristics. The thematic structure of the interview guide is shown in Table 3.3.

Focus	***Targeted Research Question / Area of Interest***
Processes & Roles	The environmental influences of a project on DM are important to understand for answering RQ-1 concerning impacts of processes and roles on human thinking and heuristics. This focus area helps to gain insights on the understanding and rating of agile or design processes by participants, which helps to identify the need of explanations for improving awareness of its influential potential, which is covered by interview questions 2a and 2b. As various roles are involved in DM during processes for specifying and designing a product, it is important to be able to differentiate needed responsibilities and skills. The insights from the interview questions 2c and 2d are intended to show participants understanding and acknowledgement of different roles and their relationships or purposes in DM processes. Interview question 2e serves as a first check of influences of processes and roles on participants and concludes this focus area to give

	a good indication on the need for enhanced awareness approaches.
Intuition and Heuristics	This focus area covers the impact of heuristics on DM in UCA-RE and addresses RQ-2. Heuristics are usually not recognized by decision makers as human thinking processes are efficiently incorporating or constructing information that is needed but not available and resulting in intuition. Both thinking processes have impacts on potential pitfalls in DM and therefore are important to be analysed and understood. To trigger a "reflection mode" of participants, an altered version of the CRT is included, which enforces dual thinking processes and an emotional state which is needed to answer follow up questions regarding comparable situations in UCA-RE environments. The CRT is altered in its objects and prices in case participants know the original CRT. A dedicated time constraint of five seconds is added to understand influences of time, which is comparable to project environments. The intention is extended from the original CRT interest in the score of correct and wrong answers to gathering insights on the emotional state. Therefore, a clarification is added to inform participants to keep their feelings in mind during responding to the altered CRT. This focus area aims to gain insights on actual heuristic or intuitive DM, including related feelings and reflections on relatable situations in business context, which is covered with questions 3a, 3b and 3c. Additionally, with interview questions 3d and 3e, importance of sufficient information is discussed to elaborate on its influence on DM.
Awareness of Influences	The level of awareness and recognition of influences of processes and roles as well as thinking processes on DM in UCA-RE is checked in this focus area to answer RQ-3. This focus area is very reflective and therefore openly

	asks participants to share their experiences of project situations with interview question 4a. Interview Question 4b asks for an opinion on the need for understanding potential influences and feasibility of developing an awareness approach.

Table 3.3: Interview Focus Areas

Even though the interview guide follows a purposeful structure for keeping focus on answering the research questions, the semi-structure gives the already mentioned flexibility of following up on evolving sub-topics. Therefore, mainly open-ended questions were used to give freedom of in-depth explanations and follow the guidelines from Kvale and Brinkmann (2009). According to the guidelines, it is expected that semi-structured qualitative interviews include different kind of questions that are used as flexible guideline. Such types of questions involve introductive, follow-up, probing and interpreting questions which help to get into deeper explanations or support the interviewees to extend on their thoughts as well as clarify initial open-ended questions.

The executions of the interviews themselves were partially digital using the online meeting tool WebEx, including audio and video, and partially in person in business locations using closed and isolated meeting rooms. Both ways of executing the interviews were supported by a presentation showing individual interview questions as focus support and for re-reading. The interviews got audio recorded either directly using the WebEx tool or using a digital recorder during personal interviews.

The chosen method of semi-structured interviews has limitations concerning reliability of gathered data and information because of the sample size and process of selecting it. This holds true for most qualitative methods as the focus is on a deep understanding of subjective insights, which can only be realized through dedicated selection of research subjects. Also, qualitative research methods focus lacks quantity due to the greater effort involved to carry them out, which makes it difficult to define an adequate extent. However, due to the structure of the core questions and at the same time freedom in answering, semi-structured interviews enable extensive comprehension of themes related to phenomena with relatively small sample size (Bell et al., 2018).

The number of semi-structured interviews was not limited or predefined, the major criteria was the coverage of various experience levels, equal number for both roles and expertise domains and, most importantly, until a certain threshold of new insight gathering got reached. In the end, 10 interviews with an approximate length of 60 minutes were conducted for reaching an adequate amount of overall more than 600 minutes of qualitative data to be analysed. After 7 interviews, data started repeating, which is an indication for data saturation, but of limited use to create new insight. To make sure high-quality insight is gathered to answer the research questions appropriately, the sampling is a critical and impactful process which must be carefully planned and caried out as described in the next section.

3.8 Sampling Procedure

The sampling process is divided into two different steps using different methods as shown in Figure 3.2.

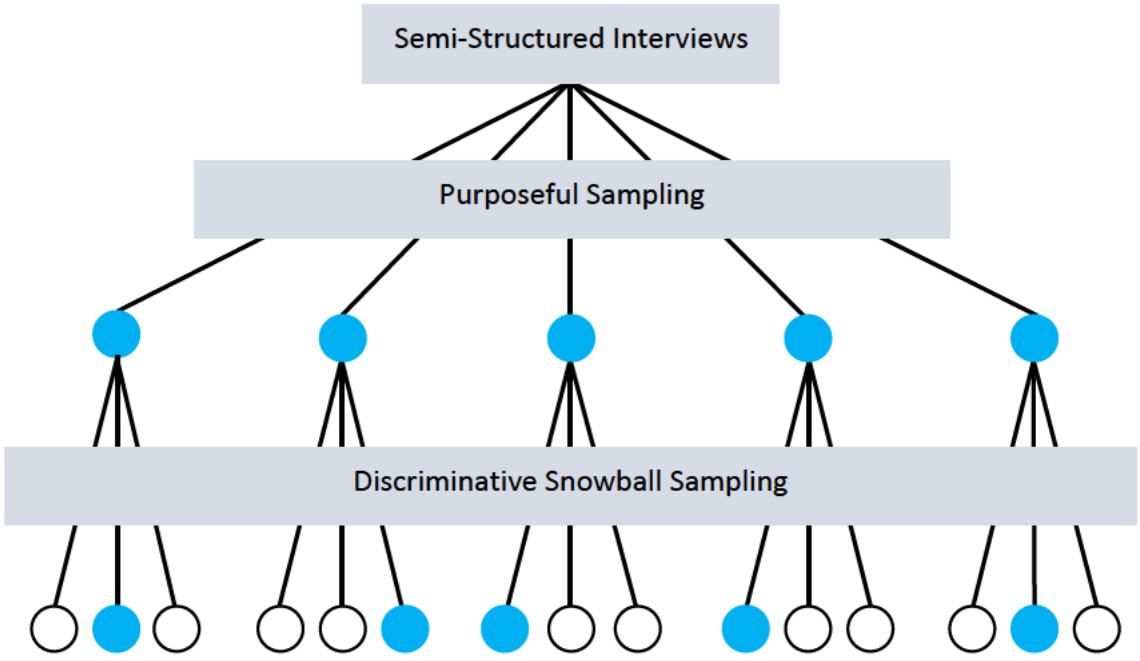

Figure 3.2: Sampling Procedure

First step starts with a non-probabilistic purposeful sampling method to target a wide range of participants for the initial five interviews (Ritchie et al., 2013). Based on the focus areas and questions of the semi-structured interview as well as the overall research context, a first indication of the type of participants is already

given (Bell et al., 2018). The first five participants are purposeful selected based on the first indication and an assessment (Black, 2019). The assessment and selection covered different roles, responsibilities, skills and expertise as well as overall business experience to evaluate who is best suitable for providing the necessary insights (Tongco, 2007).

After the initial purposeful sampling of participants, each interviewee is asked after the interview to think of three more potential participant that they think could contribute to this study (Bernard, 2017). From the gathered extended pool of potential participants, another five participants are purposeful selected using the same criteria as for the initial purposeful sampling. This exponential discriminative snowball sampling method helps to identify further potential participants of similar characteristics as the interviewee who is giving the recommendation, because usually business contacts stay in the same field of expertise and similar experience levels as shown by the recommendation results. The discriminative selection is based on selecting appropriate participant recommendation depending on the needed characteristics to ensure a broad knowledge coverage and skill variations among the selection of interviewees, but at the same time to proof that gathered insights stay true for more than one interviewee per role and level of experience. Consequently, an exponential discriminative snowball sampling is useful for an extended purposeful sampling based on recommendations from the first choice of participants (Given, 2008).

The domain of expertise focuses mainly on POs and UX designers or consultants because of the introduced research context and scope of the literature review. Some of the participants had a very dedicated domain of expertise, some were active in-between both roles and some had cross domain experiences. Furthermore, the research questions indicate the choice of expertise of participants already by questioning the understanding of those roles and experiences from their perspectives. Next to the specific role definitions and criteria for the purposeful participant selections, some more assessment criteria are defined and applied to ensure the most suitable and insightful research results (Bell et al., 2018).

Assessment criteria for purposeful selected participants:

1. No restrictions on gender, age, religion, origin.
2. At least 5 years of experience as PO / UX designer or dedicated academic degree in either one of the fields of expertise to ensure credibility of answers related to reflection tasks concerning processes and roles.
3. Experience in DM process concerning UCA-RE.
4. POs need to have at least one own product to be responsible for to have the experience in deciding on requirements and following agile processes.
5. UX designers or consultants need to have experience in user research to make sure information gathering processes for user-centred DM is understood.

The following Table 3.4 serves as overview of the participants (Part.) including main characteristics covering role (Role), expertise (Focus), business experience (B.E.) and type of sampling (Sampling). Following up on the overview, brief descriptions of the participants are presented which were gathered in the introduction phase of the individual interviews and mainly focus on the daily work of the participants, explained by themselves in two to three sentences.

Part.	***Role***	***Focus***	***B.E.(y)***	***Sampling***
01	Senior UX Designer	UX	5 - 10	Purpose
02	Managing Experience Consultant	UX / PO	5 - 10	Purpose
03	Director UX Design & DT Lead	UX	15 - 20	Purpose
04	UX Engineering Expert	UX / PO	20 - 25	Purpose
05	Senior PO	PO	5 - 10	Purpose
06	Senior PO	PO	5 - 10	Snowball
07	Associate Director Experience Design	UX	10 - 15	Snowball
08	Senior Scrum Master	SM	5 - 10	Snowball
09	Senior UX Designer	UX	5 - 10	Snowball
10	Associate Director Experience Design	UX / PO	10 - 15	Snowball

Table 3.4: Overview of Participants (Interviews)

Participant-01 (P01): Working as an UX designer and uncovering user needs for a product and aligning them with business needs, combining them into a deliverable product.

Participant-02 (P02): An experience consultant helping clients in developing digital products mainly as an UX designer creating and designing information concepts and later switching to a business-related PO role, controlling and leading a product development team.

Participant-03 (P03): A DT lead trying to find simple answers to complicated questions or challenges involving aspects of design, meaning how we perceive things visually, but also how we understand subject matter and talk about it. In essence, helping people to understand complex things better.

Participant-04 (P04): Switched roles from UX designer, translating what the client wants and what the actual end users need, to a PO. Shifting in responsibilities by doing less experience design, more requirements gathering and evaluating , including project management with not only the user in mind, but also the project requirements.

Participant-05 (P05): Acts as interface between customer and development team concerning planning, coordinating, discussing and analysing requirements, which a customer asks for or which come up in the development team.

Participant-06 (P06): Structures information and interacts with stakeholders to understand what the actual problem of a customer is, to come up with solutions which are mostly somehow technology related. In essence, help structuring challenges that customers are facing to come up with good iterative solutions.

Participant-07 (P07): A mix of aligning with project stakeholders, developers, other designers, but also crafting designs and refining concepts, so conceptual work as well as actual visual design work. Additionally, discussing staffing requests and driving joint efforts to establish common design principles and approaches.

Participant-08 (P08): Working with teams to make sure that they can perform the optimum of their capabilities, which means removing barriers on progressing

through processes and helping them along the way if needed, to achieve the project goals.

Participant-09 (P09): Working on innovation topics, especially designing and facilitating workshops or innovation trainings for introducing a method (DT) to internal colleagues or customers, including coaching on how to go through the introduced process. Basically, covering several phases from a discussion on goals or outcomes and based on that starting the process of designing including its organisation and facilitation.

Participant-10 (P10): Activities are split in three parts. First part is leading a team, planning daily and weekly meetings, taking care about staffing and that team members have work as well as reviewing this work. Second part is conceptual work, gathering all requirements, doing workshops, seeing what users need, doing iterative concept creation from first draft to final design. Third part is stakeholder management, mainly communication with POs, developers, testers, project management.

The chosen sample covers a wide range of experiences and focuses specifically on participants with appropriate expertise for this study. As mentioned in the last section, data saturation started after 7 interviews and after 10 interviews, 650 minutes of qualitative in depth interview data were gathered. According to Guest et al. (2006), this amount of interviews falls in the span of data saturation of qualitative research via interviews. According to the studies on how many interviews are enough, 80% saturation starts after 6 interviews and after 12 interviews, 92 % of codes were discovered (Guest et al., 2006).

3.9 Data Analysis

3.9.1 Transformation of Data

After purposeful selecting participants and collecting qualitative data, the audio recordings of the digital or in person interviews needed to be transcribed, which is already the first and very important step of familiarisation for later data analysis. The interviews are transcribed using different styles, which is basically a

granularity level of transcription related to including or omitting utterances such as:

- Stutters, filler speech, repeated words
- Speaker idiosyncrasies and interjections
- Non-speaking sounds such as throat clearing
- Falls starts, redirects, run-on sentences

Two styles were determined to be used during transcriptions for different participations depending on the character and quality of speech during the interview, structure of conversation and number of emotional expressions. Styles, their characteristics and usage as well as the determination reason are explained in Table 3.5 (Oliver et al., 2005).

Style	***Characteristics and Usage***	***Part.***
Naturalized	This style of transcription includes all utterances of a speaker and reflects the exact spoken words. It is mainly used to get a good idea of the thinking process during the interview and emotional expressions. Participants with a clear pronunciation and clear structure of conversation got selected for this kind of transcriptions to capture **how** something is said.	P02 P03 P04 P06 P07 P08 P10
Denaturalized	Denaturalized focuses mainly on **what** is said instead of how. Other than the naturalized style, transcriptions are cleaned from utterances or emotional expressions. Cleaning means omitting or adjusting utterances to make it easier to read. Participants with a hard to follow pronunciation or unstructured thought verbalizations got selected for this kind of transcription to uncover their thoughts without distractions through emotional expressions or confusing repetitions.	P01 P05 P09

Table 3.5: Transcription Styles

As the interviews need to serve the purpose of giving insights into experiences of the participants next to the actual expertise, most interviews were transcribed using naturalized style. The reason is the possibility to interpret utterances and taking notes on thinking as well as emotional glues during answering the interview questions, especially regarding the awareness of heuristics and expressing emotional states. In most cases, how something is said is at least as important as what is said. Only in some cases, where quality of speech or answering structure of the interviewees distract to much from the actual content, minor adjustments were made. Adjustments in this case is not changing any word or grammar during transcribing, it is leaving out utterances for less distraction during re-reading and understanding if they do not serve a specific purpose.

As mentioned, this transcription of recorded interviews into written form is already the first step of the thematic analysis and gives a very first impression on the extent and quality of data. However, as transcriptions are lengthy and get usually interrupted by replays of recordings for assuring understanding, adjustments depending on the transcription style or simply brakes to recover, the first familiarisation is only very abstract. The written transcripts (Appendix F) were imported into NVivo (version 20), an analysing software supporting coding and theming of qualitative data. After importing, the transcripts were re-read to get more familiarized with the gathered data. Additionally, annotations were used to document special behaviour or emotional glues as well as researcher thoughts during interviews. With the start of making notes, an initial coding based on the contents of the transcripts was created already during re-reading.

After the import of the transcripts, re-reading, creation of annotations for initial codes, the coding got extended based on the conceptual framework from the literature review and the related research questions reflected in the interview structure. With those predefined codes, the whole data set got separated into small sequences (Bell et al., 2018) to break down the interview data into pieces of information that can be summarized in initial coding categories (Simons et al., 2008), which build initial themes and work already into the second step of the thematic analysis explained in the next section. However, both steps of transcribing and coding must be done for every interview iteratively, which is why

they are part of the data transformation before the actual analysis. The final coding structure and initial themes are covered in the findings in Chapter 4.

3.9.2 Thematic Analysis of Data

The classification and attributes for the pilot study were very basic and separated in roles of the interviewees and their experiences, main skills and areas of interest. For the pilot study, no advanced analytics was not done, only a basic content analysis using the codes for grouping and comparing as well as some memos and annotations for clarifications and interpretations of interview situations or unspoken hints of uncertainty or frustration. This content analysis was sufficient to get provisional findings and identify potential for improvement for the main study in terms of focus areas and necessary skill sets that might be suitable to deliver insights needed for addressing the research questions, fulfilling the objectives and reaching the aim. However, the content analysis that was leading to the pilot study results described in the report (Appendix B) is not sufficient for this main study due to its missing thematic focus to precisely answer RQs aiming to complete a conceptual framework.

In this main study, the analysis needs to follow a thematic structure to generate insides for completing the conceptual framework of the literature review. In return, the conceptual framework highlights and covers already various domains for insight gathering. The relations of the domains in the conceptual framework represent themes which include gaps that need to be closed. To connect the knowledge domains and fill the gaps, the research itself must focus on the incorporated thematic framework inside the conceptual framework using the qualitative methods explained earlier in this chapter. Consequently, a thematic analysis instead of a content analysis will be used to make sure the focus stays within the already established thematic framework for contextualising the research results within the reviewed literature. Nonetheless, the themes that are evolving during the thematic analysis can of course be extended by the research results to make sure no important insights are ignored. The focus however is to follow the thematic structure, which is already incorporated into content and structure of the semi-structured interview.

This research follows the structure of the reflexive thematic analysis, which got introduced by Braun and Clarke (2006) who are doing research at the University of Auckland in the domain of psychology. The reflexive thematic analysis is explained on the university website (Virginia et al., 2020) as well as in various courses, which are also hosted on the university website (Braun & Clarke, 2017 - 2018). The analysis structure for this study is based on the same approach because the phenomena, which need to be investigated, reside in the knowledge domain of psychology, more specific in DM psychology. Due to popularity of this analysis approach as variant from the classic thematic analysis and acknowledged usage in the field of psychological research, it is the choice for this study.

The reflexive thematic analysis consists of a six-step process starting with working with data, coding, theming and of course analysing. Even though the process itself is meant to be followed sequentially because every step builds on the previous one, jumping between steps might be necessary to refine and workover results from the individual steps for comprehensive completion of the analysis. Therefore, the whole analysis should be seen as a recursive approach between the main steps of working with data, coding, theming and analysing. This study follows the intended structure of the approach including the steps shown in Table 3.6.

Analysis Steps	***Description***
Familiarisation with Data	First step is mainly part of transformation of data which got collected following the approach explained in Section 3.9.1. Becoming familiar with the content of data is achieved through transcribing and reading of the transcriptions as well as initial coding via annotations.
Coding	Important and interesting features of data must be labelled to be able to collate data increments and summarizing them using a descriptive coding structure. The content of data itself will introduce potential coding structures. However, the focus of the research questions predefines the coding structure to gather data suitable for answering

	them. The whole dataset must be coded, which partially happens already during transforming data as described in Section 3.9.1, including coding categorization for initial theming.
Generating Initial Themes	The first approach to theming in the analysis includes examination of the coded and collated data. The goal is to find initial broader patterns of meaning that summarize codes into potential themes for further analysis. Collating all data belonging to theme candidates delivers a first idea of the theming structure that needs to be reviewed including key results and initial expectations as described in Section 4.2.
Reviewing Themes	The review of the candidate themes through rechecking underpinning data and sensemaking of their summary. Furthermore, the themes and their broader meaning are checked to address the research questions. During the review, themes may get refined by splitting, combining or discarding candidate themes. Additionally, emerging themes must be considered for further interpretation and answering of the research questions. Finally, the reviewed themes must deliver an overarching theme framework of shared meaning among data and its codes as explained in Section 4.3.
Defining and Naming Themes	Identified and reviewed themes must be analysed in detail to gain a deep understanding of scope and focus of each individual one. This elaborated story of each theme must be represented by an adequate informative name which can be used for the final step of the analysis, writing up including interpretation and conceptualising within the reviewed literature.
Writing Up	The final step of the analysis is bringing together all identified data extracts, which got summarized by codes

	and interpreted using overarching themes. The result of this analysis needs to be based on and positioned in existing literature by extending the conceptual framework for sensemaking and insight creation as shown in Section 4.5.

Table 3.6: Steps in Reflexive Thematic Analysis

3.10 Limitations of Methodology

The research nature of this study limits the methodology in its focus to link different concepts for understanding of cause-and-effect relationships. In other words, the explanatory research analyses specific phenomena and explains the relationships between involved concepts as described in Section 3.3. However, to gather explanatory insights, it is needed to build upon exploratory and descriptive research, which support the identification and understanding of the investigated cause-and-effect relationships. Consequently, further insights on existing knowledge on the “What” and “How” related to the relationship of identified concepts might be covered in the results of data analysis, but the main focus is on the “Why” certain phenomena exist in already explored and described relationships between the concepts that are covered in the literature. The research nature limits the research consequently in using already explored and described concepts from the literature to explain their relationships, but at the same time enables in-depth analysis of reasons why those relationships exist via qualitative data on experiences from experts in the field of research and the context of this study.

Another limitation of the proposed research methodology is the reliability of gathered data and information because of the sample size and process of selecting it. The sampling is done purposeful, which is limiting the participant diversity by the researcher’s professional relationships and reach. Even though the sampling is extended by a snowball approach, it is again limited by the professional relationships of the interviewees and their reach. Moreover, due to the data collection method of in-depth semi-structured interviews, sampling size

is limited because of the intense effort of analysing gathered data. This extensive analysis is however needed to support the trustworthiness of this study.

In depth interviews incorporate by definition a high degree of subjectivity because the aim is to gather insights on lived experiences. Analysis of gathered data is prone to biases due to interpretation of data by the researcher. Furthermore, interferences by the researcher during the interview can lead to validity concerns but are not possible to avoid during a conversational semi-structured interview research method. Moreover, the construction of the interview questions for gathering qualitative data on thoughts and emotions can incorporate unintentional biases of the researcher and might be leading in wording or how they are read to the participant. As constructivist, the researcher acknowledges each participant's subjective view of reality as individual construct, which is influenced by a social environment and interpretated by the researcher to construct or reconstruct knowledge. The researcher is part of the environment that influences the participant, unintentional influences on the constructions that are used has therefore to be accepted.

Sampling diversity and size are reasonable argued in the previous sections to be sufficient for the purpose of this study. It is also accepted, that the research is not generalizable and may be prone to subjective interpretation but intends to be based on broadly acknowledged empirical evidence from the literature.

In conclusion, qualitative research relies on thought evolvement and interpretation of non-numerical information and is limited by time and resources due to the intense effort of the analysis. The awareness of the limitations of the method is important but at the same time accepted to gather appropriate insights for extensive analysis. The priority of research for this study is on subjective experience instead of quantitative numerical information. Due to mentioned limitations and that this research method itself is prone to philosophical criticism related to its nature of subjectivism, the validity is always subject to critical discussions (Gomm, 2009).

3.11 Ethics

Because qualitative research on real world experiences is conducted with humans, ethics need to be considered very carefully and, moreover, are legally required. Taking care of emotional states during gathering personalized information is very important to not harm individuals that get interviewed, which is a basic principle of ethical behaviour (Israel & Hay, 2007).

Consequently, the setup during research must be prepared accordingly, including location and process. Furthermore, as research is an academic and professional process to be undertaken, it is important to clearly state during research or before, that there is no direct personal judging involved and no direct testing other than for information purpose and gathering qualitative insights.

In addition, as research participants will be selected following a specific skill set, it needs to be clearly stated which rule of choice is applied and why certain participants are chosen for eliminating any concerns about discrimination. Therefore, the discriminative selection of participants from the choice following the snowball recommendation method must be clearly explained.

Following the selection of participants and conducting the actual interview, collecting and documenting the gathered personal information, including analysis results, need to be highly confidential and anonymized. However, it needs to be transparent to the individual interviewees, as curiosity might be a reason for uncomfortable feelings during the interview. Open note taking, explaining every process step during or before the interview will help to keep curiosity low and help to convey that no judgement or discrimination of any kind occurs.

Summarizing and obeying all mentioned ethical considerations for qualitative research, the conducted semi-structured interviews still need formal ethical approval and have to be aligned with general regularities and recommendations (Allmark et al., 2009) and the Napier University's "Code of Practice on Research Integrity" (Edinburgh Napier University, 2018). An introduction to the topic and content of the research, as well as the agreement of the participants to take part in the research, was collected upfront using the participant information (Appendix C) and the research consent (Appendix D).

Furthermore, during analysis of interview data, it is very important to have ethical considerations in mind when interpreting certain information. Even though the researcher views himself as incremental subjective part of the analysis, the goal is to eliminate unethical subjective reasoning related to the participants or actual content of the material. Moreover, uncertainty in understanding needs to be addressed and solved or left out of any analysis. If ethical problems are discovered, they must be treated accordingly and communicated if necessary.

3.12 Chapter Conclusion

This chapter covered the philosophical stance in constructivism and with that perspective explained, the underlying research methodology of this study. With the philosophical underpinning in mind and following the ontological, epistemological and axiological views, using subjective data gathering methods and reasoning are described to be an appropriate approach to answer the research questions. Moreover, as this study itself needs to elaborate on subjective data and reasoning, using qualitative methods and understanding knowledge and reality to be subjective is crucial for addressing the aim and objectives. Placing this study in the subjective field of research is consequently a correct approach. Constructivism serves an appropriate focus on subjectively constructing knowledge and at the same time acknowledging already existing knowledge. The explained epistemological viewpoint of radical constructivism acknowledges an understanding of psychological DM processes including heuristics based on knowledge. Understanding the impact and results of this DM in a specific field of expertise strives to find explanations for phenomena using and at the same time building on top of existing knowledge, which is why this study follows a retroductive research approach and a phenomenological research design. Even though subjective research is hardly generalizable, in-depth semi-structured interviews and their interpretation based on substantive literature serve the purpose of this study to construct new knowledge as explanations of a phenomena, which is in line with the philosophy and does not claim generalizability but more usage in the corresponding relations to recursively serve as base for creating and restructuring knowledge and reality. Because

subjective data needs to be collected from humans for explanations of phenomena, ethical principles and guidelines must be carefully considered and followed, focusing especially on the participants wellbeing as individual person supporting this study. The insights gathered from the chosen qualitative method is appropriate for extending the conceptual framework with subjective reasoning based on themes identified in qualitative data using the approach of recursive thematic analysis, which result in findings presented in the next chapter.

Chapter 4: Findings and Analysis

4.1 Introduction

This chapter presents some expectations and initial thoughts on familiarisation during transformation of data in Section 4.2 before explaining and reviewing the initial coding and theme creation (Section 4.3). After reviewing the themes in Section 4.4, the next step is to analyse the themes including contextualisation and interpretation (Section 4.5). In summary, focus of this chapter is to present the thematic framework and analyse the themes for extending the conceptual framework and answering the first two research questions.

4.2 Expectations & Initial Thoughts

This section introduces some expectations on the research after the literature review and based on the empirical knowledge of the researcher. They are not based on empirical data and do not serve as theoretical justification. Familiarization, as the first step of the thematic analysis, gives some initial thoughts on gathered data and their interpretations, which might be biased due to involvement of the researcher in the research context. Therefore, those initial thoughts need to be clarified and transparently expressed as they might influence the analysis.

4.2.1 Expectations

Processes are clearly defined in their structure and therefore adoption in projects should be straight forward for a more value driven outcome as described in Section 2.3.1. However, based on knowledge gained through professional experience, agile processes are unfortunately introduced as solution for a lot of unstructured projects which lack the ability to come up with requirements for a product that a user really needs. Moreover, user-centred is often misunderstood as requirements that are meant to meet user needs depending on a POs understanding. However, it is a process of RE involving actual users and

performing user research. Instead, user-centred is often only used as labelling indicating an intention to try thinking of users or simply for marketing purpose.

Roles, responsibilities and broad skill portfolio for POs and extended skill sets of UX designer roles should be clearly defined and known to all project stakeholders due to recent popularity of UCD and ASD, as described in Section 2.3.2. By the researchers' experience, roles are more often defined by companies and their expectations on skill sets of employees than by processes in which those roles are lived, the common understanding differs therefore a lot among project stakeholders.

DM is aiming for a best outcome for a project and, when user-centred, for users. DM processes during RE is consequently highest priority and involves extensive information for rational DM, as explained in Section 2.4. However, according to the researchers' experience, agile project environments stress timely DM and consequently do not appreciate slow thinking and only provides insufficient information, which is a suitable foundation for intuitive or heuristic DM and potential biases.

4.2.2 Initial Thoughts and Interpretation during Familiarisation

The processes which are known and used by participants match covered processes from the literature review, even though it was not included in the assessment criteria during purposeful sampling nor mentioned in any upfront participant information. The match indicates that covered processes are represented in the field of expertise and widely known by POs and UX designers. However, the structures of the processes or frameworks, as proposed by literature, are only known on a broad level due to specific adjustments in the projects of the participants. DT is mentioned in 10/10 interviews as UCD framework, Scrum as agile methodology in 3/5 interviews where ASD was mentioned, 2/5 described a Scrum like process using certain parts of the methodology.

Even though the question asked about roles should be clear for experts in the field of expertise, a noticeable struggle revealed that it is not easy to explain the own as well as the intended or accepted project roles in UCA-RE, as reaction of

Participant-05 shows: “That's tough, but I think we are getting it.” Roles of POs and UX designers are fairly known and do not always match descriptions from literature, which is not a surprise due to redefinitions by each company with each new project matching more needed responsibilities than actual intended responsibilities by processes, which shows that participants are struggling with self-recognition regarding expectations and consequently get interpreted by practitioners themselves.

A lot of thinking pauses during the second interview part about DM due to self-questioning of the interviewees show reflection efforts on known and perceived situations which must be regularly dealt with. It seems, during those situations, less deep reflection might be included due to missing time and high project environment pressure. Reactions to pointing out and elaborating on difficult situations in daily business live triggered consent and amusement, but at the same time a willingness to reflect more on causes of “difficult DM” situations.

> *“This is something I would like to hear more about it because I wasn't able to reflect, so how the decision or how the information or how my role is impacting my decision making.” (Participant-02)*

During covering the topic on impacts of heuristics and intuition on DM, answers started becoming very self-reflective and explanatory whereas the questions about roles and responsibilities got answered in a very descriptive way. A plausible reason is that the whole interview and specific questions trigger a kind of awareness process which seem to be needed to understand the full extent and impact of own DM as well as DM of others. Not many opposing arguments or discussions came up during the interview, the topics got supported by each interviewee and even extended to other fields of expertise.

> *“I sincerely think that these types of questions that you've been asking me throughout this interview are actually great questions for mentor-mentee relationships within the company.” (Participant-08)*

4.3 Initial Coding and Theme Creation

Step two of the thematic analysis covers the coding of gathered data, the interview transcripts. Transcripts of individual interviews were loaded to NVivo, a qualitative analysis tool mentioned in Section 3.9. Once transformed data was available in NVivo, all transcripts were re-read, and a direct descriptive coding was done to collate pieces of gathered data into related text segments. Simple labelling that describes the content was used to identify text segments needed for understanding gathered data and at the same time used to elaborate on themes. The whole process was iterative and is visualized as summary in Figure 4.1.

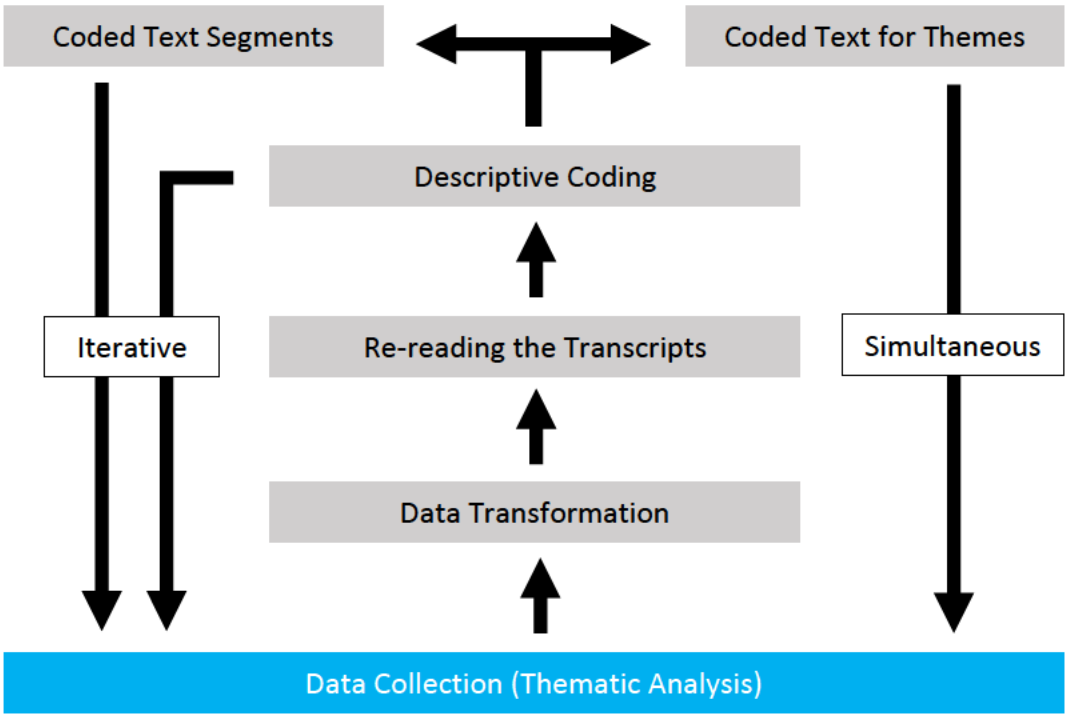

Figure 4.1: Coding and Theming Procedure

Descriptive coding resulted in a **list of 82 initial codes**, which included duplicated labels or codes with single references to data. Single references represented early descriptive codes, which resulted from descriptive labelling of the first 2-3 interview transcripts. After that, the initial list of codes from those 2-3 interviews got further extended, but codes started to differentiate depending on their representative strength in data. The aim of this iterative coding of all transcripts

was to organize all data into units for analysis. The final list of codes (Appendix G) supported finding text segments easier in all gathered data.

However, the list was unorganized and messy, which is why all initial coding was saved in a separate folder in NVivo as backup and codes were grouped related to their descriptive topics, which were determined by the overarching meaning certain codes have in common. After a first round of grouping based on the topic, leftover codes were collated into existing or new groups based on their meaning, which involved already re-reading text segments. The outcome represented a categorization of codes and was easier to grasp. The next step was cleaning the list of codes, which included merging codes that have duplicate labels or a similar meaning. The aim was to merge especially single reference codes into stronger codes and get a better overview of sub-topics inside the groups. The outcome of the cleaning and grouping was a reduced list of **32 codes**, due to merging, representing the same number of **378 references** in **11 categories.** Appendix H shows categories including codes in detail, Table 4.1 introduces the categories for the understanding of the grouping approach.

Code Categories	Awareness	Consultancy
Roles	CRT	Responsibilities
Project Environment	DM	Intuition
Team	Processes	User Research

Table 4.1: Code Categories

For the first and second step of the thematic analysis, fracturing of data was the goal for examining individual separated units of data as input for analysis and extension of the conceptual framework (Priest et al., 2002). In the third step, codes and categorizations got related to the topic of this study for further cleaning. The result of this cleaning step was an evaluation of codes depending on their relevance for the research on the topic of this study.

"Thematic analyses move beyond counting explicit words or phrases and focus on identifying and describing both implicit and explicit ideas within the data, that is, themes" (Guest et al., 2011, p. 138).

The goal was additional merging of codes into initial themes with relevance for this study, but also already deleting some codes which may not contribute. To make sure a full set of cleaned and categorized codes were still available, they were saved to a second backup folder in NVivo. The purpose of those initial themes is to reflect topics of data and at the same time give already an idea of what is studied. Therefore, codes were renamed to convey their meaning and categories were merged for self-explanatory representation of initial themes. As shown in Table 4.2, the outcome is a reduction to **7 categories** for codes which got renamed to become **30 initial themes** and reflect **376 references**.

Categories	***Initial Themes***
Awareness	need for awareness | risk awareness | how to become aware | knowledge awareness
CRT	CRT answer | CRT feeling | CRT situation in business
DM	reason for DM on insufficient info | reason for intuitive DM | need for DM on insufficient info | approach avoid or validate DM
Processes	understanding of processes | reasons to not follow processes | impact of processes on DM | no user research (necessary) | reason to follow processes | other processes | using user research (benefit)
Roles	understanding of roles | relationship PO – UX | responsibility designer | responsibility PO | impact of roles on DM | responsibility experience consultant | responsibility consultant | problem with PO role
Project Env.	time and budget constraints
Team	approach to DM as team | knowledge sharing in team | no knowledge sharing in team

Table 4.2: Initial Themes in Categories

Theme categories reflected the conceptual framework, which was a good indicator for representing the underlying thematic framework and seemed

promising to answer the research questions. Because the research questions are a foundation for the interview questions in first place, the circle starts closing at this point. As explained by King et al. (2018), even though the interview questions and gathered data are based on the research questions, the focus of the coding step during analysis is on indexing and labelling all text as relevant to the research questions. Because themes are more meaningful in relation to the research, reporting of results is done on identified explanatory themes. However, because themes aim to answer the research questions, another step of reviewing is necessary to elaborate on the relevance of references concerning answering the research questions, which is explained in the next section.

4.4 Reviewing Themes

The fourth step of the thematic analysis is the review of initial themes with the research questions of this study in mind. The difference to the initial theme creation is the dedicated relevance to answering the research questions instead of relevance for the overall topic of this study. To keep the initial themes including their categories, they were copied again into a third backup folder in NVivo.

For the review of the themes, the representation of the thematic framework incorporated in the conceptual framework set the boundaries of relevant topics. Furthermore, identified gaps in the causal relationships are the focus of the review to concentrate on data which can answer the research questions. With the research questions in mind, the categories of the initial themes were merged according to their explanatory meaning.

After the review to identify the exact themes which are used during analysis and interpretation, the fifth step of renaming and defining the final themes follows. Categories got renamed into **6 final themes** indicating their relevance for answering all three research questions. To structure the detailed explanations of the overarching themes, underpinning initial themes became **22 sub-themes**, merged and renamed as well to reflect their explanatory relevance to the research questions. Due to the strong focus of the review on the research questions, some

initial themes got deleted. However, with **373 references** remaining, available data remains high for answering the research questions.

During defining and renaming the final themes and their subthemes, two sub-themes were identified with specific explanatory strength for the causal relationships and consequently high importance for answering the research questions. Those two themes were separated from the other themes and represent emerging themes in the thematic framework which resulted in **8 final themes** with **20 sub-themes** representing the **same number of references.** The thematic structure representing the gathered data for further analysis is shown in Table 4.3.

Themes	***Sub-Themes***
Thinking is influenced by processes based on…	… the understanding of processes
	… willingness to follow processes
	… experienced influences during DM
	… inclusion of user research
Thinking is influenced by role interpretations based on…	… individual understanding of roles
	… the understanding of responsibilities
	… relationship between PO and UX designer
	… experienced influences during DM
Emerged: Time constraints moderate influences of processes and roles	
CRT confirms influences of thinking & heuristics on DM	CRT answer
	CRT feeling
	CRT in business
DM is influenced by…	… intuitive thinking processes
	… avoiding or validating potential heuristics
Emerged: Knowledge moderates influences of thinking & heuristics	

Strengthen self-awareness and de-biasing through…	… reflecting on own knowledge
	… understanding the need for awareness
	… making it an actionable habit
	… considering risk
Team collaboration supports awareness through…	… avoiding knowledge silos in the team
	… enforcing knowledge sharing in the team
	… making decisions as a team

Table 4.3: Thematic Framework for Analysis

The introduced themes build the thematic framework and the foundation for analysis, which is especially important for interpreting and reporting research results and positioning them as new knowledge in existing literature. The next section will introduce all defined themes for answering the research questions.

4.5 Theme Analysis and Interpretation

This section covers the last step of the thematic analysis, analysing and bringing together all identified data extracts, which got summarized by codes and later by themes related to the research questions. It introduces the themes including sub-themes to answer the first two research questions.

The interpretation and discussion of each theme as well contextualisation within reviewed literature creates insights regarding interdependencies in the conceptual framework, which answers the research questions and fills the gaps in literature. Even though the contextualisation within the conceptual framework for understanding the bigger picture might be confusing at the beginning, it helps to understand and even extend the causal relationships in the conceptual framework. The contextualisation spheres of the themes, including concepts and their causal relationships, are shown in Figure 4.2.

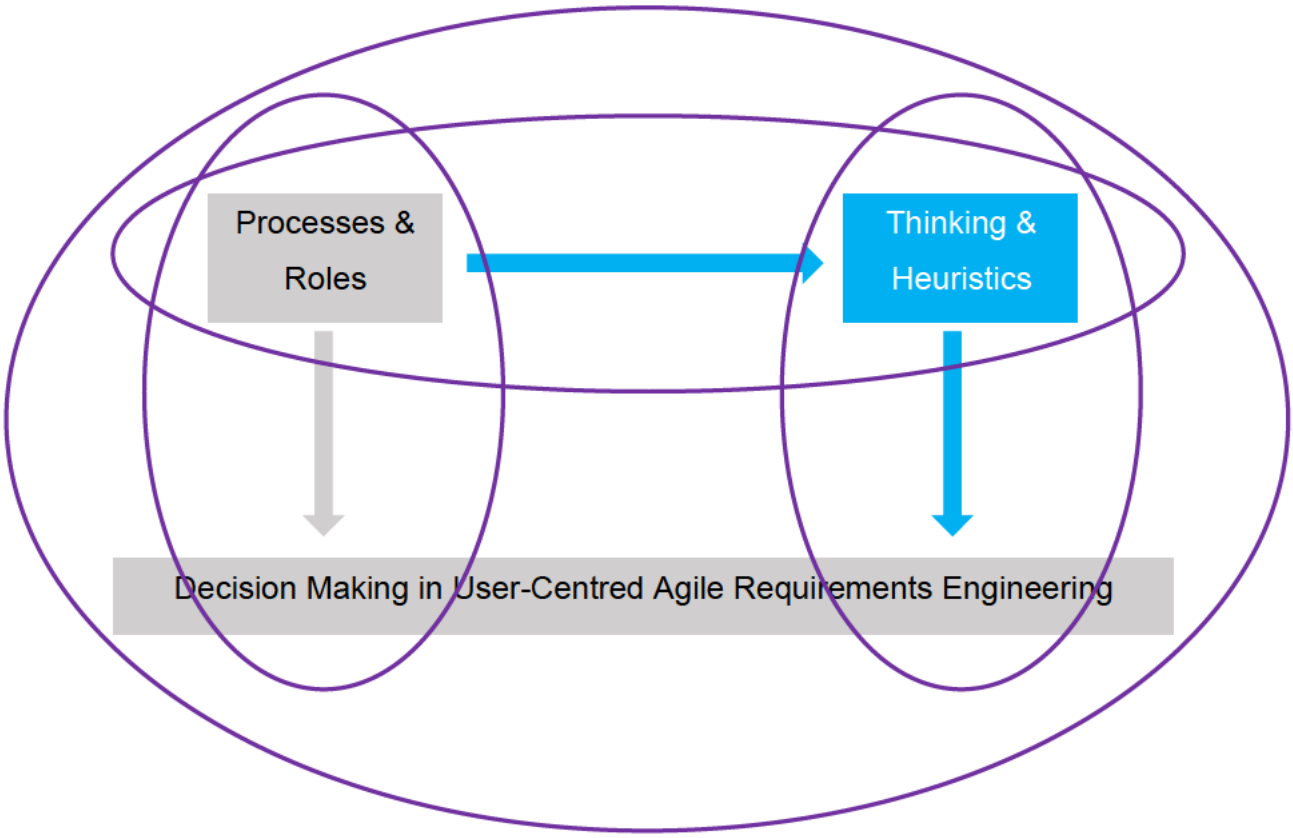

Figure 4.2: Theme Contextualisation

Because the research questions strongly focus on the mediator concept of thinking & heuristics, the themes cover mainly its causal relationships. To achieve the explanatory effect of the mediator concept, the gaps on incoming (RQ-1) and outgoing (RQ-2) causal effects from the mediator concept must be filled. The gathered insights from analysis will answer the research questions and explain the observed phenomena.

RQ-1: Why do processes and roles in UCA-RE have an impact on thinking and heuristics?

For answering the first research question, two themes from the thematic framework concerning **influences of processes and roles** on thinking give insights from data. Both themes share a common sub-theme, which states the participants' **experiences of influences during DM**. All participants stated that they feel influences during their DM related to applied frameworks or methodologies and what is expected from them related to the responsibilities according to their roles.

> *"…if you have no process, no framework in place, then people make decisions by whatever means or rules. And if you don't know about these means and rules or goals that people have, you don't know why they're making the decision." (Participant-03)*

> *"…a very clearly defined structure like an agile Scrum process, where there's actually little room to go left and right, I think the constraints are very clear. Whereas within the discovery phase, I think there's much greater freedom within the assets and methodologies of design thinking how to define the role and the decision making as well." (Participant-07)*

> *"… people in these roles, what they identify with, creates their own biases, or they create or they bring their own biases to the table. And UX is always advocating for the user. So they have this user bias, which is, if they're really working user centred, I think they achieve their job, or they also need to have if they want to be successful, not just designing, but rather really helping to prove a product, they should also think about the technical and business aspects as well." (Participant-03)*

As the references show, influences of processes and roles on DM is experienced in real business environments and underpin an existence of observed phenomena by the researcher. Considering the organizational DM models from Anthony (1965), it is important to keep the environment for operational DM in mind. Furthermore, influences of changes to role descriptions of methodologies, such as Scrum (Schwaber & Sutherland, 2020), or defined skill sets as in ISO 9241-210:210 (International Organization for Standardization, 2010) need to be considered carefully, as they influence thinking due to unclear expectations of practitioners how to fulfil their roles.

Theme: Thinking is influenced by processes based on…

To understand influences of processes on thinking, the actual **understanding of the process** by participants is an important indication. This sub-theme shows the understanding of the adopted processes after asking for a rough explanation of applied frameworks or methodologies.

> *"I've been using very, very intensely the IBM or enterprise design thinking framework…an extension of the original kind of user-centred systems design approach…encapsulating all the audit techniques from user interviews in its different facets, translating these requirements, translating these interviews into actual requirements, and starting evaluation processes and coming to a result, and sort of testing in the end." (Participant-04)*

The results indicate that knowledge about processes is limited to the area of responsibilities of participants. The reason is a specific focus on DM within process steps that reflect their responsibilities. Other process explanations are very high level due to a more overarching role including project management activities.

> *"I think I'm most familiar with design thinking. Even though in the real world we do not always use it in the way it is intended to I think…from development I'm also familiar with Scrum. And, how Scrum works and then with regards to requirements engineering, I think it's mostly bound to the role and the ceremonies that are there, which requires certain preparation of requirements… the design thinking is mostly for me in my daily work, something that comes before actually development… mostly centred really around the problem." (Participant-06)*

The understanding of processes also strongly affects the **willingness to follow processes**. This sub-theme shows the participants reasons why or why not to follow processes. Both reasons are stated to be primarily based in completeness and transparency of process steps. Structural safety was mentioned to be a main benefit of following certain processes.

> *"…reason why I follow them is because I think that a certain kind of structure helps everybody involved in the process to focus. And it also helps to come up with ideas… also to prioritize… it gives some kind of framework, which allows you to really say what we should do first, because it solves the biggest issue with the least effort … these kinds of processes are really helpful." (Participant-05)*

Next to the mentioned guidance, which is preferred, organizational preference is a reason to follow processes. Other opinions from participants showed that a preferred fixed structure is a reason to actually not follow processes.

> *"Every time I don't follow a process is when the process doesn't fit my situation or is not flexible enough to accommodate my situation. Or when I feel that I had to rework too much to fit the process…I tend to stay away from too finely detailed processes." (Participant-03)*

Almost all participants reported however unhappiness about changes in processes to adapt to difficult project environments, but even worse seems to be miscommunication about processes paired with their strong enforcement. Even though adaptions of processes are accepted by participants as flexibility and place for creativity, random process step removal or skipping is harmful but often needed due to project circumstances.

> *"…if we just have no time, or no capacity in the team. Then we, for example, if we have just a deadline and we have no time and no capacity to do all the steps, then we skip them, prioritize and then we just skip the steps that we need to skip to just achieve the deadline." (Partiticpant-10)*

These statements show that Scrum elements are left out if capacity or time constraints exist, but also when the Scrum methodology is categorized as fixed boundaries that hinders progressing. Missing elements in Scrum may lead to inefficiencies and could make the methodology useless (Schwaber & Sutherland, 2020). Moreover, agile processes strongly enforce the incremental and iterative DM during development (Pohl, 2010; Schwaber & Sutherland, 2020). Instead, finalized requirements are usually already created upfront including thinking processes on incomplete information and expected to be developed accordingly.

> *"I'm confronted with a solution to a problem. So, they already have like, everything, so they could start coding tomorrow, basically, with a solution, which was come up by the business owner who said: We need it like that, the process should look like that, done." (Participant-01)*

However, some of the adaptions to processes contribute to joining UCD and ASD approaches, as indicated in literature (Adikari et al., 2013) and supported by

participants responses. Upfront design and discovery phases with user research are reported to be efficient and effective.

> *"So, we are loosely tied to the delivery Sprints. So, I think the major part where we will have to discuss the requirements setups, actually not really in the delivery phase… the ramp up phase to handle all of those requirements and handling all of those initial ideas and concepts and client requests, in order to get to that point where we hand off our designs, and then it's pretty much a no brainer for us to deliver the project." (Participant-07)*

As shown, changing agile processes towards more adaptability of UCD and ASD influences thinking process for DM in a positive manner, some clients in consultancy even demand specific frameworks customized for user-centric DM.

> *"I'm defining a process for a client of mine… that process is not just for user-centred requirements engineering, but rather for governance frameworks for software delivery, in general. In which the user centricity is a key requirement, the client has." (Participant-03)*

However, participants also reported that whole approaches of UCD were skipped due to project timelines or simply because of missing recognition of benefits of the **inclusion of user research** and its declaration to be not necessary.

> *"…a large user group, obviously, with many different needs, many different roles. And so far, there hasn't been any kind of substantial research because it just wasn't funded." (Participant-04)*

> *"…we are already much more into the process and the client often is afraid that they would have to redesign or that they have to rework the whole process. So that they are not willing to do the design thinking in terms of validating the user needs or problems again…I was trying to convince about doing some user research and integrating the user into the process. And still up to the end of the release of the product we did not do some user research…" (Participant-02)*

Leaving out UCD approaches in UCA-RE contradicts the idea of being user focused. Unfortunately, user-centred is often used to flag a product as user

focussed, without actual following UCD process phases as defined in ISO 9241-210:2010 (International Organization for Standardization, 2010). Moreover, only very limited use of usability methods described in ISO 16982:2002 (International Organization for Standardization, 2002) or weak alternatives underpin thinking processes on user-centred decisions without focus on actual users.

> *"…after we have been creating stuff, so based on our personal knowledge based on best practices based on these kinds of things, we said, okay, now we put up something and we want to test it. And then the client came back and said, well, no, testing is too expensive. We don't want to do this, just do friends and family testing." (Participant-04)*

And sometimes, POs are very trusting in own capabilities to assume or know user's needs.

> *"…he thinks he already knows the user and what he would like to have, because he's already serving some kind of products or services for, maybe some years. So, he thinks that he doesn't need to do user research because he already knows the answer. So, he doesn't want to pay to get the answer from the user." (Participant-02)*

> *"So, I know the user, we don't need it. So, I guess they would have had the budget. I guess it would be like a time constraint. I think they thought they would be faster if they just decide on it." (Participant-03)*

It can be argued that the usability method of expert evaluation (described in Section 2.3.1) was used when deciding on not involving actual users and rely on thoughts of POs on optimal user-centred outcomes. However, even though the PO role involves a wide range of skills, as explained in Section 2.3.2, it usually does not include the skills of a usability specialist.

> *"…he's going to be taking decisions. But that's only after the UX designer has been the lead to collect all the data to parse the data and to work with that into findings, something that the PO is not necessarily trained to do!" (Participant-08)*

Theme: Thinking is influenced by role interpretations based on…

As shown by the previous example, **individual understanding of roles**, especially the own one, is influencing thinking processes and DM. This sub-theme incorporates explanations of participants on their own role and how they explain the PO or UX designer roles in comparison.

> *"…product owner defines what the product is, how it should present itself to the users, the benefits, it should deliver to the user and to the customer, or the business…negotiate with everyone else, what's actually a feasible way forward, since it's all a matter of compromise. So, the product owner has to find and define the best compromise, or the compromise that delivers the best product…user experience designer then translates that compromise or shapes that compromise for the UX part…" (Participant-03)*

Interestingly, all participants are mentioning POs as business advocates and UX designers as the user advocates.

> *"…the advocate for the user. So, I would see my responsibility to be the one who actually understands what's going on in the field, what people would need…" (Participant-04)*
>
> *"We can always be like, very passionate advocates about the design side of things and also be advocates for our users." (Participant-07)*
>
> *"…as a user experience designer, my main role is to be the advocate for the user. … always the user in mind, clearly communicate user needs to the team… always be in connection to the user." (Participant-01)*

Not all participants used those words, but all descriptions of roles match, at least from a general point of view, the ones from literature as introduced in Section 2.3.2.

However, it is easier to understand a role with an explanation of responsibilities. When it comes to the actual recognition of the full role including responsibilities, the certainty and understanding differs so much, that the full potential of UX designers and their actual responsibilities are not perceived.

> *"Because mostly, mostly clients just see the UX designers, well just put up a nice interface to what we have specified upfront, and then be gone, basically." (Participant-04)*

> *"I guess the team doesn't see my role yet. Just the product owner. So, I guess they don't know yet." (Participant-01)*

Understanding of responsibilities consequently impacts the overall understanding of the individual role, which is why the two sub-themes are strongly connected and both explanations were usually responded together by participants. Especially participants who changed roles recognized differences in responsibilities, which influences a change in DM as well.

> *"So as a PO, I'm responsible for allocating the resources that development has. So, we do have a fixed budget. We do have a time scale when the product should go live. And now I do have quite a lot of ideas in my head of what I would feel would be helpful for users, would be nice. But then now I have to allocate the resources and say, okay, this is the most important stuff we have to ship first." (Participant-04)*

The reference indicates the direct change of responsibility towards deciding with project resources in mind when becoming a PO after the participant's former role as UX designer with a very user-centred DM. All participants reported slightly different responsibilities, but overall, data represents agreement. The one responsibility which is clear to all participants is the absolute and final DM power of POs.

> *"… the decision within everything within user experience, what is best for the user, that should be held with the user experience designer. But also, of course, and that is totally fine with me, the final decision has to be made by the product owner." (Participant-01)*

The perception of PO responsibilities is described in literature, for example in the Scrum Guide (Schwaber, 1997; Schwaber, 2004; Schwaber & Sutherland, 2020) and ISO/IEC TR 24587:2021 (International Organization for Standardization, 2021). However, it is more described as an accountability, which means having the DM power on execution permission and final approval of results from legal

and financial perspective. Unfortunately, it might be misinterpreted as responsibility, which reflects leading actual realization of tasks granted by an accountable person.

> *"… the UX designer will often be someone who gives input into the whole design process for features …they'll be often doing the research with actual users to understand what are the needs. I imagine that POs will very much want to be part of that journey. But this is something where the UX designer is in the lead…" (Participant-08)*

That leads to situations of misinterpretations of responsibilities for alternative creations concerning user focused decisions. Especially because the accountable and responsible person may be the same person, which is usually the case in small teams and without distinctions in roles between POs and UX designers (Costello, 2012). However, if there is a distinction, the responsibility of creating user focused decision alternatives is on the side of UX designers as usability specialists, as defined in ISO 9241-210:210 (International Organization for Standardization, 2010). It strongly depends on POs to acknowledge this role and responsibility of UX designers due to the final decision power. Participants reported on both experiences, positive and negative related to acknowledgement. The majority however, 9 out of 10 participants, reported negative experiences.

> *"And every time when we start working with a new product owner, we have to explain them well. Just trust us, you are subject matter experts, know your customer, the end customer. But everything around the design all around how we get there. Give us some freedom for this design. Otherwise, we're very limited in our work and creativity as well." (Participant-09)*

> *"…current project I'm in, they are quite aware of what the user experience designer should do…. And our product owner is quite aware of, you know, not having tested with users or not having to take the user into account or pain points. So, they just have a new solution, and they don't want to move forward without having that validated." (Participant-01)*

The **relationship between PO and UX designer** is defined by the understanding of roles and responsibilities but at the same time also influences thinking

processes depending on the collaboration. This sub-theme collates actual experiences as well as intended and even wished for collaboration examples.

> *"…definitely built on trust. And that gives both of them the freedom that they need to do their best job…" (Participant-06)*
>
> *"So, the relationship is perfect if they understand where everyone is coming from and understand where they can actually help each other to achieve better work." (Participant-03)*
>
> *"…they benefit with their actions from each other, and they communicate on the same level about their decisions." (Participant-01)*
>
> *"…really good cooperation, really a good collaboration, where both pull the same string, right? But everyone has a different perspective on it." (Participant-10)*

Communication, trust and transparency, which leads to trustful and collaborative DM via thoughts sharing dominates the research results. However, unfortunately only in wished collaboration, even though both roles have the same mission of creating a product that is accepted by users and at the same time fulfils business purposes.

> *"…PO and UX designer can be so much in love for the same products…They need to have the same understanding of the product. But just at a different level of detail. And if that relationship is really good, it it's really aligned. They can represent each other without too much issue…" (Participant-08)*

Literature underpins those wishes with team specifications in ISO 9241-220:2019 (International Organization for Standardization, 2019). To realize those wishes and enforce an efficient and effective collaboration between ASD and UCD key roles, Kropp and Koischwitz (2016) introduced the experience consultant role, which is knowledgeable in both domains. Their study indicates success if implemented correctly into projects. However, the participants expressed issues with general consultant responsibilities that also effect the introduced experience consultant role.

> *"…in reality, yeah, customers are hard to convince that they don't know what the actual problem is already." (Participant-06)*

> *"…it's definitely very client centred, because they are paying for our solution in the end of the day." (Participant-07)*

The references state an important point of the timing of introducing roles into a project, which is usually happening too late to make impactful contributions to DM. Time was part of every interview when talking about influences of processes & roles on thinking processes and DM, which is why a corresponding theme emerged during analysis.

Theme (emerged): Time constraints moderate influences of processes and roles

This theme covers time and budget as constraints. Even though time constraints not always refer to budget constraints, budget constraints usually lead to less time. The focus is on time for this theme and moderates processes and roles influences in two ways. Firstly, the timing when UX designers get involved in processes or point in time when POs decide to share information with them.

> *"…as a designer, you quite often joined during the project not at the very early stage, sometimes you're just getting thrown into the project, where it's already running, and the requirements have been defined." (Participant-07)*

Heuristics may be based on insufficient information, shortcuts to processes are potentially a reason for insufficient information for DM, especially if initial phases including research are missing or are conducted without usability specialists. Process shortcuts are based on missing time for following an initially intended process and consequently influence information gathering which is a base for DM. Another reason for process shortcuts and why steps could be skipped might be a belief to know or having all necessary information while missing potential influences of heuristics that could cause that belief. If UX designers get involved too late in a project due to processes being altered or steps left out for user-centred approaches, thinking processes and DM are limited by already specified requirements or fixed availability of information. Furthermore, if POs share

information or involve UX designers to late, thinking processes for DM are already completed and no opportunities for additional thoughts are given.

> *"…already defined requirements that they would like to see addressed…not so much from a user centered perspective…we're trying to retro engineer when we come in." (Participant-07)*

Literature advices on early inclusion of user research by usability specialists to gather information for optimal DM by POs (Adikari et al., 2009). At the same time, this approach contradicts the traditional agile ways of working, which is why most UCD frameworks incorporate an iterative approach (Studios, 2018). Literature also states that decisions need to be made in timely manner (Adikari et al., 2013; Schmiedgen & Rauth, 2019; Schwaber, 2004; Schwaber & Sutherland, 2020). Time constraints add pressure to a project environment and therefore increase the effect of processes & roles related to including or leaving out process steps or involvement of specialized roles. If decisions need to be made in timely manner, efficient DM is key, especially if project constraints on time are tight. Consequently, the time given by a project environment moderates influences on thinking & heuristics because it creates stress due to expectations to follow processes and fulfil responsibilities.

> *"…there are also other framework conditions… budgets, timeline, and so on, which mostly when the contract is not shaped in an agile, perfect way, give you some restrictions to the work that you're doing." (Participant-06)*

> *"…tight time schedules, tight budgetary situations, which sort of leads me to take shortcuts in places where I don't want this…" (Participant-04)*

The amount of time consequently either increases or decreases introduced influences of processes and roles on thinking processes and with it on DM. Consequently, time has an altering effect on the causal relationship from processes & roles towards thinking and heuristics. Even though time pressure is known to increase potential pitfalls in DM, it is worth to be added to the conceptual framework as it is a daily driver in most projects as shown by the findings. The emerged theme extends the conceptual framework with a moderating concept as shown in Figure 4.3.

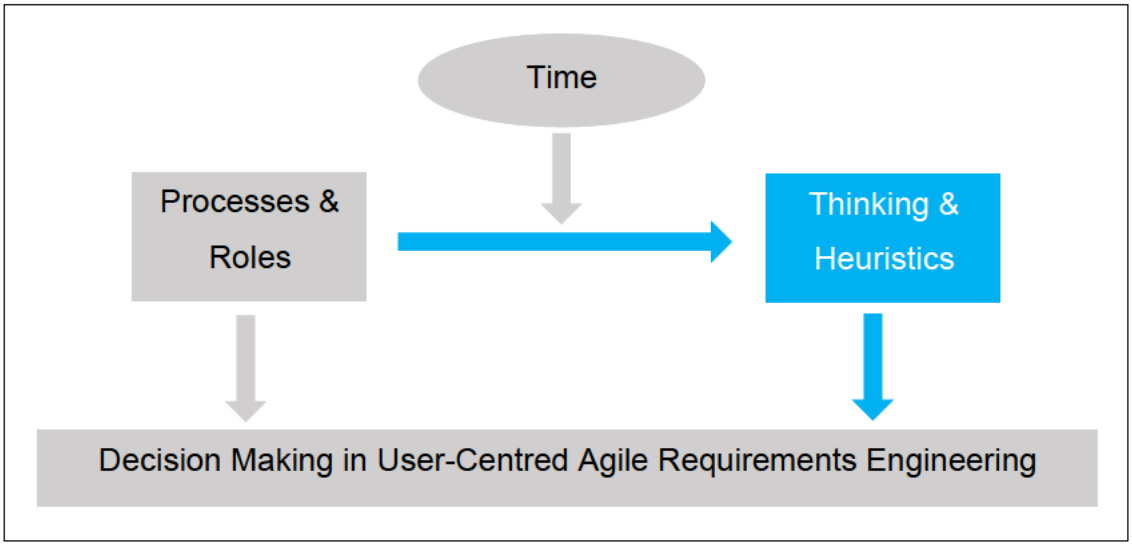

Figure 4.3: Extended Conceptual Framework (Time)

Summarized answer to RQ-1

Influences of processes & roles on DM is on the one hand defined by their definitions in literature, on the other hand shaped by project environments and therefore differ from project to project. The gathered data shows influences of processes & roles on participants and uncovers time as effect moderator for those influences.

The theme covering influences of processes describes why the understanding of processes impacts the willingness to follow them or not and whether the inclusion of UCD or alteration of ASD processes influences thinking processes for DM.

Furthermore, the theme about role influences shows that role definitions by literature are interpreted by practitioners depending on the expectations from project environments including processes. The individual understanding of roles including responsibilities determines lived roles as POs and UX designers. Consequently, the relationship between the two roles is defined by their understanding and is a potential representation of success or failure of combining UCD and ASD. The aim is to create a collaborative UCA environment, even if it means introducing new roles, such as the experience consultant role, to a RE process.

The emerged theme of time extended the conceptual framework due to its importance during the discussions on making decisions in process environments

with expectations on fulfilling a specific role. It described two possible effects which moderate influences of process & roles on thinking & heuristics. The timing of including UX designers into processes and time constraints for DM create stressful project environments. Even though, time constraints are a defined characteristic of agile environments, it has negative effects on a user-centred approach because qualitative research and UCD requires time. Both time effects must be considered carefully due to their strong effects on thinking processes and triggering effect of heuristics, especially in user-centred and agile RE environments.

RQ-2: Why is DM in UCA-RE impacted by intuition and heuristics?

This research question demands an analysis of reasons why DM in UCA-RE is influenced by thinking processes and heuristics. Analysis of altered CRT results and participant responses on direct influences on DM in business provide insights to answer this question.

Theme: CRT confirms influences of thinking & heuristics on DM

Starting with **CRT answers** from the interview and analysing the results, the sub-theme presents responses in the altered version of CRT (Frederick, 2005) , which is included in the attached interview guide in Appendix E.

> *“I know it's not one fifty. I know that.” (Participant-01)*
>
> *“I would say it is wrong, but it's then one fifty…” (Participant-02)*
>
> *“One euro fifty, but that's probably wrong.” (Participant-06)*
>
> *“Well, obviously my gut reaction and my basic math resources would probably say one fifty.” (Participant-07)*

The answers show impacts of the dual thinking processes (Evans & Stanovich, 2013; Wason & Evans, 1974) or two-systems (Kahneman, 2011; Stanovich & West, 2000). The answers to the altered CRT correlate with results from the CRT study by Frederick (2005) and show fast and intuitive responses from System 1 and at the same time triggers System 2 to override those responses. However, it also supports the interpretation of Kahneman (2011); Kahneman and Frederick (2005) that System 2 might fail to override under certain circumstances such as

stress or exhaustion. Even though some participants knew this type of question, which was the reason for altering the question in its objects and prices, they had still trouble solving the altered CRT.

> *"It's more like, "Oh, s…t, I know how it works but I can't figure it out now. I know how that question works. What the question is doing with you. I know how to solve it. And I know that I can't solve it in five seconds." (Participant-03)*

The sub-theme covering **CRT feelings** presents insights on reasons why participants answered directly, but with uncertainty. Participants were asked to reflect on their feelings, which triggered self-questioning and even kept them busy trying to solve the altered CRT.

> *"I was stressed. I also had a little bit of fear of making a mistake. But I also had the fear of not giving any answer in the five seconds." (Participant-10)*

> *"I felt nervous answering that… I would need time to really understand… I knew that the first intuition would be wrong… I felt under pressure." (Participant-01)*

Responses from the participants showed stress, fear and nervousness to make a mistake but at the same time also fear to not give an answer, which created pressure to answer the question even though the feeling that a first intuition might be wrong. Moreover, it was mentioned that the test is not for evaluation, the focus was on the feelings. The slow response of System 2 in combination with the time pressure triggered a heuristic judgement from System 1 (Gilovich et al., 2002; Kahneman, 2011; Kahneman & Frederick, 2005; Tversky & Kahneman, 1974). However, all participants were aware of their potential biased thinking and the high probability of a wrong answer due to the circumstances of the altered CRT.

> *"…it's so obviously… that was the warning signal… okay, it can't be that simple… there was just a nagging feeling that it wasn't correct. But I didn't have enough time to do the proper calculation…" (Participant-04)*

> *"I feel uncertain…I didn't think it through. I have no time to completely think it through. Or to evaluate it or … quality assurance. So, I just told you my first best guess." (Participant-10)*

The results of the altered CRT support already explored and described effects of heuristic thinking during DM for structured decision problems using explicit information and is not intended to question literature. However, it is useful to understand the underlying mechanism and especially feelings during the altered CRT to explain why thinking and heuristics have an impact on DM in UCA-RE. Therefore, the awareness of the participants is important to understand, because the CRT enforced environment for DM represents a process and role as well, which was the main intention to incorporate the altered CRT. The process is explained in the task to answer the question after a certain time and the role of the participant is defined as expert solving the problem stated in the CRT. Participants reported they had comparable situations and feelings from **CRT in business**, which indicates that the DM environment in UCA-RE is prone to similar heuristics in DM and potential biases.

> *"…definitely there were situations… we have limited time, or we need to take a decision… left or right… one of them seemed like the better option and you just followed it for the sake of taking a decision." (Participant-06)*

> *"Where my intuition or where my gut feeling is somehow trying to protect me from going with this situation or with this option. But where I cannot provide, at this moment an answer, why it's maybe not the correct way to go further." (Participant-02)*

It is important to understand mechanisms of thinking processes and comparing them to real world business environments in order to become aware that psychological influences are present in an environment where timely DM on limited information is essential, which is the case for UCA-RE.

Theme: DM is influenced by…

Using mainly System 1 information processing for DM enables such timely DM on limited information. The fast system for alternative evaluation and information substitution uses **intuitive thinking processes** for rapid response creation (Kahneman, 2011). This sub-theme includes situations from participants, which got characterized as intuitive DM.

> *"Every time I start working… Because it's the fastest way to start and to make progress." (Participant-03)*

The explained situations by participants report time to be a major cause for intuitive DM, which supports the theory of using System 1 for intuitive thinking because it is defined to be automatic, fast, effortless, unconscious and based on experience (Hammond et al., 1987). All those characteristics fulfil the need for fast decisions but indicate that no deliberative thinking is triggered in System 2, which would involve analysing information on effortful, rule governed processes as explained in more detail in Section 2.4.2. Because the cost of intuitive thinking is less than for deliberative thinking (Hogarth & Karelaia, 2007), DM is more efficient when done without reasoning, based on gut feeling (Horstmann et al., 2009).

> *"…the fear of not getting done in time is bigger than the fear of not having it completely right. So, if there is a solution which seems to be a good fit, which seems to be obvious at the beginning, then we normally take it for the first version." (Participant-10)*

As stated by Hogarth and Karelaia (2007), intuitive thinking is the process of weighting and comparing multiple pieces of information. The slow and analytical process of deliberate thinking is used for complex solutioning. Most of the situations reported by participants required fast DM instead of detailed analysis, even though analytical information processing might be appropriate and even intended by decision makers. Due to the iterative approach of ASD and continuous gathering of information, DM can be changed throughout a development process, which allows an efficient and fast DM on available information and experiences because flawed inferences can be corrected at a later stage.

> *"…I argue with myself about this so that I can always say: "okay, we are in software development, and we can change it in the next version." It's not like it has to be like this forever." (Participant-10)*

However, if intuitive thinking processes are based on insufficient information, the weighting and comparing of pieces of information is potentially flawed and heuristics cannot be effective. The result is fast conscious or unconscious DM on

either wrong or missing information. The situation of wrong information is based on gathering data from incorrect sources. At this point, DM is not wrong due to intuitive or heuristic thinking, because the same would result from deliberative thinking when analysing wrong information effortful.

> *"… if we do it now the simple way, we always have a chance to revise that and do it the proper way afterwards… we're doing something deliberately, where we know that it's probably not optimal. But we will always be able to revise that later and do a proper version afterwards." (Participant-04)*

DM is however influenced by thinking and heuristics when either complex information is not analysed, or missing information is replaced. The first scenario of missing analysis is tight to the law of least effort (Kahneman, 2011) and represents the thinking processes presented with the result of the CRT (Frederick, 2005). The altered CRT from the interview included all necessary information to solve the problem correctly. Even with removing the time pressure, the participants still struggled to get System 2 to correct the intuitive thinking process of System 1.

> *"…I can see the obvious solution. So, I try this one." There's always the risk that even if I have the time that I don't test it sufficiently, might be still the wrong solution… " (Participant-10)*

However, intuition is not a definitive reason for wrong DM, it is a best guess approach which can, if based on good information and a lot of experience, deliver correct inferences fast and efficient (Gigerenzer & Gaissmaier, 2011). During the second half of the interview, which covered thinking processes, heuristics and intuition, the question about experiences with situations where decisions were made on insufficient information was asked. Participants responses showed a strong moderating effect of knowledge on the causal relationship between thinking & heuristics and DM in UCA-RE.

Theme (emerged): Knowledge moderates influences of thinking & heuristics

The emerged theme includes important responses from participants on reasons for DM on insufficient information from a business perspective. This theme

delivers insights on reasons for DM on insufficient information in a UCA environment.

> *"All the time… I don't have the time, I don't have the permission, I don't have the access, I don't have the budget." (Participant-03)*

Participants responses indicate that sufficient information for less complex problems result in intuitive DM with high probability of success. However, it also shows that insufficient information triggers a variety of heuristics, depending on the situation, to fill the gap of information and create short cuts in reasoning, which consequently leads to biases in intuition (Tversky & Kahneman, 1974). As introduced by Sibony (2020), such heuristics can lead to traps in DM, which include even combinations of different heuristics. If System 2 fails to recognize those heuristics and does not intervene, the result is a misstep in thinking that causes flawed DM because of missing reasoning (Haselton, Nettle, & Murray, 2015).

Consequently, knowledge is essential in a DM environment where enough time is rare. In UCA-RE, knowledge is a combination of subject matter expertise about products and value of products to users. Gathered information for the knowledge is coming therefore from two sources, feature specifications out of business needs and value by fulfilling user needs. However, project environments have a constraining effect on those sources needed for thinking processes and consequently, there is a need for DM on insufficient information.

> *"In an ideal world, I think there would be no need for making decisions on insufficient information because you just have the time and are able to research as much as is required and think things through." (Participant-04)*

> *"…I think that's totally fine. Because like in the idea of everything is prototype, you go along, and you keep refining it. And if there's like any information missing, you try to get it along the way, maybe through user testing, or like talking to stakeholders and parties involved, who might be able to deliver you that information. So, yes, totally!" (Participant-07)*

Participants responses show the need of DM on insufficient information. However, with sufficient information, heuristics have less chance to negatively

influence DM on structured decision problems if the project environment allows for flexibility to gather and use information appropriately. Also, if information cannot be used appropriately and is not comprehended, it counts as missing information and enforces triggers for heuristics using information replacements from implicit knowledge or guesses. In structured decision problems, usage of implicit knowledge intuitively might lead to biased intuition and would be more appropriate for unstructured decision problems. Also, heuristics based on insufficient information used for solving unstructured decision problems lead to biased analysis. Insufficient information of any kind consequently leads to missing knowledge for either intuitive or analytical information processing, which may result in flawed DM.

Because of the agreement among participants and the strong moderating effect of knowledge on the causal relationship between thinking & heuristics and DM in UCA-RE, it is added to the conceptual framework as shown in Figure 4.4.

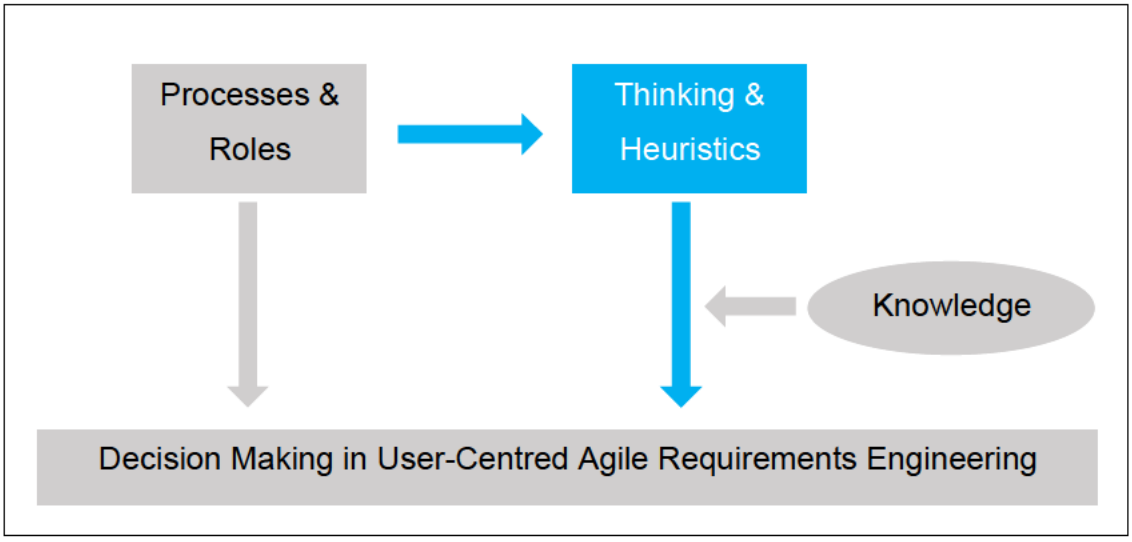

Figure 4.4: Extended Conceptual Framework (Knowledge)

Summarized answer to RQ-2

DM is influenced by dual-processing or two systems of thinking. Whereas System 1 is responding with automatic, fast and effortless inferences, System 2 is responsible for the deliberative thinking using effortful analysis of information for inference creation (Evans, 1984; Evans & Stanovich, 2013; Kahneman, 2011). The two ways of thinking are psychological underpinning concepts which always influence DM. The results from the altered CRT show, with the help of real live

business examples, that DM especially in UCA-RE involves similar situations. An agile environment constraints the time for DM, which demands intuitive DM for efficient responses to challenges in order to progress fast in development. A user-centred approach however needs information from time intensive sources or specific experience as UCD specialist. Because of the time constraints and fast iterative ASD processes, information is a limited resource for DM in UCA-RE. Therefore, DM is influenced by heuristics to fill knowledge gaps and use reasoning short cuts for inference creation. Knowledge is consequently an important moderator to avoid or increase influences on DM in UCA-RE by thinking & heuristics.

Completing the conceptual framework

Even though the themes underpin the causal relationships between the concepts in the conceptual framework with data insights, only a complete holistic view on the conceptual framework shows the explanation of the mediator concept. For complete comprehension of the cascading causal relationship from processes & roles to DM through the mediator concept, it is necessary to include both emerged themes. Time and knowledge are key moderating concepts in the conceptual framework and have high importance for influences on DM in UCA-RE (Figure 4.5).

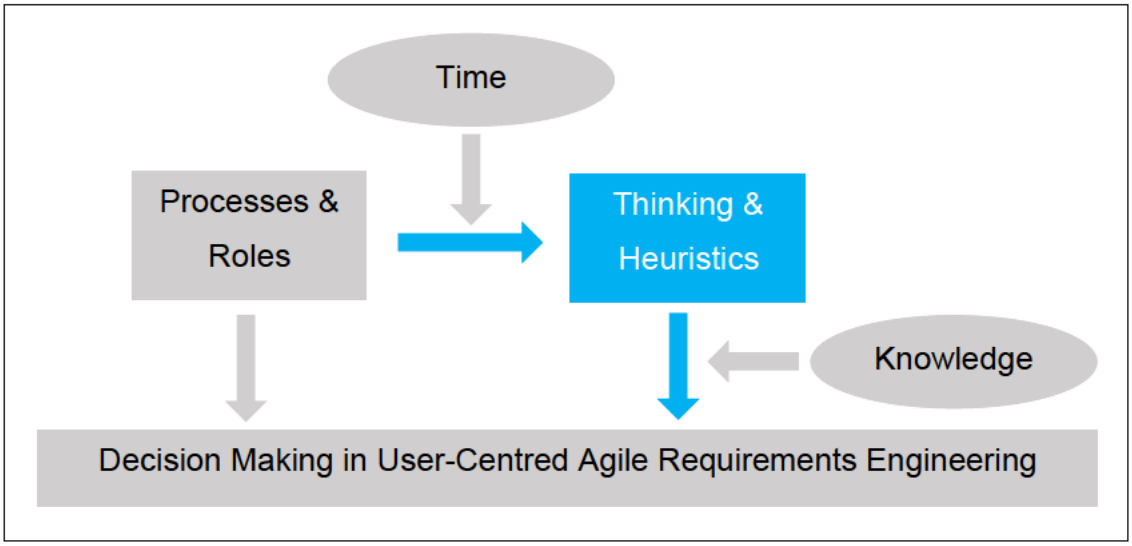

Figure 4.5: Final Conceptual Framework

As explained, processes & roles as independent concept influence thinking & heuristics due to project environment characteristics. Thinking & heuristics influence DM in agile RE exactly because of their causal relationship with processes & roles defined in UCA-RE project environments.

Psychological explanations by literature clarify how DM might be influenced no matter the processes & roles behind. However, to create a complete and explanatory picture of the phenomena, two important moderating concepts were introduced to show the altering effects on the mediator concept, which is the key for the phenomena explanations.

How to become aware of biases in our intuition and what to do to strengthen the awareness based on the research results is not explained in this section. It is therefore the first part of the writing up step in the thematic analysis. The second part of the analysis and answering RQ-3 is covered in the next chapter.

4.6 Chapter Conclusion

In this chapter, initial expectations and thoughts during familiarisation during data transformation and development of the coding structure have been presented. Based on the key findings and the conceptual framework from the literature review, the identified themes got reviewed and backed up by examples from the

data set to present the thematic framework. The themes got analysed as well as contextualized using the gathered knowledge from the literature to present a first interpretation of their meaning. The interpretation is important to explain the observed phenomena and complete the conceptual framework by answering the research questions and filling the gaps. The third research question is answered by the next chapter, which introduces an initial approach to create awareness and understanding of the phenomena.

Chapter 5: Approach to Biases Awareness

5.1 Introduction

This chapter covers the second half of the writing up step in the thematic analysis. It presents an awareness approach for biases in our intuition and thinking with the goal to understand influences on DM in UCA-RE. The developed approach, including the checklist, is based on findings from the analysis and the extension of the conceptual framework. Based on insights from answering RQ-1 and RQ-2 and supported by further themes, an awareness approach is introduced to answer the third research question.

RQ-3: How to become aware of biases in intuition due to heuristics and their triggers during DM in UCA-RE?

The structure of the approach follows the cascading causal relationship of processes & roles on DM in UCA-RE through the mediator concept of thinking & heuristics. The identified moderator concepts based on the emerged themes are used for highlighting triggers causing unwanted effects. In Section 5.2, the awareness of the project environment and its potential influences on thinking are checked. After the identification of influences on thinking, a categorization of knowledge is necessary to check for potential biases based on common heuristic concepts from literature, which is presented in Section 5.3. Finally, some alternatives for DM and potential follow ups are introduced in Section 5.4. Additionally, a brief step-by-step guide on introducing the whole approach to business projects is presented in Section 5.5. The approach got reviewed through an expert group, which is described and reported in Section 5.6 before concluding this chapter.

Theme: Strengthen self-awareness and de-biasing through…

According to Kahneman et al. (2021), people usually try to remove biases by correcting DM after it happened or trying to control biases before any judgment happens. Removing biases by correcting DM is also common in business as supported by participants who report on **making reflection a habit**. The sub-theme presents some examples how participants reflect on their DM.

> *"…self-awareness and reflection. I think that's something that is not a given because it really depends on the individual. Some might be very reflected on their actions and on their words and how they communicate, and others might just kind of keep going… without stepping back maybe and trying to reflect what they could improve on." (Participant-07)*

Reflection after DM is important, but recognizing and controlling potential biases before or during DM is the aim of this approach with strengthening self-awareness throughout the whole DM process. To achieve this aim, the approach is divided into two steps. First step is a project environment check according to a list of questions on processes & roles with timelines in mind to identify external pressure and possible options how to react to it. Second step is a quick categorization of available knowledge to become aware of potential heuristic triggers, which can be identified using an extended knowledge matrix. The extension covers categories of knowledge which represent potential influences of heuristics that might influence inference creation and could lead to biases. After, a short reflection on decision alternatives is covered to finalize addressing the aim.

The altered CRT of the semi-structured interview (Appendix E) triggered reflections on potential biases in intuition and their influence on DM. All interviewees responded with long reflecting periods to what happened during the quiz scenario and their feelings about it. The same altered CRT is therefore used to trigger a "self-awareness mode" and open up to the awareness approach. Instead of reflecting on business situations with the triggered emotional state, it is intended to support decision makers to strengthen awareness during DM processes including knowledge categorization and inference creation.

> "A sandwich and a drink cost together 4,50€. The sandwich costs 3€ more than the drink. How much does the drink cost?"
>
> 5 seconds for answering!
>
> Please keep that feeling you had during answering in your mind! It is important for answering the next questions.

5.2 Recognizing Project Influences

This first step of the approach checks influences from processes & roles on thinking for eventual intuitive and heuristic DM. Moreover, as processes and even roles might change midstream due to project circumstances, as shown by the analysis in Section 4.5, it is important to continuously check for potential influences on DM. Especially in continuous changing environments of ASD with a focus on UCD, awareness of changes during processes and in roles due to alterations in priorities and scope is essential to avoid flawed DM. Most of midstream changes are related to timing on delivery deadlines. The checklist helps to become aware of influencing factors with special focus on time constraints in project environments. As described by Anthony (1965), decisions on strategic, management and operational level influence all activities in an organisation, including DM in UCA-RE. Especially in today's fast changing market situations, changing macro decisions have a direct impact on micro decisions in whatever state of a project, which is the intention of agile project management, as explained in Section 2.3. Consequently, this first step of recognizing project influences needs to be executed thoroughly and continuously in whatever stage of a project, at start, midstream or close to completion.

The altered CRT incorporates a process structure and role definition on very abstract level, as explained in the analysis Section 4.5. It is important to keep influences of the CRT structure in mind during answering the checklist.

Themes covering influences from processes and roles with their sub-themes of experienced influences on DM by the participants adds examples on potential influences to be aware of.

The gathered insights from answering RQ-1 are used to identify checklist questions and at the same time underpins the necessity to identify potential influencers that may lead to heuristics and even biases.

5.2.1 Frameworks and Processes

Theme and sub-theme: Thinking is influenced by processes based on experienced influences during DM

Participants reported their experiences in UCA-RE environments during a reflection phase of the interview. Results indicate influences from processes depending on their degree of customization.

> *"…they always have to orientate themselves in that process, and then make or decide whether they're actually following the process or not. And that becomes even more complex, if they figure that they're doing good work, or they feel they do good work. But then the process tells them they're doing something not according to the process. And that creates a bit of a headache in people's mind, I would say, or cognitive dissonance… " (Participant-03)*

Therefore, becoming aware of processes in projects and if they are following defined steps by literature is essential. If processes got changed or steps skipped due to project circumstances, it is important to become knowledgeable about the exact changes and how they influence daily work.

The altered CRT shows how processes might influence DM. The process in the altered CRT is straight forward. Reading the question and listening to the researcher. Giving an answer in a specific time. An additional information on the expectations was given as well:

"The answer is not going to be evaluated, the importance is in the feeling during answering. This is not a test of any kind; straight honesty is highly appreciated!"

Process environments are more complex in real business context but reported by participants to be comparable in their DM environment structure. Answering the following questions, based on the answer to RQ-1 will identify potential influences on thinking processes during DM.

1. Are UCD or ASD processes in the project following the structure defined by literature or are they customized?
2. Is the team following defined processes in the project or are steps skipped / ignored?
3. Is user research included in the project for data gathering or is user data already available?

5.2.2 Roles and Responsibilities

Theme and sub-theme: Thinking is influenced by role interpretations based on experienced influences during DM.

Experiences of participants about their role in UCA-RE environments were part of the reflection phase as well and closely connected to responsibilities within the processes. Even though the differentiation between business and user advocate is mentioned by all participants, the role description based on responsibilities differs and consequently the interpreted expectations for the participants.

> *"Okay, so my key responsibility in the role. I mean, the role always depends on the project I'm in." (Participant-03)*

> *"…as a product owner, or whatever role I have, and I would never start doing designs. This would be restricted for me… that's good in that situation, because I can focus on what I am responsible for, and the designers focus on what they are responsible for. So, it gives you also some kind of certainty about the role you have and the responsibilities that you need to follow up on." (Participant-06)*

Therefore, becoming aware of the own role and its definition by literature is important to identify needed skills and capabilities to fulfil responsibilities. If role expectations are changed due to project circumstances, responsibilities need to be clarified. Eventual misinterpretations of roles or identified skill gaps need to be communicated and addressed.

The altered CRT defines the interviewee as expert to answer the question. Even though the question is not directly connected to the expertise of the interviewee, the role and responsibility in the altered CRT became implicitly clear and all

participants answered. In projects it is more complicated, but this situation is comparable if no explicit role and responsibility definitions are communicated. The following questions will help to identify potential influences on thinking by roles and responsibilities.

1. Are roles in the project clearly defined or altered due to project circumstances?
2. Are role responsibilities clear to all project stakeholders and is that understanding confirmed and lived?
3. Is the relationship between PO and UX designer collaborative and based on communication and trust?

5.2.3 Time Constraints

Theme: Time constraints moderate influences of processes and roles

Because the emerged theme of time constraints is moderating influences from processes and roles, it is important to identify time pressure according to its source and criticality. This theme presents some examples how time can influence DM environments and increase the influential effect of processes and roles.

> *"…we have those processes in place, some of them require short term solutions as well or really solutions in a short timeframe. And of course, all of that can lead to an influence on my decision making…" (Participant-05)*

Become aware of time criticality of the project and qualify time constraints related to the overall timeline and dependencies is important to understand if time constraints are valid.

The time constraint in the altered CRT was a key influence on thinking processes of participants as explained in the analysis in Section 4.5. It shows the strong effect on intuitive thinking and at the same time the increased influence of the altered CRT process to give an answer and the expectations for the participants to do so. The following questions will help to identify sources of time constraints and their validity.

1. Are time constraints confirmed by the overall timeline or related to individual stakeholder priorities?
2. Who is setting time constraints and is this person eligible to do so according to the process and role definitions?
3. What exactly is expected within the time constraint and is the understanding of expected deliverables shared with all involved stakeholders?
4. Is there any flexibility in the time constraint and if so, who is responsible for the decision on its extension under which circumstances?

5.3 Becoming Aware of Biases

The second step of the approach checks for influences on DM by heuristics in thinking. The categorization of knowledge helps to identify potential triggers for heuristics with focus on UCA-RE environments.

The altered CRT represents mechanisms of thinking processes and as explained in the analysis Section 4.5, it is important to keep this feeling during answering the altered CRT in mind as reminder when categorizing knowledge and identifying heuristics and potential biases.

Gathered insights from answering RQ-2 are used to underpin the necessity of categorizing knowledge due to insights on DM on sufficient or insufficient information. Furthermore, insights on intuitive DM support the understanding of effects of heuristics in UCA environments.

5.3.1 Categorizing Knowledge

Categorization of knowledge is important for understanding the extent and quality of information gathered that can be used for DM. Participants reported on ways of **reflecting on own knowledge**, when asked to think of DM based on insufficient information.

> *"The problem is only when you work on the basis of unknown unknowns, you're not aware of having risks and having no data to back up your decisions." (Participant-03)*
>
> *"…document what you don't know. Or think you don't know. And you probably know this sort of matrix of the known unknowns, the unknown unknowns, these kind of things..." (Participant-04)*

Because knowledge was introduced as important moderating concept in the conceptual framework for influences of thinking & heuristics on DM in UCA-RE, it represents an important step in becoming aware of biases to categorize knowledge.

Due to mentioning of the theory of knowns and unknowns in multiple interviews as shown by the references, it is considered to be useful in this study for the categorization. This theory was used by Donald Rumsfeld on the 12th February 2002 in a press conference and got later re-used in the book "Known and Unknown: a Memoir" (Rumsfeld, 2011). It explains knowledge categories as follows.

Donald Rumsfeld (2002) said in the press conference: (CNN, 2006)

> *"As we know; There are known knowns; There are things we know we know."*
>
> *"We also know; There are known unknowns; That is to say; We know there are some things; We do not know."*
>
> *"But there are also unknown unknowns; The ones we don't know; We do not know.*

Zizek (2006) added a fourth category related to Freudian unconscious theory in his article "Philosophy, the "unknown knowns," and the public use of reason" (Zizek, 2006):

> *"The unknown knowns; Things we don't know that we know."*

The added category of the unknown knowns includes knowledge that we may not be able to access and therefore don't consciously know that we know. The reason why the knowledge is not accessible may be limitations in cognitive capabilities,

which is supported by the theory of bounded rationality (Simon, 1955). Another reason might be biases in inference creation which are not based on limitations in cognitive capabilities, but on heuristics in DM. When becoming aware of those heuristics and potential biases, unknown knowns may even become known knowns that we do not want to know, and consequently stay intentionally unknown because we refuse to access that knowledge . This knowledge category shows importance for awareness of potential biases and is further discussed in Section 5.3.2.

All categories of knowns and unknowns are represented in a matrix to support categorization, which is shown in Figure 5.1.

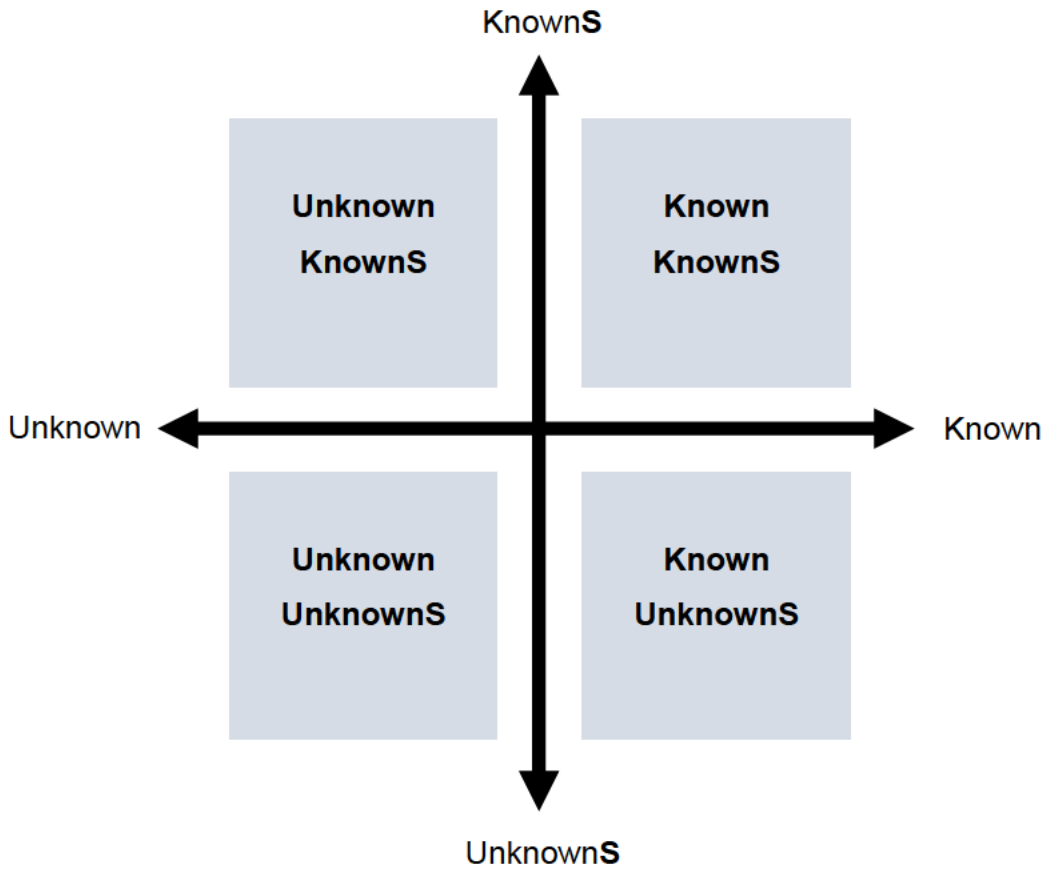

Figure 5.1: Initial Knowledge Matrix

The representation as a matrix helps to understand the foundation of decisions in categorizing available knowledge, which represents on the one hand sufficiency of available information and on the other hand cognitive capabilities to understand available information. For application of the knowledge matrix, each quadrant is set in relation to the UCA-RE business context, based on

empirical knowledge of the researcher and reported experiences from participants during the reflection part of the interview (Appendix E). Examples from data are drawn from various themes, but especially from the **experienced influences on DM** and the emerged theme: **Knowledge moderates influences of thinking & heuristics.** Table 5.1 summarizes the categories with examples and references from data.

Category	***Business Context***	***References***
Known Knowns	Enough information from market and user research is available.	*"…we could actually trace back every decision we finally made … one or the other interview requirement statement we had from the research." (Participant-04)*
Unknown Knowns	Information is available, but the PO or UX designer is not transferring the information into knowledge due to skill limitations, missing experiences or intentionally.	*"… no real metrics, or they are not visible to us on how success looks like." (Participant-01)*
Known Unknowns	Information to the market and user needs is missing and mitigations are in place.	*"… PO is quite aware…not having tested with users … And they don't want to move forward without having that validated." (Participant-01)*
Unknown Unknowns	No dedicated market or user research is conducted and there is no awareness of possibly specific and important information.	*"…it's based on very well-known patterns, for example, and then we just do it!" (Participant-10)*

Table 5.1: Traditional Knowledge Categories in Business

During analysis of gathered qualitative data and contextualising results in the reviewed literature, a missing perspective on those knowledge categories emerged. In RE, POs and UX designers try to be in the known quadrants of the knowledge matrix and not in the unknown quadrants due to the expectations of making decisions which serve the best quality of products and manage their development in best possible way.

Consequently, the goal is to know the knowns and unknowns to make informed decisions. If all available and missing alternatives for inference creation are known, DM becomes transparent and traceable, which is especially important in agile environments with continuous changes and high expectations of customers or users. Additionally, people rather decide in favour of certainty than uncertainty in the case of not knowing (unknown) why a decision is made, which makes the quadrants in the known area the comfort zone.

The discomfort zone is the unknown area of the matrix. Consequently, unknown unknowns tend to be taken as granted and not cared about enough. However, they are important because they might uncover crucial information necessary for DM, which need to be exploit by research. The unknown knowns are critical, because they describe information which are available to the decision maker, but the willingness or capabilities are missing to harness that knowledge. According to Zizek (2006), those information are knows which remain hidden and unknown due to limitations in comprehension. Limitations in comprehension can refer to cognitive limitations, heuristics in reasoning due to DM circumstances or intentionally to ignore unwanted knowledge. In any case, knowns might get neglected instead of being simply unknown to the decision maker, with the purpose to stay in the comfort zone.

The mentioned differentiation between the areas of comfort (green) and discomfort (red) for POs and UX designers, as well as all other stakeholders in the project, are shown in Figure 5.2.

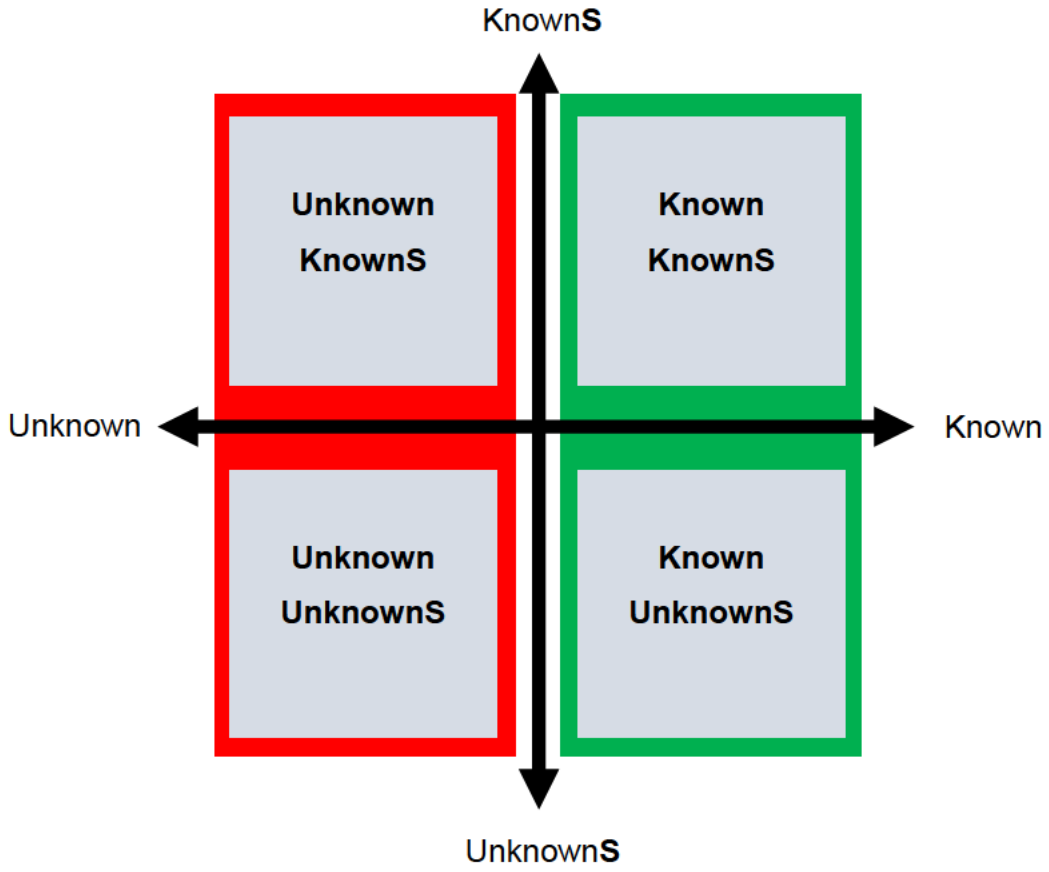

Figure 5.2: Comfort Zones of the Knowledge Matrix

The two quadrants of the comfort (known) zone expect total rationality in DM. The assumption is that decisions are made by fact based validation of options (Russ et al., 1996) by following a structured and controlled orientation (Rotter, 1966). The underlying assumptions include complete and perfect information. In addition, cognitive abilities as well as time and resources to evaluate all possible options for DM (Simon, 1957). Following those assumptions and expectations, knowledge may move from one quadrant to another depending on actions how do deal with uncertainty and equivocality of decision problems and what knowledge from which information processing is leveraged for DM. As an example, knowledge for handling a decision problem may be placed in the unknown unknowns, which indicates, that a decision maker may never know what information might be missing. However, with research in a decision environment, unknowns might become known unknowns and reveal themselves during analysis of gathered data for DM. Depending on how to deal with the now known unknowns, further research can be undertaken for explicit information through

extended data gathering, which after analysis would benefit reducing uncertainty. Also, if harnessing more implicit information gathered through experience, equivocality might be dealt with. Whichever information is used to get from known unknowns to know knows, it would benefit decision making if the choice of information processing matches the decision problem structuredness and environment. However, the choice of dealing with known unknows could also lead to acknowledgement and risk management related to unknowns. No matter which approach for handling the unknowns is used, it is always assumed, that available knowledge is based on the potential to gather perfect information and on analysis with unlimited cognitive capabilities and resources to get to knowns that can be known of without doubt and as absolute truth. Those assumptions contradict the theory of bounded rationality from Simon (1955), which states that the model of rational DM is not reflecting the complexities of organizational settings, because they are bounded to context and limitations of the environments in which decisions are made.

> *"…usually, the information situation always keeps evolving and changing and requirements are changing regardless from what side. So, I guess there's probably always a situation that there's not all information in place, there's always insufficient information." (Participant-07)*

Even if the assumption on availability of perfect information for a decision problem would hold true, cognitive abilities of a decision maker to process needed information might be limited, which shifts the starting point from the unknown unknows to the unknown knowns. The movement from that knowledge category to the known knowns would indicate that a decision maker somehow gained capabilities to process available perfect information. Another possible shift would be also to the known unknows, if comprehended what is known reveals what is unknown and therefore gives the chance to gain suitable information for the final shift to known knows as described before. In any case and as indicated by the examples, the discomfort (unknown) zone is avoided, which influences thinking and might trigger heuristics. The comfort zone is where POs and UX designers want or are expected to be, to make informed decisions.

> *"… But as soon as you venture into this territory of the unknown unknowns, we just have this gut feeling there's a lot more deep below the surface that you don't know. But instead, push ahead." (Participant-04)*

Influences of processes and roles demand to make informed decisions and stay in the comfort zone at all costs, which benefits potential biases in DM due to triggered heuristics. UCA-RE is an environment where decisions need to be fast and mostly on incomplete explicit information. Having the introduced examples of knowledge category movement in mind with the assumptions of availability of perfect information and unlimited cognitive capabilities and resources, UCA-RE is in a constant mode of dealing with unknown unknowns and unknown knowns, which need to be moved to known knowns harnessing additional information. However, with the acknowledgement of no possibility of perfect information and limited cognitive possibilities, the movement on the knowledge matrix chances when aiming for the comfort zone. Especially in a DM environment of UCA-RE with limited time and resources but high expectation on decision makers, risks are high that heuristics trigger biases. One possibility is using intuitive heuristics and implicit knowledge for structured decision problems, which causes biased intuition. The other possibility is using heuristics as analysis of decision problems with high equivocality, which causes biased analysis due to usage of incomplete explicit knowledge or not accepting implicit knowledge as potential solution. In any case, potential biases are harmful if not identified successfully and handled accordingly, either by corrections or acknowledgements. An approach to identify potential biases is covered in the next section including an adaption of the knowledge categories to acknowledge boundaries in rationality and eventually triggered heuristics.

5.3.2 Identifying Potential Biases

Combining the results from research, literature insights and empirical knowledge of the researcher extends the knowledge matrix. This section presents the extensions of the knowledge matrix and includes misinterpreted knowledge due to intuitive thinking processes and heuristics, which may lead to biases.

The sub-theme of **understanding the need for awareness** shows participants' views on importance of becoming aware of intuitive thinking processes and potential heuristics.

> *"I would go that far as saying that 90% of the decisions, if not more, are based on intuition… the easiest part, actually for the brain for ourselves to just make something and then come up later with reasons why it is good what you made…the challenge is to remind yourself of having to verify or to evaluate whether the decision and how you made it was actually a good one." (Participant-3)*

Due to supporting responses of participants and considering the introduced necessity of being or staying in the comfort zone of the knowledge matrix and acknowledging DM environments with imperfect information and limited cognitive capabilities or resources, the traditional knowledge categories may change due to triggered heuristics that might lead to biases if not becoming aware of them. To emphasize this change of categories, the traditional knowns and unknowns get extended. The new categories include insights from the literature review, specifically thinking process theories from Section 2.4.1 and heuristics and biases definitions in Section 2.4.2. Furthermore, research results from analysis are used, especially related to answers from RQ-2. [1] All introduced category extensions are chosen primarily following the default-interventionist view of system interactions during DM and the related concept of unconsciously triggered heuristics of system 1 that might be flawed and not be corrected by system 2, which leads to potential biases in intuition.

Believed Knowns This category is defined by the strong belief that complete and perfect information is successfully comprehended and consequently known to the decision maker. The believed knowns are results of heuristics, which declare all available information as complete and true. It represents the introduced idea of being intentionally rational

[1] Parts of the original theory of knowns were adapted and the researcher developed the theory further based on the literature review, research results and empirical knowledge.

(Simon, 1955). A heuristic example leading to potential bias is “Trust expert intuition”, the trust in experts, and the intuition they have as subject matter experts. The trust is also possible in own expertise, especially in the role as subject matter expert. The belief in complete and perfect information may have two reasons. One is the believe that all available information for solving a decision problem got successful gathered, even though there might be more information available. Complete information for structured decision problems could be gathered successfully but can be limited by resources and accessibility. Furthermore, cognitive capability limitations may hinder comprehension and consequently not all knowns which are available are actually known. Moreover, they are believed to be known because of missing awareness of those limitations. If a decision maker is aware of incomplete external information, it may also be extended by experts’ implicit knowledge and believed to be complete for structured decision problems, which is giving the extended category its name as well. Considering that analytical external information processing for DM is perceived to be rational, and intuitive DM based on implicit knowledge not, trust in expert intuition might lead to an intuition bias. If that assumption is not holding true and both types of knowledge are accepted, implicit as well as explicit knowledge can qualify for being as close to complete as possible. Consequently, next to believed knowns, it is valid to argue that accepted knowns can be considered for acknowledging that perfect information is not possible, and the choice of information processed to gather knowledge depends on the structuredness of the decision problem and the DM environment. In case of trust in expert intuition, intuitive DM would be rational in case of dealing with unstructured decision problems. Additionally, if intuition is harnessing trained heuristics for fast analytical reasoning or pattern recognition, trust in expert intuition might even be more efficient and effective than analytical deliberate thinking.

Neglected Knowns Information which is available for knowledge creation is not possible to comprehend due to cognitive or resource limitations. Some information might be comprehended using System 1, but indications of incomplete analysis of information from System 2 is ignored. The

concept is based on the substitution theory from Kahneman and Tversky (1972) explained in Section 2.4.2. Heuristics replacing complex information are reasons for neglecting potential knowns. An example of such heuristic is “cognitive ease”, as version of substitution. Cognitive ease describes an evaluation of information based on complexity of comprehension. Consequently, information which is easier to comprehend replace complex information and are valued to be truer. This description relates to the assumption that System 2 is needed to check information processing from System 1, which is usually the case for complex structured decision problems. If, however, System 1 inferences are valid due to reasoning on unstructured decision problems or even using heuristics for solving simple analytical problems efficiently, the knowns should be known to a decision maker. If the decision maker chooses to neglect those knowns, they become unknown intentionally. In summary, knowns might stay unknown due to cognitive limitations for comprehension, heuristics hindering information processing or intentionally by choosing not to acknowledge actual or potential knowns even when becoming aware of potential biases.

Accepted Unknowns It is simply accepted that certain information is not available. Consequently, an informed decision is not possible due to missing alternatives because no further effort is going into gathering more data and information on the known unknowns. The cognitive style of a satisfier fits this category, because of the acceptance of chosen limitations to make fast and good enough decisions (Gigerenzer & Selten, 2002; Simon, 1955). Heuristics of ignoring statistical or other accessible information, which can increase a value of an outcome or during planning, are characteristics of this category. A heuristic example can be the “planning fallacy”. Planning just too optimistic without dealing with known unknowns might lead to risk of flawed DM. Known unknowns make product specifications and project planning more complex if they need to be integrated as potential risks. They are simply accepted at the moment of decision and dealt with ones they evolve into problematic situations. If known unknowns are perceived as potential benefits, they may get further

investigated by gathering more suitable implicit or explicit information to become known knowns. The basic principle of this category is to show that DM can be influenced when accepting unknowns as given and being satisfied with the fact to know that there are unknowns. However, to accept unknowns would imply to know all that can be known about unknowns, as an unknown can only be accepted when having all available information on the unknowns, it may also be name believed unknown due to potential uncertainty and equivocality the unknown comes with. Believed unknowns can be accepted again. In the end, planning with accepting unknowns raises potential risk in DM because a believe in “knowing” even the unknowns and simply accepting this believed knowledge about the unknowns may result in flawed DM and potentially leads to biases.

Feared Unknowns: Even though it is not possible to have complete and perfect information (Simon, 1957), it is about feeling comfortable with the information that is available and hiding behind excuses of making the best decision with the available information.

> *“…says "Don't be hard on yourself, you did the best with the knowledge you had at this point of time!" And I really liked that one.” (Participant-07)*

Moreover, not only the comfort with available information and its justification to be sufficient, a fear of uncovering potential unknowns which may need to be dealt with defines that category.

> *“So, the unknown unknowns are actually what scares me, if there are known unknowns, you can always sort of have mitigations, for that, potentially… But as soon as you venture into this territory of the unknown unknowns, we just have this gut feeling there's a lot more deep below the surface that you don't know. But instead, push ahead. That's, I think, what's really scary, and what you should avoid at all costs.” (Participant-04)*

Characterizing heuristics for this category give a feeling of comfort with known information and the need to research more information for knowledge gathering is denied moving forward without new insights which

might intervene in DM. A correlated bias which might not explain a fear but may be a result of that fear to focus to much on existing information and knowledge is the focussing illusion. The key to that illusion is that processing known information is easier than thinking about potential unknowns, which would be research. Decision maker who fear unknowns due to their complexity and the effort to uncover them, are prone to heuristics leading to focusing illusion. However, such fear may be valid due to sensible DM environments which may be harmed by ambiguous knowledge, which may also result in another triggered heuristic, including potential biases. It of course could also lead to beneficial uncovered knowledge that support DM. If DM environments do not allow for continuous research on potential unknowns, the excuse on making the best decision possible with available knowledge seems valid as well. In the end, fearing unknowns depends on the DM environment and decision maker character, but it is important to be aware of potential biases.

To emphasize on the differences between the traditional and new categories, business context examples including related references from data clarify the differences and can be compared to the examples from the traditional categories. Table 5.2 shows the examples and is comparable to Table 5.1.

Extended Categories	***Business Context***	***References***
Believed Knowns	POs or UX designers believe that they know, without any doubt and decide on that belief.	*"…bring their biases…UX is always advocating for the user… product owners coming from a more business or market-oriented perspective… creates its very own bias." (Participant-03)*
Neglected Knowns	Accessible information is ignored or not analysed because it would deny an	*"…one solution might be better; I just want to avoid the conflict of kind of changing the whole back end and making all*

	expected answer or hinder necessary DM.	*that much effort." (Participant-10)*
Accepted Unknowns	POs and UX designers accept the unknowns in favour of what they know and decide anyway, without mitigation of risk.	*"Let's get something done…we can optimize it later in the second or in the third iteration. And that's, I would say it's a risk." (Participant-10)*
Feared Unknowns	No resources are invested into market or user research due to the possibility of uncovering insights which lead to timeline or scope changes.	*"…client often is afraid that they would have to redesign or that they have to rework the whole process." (Participant-02)*

Table 5.2: Extended Knlowedge Categories in Business

The introduction of the new knowledge categories includes only one potential bias, which indicates the type of potential heuristic related to the knowledge category. However, there are more potential biases that can be related to the individual categories. Table 5.3 gives an overview of the categories including short definitions, which are based on the research results of this study, in the same linguistic style as the traditional knowledge category definitions (we-form). Additionally, a set of potential biases for each category is presented, which are explained in Section 2.4.2.

Extended Categories	***Definition***	***Potential Biases***
Believed Knowns	We believe to know everything to make the correct decision.	Affect Confidence over Doubt Intuitive Predictions The Illusion of Validity Trust Expert Intuition
Neglected Knowns	We neglect potential knowns in favour of more comfortable	Cognitive Ease Associative Coherence

	or expected “correct” decisions. (Ignoring gut feeling)	Confirmation Bias Substitution Representativeness
Accepted Unknowns	We accept the unknowns in favour of what we “know” and decide anyway.	Ignoring Algorithms Overlooking Statistics The Planning Fallacy Overlooking Luck
Feared Unknowns	We fear unknowns that we might encounter and do not acknowledge their potential existence.	The Optimistic Bias The Focusing Illusion

Table 5.3: Potential Biases in Knowledge Categories

All new categories are based on the traditional categories introduced in the last section, with an additional focus on related heuristics. The following positioning of the new categories within the knowledge matrix as an extension is shown in Figure 5.3, followed by an explanation.

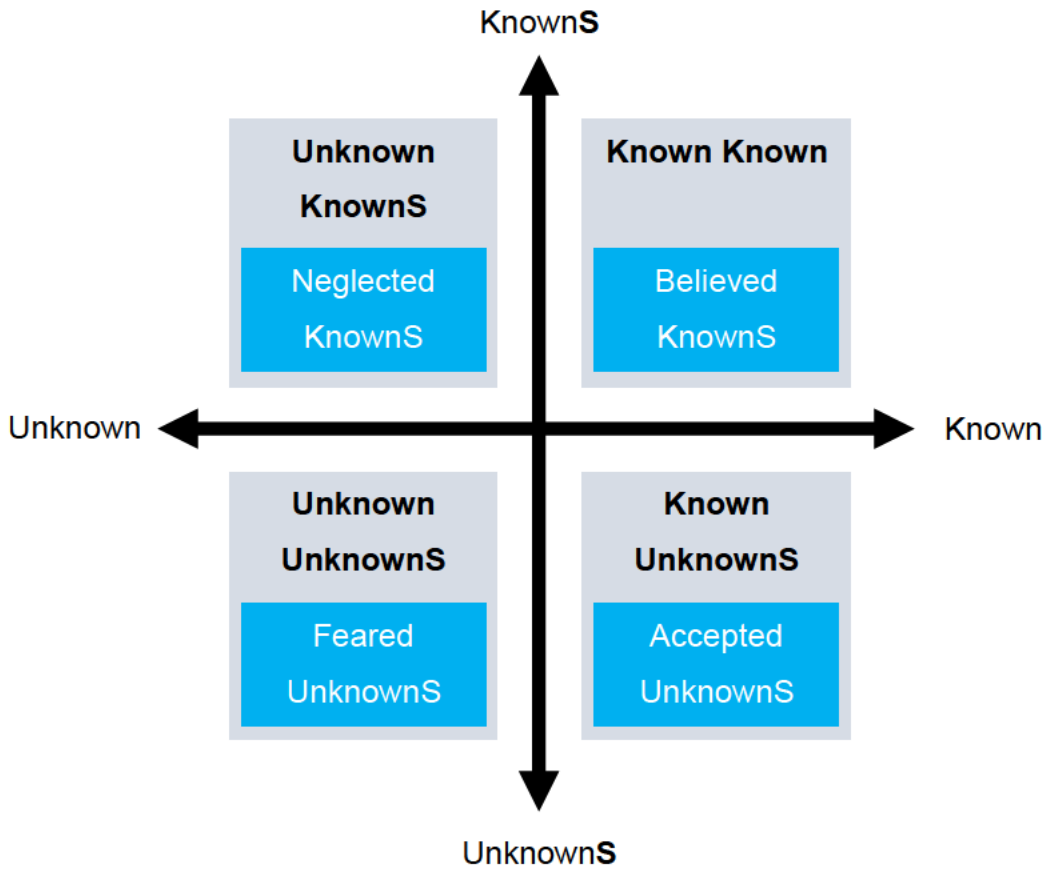

Figure 5.3: Extended Knowledge Matrix

Believed Knowns extends the matrix as another version of Known Knowns because heuristics give a decision maker the illusion of being in the category of the known knowns. The belief can be so strong, that a decision maker is certain and System 2 fails to check inferences of System 1.

Neglected Knowns are placed into Unknown Knowns because heuristics avoid additional effort on knowledge creation based on information which is accessible and available due to limitation in cognitive possibilities or resources. Even if cognitive capabilities would be sufficient, heuristic reasoning may lead to bypassing or refusing to access available knowledge. A result may be biases that neglect knowns but happen unconsciously so that they become unknown to the decision maker. When becoming aware of such heuristics and biases, the unknown knowns become neglected knowns and stay intentionally unknown.

Accepted Unknowns extend Known Unknowns due to their similarity in awareness of missing information. The difference however is the handling of the known unknows. Whereas known unknowns are used to mitigate risk or identify

potential benefits, accepted unknowns are underestimated and taken for granted. A result from ignoring known unknowns by accepting them is a stagnation of investigation of unknowns for potential risk mitigation or benefits.

Feared Unknowns can originate from Unknown Unknowns when decision makers stop researching for avoiding new insights. Only continuous research can possibly encounter potential unknowns that were not known to be existent. If no research is done, unknown unknowns cannot become known unknowns and consequently never known knowns. It is reasonable to stop researching at one point if data saturation justifies it, this category however is the direct denial to research even saturation is not reached.

The introduction of the new knowledge categories and positioning them within the knowledge matrix indicates also that movement of knowledge categories to known knowns changes as well. As explained in the positioning justifications, movement is either blocked or misinterpreted and may, intentionally or unintentionally, lead to DM based on insufficient information. To avoid stagnation of movement to knowledge categories for successful DM, it is important to practically identify triggered heuristics that might lead to biases. Therefore, an incorporation of the approach into UCA-RE project environments for DM is necessary and covered in the next sections.

5.4 Decision Making

Following the recognition of the project influences and becoming aware of biases in our intuition with an understanding of influences on DM in UCA-RE environments, this section covers the introduction of the awareness approach into projects for operational DM. Even though the aim of this study is to understand influences on DM and not handle them, as described in the boundaries Section 1.4, it is important to highlight certain DM aspects in order to strengthen the awareness approach. This section follows the final of the three steps of the introduced micro decision flow after the first step of identifying the problem and second step of searching for already existing solutions or creating new solutions. The third step is the selection of potential solutions for an

evaluation and choice of a solution to move forward. The first two steps incorporate the two-step approach to become aware of potential biases when identifying the problem and creating inferences. The third step is dependent on the outcome of the first two steps and relies on the adoption of the awareness approach into projects and the setting of the DM environment that influences the moderators of time and knowledge.

Before covering influences on moderators, a clarification on the topic of risk as influence on DM is needed since decision makers are risk averse and decide in favour of the least risky alternatives or even avoid decisions if too risky (Kahneman, 2011). Especially when it comes to ad-hoc decisions using System 1, risk is a strong moderating influence on the laziness of System 2 to cross-check any inference created by System 1. Using follow up questions for the altered CRT in the interviews which involved risk when answering the question changed the outcome.

> *“...if it's clear for me that I have the option to ask for more time, I would ask for more time.” (Participant-10)*

Influences of risk is however different in sequential planned development from ASD, because wrong decisions cannot be easily changed (Royce, 1970). Due to the iterative approach of ASD, the influence of risk is diminished because wrong decision can be corrected at a later stage in the development.

> *"Oh, it's okay it's just the MVP. So just bring it, make it!" Just let's finalize the MVP, let's finalize the first iteration. Let's get something done, right? And then, we can optimize it later in the second or in the third iteration. And that's, I would say it's a risk.” (Participant-10)*

Because involving risk in the altered CRT caused different results indicates that it has an important and strong influence on DM. However, the responses from the participants show that risk in ASD is negligible to a certain degree due to the iterative incremental approach and only 4/10 participants mentioned risk, which supports the finding that risk is generally accepted because decisions need to be made on insufficient information.

> *"I feel that it's the risks of being wrong rather little. So, it would be an investment, not worth the time and effort." (Participant-03)*

Therefore, risk is incorporated in the conceptual framework as control concept. It is considered to be important but kept constant during the research because the knowledge domain of risk management is not in scope of this study.

However, to manage potential risk in DM and reduce environmental influences on DM, it is important to control the moderating concepts in the conceptual framework. As explained in the analysis Section 4.5, the moderating concept time and knowledge affect the influences on DM in UCA-RE.

Controlling the time moderator depends on the project environment and set-up. However, with the reasoning of the introduced approach to get aware of biases in our intuition and DM, it is possible to argue for avoiding DM in order to validate more alternatives for an optimal decision.

Theme and sub-theme: DM is influenced by avoiding or validating potential heuristics

If the biases in intuitive thoughts are identified due to the introduced approach or simply because of bad gut feeling, it is an option to avoid DM to either validate information and alternatives which are considered for DM or avoiding DM completely due to limitations in information gathering or cognitive abilities to comprehend given information due to missing skills or experiences.

> *"I feel that I get rushed to make a decision or push to make a decision, then I would never ever give away something that they will take for granted…I would always say that is something I need to reflect on. I will get back to you in hours or days or whatever it takes. So, we have a better idea, and I can totally stand behind that." (Participant-07)*

The reported situations from participants show that asking for more time for better DM is a common approach to get a possibility to validate information and potential decisions. Totally avoiding DM is not a preferred or expected alternative. Especially in the consultancy sector, a goal is to provide at least decision options.

> *"…you don't have like 100% of information you would usually say you are not comfortable with taking that decision or designing this requirement… if such a situation comes up, obviously, I'm still the one who tries to provide decision options." (Participant-05)*

Those decision options can be discussed with a final decision maker in case of the roles as consultant or UX designer, who provide decision options to a PO with final DM power. However, even though a PO is accountable for a final decision, it is not necessary to make a decision alone. Due to needed diverse skill sets for DM in UCA-RE, as defined by ISO and explained in Section 2.3.2, the whole team can and should be included.

Theme: Team collaboration supports awareness through…

The moderating concept of knowledge can be controlled by getting more information during validation of alternatives for DM, but still involves DM by one person. The sub-theme of **making decisions as a team** introduces reported approaches of participants on how to involve a whole team in actual DM.

> *"…provide a platform for discussion and opportunities… pros and cons and then trying to make this decision as a team…" (Participant-01)*

The available knowledge of an individual decision maker is extended by group knowledge. For example via group interpretations for DM on unstructured decision problems with high equivocality, as explained by Crossan et al. (1999). Furthermore, potential biases in intuition due to heuristics are uncovered by cognitive abilities of a group. The approach to involve outside views on DM is also covered by Sibony (2020) and Kahneman et al. (2021). For an efficient and effective involvement of a team in DM it is important to adopt the awareness approach in projects for transparent DM, as explained in the next section.

5.5 Adopting the Awareness Approach in Projects

To use the benefits of collated knowledge and cognitive abilities from a team as mentioned in the previous section, it is important to communicate transparently how and why decisions are made. The goal is efficient and effective team

collaboration on complex problems to avoid biased intuitive DM caused by heuristics and at the same time aim for a best possible outcome, which is the value of the product in the case of UCA-RE. Therefore, this section concentrates on the actual adoption of the awareness approach into UCA project environments.

The theme covering collaboration in teams for joint DM is used in this section as well. The sub-theme of **enforcing knowledge sharing in the team** covers the need for joint information gathering and evaluation for comprehensive DM.

> *"I feel uncomfortable taking decision where I'm not really standing behind the option or the decision itself tends to be at least discussing that often times with the team and to get their feedback… not being the only one who's gathering information… provided the decision options and then discuss them with members of the team…" (Participant-05)*

The aim is **avoiding knowledge silos** in the teams, which contributes to transparency of DM and consequently higher acceptance according to the related sub-theme.

> *"I think it would be ideal that the whole team knows the goal or the vision, and then everybody can contribute in their expertise towards this goal." (Participant-01)*

The following steps give initial guidance on how to introduce the awareness approach in the project, incorporate its insights into the process and reflect on DM during UCD and ASD processes. [2] The steps are shown in Figure 5.4 and explained in the following sub-sections.

[2] The adoption approach extension of Scrum and EDT process steps are based on the certified knowledge of the researcher as Scrum Master, Product Owner, SAFe Agilist and Design Thinking Practitioner and relate to the literature review on frameworks and methodologies.

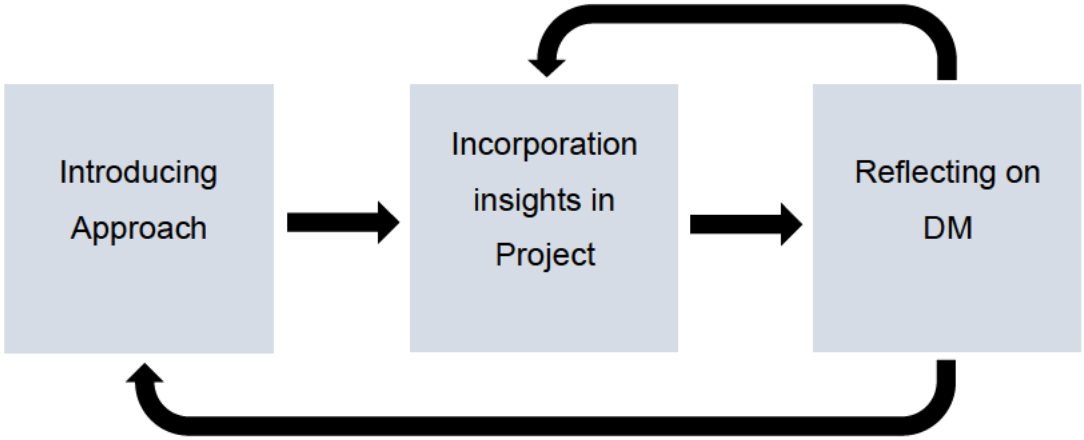

Figure 5.4: Awareness Approach Adoption in Projects

5.5.1 Introducing Approach

The main goal of the approach introduction is not to add another process step or tool that must be used. The focus is on fostering the mindfulness of causes and effects of intuitive and heuristic DM due to the influences of the processes and roles, especially for POs and UX designers in UCD and ASD project environments. Awareness of POs and UX designers is especially important since their decisions have a direct impact on product specification and realization. However, all decision makers in a project should be aware of influences on their DM for reasons explained in the previous section.

To use the awareness approach appropriately, processes and roles including responsibilities need to be known to all stakeholders. However, this study shows, that most experts are not always aware of their own role in daily business and have trouble explaining it. Therefore, part of the introduction of the awareness approach is the clarification on roles, to make sure every stakeholder is aware of DM power and limitations. Those roles and responsibilities are unique to each individual project and must be specified and communicated by a project sponsor after defined according to project needs.

Due to power and hierarchical discussions during DM, an independent responsibility for observing DM and identifying potential biases must be nominated and announced to avoid decisions based on centralized knowledge positions.

> *"…it's more of like a top-down decision… the expert, who was also the business owner, and who took all the decisions… all the knowledge was, is within him… there was no other knowledge within the team. So, he was the decision maker." (Participant-01)*

Finally, making sure that pre-requisites are fulfilled, the approach needs to be presented to a team as guiding principle for biases checks on DM which aim to improve the quality and transparency of final decisions. Furthermore, it benefits collaboration in a team and continuous improvement of a project setup. How the insights from the approach can be incorporated into a project is covered in the next section.

5.5.2 Incorporation Insights in Projects

The process owners must be aware of influences of process steps and their sequence on decision makers. Furthermore, process-owners must make sure that decision makers are aware of certain high pressure process steps and how to cope with them. The awareness approach serves insights on which circumstances related to processes and roles influence DM. Process owners can use those insights to check process set-ups to avoid intuitive and heuristic heavy situations for DM. To enforce awareness of potential biases, the process should include quality gates for decisions on important or risk prone decisions.

> *"…decisions which have a big impact on the end user, a big impact on effort for implementation. I think here, it's not advisable to not collect as much information as possible.." (Participant-06)*

And, according to the research results, decision makers follow processes because they give them guidance.

> *"…It gives us a guidance, a standardized guidance on the process… It's also quite helpful for other new colleagues… being new in a topic you always usually require guidance on what not to forget what is important..." (Participant-09)*

Consequently, to assure a constant bias check of decisions, it needs to be directly incorporated into the processes of the project. However, every stakeholder needs

to be continuously aware of potential biases in their DM. The two-step awareness approach includes needed insights for self-awareness relate to influences through processes and roles (step one) as well as guidance on knowledge categorization for individual de-biasing (step two). An intrusive motivation of each decision maker must be backed up by project culture to ensure continuous quality checks of decisions.

As stated by Kahneman et al. (2021), self-awareness and individual de-biasing needs a lot of training. An observer responsible for identifying potentially biased DM based on flawed intuition due to heuristics needs to be announced as mentioned in the previous section. In ASD, the Scrum Master serves as advocate of process implementation, supporter of a team and method trainer for a PO (Schwaber & Sutherland, 2020). Therefore, the role is suitable to take over the observation for the ASD processes. In environments where ASD and UCD processes are combined for UCA-RE, the introduced role of the experience consultant is suitable to be the observer. Extensive training and knowledge in ASD / UCD methods and practices (Kropp & Koischwitz, 2016) as well as constant availability makes that role a good choice.

Whatever role is announced to be the observer, the responsible stakeholder must be knowledgeable about the awareness approach and the underlying concept and theories from the literature review. The observer acts as specialist in the awareness approach and must be able to clarify open questions from a team on bias awareness. Furthermore, the observer must be included in any quality gate for decisions.

The incorporation of the approach into projects should be easy to follow and as less time consuming as possible to not add additional complexity to the processes. However, it is important to include structures for transparency in the process and give guidance for transparent DM.

> *"…if you have no process, no framework in place, then people make decisions by whatever means or rules. And if you don't know about these means and rules or goals that people have, you don't know why they're making the decision. And you can't anticipate that in your work. Meaning you can't do your work with these potential decisions and requirements*

> *that people have in mind. Because you don't know about them." (Participant-03)*

If appropriate, such trigger can be tool based and enforce checks of decisions before approving certain requirements, which are transferred to development or moving to a next phase in specification.

The usage of the awareness approach to check DM in a fast-changing project environment with time pressure and flexible scope must be re-checked regularly for proper incorporation. How to reflect on DM and the incorporation of the awareness approach is described in the next section.

5.5.3 Reflecting on Decision Making

Next to the continuous individual reflection on DM, ASD and UCD frameworks and methodologies include already process steps for reflections. Those process steps can be extended to include reflections on actual DM. The awareness approach supports as guidance on which influencing factors need to be reflected on.

In the ASD methodology Scrum, a reflection on the development process and team collaboration happens during the retrospectives. (Schwaber & Sutherland, 2020) A similar approach is recommended for reflection on DM during ASD. Unfortunately, according to the agile framework, the POs and UX designers are only optional for retrospectives, which focus more on a development team. Consequently, a joint or additional retrospective including them with focus on knowledge sharing and DM is necessary to reflect on success for incorporating the awareness approach for transparent DM. The retrospective has to be moderated by the announced observer.

In the UCD framework EDT, the reflection on potential decisions is part of the Reflect phase. Reflect is the intermediate step of deciding on next actions before execution (Studios, 2018). During the Reflect phase, the observer can control and directly include reflections on DM. As the phase is designed for reflection on DM, checks on correct incorporation of the awareness approach can be directly included.

Both examples of including reflection into existing processes have in common that changes to usage of the awareness approach can be made in direct incorporation into projects or by going back to the introduction and set-up of projects. Those changes must be monitored by the observer. The reflection follows the iterative approach of agile environments and therefore enables continuous self-awareness on DM quality and eventually identify necessary improvements or role / process adjustments for the individuals or the team.

> *"…teams are made of individuals who also have their own quirks. And some people will want to pay more attention to certain aspects than others… that's where the customization comes in… by adding new things, or maybe tweaking other things, and help the team understand what is it that makes us work best… over time, people also change and they learn things and, and they evolve." (Participant-08)*

Summarized, reflection is important to continuously check the incorporation of the bias awareness approach into the process to keep the quality of DM high through honest individual reflection as a team. A successful adoption of the awareness approach depends on each individual stakeholder in the project, the incorporation must be managed actively to ensure bias awareness and avoid flaws in decisions on product specifications and development. How the awareness approach is viewed by mentioned stakeholders and involved subject matter experts is reported in the next section based on an expert group review.

5.6 Review of the Awareness Approach

5.6.1 Introduction

For reviewing the preliminary research results, a presentation by the researcher including an organized discussion phase with an expert group gave the opportunity to gather feedback with specific focus on practicability of the awareness approach. The practical proofing of the research results is especially important for a DBA, unfortunately research for this study is limited in time and resources for longitudinal research on the practical effect of the awareness approach. Instead, a review through empirical knowledge of an expert group got

chosen as alternative with the aim to understand if identified influences on DM in UCA-RE exist, which serves as incremental part of the professional contribution by elaborating on the research results and the potential success of the awareness approach to DM in UCA-RE. The gathered insights from the discussion were used to review the research and its results identified in the interviews, including the emerging themes. This section reports on the result of a broader reflection by presenting the research and asking the expert group to reflect and discuss on it. The results of the review influence the contribution to practice due to the feedback on feasibility in the industry and business context. Additionally, the expert group review on the feasibility of the research results and the underlying theoretical concept influence the contribution to knowledge due to its applicability in the research field of DM, especially in UCA-RE environments. The next two sections will describe the setup and present the results of the expert group review.

5.6.2 Expert Gathering and Presentation

The experts were not chosen purely according to their roles and experiences in business. A broader purpose sampling was used to target for potential respondents and make sure they are best suited to elaborate intensively on the research topic but at the same time represent a specific skill set. Therefore, the invitation for the presentation was not limited and send to specific experts, it was sent openly to a department which is specialized in UCA-RE. However, the invitation, including the participant information for the presentation (Appendix I), will make clear that the presentation is addressed primarily to the role of POs, UX designers as well as experience consultants, who are familiar with the UCA-RE processes, because the same is true for this study which is presented. However, due to the broad invite with no aim for specific experts, all other stakeholders have a possibility to join. The reason for the specific focus on UCA-RE knowledgeable stakeholders is the scope of the review to gather feedback on the developed approach and its purpose for self-awareness. In addition, if the awareness approach is understood and applied, it can also be used to monitor DM when appointed to be the observer.

The department itself, which the researcher is part of, is a design studio that focuses mainly on visual, experience and process/service design. The invite was

sent to the whole department, no individual participation got checked during the presentation. It is consequently possible that a subset of the expert group review could be included in the previous sample pool for the semi-structured interviews, which was however not intended and also not controlled. The participation in the interview has no impact on the expert group review, because the awareness approach was not in scope of the interview and the expert group got introduced to the topic the same way the interview participants were.

The main roles in the studio department are visual / UX designers and experience consultants as well as business / service designers, who are mostly active as POs. The roles are described in the studio as the following:

- **Visual designer** mainly focuses on the creation of user interfaces from a visual point of view.
- **UX designers** and experience consultants cover information architectures and interface layouts as well as broader experience influencers such as user research, user journey creation and user centred process analysis.
- **The business / service designer** support as proxy PO, making sure that the decisions of a PO are fact based and underpinned by actual related knowledge. They mainly act as sparring partner for a PO with a specific focus on process validation and risk management during RE.

The presentation (Appendix J) is separated in an informational and a discussion part. The informational part of the presentation is structured in the following agenda covering and introducing all main areas from the research to the participants.

1. **Motivation** - Introducing the main motivation for conducting the research, especially from the business perspective.
2. **Research Context & Aim** – Presenting the research context from academic as well as business point of view and highlighting the mix between methodological and psychological subjects resulting in the aim of the research.
3. **Literature Insights & Actual Research** – Explaining the thematic structure of the literature research to gather insights, identify the gaps and

conducting the actual research through semi-structured interviews via discriminative snowball sampling.

4. **Analysis / Contextualising / Result** – Describing the process from executing a thematic analysis on gathered data including first key results identification, followed by contextualising the results and finally revealing the initial research results based on the emerged themes.

The informational part of the presentation took 30 minutes. The interactive discussion session started with a reflective thinking and note taking phase of 3 minutes for preparing an individual response to the introduced research results including an experienced situation related to the topic. During the preparation, the extended knowledge matrix was shown with some example situations to support the participants in their response creation. After the preparation, the participants were asked to get involved in a free discussion about their personal experience and opinions on the research topic. There was no test involved and no judgement intended. The tasks included to share experiences, feelings about the chosen situations and how participants handled them. The aim of the interactive discussion session was feedback gathering on the research results and potential identification of necessary additions for practical usage. The whole presentation, including interactive discussion session, took 70 minutes and the report and feedback is presented in the next section.

5.6.3 Report and Initial Feedback

The presentation got recorded for reporting to capture tone as well as facial expressions and body language during the discussion phase. The researcher's presentation itself was not transcribed, but every question or statement from the participants got transcribed for later use with additional notes taken by the researcher during the discussion. More information was added by reviewing the recording repeatedly. The recording as well as the transcribed and noted information were used for the report creation. The analysis did not cover the individual participants. All insight got used, no discriminative selection of information was applied.

After the presentation of this study including preliminary results, the researcher initiated an interactive discussion session for elaborating on the research among the experts. To make sure, that interference of the researcher as presenter and facilitator during the discussion phase is very low, the degree of active involvement was kept to a minimum. The researcher acted as moderator, who asked some guiding questions depending on how the discussion progressed. Moreover, to keep risk of agreeable bias as low as possible, considering that the participants are colleagues from the same department who may or may not know the researcher and could be part of the previous interview sample, no statement for confirmation or for agreement by the researcher was part of the presentation and discussion phase. The results to the main topics of the discussion got noted by the researcher, later extended by the review of the transcription, and interpreted as shown in Table 5.4.

Note / Statement	***Discussion and Interpretation***
Decisions on how to move forward	Discussion was about the next steps on a prototype. The preferred choice was another iteration on validating the prototype, but the PO decided against it for no transparent reason. Hidden statistics on features were the reason which was not shared in the team. No sufficient information for DM in the team.
Underestimating Decisions	No risk evaluated or involved. Fights over decisions based on preferences from the designer. The solution to get user feedback was denied, even for a quick validation.
Decision Power	The mentioned example involved agencies fighting over a decision because of political reasons. We tried to limit the unknown unknown by highlighting some known unknowns.

Team Diversity	Using the team diversity and involving experts with different background to avoid potentially biased DM.
Self-Awareness	The awareness that individual DM is easier to be biased than DM in the team. After DM, reflecting helps to find out about biases, but a team may already avoid biased DM.
Complexity of Process	The approach should no add to much complexity to the overall process, but it would be nice to have action recommendations.

Table 5.4: Expert Review Results

The table of the review results and feedback during the interactive discussion session supports results from research regarding DM power of POs including missing transparency of DM in a team. Furthermore, situations on risk awareness due to missing research and user feedback was discussed to be problematic. Another discussed topic was the involvement of a team in DM with the result to embrace the collective knowledge to avoid biased DM. Finally, the awareness approach adoption in project environments was discussed and clarified the need to keep complexity low for applicability as action recommendation. All gathered insights from the discussion are included in the research results and uncovered new thoughts and extensions on the research topic which are introduced as implications for further research in Section 6.6.

5.7 Chapter Conclusion

The conclusion of this chapter represents the answer to RQ-3. The question on how to become aware of biases is answered with the developed approach and consists of two steps. The first step is a comprehensive project environment check according to a checklist of questions. The project environment check creates awareness based on the insights from answering RQ-1 concerning processes, roles and time constraints as external source of pressure. Checking the questions creates awareness of potential stress factors triggering biased

intuition. The second step is a categorization of the availability of knowledge for DM. It creates awareness for information completeness and if available information can be fully comprehended. A knowledge matrix supports the categorization and includes potential heuristic triggers for identifying biases. After the identification of influences in project environments and categorization of knowledge, DM alternatives and guidance on how to adopt the awareness approach in project environments is covered as final part of the answer to RQ-3. With answering the RQ-3, POs and UX designers are equipped with knowledge to recognize influences on DM in UCA-RE. Even though the observer, which is ideally a single neutral person that gets nominated, is introduced to monitor DM in project, every team member, including POs and UX designers, are responsible for individual de-biasing to ensure DM quality. To gather feedback on the awareness approach, an expert group review including an interactive discussion was conducted and reported on as final section of the chapter. The outcomes of the review support the purpose of the study and its results, but also uncovered potential limitations and enhancements which are described in more detail in the upcoming conclusion covering what got achieved, where are the limits and what needs to be further researched.

Chapter 6: Conclusion

6.1 Introduction

The final chapter of this dissertation summarises this study starting with describing the achievement of the aim and objectives in Section 6.2 and continuing with responses to the research questions in Section 6.3. Furthermore, potential contributions to knowledge and to practice (Section 6.4) are explained and claimed. Section 6.5 describes limitations of this study. This chapter and the overall main content of this study ends with the emerging possibilities for further research in Section 6.6 and is followed by references and appendices.

6.2 Achievement of Research Aim and Objectives

The aim of this study was **to understand influences on DM in context of UCA-RE by investigating influences of UCD and ASD processes including involved roles and human thinking processes.** Whether the aim got achieved depends on the fulfilment of each individual objective as described in this section.

Research Objective 1: Information on DM psychology, UCD, ASD, RE processes as well as participating roles were gathered during the literature review described in Chapter 2. The Identified concepts and theories got critically discussed throughout the literature review and resulted in a conceptual framework explained in Section 2.5. The model of the framework supported the identification of gaps within the interrelations of the concepts, described in Section 2.6. Based on the identified gaps, the research questions of Section 2.7 aim to answer questions regarding the interrelations and the overall comprehension of the conceptual framework.

Research Objective 2: Qualitative data on lived experiences during DM in UCA-RE was collected using semi-structured interviews, as described in Section 3.7. Participants for collecting data were selected purposefully, as explained in Section 3.8, to ensure a comprehensive foundation for the thematic analysis defined in Section 3.9.

Research Objective 3: As part of the thematic analysis, collected data was coded (Section 4.3) and represented in a thematic framework providing themes (Section 4.4) for analysis and contextualisation of results in Section 4.5. During analysis, influences of interrelations of concepts were discussed and awareness of intuition and heuristics during DM in UCA-RE identified. Additional themes emerged during analysis of gathered data which got used to extend the conceptual framework during contextualisation.

Research Objective 4: Based on results of the thematic analysis and the extension of the conceptual model after contextualisation, an approach for awareness of biases was developed in Chapter 5. With the help of the approach, insights from the conceptual model can be applied for becoming aware of biases in intuition due to potential heuristics during DM in UCA-RE. The approach was presented to an expert group for a review, as reported in Section 5.6.

With the last objective fulfilled, the aim of the research was reached and understanding gained through contextualising research results into a comprehensive conceptual model of the literature review. On top, the identification of emerged themes, described in the findings in Chapter 4, revealed additional insights on project environments and importance of knowledge which built the foundation for the introduced awareness approach, explained in Chapter 5. Consequently, the initial scope of the aim got extended because the research results provided not only an understanding of influences through the extended and explained conceptual model, but also provided the approach for awareness by answering the research questions described in the next section.

6.3 Responses to Research Questions

The research questions introduced in Section 2.7 are based on identified gaps in the conceptual framework from the literature review. The answers to the first two questions aim for explaining the interrelations in the conceptual model, whereas the answer to the third research question aims for general awareness of

interrelations. Awareness of interrelations and their influences on the concepts is based on their understanding. Consequently, the answer to RQ-3 is based on the insights from answering RQ-1 and RQ-2.

RQ-1: Why do processes and roles in UCA-RE have an influence on thinking and heuristics?

RQ-1 is based on the gap in the literature focus on “how” processes and roles influence DM with structures and responsibilities. The “why” however remains unanswered by literature. The analysis of lived experiences through qualitative data showed influences of processes & roles on participants and uncovered time as effect moderator for those influences. Results showed that the understanding of processes impacts willingness to follow processes and consequently has an influence on thinking processes for DM. Especially the inclusion of UCD methods in processes influences heuristics during thinking processes due to availability of information for user-centred DM. Processes define needed responsibilities and consequently shape understating of individual roles. Individual understanding has an influence on thinking processes and demand heuristics if skills or experience do not allow the fulfilment of expectations. Next to the operational set-up with defined processes and roles, the timing of including UX designers into processes as well as time constraints for DM create stressful project environments, which additionally increase or decrease influences of processes and roles on thinking and heuristics.

RQ-2: Why is DM in UCA-RE influenced by intuition and heuristics?

RQ-2 extends the focus of processes and roles interrelation with DM in UCA-RE. It is based on the gap in the literature revealing no insight on “why” DM in UCA-RE is especially influenced by thinking processes and heuristics. Literature gives answers on “how” DM is influenced by dual-processing or two systems of thinking and heuristics (Evans, 1984; Evans & Stanovich, 2013; Kahneman, 2011). However, lived experiences are needed to understand reasons why especially UCA environments are impacted. Results from the altered CRT showed the general impacts of thinking processes on DM. In relation to the altered CRT experience, real live business examples from participants showed that agile environment constraints of time demand intuitive DM for efficient responses to

challenges. However, user-centred approaches need information from time intensive sources, consequently information is limited for DM in UCA-RE, which triggers heuristics to fill knowledge gaps and explains the strong influence of DM by intuition and heuristics. Additionally, UCA-RE deals with different structuredness of decision problems including necessity for explicit as well as implicit information processing to handle uncertainty and equivocality. Agile got identified to support uncertainty whereas user-centricity comes with high equivocality due to subjective perspectives. Not being aware of those DM environments requirements may lead to biases in intuition due to mis triggered heuristics.

RQ-3: How to become aware of biases in intuition due to heuristics and their triggers during DM in UCA-RE?

RQ-3 focuses on the awareness of the influences identified with answering RQ-1 and RQ-2, which is observed by POs, UX designers and usability specialists, but not questioned or covered in literature. The answer to the RQ-3 is important to understand how to become aware of unintentionally biased intuitions. For answering the question, a two-step approach was developed, which includes as first step a project environment check based on insights from answering RQ-1 and as second step a categorization of knowledge with advice on related heuristics. Additionally, for best use of the awareness after the identification of potential biases in intuition, the approach also includes some alternatives on DM and how to adopt the approach in project environments. Table 7.1 shows the observed phenomena explained in the introduction as motivational trigger for the research. With the support of the developed awareness approach, the observed phenomena can be identified and understood to stop the continuous self-questioning.

Observed Phenomena	***Knowledge Category***	***Potential Bias***
Request to get more insight for making a decision is rejected…	Feared Unknowns	The Focusing Illusion

You cannot understand how somebody can make such an uninformed decision…	Believed Knowns	Trust Expert Intuition
Accessible insights on information necessary for a decision is ignored or neglected…	Neglected Knowns	Confirmation Bias
Somebody is really convinced of his opinion with no valid reason…	Believed Knowns	Confidence over Doubt
Risks of taking a decision are not even considered…	Accepted Unknowns	The Planning Fallacy
You are taking a decision because you have to and are not really feeling good about it…	Neglected Knowns	Associative Coherence

Table 6.1: Identified Phenomena

With answering the research questions and filling the gaps identified during the literature review, a significant contribution to knowledge for **understanding influences on DM in UCA-RE** is accessible in academic context and supports **the awareness of biases in our intuition** as contribution to practice in business context. The following sections will summarize the contributions of this study.

6.4 Contribution to Knowledge and Practice

Contributions to knowledge is as important as contributions to practice. A DBA addresses both contributions as the research context is situated in practice and needs to be clarified using academic knowledge and methods. By applying knowledge to explain and enhance practice, insights are created which feed back into knowledge.

6.4.1 Contribution to Knowledge

The main contribution to knowledge of this study concerns the research area itself and the creation of a conceptual model representing it. Two different knowledge domains got reviewed in this study to identify their joint influences on DM in UCA-RE. One knowledge domain covering organizational structures including frameworks, methodologies, processes, whereas the other knowledge domain covers human psychology. The research area of UCA-RE is a trending topic in business and covered in literature. However, DM is only covered as instructional process to make better decisions. The actual influences of processes on DM psychology is not covered and consequently a contribution to knowledge.

For both knowledge domains, a specific funnel and spotlight approach were used to gather comprehensive insights on the high-level theories as well as specific underlying concepts of both domains. The separated funnel approach was a dedicated decision for this study to build a conceptual model explaining how processes and roles as well as thinking processes including intuition and heuristics influence DM in UCA-RE. The conceptual model is a contribution to knowledge because it represents insights of two exclusive knowledge domains influencing the same DM environment.

With contextualising the separated insights into the conceptual framework, the identified gaps in the literature for the interdependencies of processes and roles and thinking and heuristics revealed another contribution to knowledge. The answered research questions related to the influences of processes and roles on thinking and heuristics as well as the cascading influences on DM in UCA-RE completed the conceptual model by explanations why those influences exist and what is causing them.

Furthermore, the qualitative research using in depth interviews uncovered additional themes during the thematic analysis, which extend the conceptual model further and explain the interrelations of two exclusive knowledge domains around DM in UCA-RE in more detail. This is the third contribution to knowledge and a comprehensive extension of both knowledge domains in the academic context of this study, because the literature revealed information on what and how identified concepts interrelate but lack insights on why those interrelations

exist. By extending the conceptual framework using moderating concepts, explanatory insights were added to the influences on the relationships in the conceptual framework.

Answering RQ-1 and RQ-2 contributes consequently mainly to knowledge due to their explanatory purpose of gathering insight on why interrelations of the introduced concepts exist and add to the individual knowledge domains by extending the exploration and description of the concepts and their relationships with reasons why they exist.

The contributions to knowledge by explanations on why the identified relationships between the concepts exist are necessary to create approaches on how to become aware of the gathered insights in practice, which is explained in the next section. Even though the approach is mainly a contribution to practice, it contributes to knowledge as well due to its extension of theories on knowledge based on the research results from the qualitative data analysis. The gathered insights on influences between concepts from two distinct knowledge domains and its representations in an extension of knowledge categorizations might serve as base for further research on DM in UCA-RE.

6.4.2 Contribution to Practice

Using the contributions to knowledge, a main contribution to practice is the transfer of gathered insights into an approach for better awareness of biases during DM in UCA-RE. The explanatory insights from answering RQ-1 and RQ-2 to know why certain interrelations exist serve as base to explore an approach to answer the RQ-3 on how to become aware of the gathered insights, which contributes to practice by adopting the approach for DM in organisational environments.

The approach covers potential identification of stress factors in project environments which might benefit flawed DM and consequently negative impacts on product development. Furthermore, with the help of the introduced extended knowledge matrix in Section 5.3, a fast and guided knowledge categorization including potential heuristics supports decision makers in identifying potentially biased intuition.

Finally, some guidance on DM alternatives clarifies potential next steps including best practices to include a team or validate decisions. The approach streamlines DM especially for POs and UX designers, but also for any other stakeholder. With the approach, time could be saved in DM, which is important in a time stressed agile environment. Additionally, decision makers can use the awareness for DM clarification and justification in a team or towards customers. Summarized, contribution to practice is the approach to support decision makers to become aware of own thinking during DM in UCA environments and at the same time being able to communicate clearly and transparently reasons for DM.

With an initial guide on how to incorporate the approach into projects, process owners can validate the efficiency and effectiveness of user-centred and agile processes as well as identify potential improvements. Using the insights on influences of processes and roles on DM for process customizations can improve development efficiency and product quality significantly due to less flawed DM during RE. Especially the awareness about importance of user research inclusion is a significant contribution to practice in the context of this study, due to the strong recommendation on gathering enough and appropriate knowledge for DM.

Better decision quality based on less negative influencing processes and more transparent understanding of DM results in less risk on misleading or faulty decisions. Especially in subjectivity heavy UCD processes, decisions are vulnerable to discussions based on personal preferences or hierarchal power. The awareness approach works in both directions, self-awareness and as observer, which contributes to better understanding of limitations in DM without emotional triggers. This contribution benefits the practice in terms of social contracts, which are important to keep motivation and engagement high.

6.5 Limitations of Study

Both contributions, to knowledge and practice, are within the boundaries of this study, which at the same time poses some limitations.

Regarding the literature review, a limitation is the spotlight approach covering only very specific concepts and theories in both knowledge domains. The

limitations are due to the scope of this study and the need of deep insights of each concept for a comprehensive contextualisation of the research results in the conceptual model.

During the interview, the researcher becomes part of the influential environment on participants by creating the interview questions and presenting them. As mentioned in Section 3.10, limitations of the methodology, it needs to be accepted that the researcher might be unintentionally biased, which could result in leading questions. Question 2e and 4b of the interview guide (Appendix E) are acknowledged to be unintentionally leading in their wording. Question 2e was meant to be a yes/no question followed by explanations, but when asked incorrectly could potentially enforce a positive response. Question 4b was intended to be a proving question at the end of interviews to ensure feasibility and integrity of answers during the interviews. The wording however is leading and might result in similar worded answers.

The analysis of qualitative data is subjective and consequently prone to biases of the researcher, who is actively involved in the research context as explained in Section 1.2. To clarify the chances of potential biases during data analysis and to be transparent, expectations and initial thoughts before the analysis were reported in Section 4.2. The interpreted results of the analysis can be potentially biased due to the expertise and involvement of the researcher in the research context. However, it is impossible to interpret qualitative data without subjective reasoning by the researcher, which has to be acknowledged.

Another limitation due to scope and aim of the study is related to the awareness approach. The DM guidelines only represent alternatives which were results of the data analysis. No handling instructions of the knowledge categories or even heuristics got covered in this study. However, the aim of the research is to understand influences not to handle them, which also limits the possibility to cover risk awareness and its influences on DM.

Furthermore, related to the approach, the extent of the research limits the detailed elaboration on the adoption of the approach in project environments by giving high level guidelines on how to introduce, incorporate and reflect during ASD or UCD processes. Some initial recommendations on roles and

responsibilities for successful adoption is included as well and should be sufficient to start using the awareness approach without too much pressure on heavy process alterations due to the incorporation.

Finally, comprehensive testing of the research results is only partially possible because of time and resource limitations. Valid extensive testing would be only possible in a long-term project, which exceeds the time frame of the DBA. Consequently, the research got supported by a review through a presentation to an expert group including an interactive discussion session on the results of the research to compensate missing testing possibilities.

Finally, the research results and awareness approach are not generalizable due to a specific research context and strong focus on selected processes and roles. However, they could be a helpful as framework to be used in various unique situations or project setups.

6.6 Implications for Further Research

The limitations covered in the last section give chance for further research to extend the topic of this study. This section presents brief introductions to further research and represents an outlook for the topic. The research results are intended to serve as foundation for further research with contributions to knowledge and practice. The main part of this research is finished with this section.

6.6.1 Process and Role Scope Extension

The extension of the scope to cover more processes than Scrum for ASD and EDT for UCD is an implication for further research. Even though literature on various integration possibilities of ASD and UCD frameworks, methodologies and processes already exist, influences of those combinations on thinking and heuristics, and in return on DM in UCA-RE, is not covered and can be explored by future research. The focus on the roles of POs and UX designers is a limitation due to the scope of this research and its business context. However, DM is essential for every role in ASD or UCD processes and therefore influence the

overall success of product development. Dedicated research of influences from other roles next to POs and UX designers has the potential to provide understanding of lived roles in UCA-RE better and might improve collaboration in teams. A valid extension could be also perceiving a team as a DM unit and focussing specifically on team dynamics within user centred and agile development teams, including characterization of roles within highly iterative ASD and time consuming more sequential UCD.

6.6.2 Parallel-Competitive View for Unstructured Decision Problems

Considering primarily the parallel-competitive view on interaction styles of dual processes instead of the default-interventionist one is an alternative approach to this study approach. Showing benefits of intuitive systems for highly equivocal and not analysable unstructured decision problems through pattern recognitions using implicit information if explicit information is not sufficient. Especially in user-centred and design heavy decision problems with high subjectivity, intuition might outperform analysis to guide decision makers towards a solution that can be either analysed later in a DM process or provides answers for moving forward and gather new insights that can be included in DM during agile and iterative development of a product in UCA-RE.

6.6.3 Evolvement to Guideline and Dedicated Process Incorporation

With integrating the awareness approach as dedicated process extension, it would be necessary to develop a step-by-step guide within the approach as well. Even though the approach is already a two-step approach indicating the order in which steps should be executed, there is no rule-based application of the approach. For the transformation of the awareness approach into a DM guideline for certain types of decisions and overall best practices, it is necessary to refine the two steps and extend the approach to be more generalizable. Especially the topic of risk awareness needs to be included, since the limitations of this study did not allow it. The dedicated set of rules to applicate the awareness approach need to be part of company trainings and even part of processes and roles certifications for ideal adoption.

Another extension of this study could be the specific incorporation of the awareness approach into dedicated processes. This research covers already basic ideas how to incorporate the approach successfully, but also states that it is in the responsibility of the process owner to do so the best way possible. The extension would cover a step-by-step guideline for dedicated frameworks or methodologies to involve the awareness approach as DM support for practitioners and even rules on DM quality assurance within processes.

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Appendix A: Pilot Study Interview Guide

Interview

Overcoming Challenges in User Experience Design Decision-Making

Introduction/Scenario:

Imagine you are part of a project for developing an application that supports employees in tracking and scheduling their daily work life in a personalized and appealing way. Furthermore, it has to reflect legal work constraints to make sure the company and employees are following them.

Focus:

The focus of the interview is on the decision-making process, development and testing is out of scope. The final product that we would like to create in the scenario is a concept based on requirements for the app.

1. Describe the process from your perspective that is needed for engineering the requirements and create a user experience concept.

   PROBES: Do you recognize different requirements and decision-making types based on the focus on process or legal constraints and user experience? What is more important for the acceptance of the app, constraints or experience? Do you have any best practice or process in mind? (Experience)

2. How would you explain your involvement and role in the project?

   PROBES: Which responsibilities come with the role? What type of requirement needs to be decided on by your role? Do you feel you can fulfil the expectations of the role? What do you do if something is expected from you that fits not your role?

3. When would you expect to take part in the decision-making process?

   PROBES: What are preconditions that need to be met before you take part? What would you do if the conditions are not met?

4. Can you think of difference in decision-making between requirements that need to fulfil constraints and requirements which address user experience?

   PROBES: How would you describe decision making behaviour regarding process or legal constraints? How would you describe decision-making behaviour regarding user-experience? How do you feel in discussions about requirements of both types?

5. Do you recognize any point in time when decision-making is changing between the types?

   PROBES: How do you recognize if the types are changing? What is your reaction if types are changing? Is a change between types appropriate in your opinion?

6. What comments or questions do you have for me?

   PROBES: Is there anything you would like me to explain? What would you like to tell me that you've thought about during this interview?

Appendix B: Pilot Study Report

Data were collected using semi-structured interviews to follow a contextual structure but leave room for interpretation and thought evolvement so that the freedom for expressing the inner experiences was kept. The field manual of the semi-structured interview is attached in the appendix and is briefly explained in this section. The structure of the semi-structured interview reflected the needed clear understanding of the situation by starting with an introduction scenario which set boundaries for the scope of the business situation. The scenario set up a very abstract project in which the situation of interest, the DM process on UX RE, was the main scope. The interviewee had to think in the same role as in real-life in relatable business projects. The semi-structured interview had a core group of questions which structured the interview in topics to make sure the required inner experiences reflected the business situation of interest. However, at the same time the semi-structure gave enough space for following up on evolving sub-topics. Therefore, mainly open-ended questions were used to give the freedom of in-depth explanations. Moreover, probes helped to get into deeper explanations or supported the interviewees to extend on their thoughts as well as clarify the initial open-ended question. Due to the structure of the core questions and at the same time the freedom in answering with the help of probes, the interviews were comparable but gave insights on differences between the interviewees as described in the chapter of provisional findings.

The participants were chosen according to skills, roles in their business and overall business experience. This purpose sampling was used to target for potential respondents that were best suited to answer the research questions and objectives. In the pilot study, one interviewee was selected to target a senior PO and business analyst for exploring thoughts on business DM. The second interviewee covered the role of a junior UX consultant to elaborate the view on UX design following best practices and patterns as well as get impressions on first experiences with the full DM process from business to experience related topics and requirements.

The interviews of the pilot study were transcribed in two different formats, naturalized and denaturalized. In addition to the transcription of the interviews,

drawings during the interview were interpreted after the interview and used for the provisional findings.

The transcriptions and re-reading of the transcripts helped to understand the data better and in more detail. Furthermore, it gave the chance to detect important topics, which were not addressed initially but evolved during the interviews. That was important for the next step of the analysis, a content analysis including theme identification. The identified themes and categories were mainly coded according to the topic structure of the interview but got extended through topics which were extensively described by the interviewees. The main interviewee statements to the themes were compared and interpreted for research insight and provisional findings. In addition, memos were used to describe the interviewees in general and their behaviour during the interview. Also, annotations of the interview were used to document special behaviour or researcher thoughts during the interview. The coding was created using the structure of the interview and some additional codes which were identified during the re-reading of the interview transcripts. After setting up the coding framework, the interviews were analysed focusing on the specific codes. Important parts of the interviews were assigned to the related code. The classification and attributes for the pilot study was very basic and separated in the roles of the interviewees and their experiences, main skills and area of interest. For the pilot study, any advanced analytics was not done, only a basic content analysis using the codes for grouping and comparing as well as some memos and annotations for clarification and interpretation of the interview situation or unspoken hints of uncertainty or frustration. This content analysis was sufficient to get provisional findings and identify potential for improvement for the main study in terms of focus areas and necessary skill sets that might be suitable to deliver the insight that is needed to address the research questions, fulfil the objectives and reach the aim.

One of the very surprising provisional findings was the missing usage of processes or patterns for the DM in UX RE. Both interviewees were not relating to any of the well-known processes from the literature such as DT for example. The PO and business analyst referred to a known process framework for agile development of software products at one point, but only refers very poorly to the DM on the UX design.

Another provisional finding could be observed that the DM-process can be definitely separated in different process steps that are of interest to different roles and responsibilities. Both interviewees were talking about DM on business as well as experience requirements. However, especially the transition from process step to process step with changing requirements and needed skill sets of decision makers were differently noticed by the interviewees but is not addressed by the literature for explanation and understanding.

Moreover, processes such as DT or agile Scrum agile development focus on involving all subject matter experts throughout the whole DM process. The interviewees clearly stated that this approach is not efficient or effective as to many experts with distinct skill sets practice to much influence on the experience design. Instead, the process has to be clearly separated into the business and experience focused process steps which are decided on by the appropriate roles and responsibilities with the necessary skill sets.

Interestingly, both interviewees stated the importance of participation of the PO and UX designer differently and placed their involvement from being completely involved in the DM to being selectively involved depending on skillset, experience, role and responsibility. In the end, the transition between the two DM focus areas, business and experiences, has to be clearly identified to avoid loss of efficiency and avoid friction between the DM roles of the PO and UX designer. In summary, the combination of collecting insight with the help of different skilled and experienced participants showed a very clear difference in the awareness of the power balance and perspective of an ideal DM process.

However, for the main study a broader skill and experience set of participants is needed to recheck the provisional findings and even get deeper insight into the impact of the experience and skill level on the quality of DM related to UX RE. Also, the interesting provisional finding of the various interpretation of involvement of the roles needs to be researched in more detail to get a better picture on the understanding of the participants view on their own as well as on the corresponding role of either a PO or UX designer. In general, the understanding of the roles and responsibilities by the participants has to be gathered for a crosscheck with the definitions by literature.

One of the most important provisional findings however was the uncertainty of the participants in the description of the decision-process itself related to its characteristics such as chosen wording, reasoning, behavioural situations. In essence, the participants could not explain the felt difference in DM related to the types of requirements that needed to be decided on and therefore the identification of the responsible role and needed skillset was described as fuzzy and confusing. This provisional finding impacts the main study to include more focus on the DM process itself including psychological and behavioural elements. Furthermore, the elaboration on the types of requirements is very important to identify the responsible roles capable of making the “least wrong” decisions. Besides the change and addition of the literature review by the psychological knowledge domain of DM, it impacts the structure of the semi-structured interview. The result of the research is changing from a new solutioning process to an updated approach to the process. Moreover, it became clear that it is necessary to validate the updated approach via an expert group to make sure the already recognized, but unknown phenomena during the DM process can be successful addressed.

Appendix C: Participant Information (Interview)

Participant Information

Understanding the Impacts on & of Heuristics in UX Requirements Engineering:

The awareness of biases in our intuition

Introduction My name is Robert Krombholz, and I am a research student at Edinburgh Napier University. As part of my doctoral degree, I am undertaking research for my Honours dissertation. The study will be undertaken in professional as well as academic research.

Research & Contribution This study will investigate potential pitfalls during the decision-making for user experience requirements engineering. For that, observable phenomena during the requirements engineering process is explored concentrating especially on the role of the product owner and user experience designer. The process and role definitions in conjunction with psychological insight provide the underpinning of the conducted research for professional contribution by creating awareness and explanation for business situations struggling with those phenomena. Moreover, the analysis and discussions of the research findings are an academic contribution by filling the gap in understanding of psychological influencers during decision making related to user experience design.

Sampling & Requirements I am looking for volunteers to participate in the project. Potential participants are purposeful selected by criteria such as primary business role and experience in business.

Approach & Process If you agree to participate in the study, you will be asked to take part in a semi-structured interview (guiding questions) in a conversational style. There is no test involved and no judgement intended. The whole procedure should take no longer than 45-60 minutes. You will be free to withdraw from the study at any stage, you would not have to give a reason, and it will not affect you in any way.

Data & Result Usage All data will be anonymised as much as possible, but you may be identifiable from the recordings of your voice or by a short participant introduction in the dissertation based on your information given at the beginning of the interview. Your name will be replaced with a participant number, and it will not be possible for you to be identified in any reporting of the data gathered. All data collected will be stored on a pc that is encrypted, password protected and to which only I have access to. These will be kept till the end of the examination process, following which all data that could identify you will be destroyed. The results may be presented at conferences, in business workshops or other kind of talks and presentations.

Questions & Consent If you have any other concerns or questions, please feel free to contact me any time. My contact details are given below.

Robert Krombholz

[redacted]

[redacted]

If you have read and understood this information sheet, any questions you had have been answered, and you would like to be a participant in the study, please now see the consent form.

Appendix D: Research Consent Form

Edinburgh Napier University Research Consent Form

Understanding the Impacts on & of Heuristics in UX Requirements Engineering:

The awareness of biases in our intuition

Edinburgh Napier University requires that all persons who participate in research studies give their written consent to do so. Please read the following and sign it if you agree with what it says.

1. I freely and voluntarily consent to be a participant in the research project on the topic of explaining the impacts on and of heuristics on the decision-making in the context of user experience requirements engineering to be conducted by Robert Krombholz, who is an undergraduate/postgraduate student/staff member at Edinburgh Napier University.

2. The broad goal of this research study is to explain impacts of processes and roles on the thinking of decision makers. Moreover, understanding how impacted thinking by biases in intuition through heuristics influences the decision making in user experience requirements engineering. Additionally, how to become aware of the biases and deal with them in nosiness context. Specifically, I have been asked to take part in a semi-structured interview with guiding questions which should take no longer than 45-60 minutes to complete.

3. I have been told that my responses will be anonymised. My name will not be linked with the research materials, and I will not be identified or identifiable in any report subsequently produced by the researcher.

4. I also understand that if at any time during the interview I feel unable or unwilling to continue, I am free to leave. That is, my participation in this study is completely voluntary, and I may withdraw from it without negative consequences. However, after data has been anonymised or after publication of results it will not be possible for my data to be removed as it would be untraceable at this point.

5. In addition, should I not wish to answer any particular question or questions, I am free to decline.

6. I have been given the opportunity to ask questions regarding the interviewing procedure and my questions have been answered to my satisfaction.

7. I have read and understand the above and consent to participate in this study. My signature is not a waiver of any legal rights. Furthermore, I understand that I will be able to keep a copy of the informed consent form for my records.

_____ _____

Participant's Signature Date

I have explained and defined in detail the research procedure in which the respondent has consented to participate. Furthermore, I will retain one copy of the informed consent form for my records.

_____ _____

Researcher's Signature (Robert Krombholz) Date

Appendix E: Main Study Interview Guide

Interview

Understanding the Impacts on & of Heuristics in UX Requirements Engineering:
The awareness of biases in our intuition

1. Introduction (3):

    a. Could you please introduce yourself shortly by stating your role and business experience in years? (1)
    b. How would you describe your daily work in 2 to 3 sentences? (2)

2. RQ-1: Impact of Processes and Roles on Thinking and Heuristics (10):

Please keep your own role and all your experience in mind while we are going through the questions of this part of the interview.

    a. Which user centred processes for requirements engineering do you use or know and how do they look like (roughly)? (2)

    b. What are the reasons why you do or do not follow those processes? (2)

    c. How do you explain your own role and your responsibilities? In comparison: How would you explain the role of the product owner / user experience designer with your own words? (2)

    d. In your own word, how would you explain a “perfect” relationship of a PO and UX designer? (2)

    e. Do you have the feeling that the mentioned processes and expectations on your role impact your decision making? Please explain! (2)

3. RQ-2: Impact of Intuition and Heuristics on UX Requirements Engineering (10):

For the second part of the interview, we start with a short quiz. The answer is not going to be evaluated, the importance is in the feeling during answering. This is not a test of any kind; straight honesty is highly appreciated!

"A sandwich and a drink cost together 4,50€. The sandwich costs 3€ more than the drink. How much does the drink cost?"

Please keep that feeling you had during answering in your mind! It is important for answering the next questions.

a. How would you describe the feeling that you just had when answering the question? (2)

b. Have you had this kind of feeling at any point when making decisions for a product? If YES, please explain why you think this feeling comes up. (2)

c. Can you think of situations during RE when you are deciding intuitively? If YES, how would you describe those situations? (2)

d. Have you had the situation of making decisions in RE based on insufficient information? If YES, why are you making the decision anyway? If NO, how do you know the information is sufficient? (2)

e. Do you think POs and UX designers should make decision on insufficient information? Please explain your answer. (2)

4. RQ-3: Awareness of Impacts on Decision Making (10)

    a. Please reflect on any project taking in account the content of the interview about impacts on your decision making by processes, your role and your thinking. Think loud, please! (5)

    b. Would you agree that it is important to know how processes and roles impact your decision making? If YES, how would you check for impacts on you decision-making? If NO, why not? (3)

5. Conclusion (2):

    a. What additional comments or questions do you have for me? Or is there something you would like to tell me that you've thought about during this interview? (2)

    b. Would you like to be informed about the research results? (Yes/No)

Appendix F: Interview Transcripts

The transcribed interviews are provided upon request.

Appendix G: Coding Book (Initial Codes)

Initial Codes	*Files*	*References*
absence of risk management	1	1
afraid of new insights	1	1
agile process	2	2
approach avoid DM	5	8
approach to DM as team	2	8
approach to validate DM	2	6
ask for more time	2	4
awareness depends on experience	2	2
awareness of designer role	3	6
awareness of intuition	1	1
benefits of using user research	1	1
blind DM	1	1
business analysis	1	1
challenge combining UCD and ASD	1	1
challenge for awareness	2	2
change DM afterwards	3	4
client centred RE	1	1
client not willing to UCD	1	1
confronted with solutions	2	2
convince for user research	1	1
convince PO from UCD	1	1
CRT answer	10	21
CRT feeling	10	17

CRT situation in business	10	12
decisions based on gut feeling	1	1
design subjectivity	1	1
DT	10	11
DM based on gut feeling	1	1
DM biases	1	1
DM without knowing	1	1
effect of missing processes	1	1
expectation on designer	1	1
expecting DM from PO	2	2
how to become aware	3	6
impact PO role on DM	1	1
impact UX role on DM	2	2
impact of process on po	3	6
impact of project environment	3	3
impact process on team	1	2
impact process on UX	3	4
impact role on DM	3	3
intuitive thinking po	2	4
knowledge awareness	2	2
knowledge sharing in team	3	5
later repair of wrong DM	1	1
need for awareness	4	6
need for DM on insufficient info	7	18
need for reflection	1	2

no design needed	1	1
no knowledge sharing in team	3	4
no research needed	4	7
not enough research	2	2
other processes	3	3
own role	10	12
own role change	2	3
PO UCD capability	1	1
pre-development design phase	1	1
PROBLEM with PO role	1	3
project environment restrictions	1	1
proxy po	1	1
reason decision on insufficient info	10	21
reason following processes	5	7
reason for awareness	3	4
reason for intuitive DM	10	17
reasons to not follow processes	7	10
relationship PO - UX	7	16
responsibility consultant	2	2
responsibility designer	7	15
responsibility experience consultant	4	9
responsibility PO	7	20
risk awareness	6	7
self-expectation pressure	1	2
solution analysis	1	1

team skill needed	2	2
time and budget constraints	4	7
time pressure	1	1
UCD process	3	3
user research	2	2
UCA-RE process	1	2
using user research	2	2
UX friendly PO	1	1
validation need	1	1

Appendix H: Coding Book (Categorized Codes)

Codes in Categories	*Files*	*References*
AWARENESS	10	35
how to become aware	5	10
knowledge awareness	2	2
need for awareness	10	15
risk awareness	6	8
CONSULTANCY	4	8
client not willing to do UCD	1	3
confronted with solutions	2	2
responsibility consultant	3	3
CRT	10	51
CRT answer	10	21
CRT feeling	10	18
CRT situation in business	10	12
DM	10	65
approach avoid or validate DM	5	18
need for DM on insufficient info	7	18
reason for DM on insufficient info	10	29
INTUITION	10	20
reason for intuitive DM	10	20
PROCESSES	10	54
impact of processes	6	13
other processes	3	3
reason to follow processes	5	7

reasons to not follow processes	7	11
understanding of processes	10	20
PROJECT ENVIRONMENT	7	11
time and budget constraints	7	11
RESPONSIBILITIES	10	45
responsibility designer	7	16
responsibility experience consultant	4	9
responsibility PO	7	20
ROLES	10	51
impacts of roles	6	10
PROBLEM with PO role	1	3
relationship PO - UX	7	16
understanding of roles	10	22
TEAM	6	19
approach to DM as team	3	10
knowledge sharing in team	3	5
no knowledge sharing in team	3	4
USER RESEARCH	4	19
no user research (necessary)	4	11
using user research (benefit)	2	6

Appendix I: Participant Information (Presentation)

Edinburgh Napier UNIVERSITY

Pre-Information for Presentation

Understanding the Impacts on & of Heuristics in UX Requirements Engineering:

The awareness of biases in our intuition

Introduction As part of my doctoral degree, the presentation will be used for verification purpose. The presentation is not part of the actual research, but an important insight gathering for the discussion phase in the dissertation. Especially the discussion part of the presentation contributes to the validation of the findings.

Research & Contribution The study investigates potential pitfalls during decision-making for user experience requirements engineering. More precisely, psychological influencers, such as heuristics, biases and empathy, during thinking processes and their impacts on the decision making are investigated and explained. Furthermore, impacts of processes and roles in user experience requirements engineering on those psychological influencers are investigated as well. Therefore, the study is based on a thematic literature review covering various knowledge domains by combining requirements engineering and human psychology. The research itself is following a qualitative approach and uses semi-structured interviews for data collection which is analysed using a retroductive thematic analysis. The presentation, especially the discussion part, serves as incremental part of the professional contribution by elaborating on the validity of the findings and the potential success of an updated approach to decision making in user experience requirements engineering.

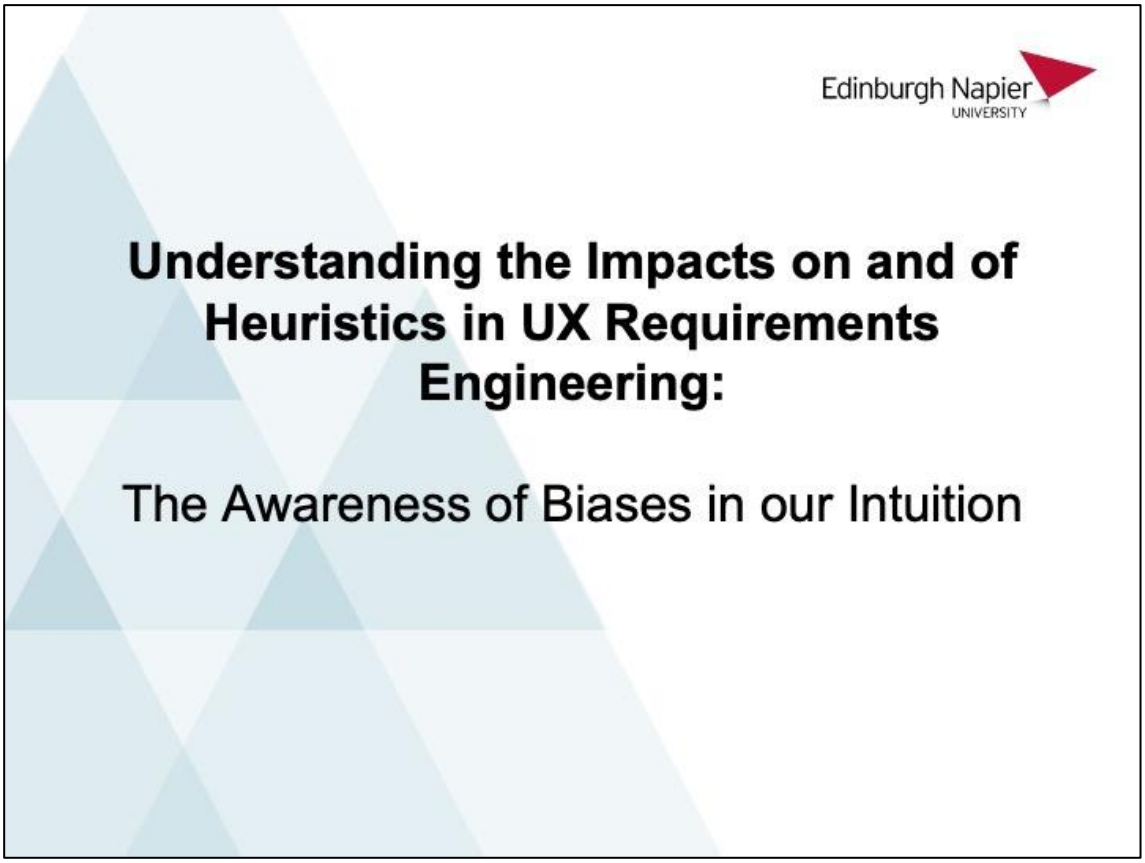
Approach & Process The presentation is separated in an informational part and a discussion part. The informational part covers the research intend, an introduction to the knowledge base and research approach as well as the findings and analysis. The informational part takes about 15 minutes. The discussion part starts with a reflective thinking and note taking phase of 5 minutes for preparing an individual response to the introduced research results. After the preparation, the participants are asked to get involved in a free discussion about their personal experience and opinions on the research topic. There is no test involved and no judgement intended. The whole presentation including discussion should take no longer than 40-45 minutes.

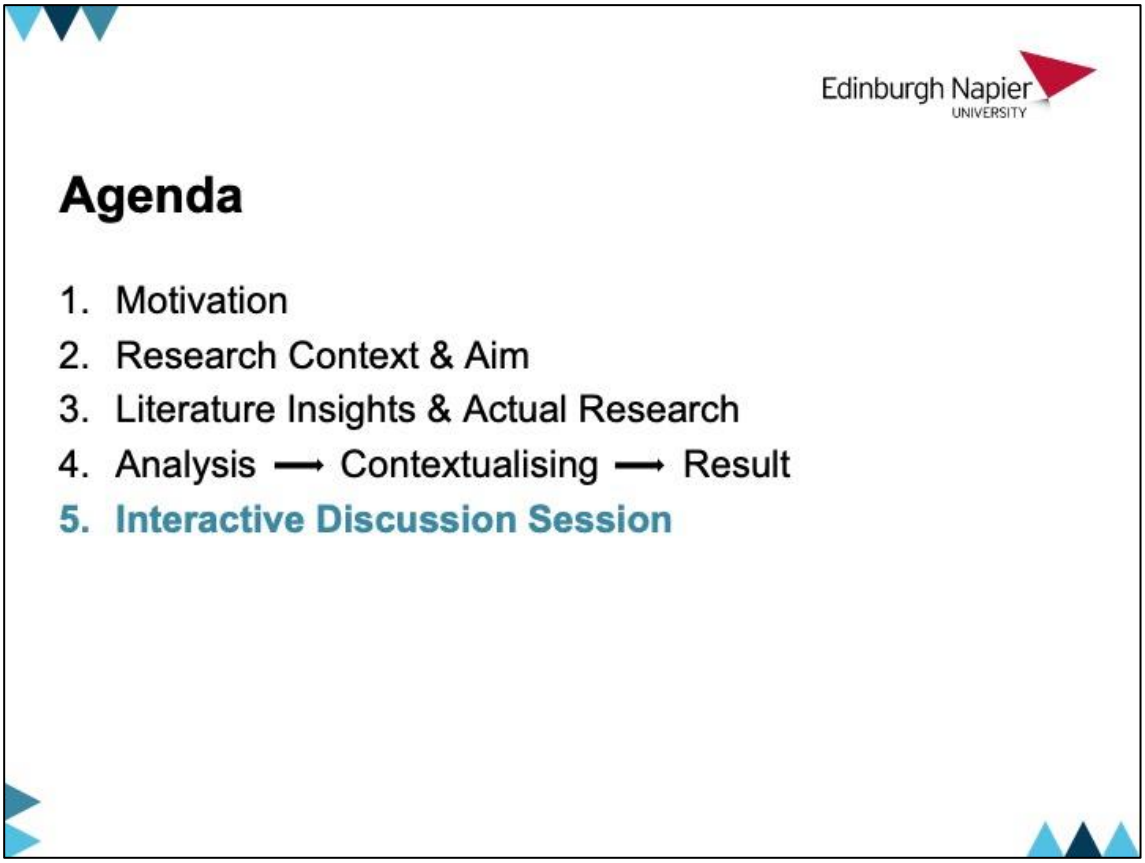
Data & Result Usage The presentation will be recorded and analysed afterwards. The analysis will not cover the individual participants. All data will be anonymised as much as possible, and it will not be possible for you to be identified in any reporting of the gathered insight. Notes, which got taken during the presentation, will be verified using the recoding and missed insight on the topic will be added to the notes. The notes will be mentioned and interpreted in the study for verification purposes. All insight will be used, no discriminative selection of information is intended. All data collected will be stored on a pc that is encrypted, password protected and to which only I have access to.

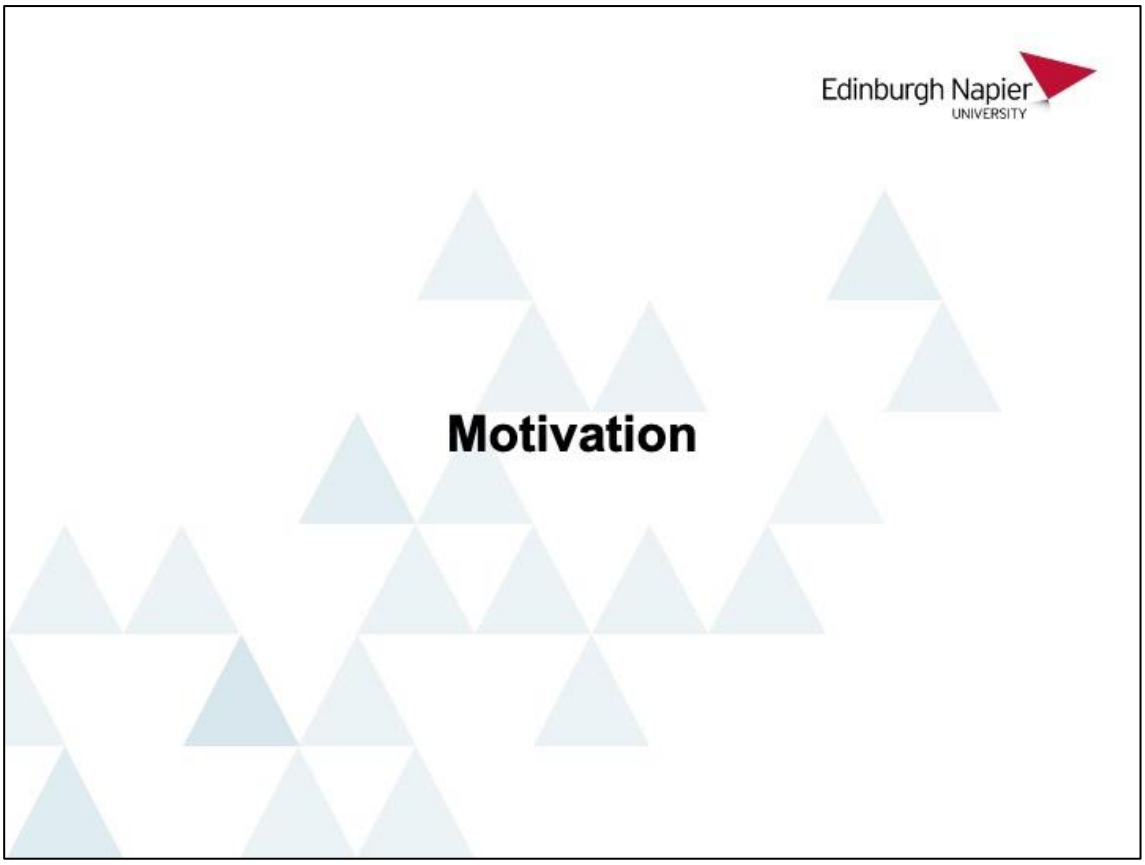
Questions If you have any questions upfront or after the presentation, please feel free to contact me any time. My contact details are given below.

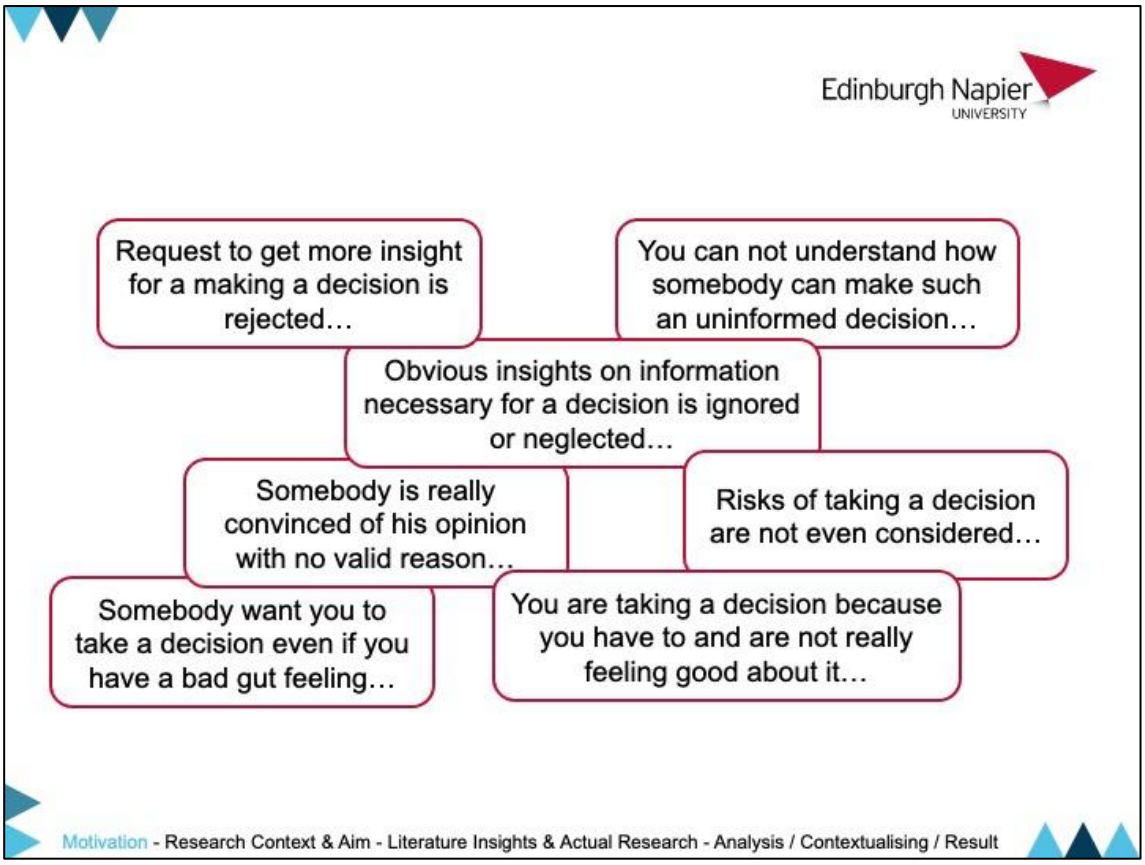
Robert Krombholz
[redacted]
[redacted]

Appendix J: Expert Group Review Presentation






Edinburgh Napier
UNIVERSITY
Motivation


Edinburgh Napier
UNIVERSITY
Request to get more insight for a making a decision is rejected…
You can not understand how somebody can make such an uninformed decision…
Obvious insights on information necessary for a decision is ignored or neglected…
Somebody is really convinced of his opinion with no valid reason…
Risks of taking a decision are not even considered…
Somebody want you to take a decision even if you have a bad gut feeling…
You are taking a decision because you have to and are not really feeling good about it…
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result

Source (Image): https://uxdesign.cc/decision-making-for-product-managers-7fef3292cb65

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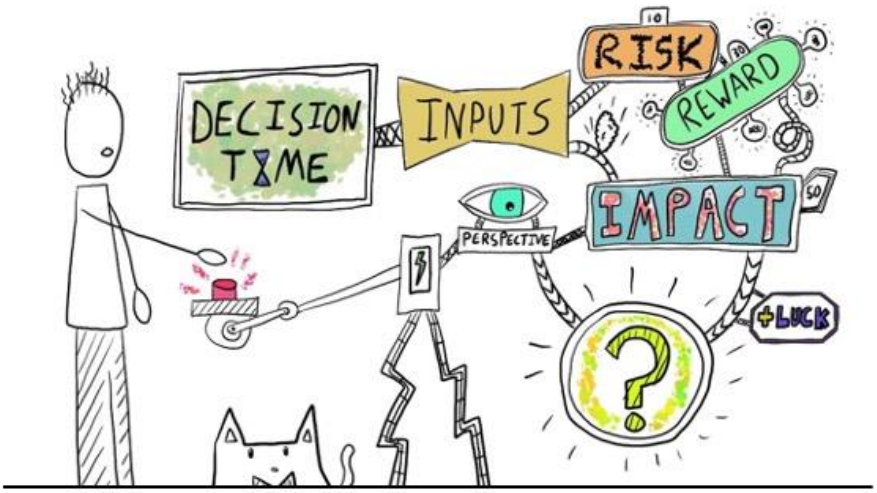

Why are we …

… making decisions even if we are not really capable of doing so?
… really convinced by our decisions even if there is no valid base for it?
… rarely really changing perspective when making decisions?
… sometimes not evaluating or ignoring the risks of our decisions?
… not fully aware of the impact of our decisions, especially on others?
… making decisions even if we have a bad gut feeling about it?
… making decisions using: I am not sure, but…. / … IMHO) / I believe …

Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result

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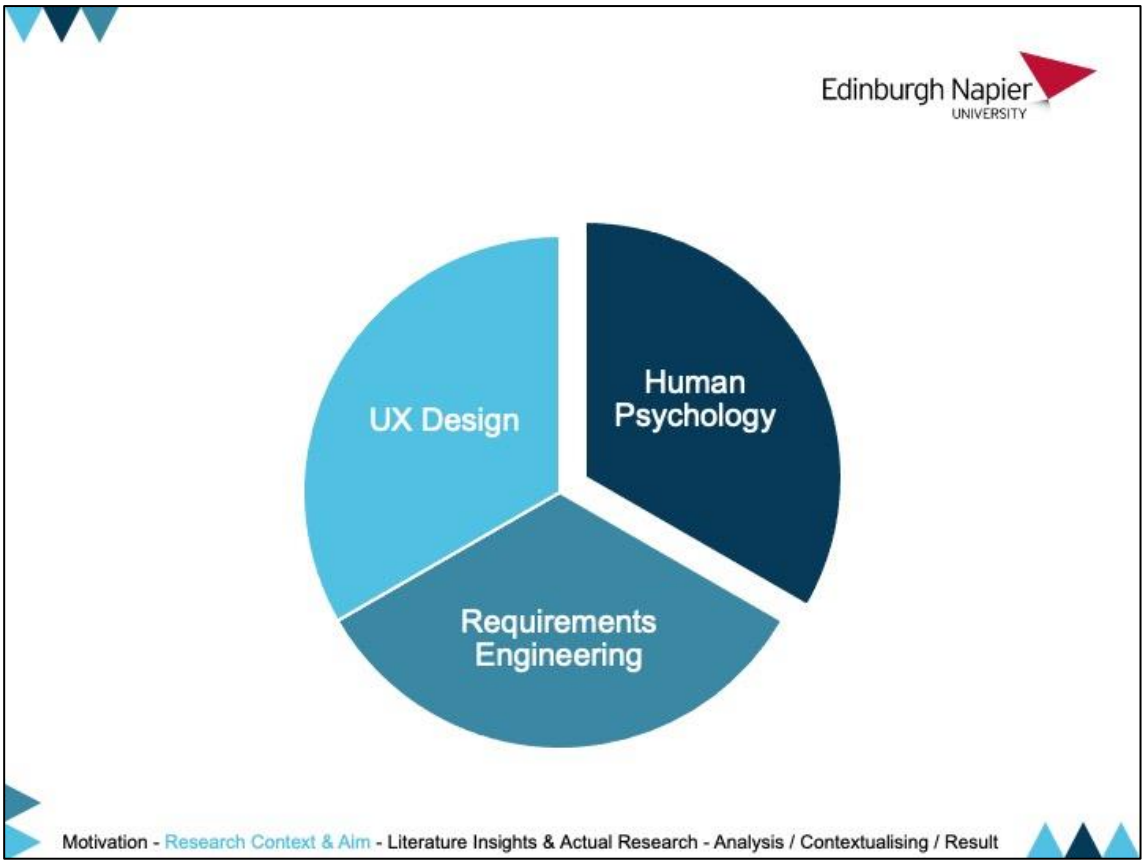
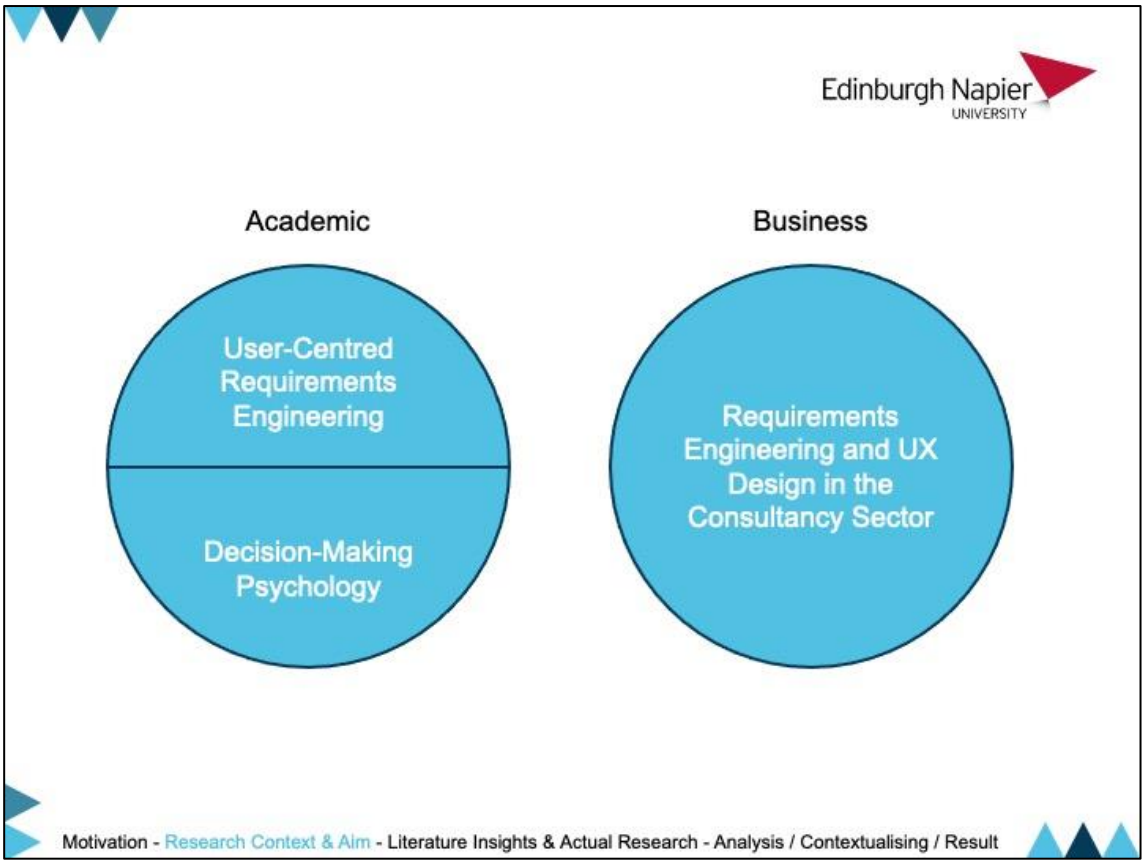
Research Context & Aim


Edinburgh Napier UNIVERSITY
UX Design
Human Psychology
Requirements Engineering
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Edinburgh Napier UNIVERSITY
Academic
Business
User-Centred Requirements Engineering
Decision-Making Psychology
Requirements Engineering and UX Design in the Consultancy Sector
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result

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Literature Insights & Actual Research

Edinburgh Napier UNIVERSITY

Processes and roles in user-centred requirements engineering are well described. Studies on the actual usage and applicability lack scientific evidence.

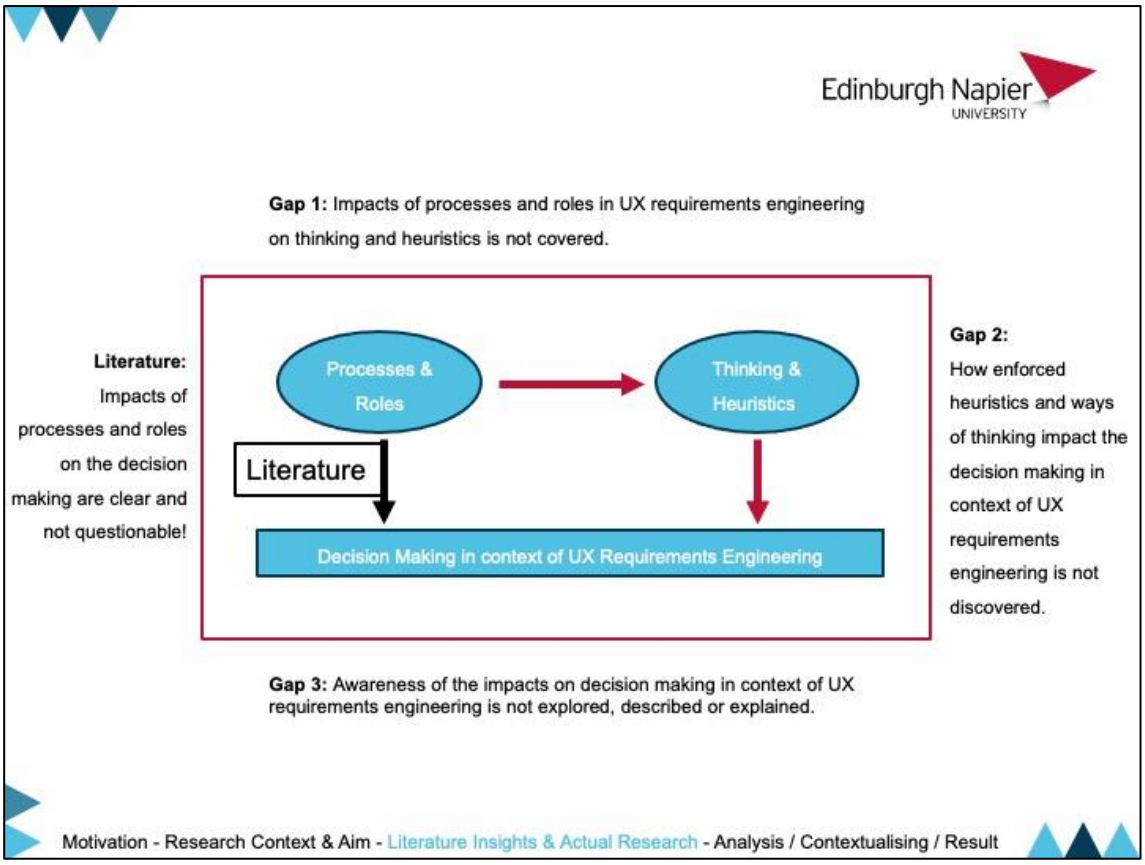
Processes & Roles

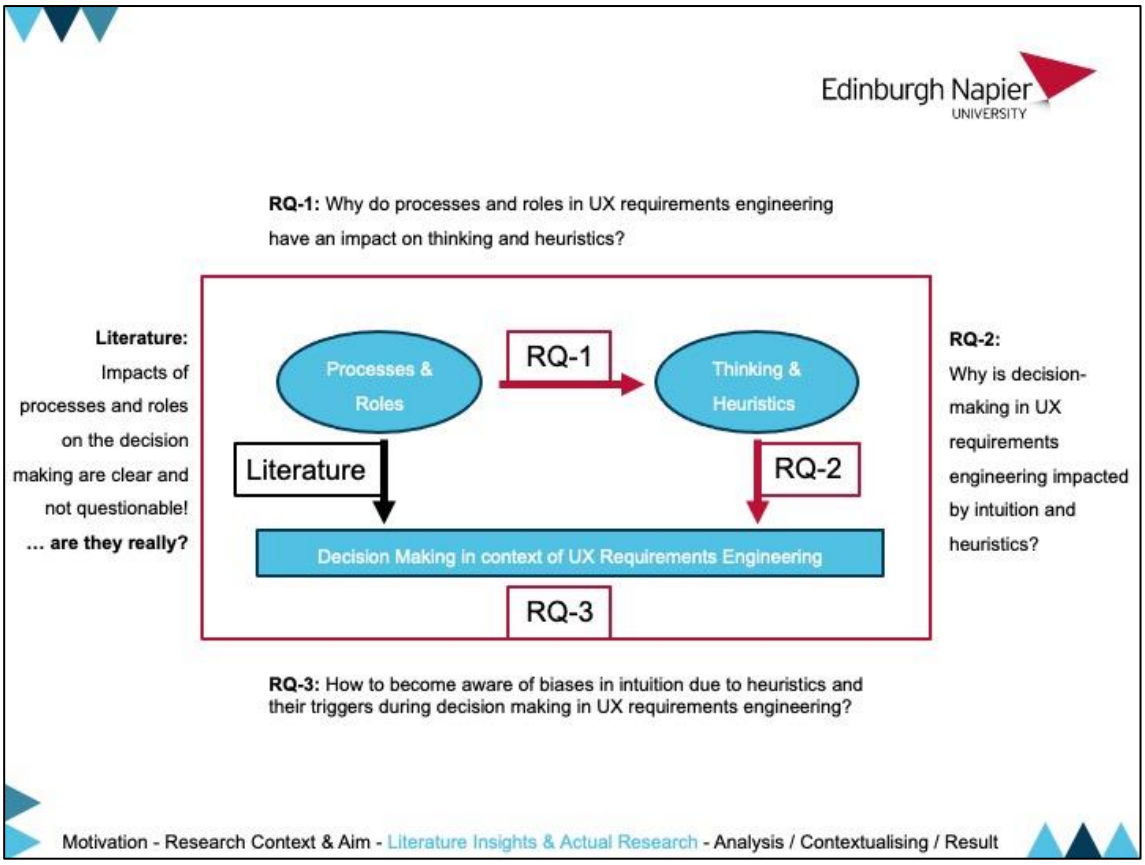
Thinking & Heuristics

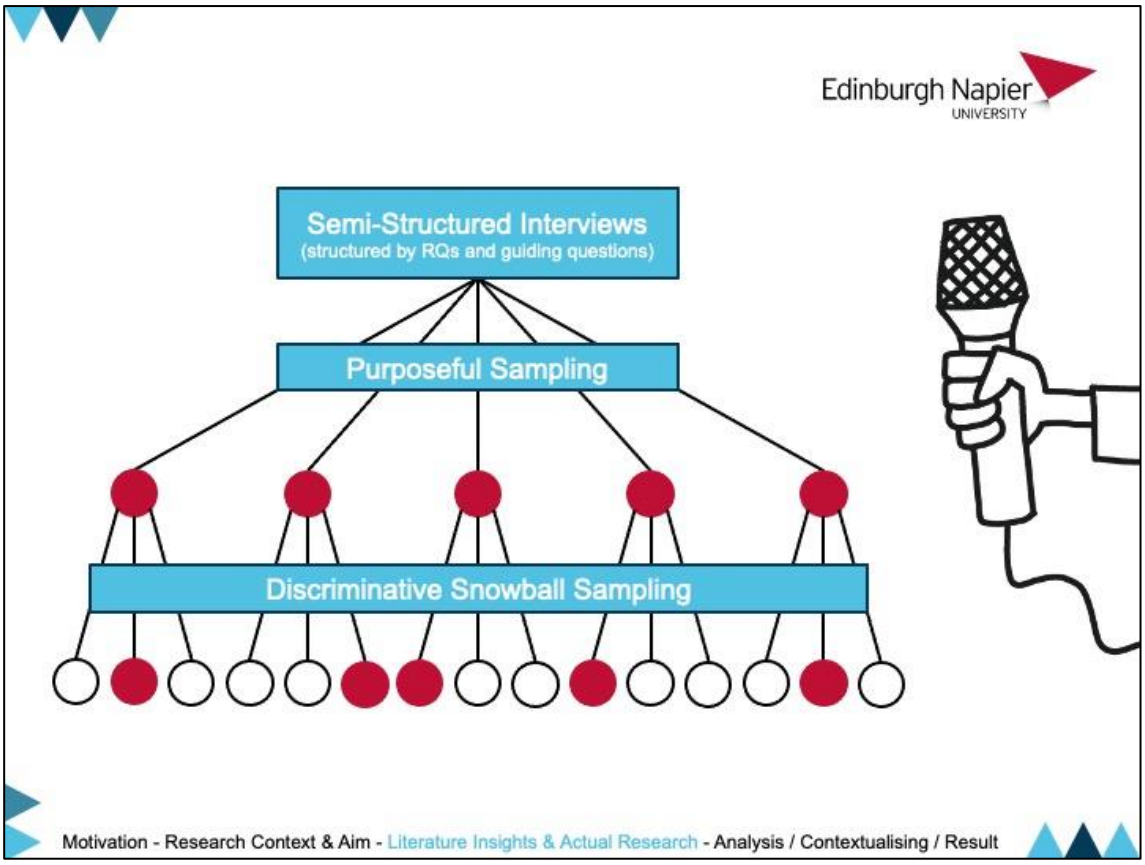
Especially the field of study about heuristics and intuition in decision making psychology presented a lot of insight which matches experienced phenomena.

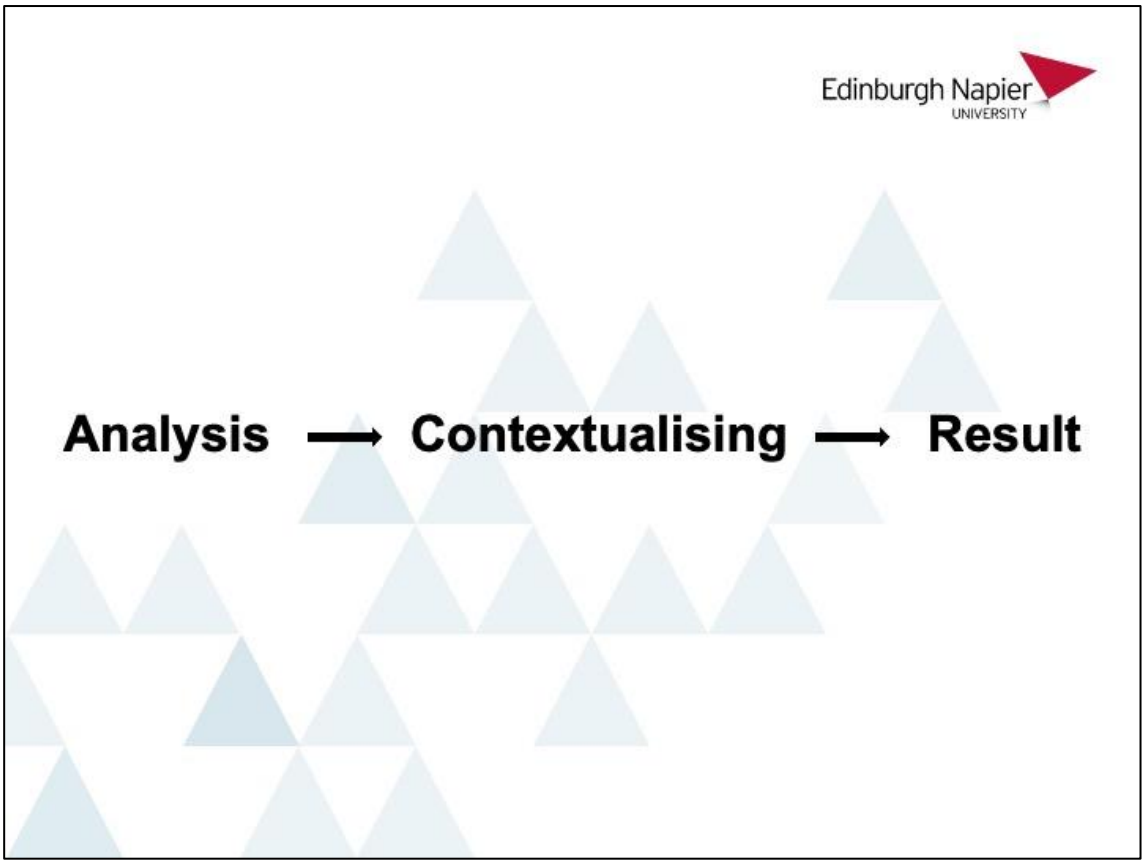
Decision Making in context of UX Requirements Engineering

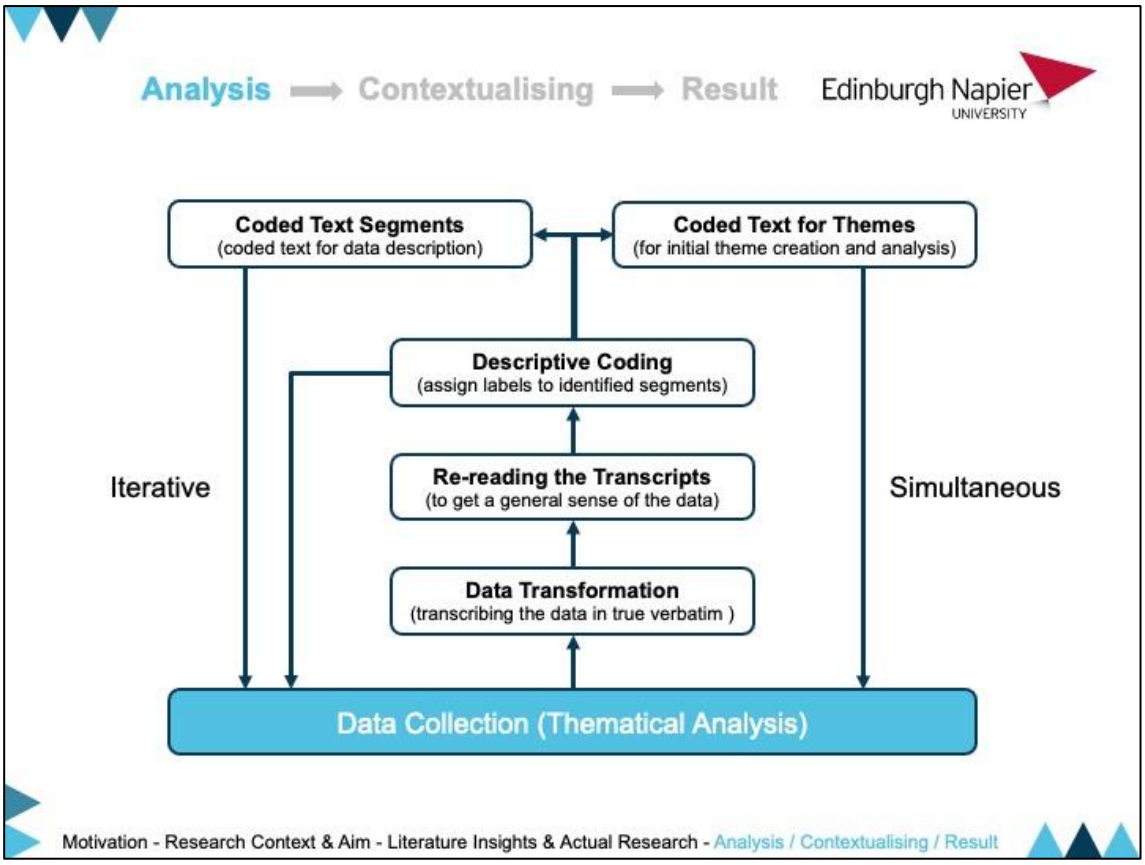
Decision-Making in the context of UX design is mainly focusing on the decisions which are enforced while users experiencing the product. The literature rarely covers the aspect of decision-making during requirements engineering for a product, which becomes especially important when deciding on user-centred requirements.

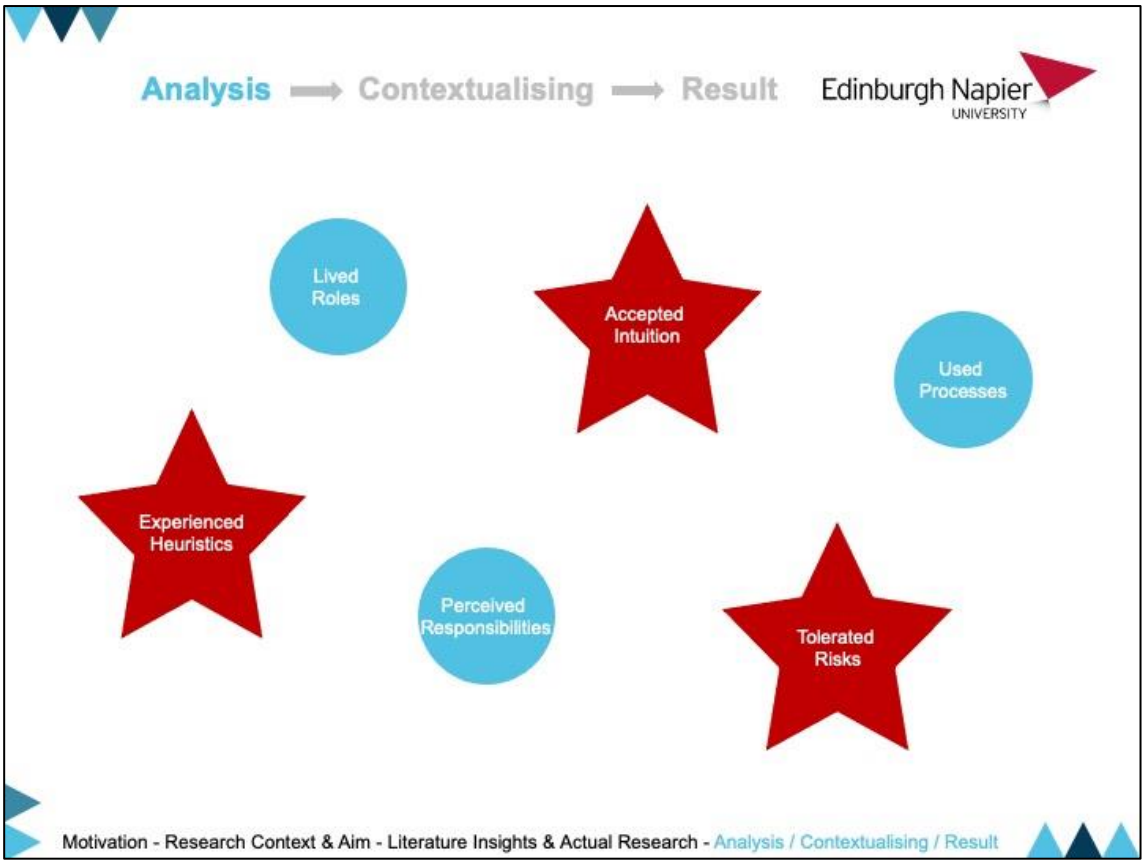

Edinburgh Napier UNIVERSITY
Gap 1: Impacts of processes and roles in UX requirements engineering on thinking and heuristics is not covered.
Literature: Impacts of processes and roles on the decision making are clear and not questionable!
Processes & Roles
Thinking & Heuristics
Literature
Decision Making in context of UX Requirements Engineering
Gap 2: How enforced heuristics and ways of thinking impact the decision making in context of UX requirements engineering is not discovered.
Gap 3: Awareness of the impacts on decision making in context of UX requirements engineering is not explored, described or explained.
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result

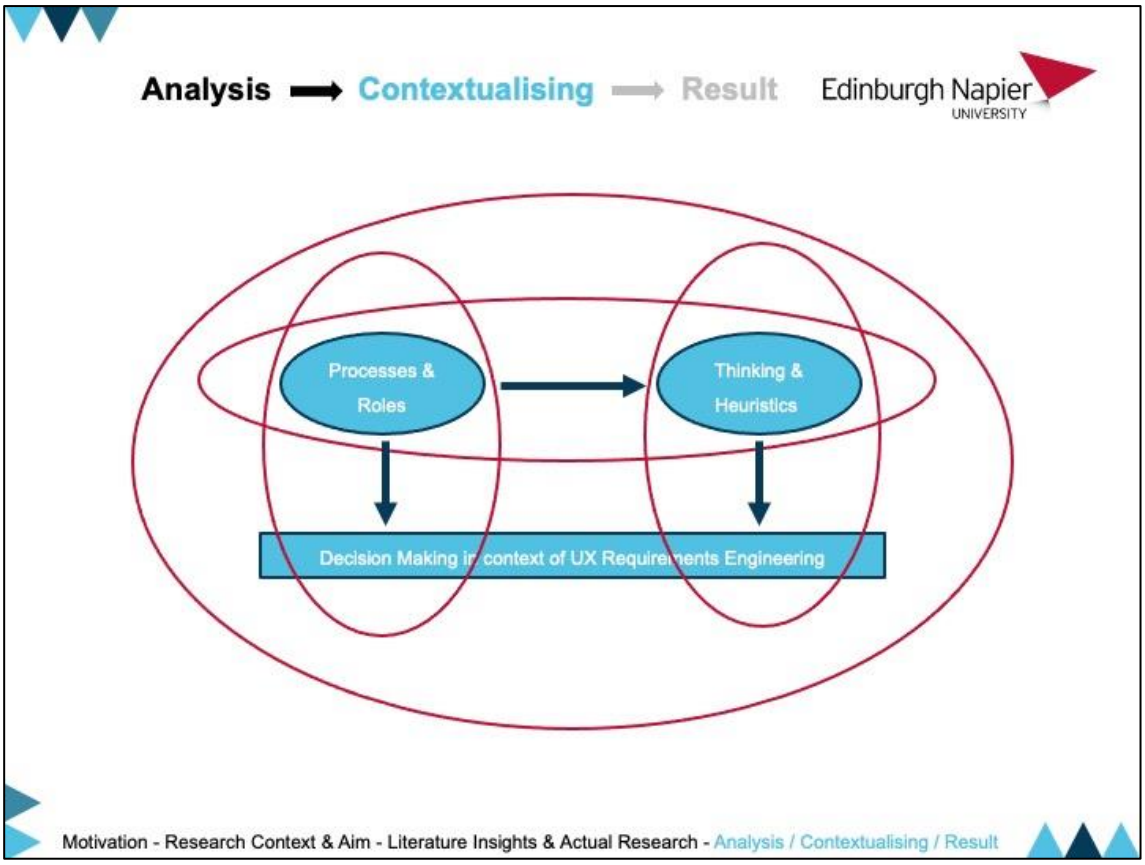

Edinburgh Napier UNIVERSITY
RQ-1: Why do processes and roles in UX requirements engineering have an impact on thinking and heuristics?
Literature: Impacts of processes and roles on the decision making are clear and not questionable! ... are they really?
Processes & Roles
RQ-1
Thinking & Heuristics
Literature
RQ-2
Decision Making in context of UX Requirements Engineering
RQ-3
RQ-2: Why is decision-making in UX requirements engineering impacted by intuition and heuristics?
RQ-3: How to become aware of biases in intuition due to heuristics and their triggers during decision making in UX requirements engineering?
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Edinburgh Napier UNIVERSITY
Semi-Structured Interviews
(structured by RQs and guiding questions)
Purposeful Sampling
Discriminative Snowball Sampling
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Edinburgh Napier UNIVERSITY
Analysis → Contextualising → Result


Analysis → Contextualising → Result
Edinburgh Napier UNIVERSITY
Coded Text Segments
(coded text for data description)
Coded Text for Themes
(for initial theme creation and analysis)
Descriptive Coding
(assign labels to identified segments)
Re-reading the Transcripts
(to get a general sense of the data)
Data Transformation
(transcribing the data in true verbatim)
Iterative
Simultaneous
Data Collection (Thematical Analysis)
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Analysis → Contextualising → Result
Edinburgh Napier UNIVERSITY
Lived Roles
Accepted Intuition
Used Processes
Experienced Heuristics
Perceived Responsibilities
Tolerated Risks
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Analysis → Contextualising → Result
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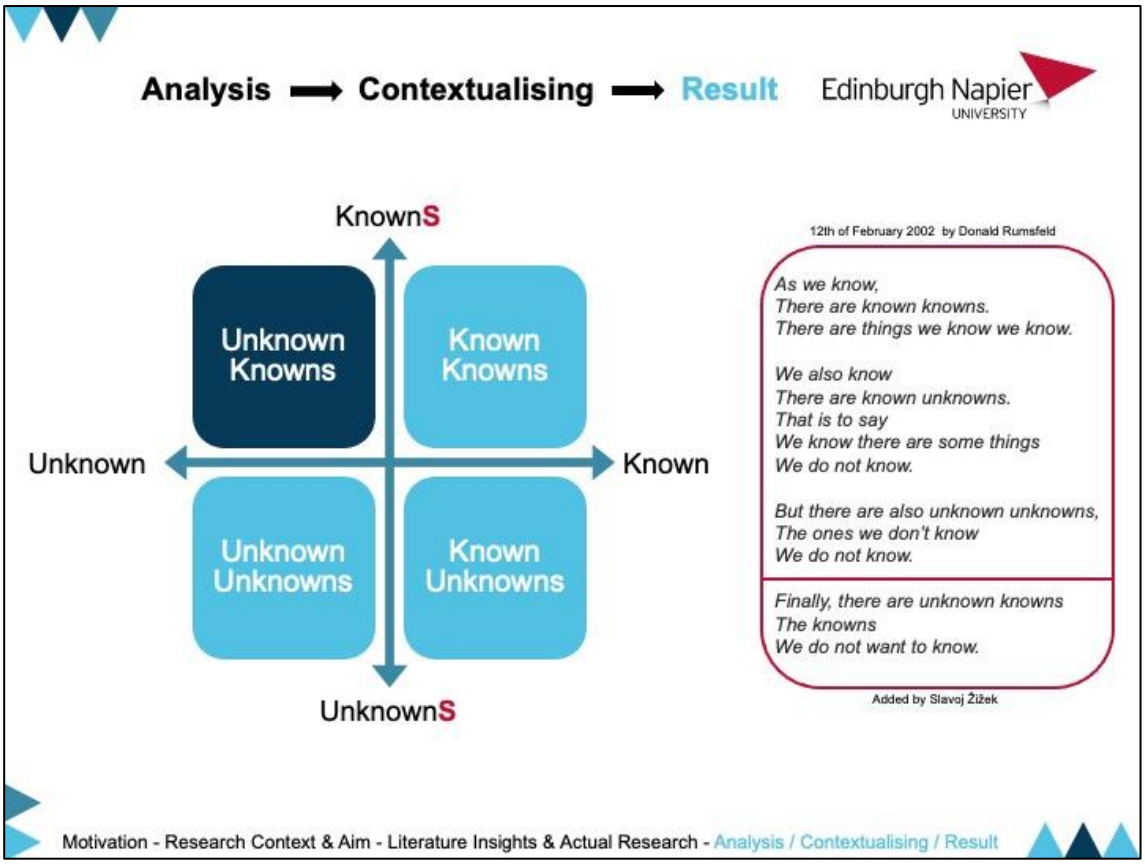
Processes & Roles
Thinking & Heuristics
Decision Making in context of UX Requirements Engineering
Motivation - Research Context & Aim - Literature Insights & Actual Research - Analysis / Contextualising / Result


Analysis → Contextualising → Result
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KnownS
Unknown Knowns
Known Knowns
Unknown
Known
Unknown Unknowns
Known Unknowns
UnknownS
12th of February 2002 by Donald Rumsfeld
As we know,
There are known knowns.
There are things we know we know.
We also know
There are known unknowns.
That is to say
We know there are some things
We do not know.
But there are also unknown unknowns,
The ones we don't know
We do not know.
Finally, there are unknown knowns
The knowns
We do not want to know.
Added by Slavoj Žižek
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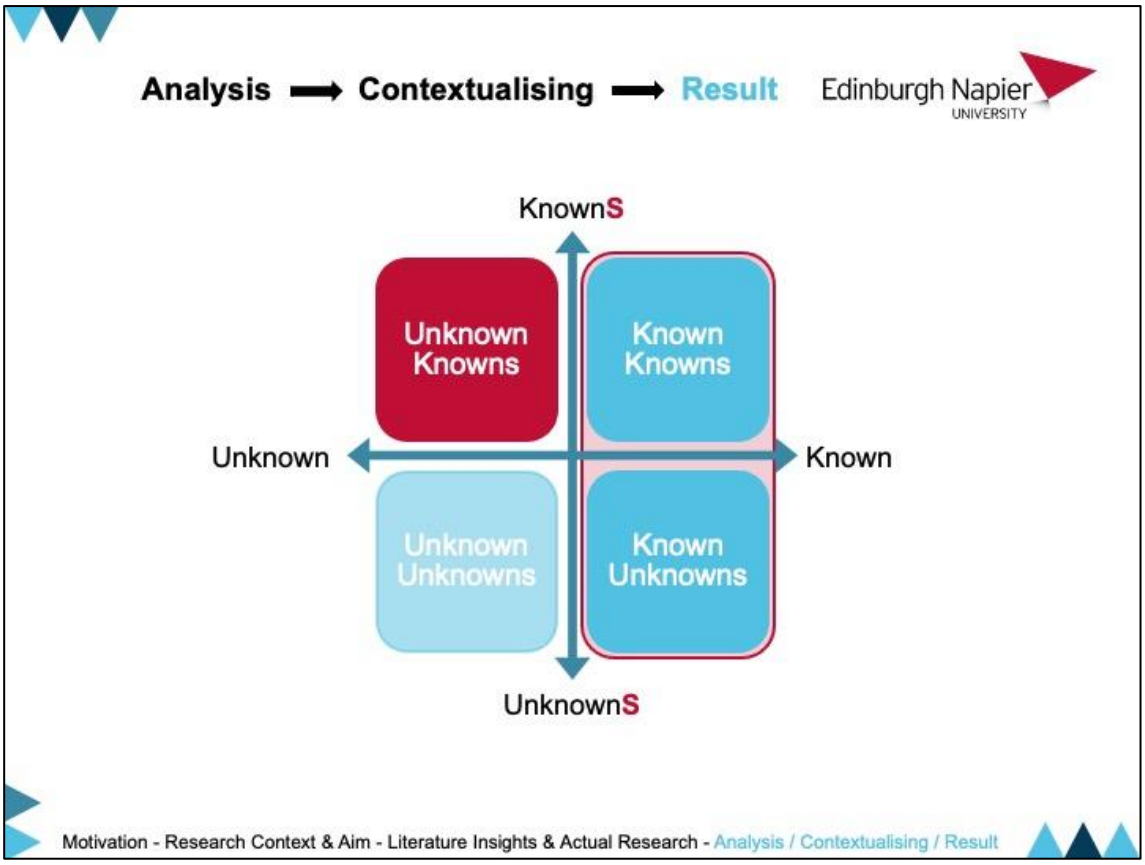
Analysis → Contextualising → Result
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Unknown Knowns
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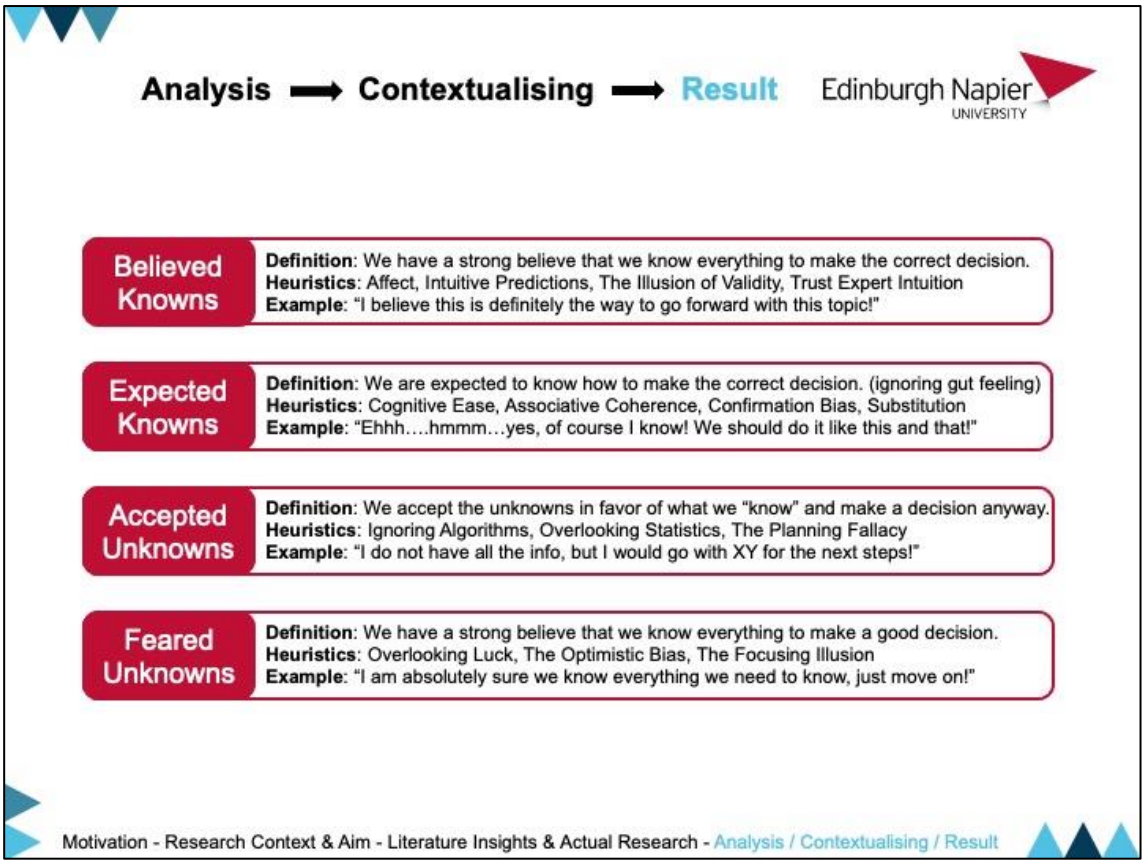
Analysis → Contextualising → Result
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Believed Knowns
Definition: We have a strong believe that we know everything to make the correct decision.
Heuristics: Affect, Intuitive Predictions, The Illusion of Validity, Trust Expert Intuition
Example: "I believe this is definitely the way to go forward with this topic!"
Expected Knowns
Definition: We are expected to know how to make the correct decision. (ignoring gut feeling)
Heuristics: Cognitive Ease, Associative Coherence, Confirmation Bias, Substitution
Example: "Ehhh….hmmm…yes, of course I know! We should do it like this and that!"
Accepted Unknowns
Definition: We accept the unknowns in favor of what we "know" and make a decision anyway.
Heuristics: Ignoring Algorithms, Overlooking Statistics, The Planning Fallacy
Example: "I do not have all the info, but I would go with XY for the next steps!"
Feared Unknowns
Definition: We have a strong believe that we know everything to make a good decision.
Heuristics: Overlooking Luck, The Optimistic Bias, The Focusing Illusion
Example: "I am absolutely sure we know everything we need to know, just move on!"
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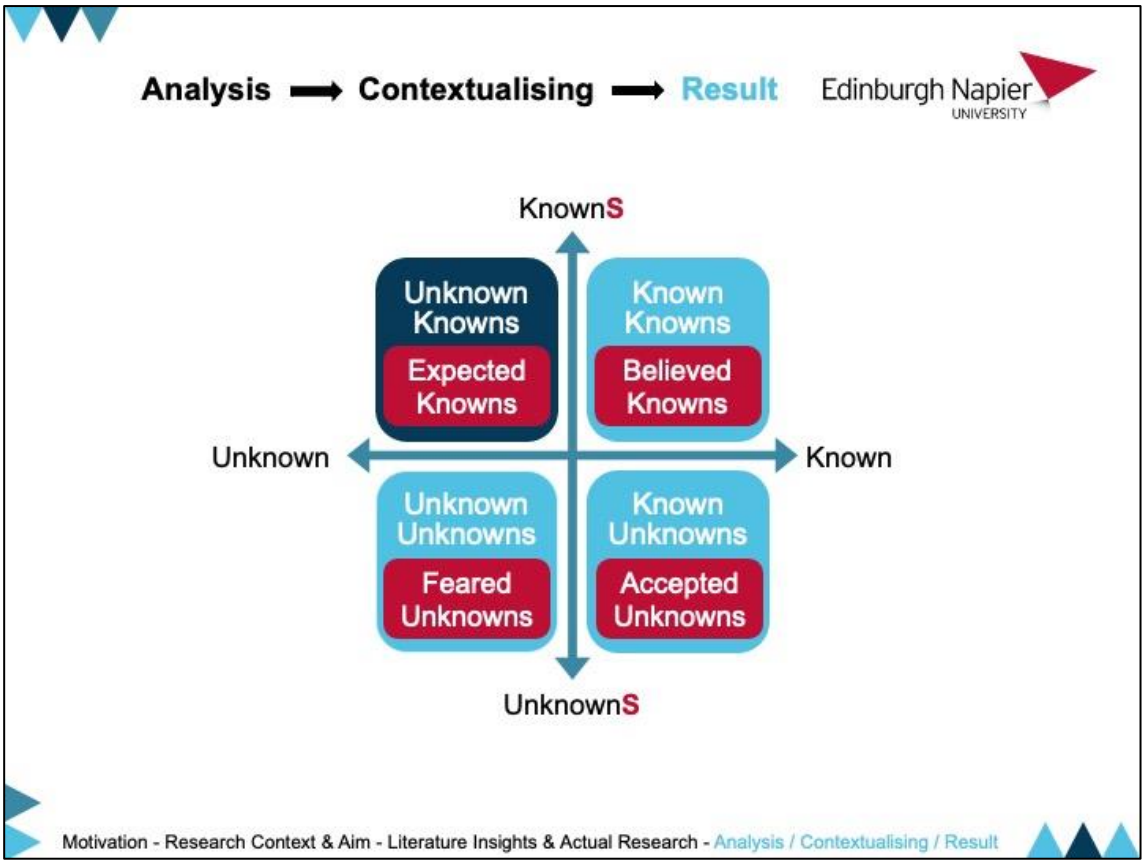
Analysis → Contextualising → Result
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KnownS
Unknown Knowns
Expected Knowns
Known Knowns
Believed Knowns
Unknown
Known
Unknown Unknowns
Feared Unknowns
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Accepted Unknowns
UnknownS
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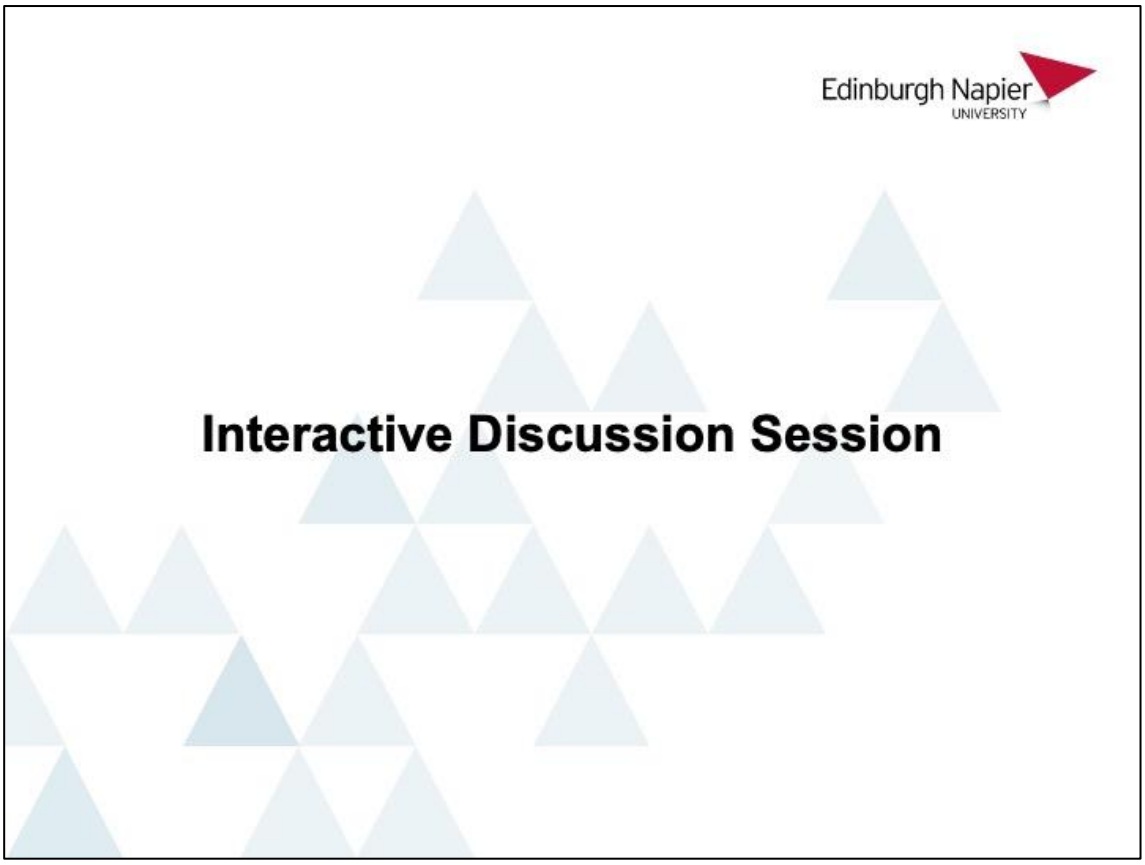
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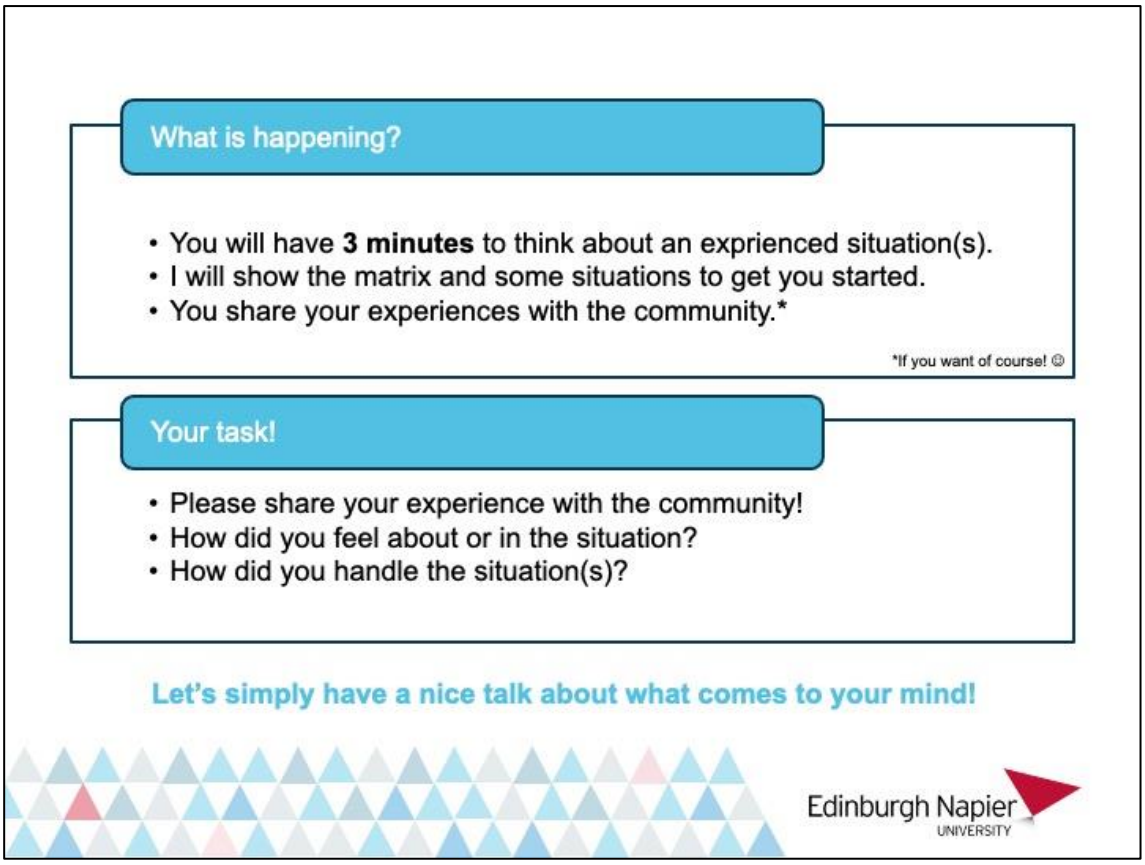
Interactive Discussion Session


What is happening?
• You will have **3 minutes** to think about an exprienced situation(s).
• I will show the matrix and some situations to get you started.
• You share your experiences with the community.*
*If you want of course! ☺
Your task!
• Please share your experience with the community!
• How did you feel about or in the situation?
• How did you handle the situation(s)?
Let's simply have a nice talk about what comes to your mind!
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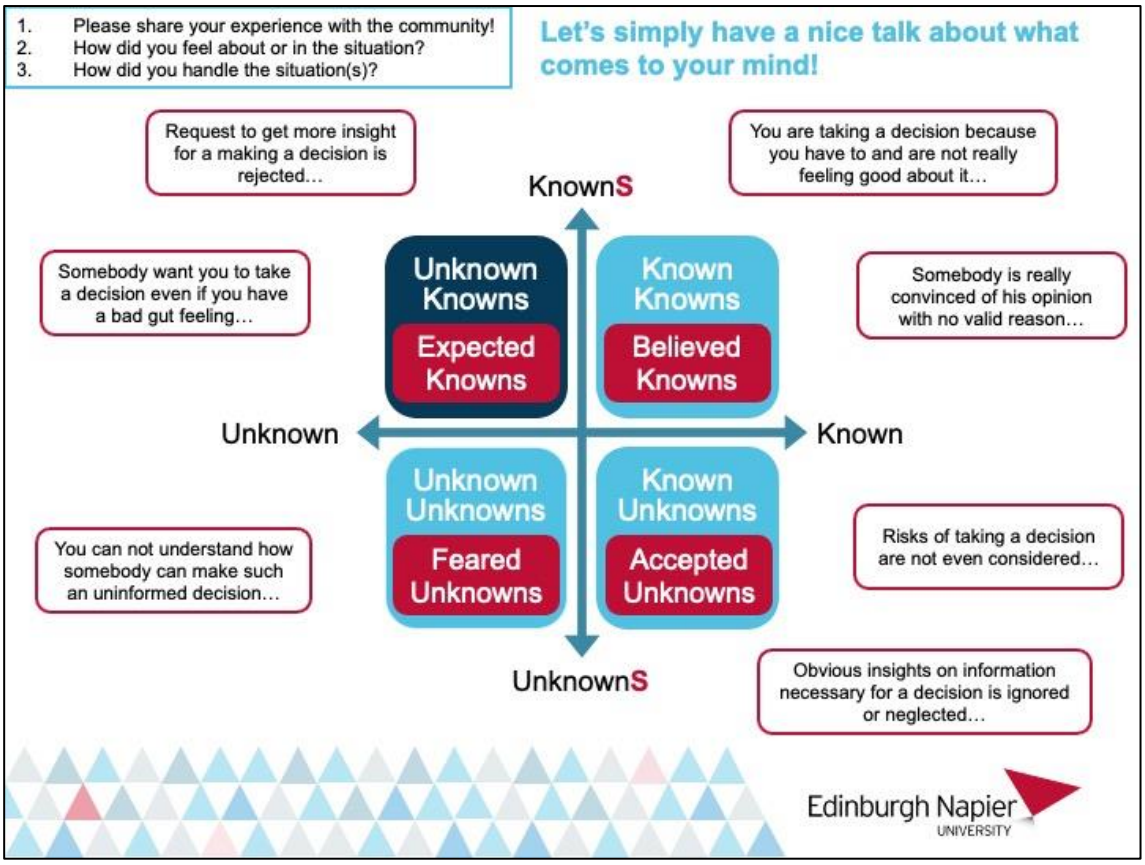
1. Please share your experience with the community!
2. How did you feel about or in the situation?
3. How did you handle the situation(s)?
Let's simply have a nice talk about what comes to your mind!
Request to get more insight for a making a decision is rejected…
You are taking a decision because you have to and are not really feeling good about it…
KnownS
Somebody want you to take a decision even if you have a bad gut feeling…
Unknown Knowns
Expected Knowns
Known Knowns
Believed Knowns
Somebody is really convinced of his opinion with no valid reason…
Unknown
Known
Unknown Unknowns
Feared Unknowns
Known Unknowns
Accepted Unknowns
You can not understand how somebody can make such an uninformed decision…
Risks of taking a decision are not even considered…
UnknownS
Obvious insights on information necessary for a decision is ignored or neglected…
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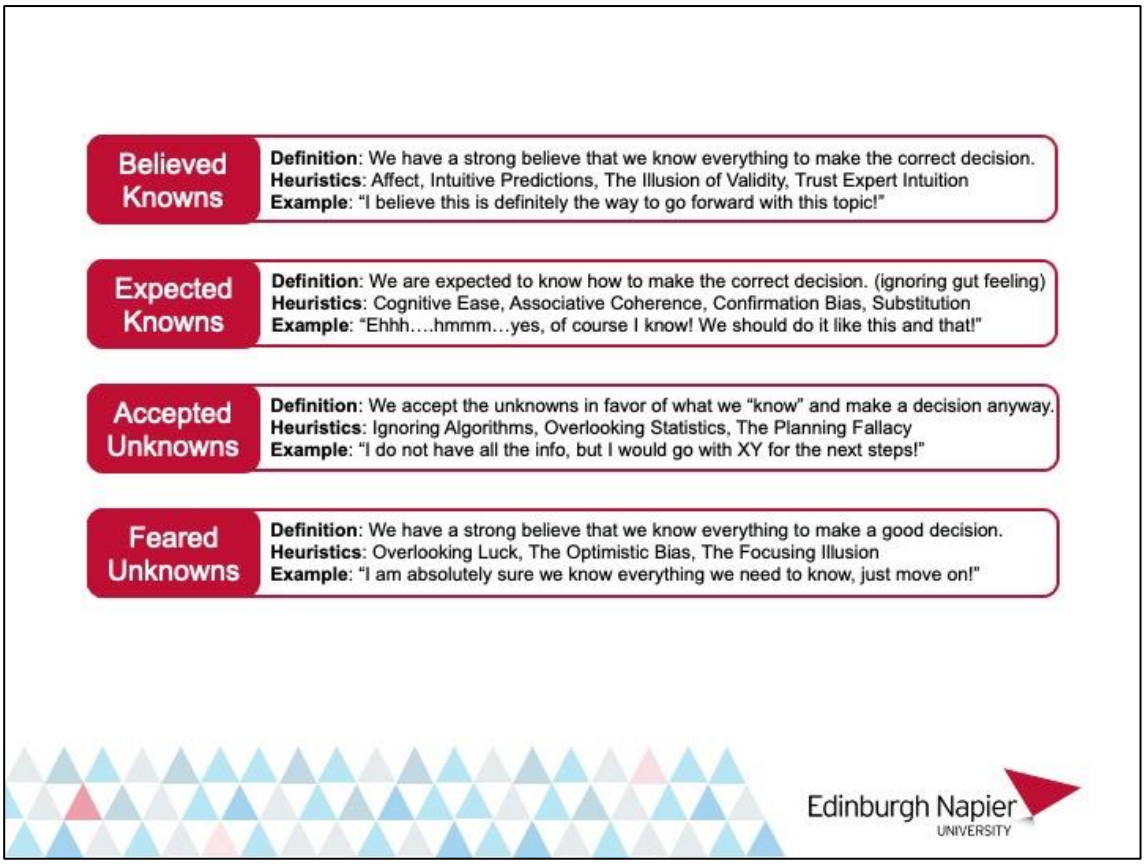
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BIG
Thank you for this chance and your participation!
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