A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

by

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GLOSSARY OF ABBREVIATIONS

Abbreviation	Meaning
BCBS 239	Basel Committee on Banking Supervision – Principles for effective risk data aggregation and risk reporting
BI	Business Intelligence
CAS	Complex Adaptive System
CSH	Critical Systems Heuristics
CST	Critical Systems Thinking
DAMA	Data Management Association International (global data management community)
DC	Dynamic capabilities
DM	Data Management
DM-BOK	Data Management Body of Knowledge
DSR	Design Science Research
EDM	Enterprise Data Management
IA	Information Architecture
IS	Information Systems
ISD	Information Systems Development
IT	Information Technology
QR	Qualitative Research
SLR	Systematic Literature Review
TA	Thematic Analysis

Abstract

The role of data in organisations has changed from primarily supporting operational processes and management reporting to enabling strategic decision-making. However, organisations are having difficulty in successfully managing their data in an agile manner to support these requirements. At the time of this study, there was limited scientific literature, and only some practitioner literature, presenting practical models and methods for how organisations can achieve agile enterprise data management (EDM) in real-world contexts. This research used a design science research (DSR) strategy to develop a framework for agile EDM founded on scientific knowledge, theory and empirical qualitative case study research. The first DSR cycle developed the structural part of a framework for agile EDM based on a systematic literature review (SLR) of the characteristics of agility in information systems (IS), and applied the components of the structural part to a qualitative case study conducted at a large financial services organisation. The second DSR cycle developed the dynamic part of a framework for agile EDM by systematically reviewing the literature on the dynamics of achieving agility in organisational and sociotechnical contexts. The constructs and relationships of the dynamic part of a framework for agile EDM were applied to the qualitative case study data to develop and propose a framework for agile EDM. Using the Delphi method, data management experts evaluated the proposed framework for use in real-world contexts. The primary contribution of this research to IS and data management practitioner knowledge is the DSR artefact that was produced, a framework for agile EDM, that can help organisations to achieve agile EDM, thereby enabling overall enterprise agility. This study also offered two potential secondary contributions in the form of solution development approaches which could be useful to researchers for the study of phenomena, other than agility, in sociotechnical contexts, other than EDM.

Keywords: enterprise data management, agile enterprise data management, agile EDM, agility, complex adaptive systems, CAS, sociotechnical, dynamic capabilities, critical systems heuristics, Cynefin, data governance, data management, information management

1 INTRODUCTION

1.1 BACKGROUND

This thesis considers how enterprises should manage their data assets to achieve agility. Data management in organisations is an integrated domain of interdependent sociotechnical data governance and management functions (Otto, 2011a; Brous, Overtoom, Herder, Versluis and Janssen, 2014; DAMA International, 2017; Legner, Pentek and Otto, 2020) that interact across the enterprise at an individual, team, and organisational level in a collective effort to derive value for the organisation from its data assets (Brous, Janssen and Vilminko-Heikkinen, 2016; Seiner, 2019). Data management activities require interacting specialists and specialised technologies to perform the specification, planning, designing, creation, acquisition, use, securing, maintenance, archiving and purging of an organisation's data assets (DAMA International, 2017).

There are various reasons why organisations experience difficulties in managing their data assets. Davenport, Barth and Bean (2012, p. 22) define big data as "an expanding sea of data that is either too voluminous or too unstructured to be managed and analyzed through traditional means". Data practitioners in the industry speak about the "4 Vs" that contribute to the complexities and urgency of data management: (1) volume, which refers to the increasing amount of available data for which processing capability, scalability and distribution are key considerations; (2) velocity refers to the importance of flowrates of data, including response times to exploit data for business benefit; (3) variety of data implies its messiness, inconsistencies and multiplicity in its types and formats; and (4) the importance of deriving value from data, for example, improving business performance by using rigorous data analytics to inform strategy and operational decisions (Lycett, 2013; DalleMule and Davenport, 2017; Kappelman *et al.*, 2020; United Nations Global Compact, 2021).

The role of data in organisations has changed from supporting operational processes and management reporting to one that enables strategic decision-making across the entire enterprise (Legner, Pentek and Otto, 2020). However, organisations are struggling to successfully manage their data as a strategic asset (Marchand and Peppard, 2013; Peppard, 2016; DalleMule and Davenport, 2017; Benfeldt, Persson and Madsen, 2020). Furthermore, research has established that effective and efficient data management directly

influences the quality of decision-making in organisations (Marchand and Peppard, 2013; Jia, Hall and Song, 2015; Otto, 2015; DalleMule and Davenport, 2017) and increases operational efficiency, ameliorates business integration, and improves customer satisfaction (Otto, 2011a).

Despite the apparent demand for agility in organisations, as documented in the scientific literature, there is neither sufficient scientific research on agility in organisations nor consensus on what an “agile organisation” is (Wendler, 2016; Appelbaum, Calla, Desautels and Hasan, 2017). Approaches and methods for achieving organisational agility seem equally intangible (Sanchez and Nagi, 2001; Teece, Peteraf and Leih, 2016; Wendler, 2016; Appelbaum *et al.*, 2017; Sidky, 2017). Thus far, scientific research has focused primarily on the features of agile organisations, with limited studies on how organisations can develop and embed agile capabilities enabling them to thrive in continuously changing environments (Appelbaum *et al.*, 2017). Nonetheless, new data management strategies are needed to emerge and evolve agility in those organisational structures that deliver valuable data and information to the business (DalleMule and Davenport, 2017) to support the requirement for organisational agility (Teece, Peteraf and Leih, 2016).

1.2 PROBLEM STATEMENT AND PURPOSE OF THE STUDY

Sensing and responding have been identified in the scientific literature as antecedents for organisational agility (Sambamurthy, Bharadwaj and Grover, 2003; Teece, Peteraf and Leih, 2016; Tallon, Queiroz, Coltman and Sharma, 2019). However, there is a lack of synthesised consensus on the characteristics of agile organisations (Wendler, 2013, 2016) and, thus, no clarity on what would constitute the structural components of agile EDM. In addition, there is limited scientific research on the processes for achieving agility in organisations (Park, El Sawy and Fiss, 2017; Walter, 2021; Limaj and Bernroider, 2022), but there is less on processes for achieving agile EDM. A diversity of scientific theories have thus far been applied to study how organisations can achieve agility enabled by IT capabilities (Tallon *et al.*, 2019).

There is a requirement for organisational agility (Teece, Peteraf and Leih, 2016) which, in turn, requires urgent responses from organisations to develop effective data management strategies (DalleMule and Davenport, 2017) that can achieve agility in those organisational structures and activities that deliver valuable data and information to the business

(Marchand and Peppard, 2013). However, at the time of this study, there was limited scientific literature and only some practitioner literature presenting practical models and methods for how organisations can achieve agile EDM in real-world contexts.

In their 2019 *Society for Information Management (SIM) IT Issues and Trends Study*, Kappelman *et al.* (2020) found data analytics and data management to be the third most important information technology (IT) management issue faced by senior IT executives. Additionally, in 2019 organisations prioritised IT investments for analytics, cloud, and cybersecurity (Kappelman *et al.*, 2020). These aspects all point to the increasing urgency for organisations to focus technological, specialist and management resources on improved data management. Currently, the cost of data management solutions is trending upwards, yet data management solutions are struggling to cope with the ever-increasing volumes and complexity of data (Al-Ruithe, Benkhelifa and Hameed, 2019).

Data and information management actors are social and technological agents that operate in high levels of interdependent interactions (Marchand and Peppard, 2013; DAMA International, 2017). Therefore, data and information management is considered sociotechnical by nature. In addition, data management contexts are subject to the internal and external unpredictability of the overall organisational environment and require expertise and specialisation to solve problems. The pervasiveness of technologies and the entangled nature of the interactions among social and technical agents in organisations continuously result in complex and complicated situations (Kurtz and Snowden, 2003; Gregor, 2009; Peppard, 2018).

Lillie and Eybers (2019) conducted a literature review to understand the constructs and capabilities associated with data management and governance agility. They concluded that agility in data management and governance has identifiable features that have meaning and consequences for managing an organisation’s data assets. Werder and Maedche (2018) found that team agility in organisations is an emergent and evolutionary phenomenon. However, agility can be elusive when heterogeneous teams of technical specialists and generalists must collectively interact in complex and complicated contexts to create data management solutions for the enterprise.

1.3 DELINEATION OF "AGILE ENTERPRISE DATA MANAGEMENT"

The word "agility" is defined as "the power of moving quickly and easily; nimbleness" and "the ability to think and draw conclusions quickly; intellectual acuity" (Dictionary.com LLC, 2022, n. p.). Merriam-Webster Incorporated (2022, n. p.) defines "agile" as being "marked by ready ability to move with quick, easy grace" and "having a quick resourceful and adaptable character". These definitions, in turn, introduce further abstractions such as "power", "ability", "acuity", "grace", and "adaptability". The elusiveness of the meaning of "agility" and how to contextualise it for data management posed a challenge that had to be addressed scientifically in this study of agile EDM.

The word "enterprise" is a noun defined as "a commercial or industrial activity or organization" with synonyms of "business", "company", "concern", "establishment", and "firm" (Merriam-Webster Incorporated, 2022, n. p.). The noun "organization" is defined as "an administrative and functional structure (such as a business or a political party)", whereas the verb "organize" means "to form into a coherent unity or functioning whole", and "organization" refers to "the act or process of organizing or of being organized" (Merriam-Webster Incorporated, 2022, n. p.). The Open Group (2014, p. 5) defines an "enterprise" as "any collection of organizations that has a common set of goals".

This study defines "enterprise data" as a collective term that refers to the enterprise's data assets requiring management as an integrated whole. Therefore, the singular verb form for data is used instead of the plural form. The term "enterprise data management", as used in this study, encompasses all technological and social activities and components relating to the management and governance of an organisation's data and information. According to Ackoff (2010), data comprise symbols that represent the characteristics and qualities of events and objects, whereas information is data that has been processed to make it valuable. However, data needs to be managed before the information generated through its processing. For example, analytics is worth managing for its value to inform effective decision-making in the enterprise (Marchand and Peppard, 2013). Therefore, this study of agile EDM does not rely on idiosyncratic differences in the definitions of "data" and "information" because it considers agility to be relevant across the entire continuum of "data" becoming "information".

Data governance governs the decision domains for effective use and management of IT and the accountability and locus for decision-making, whereas data management makes and implements data-related decisions (Khatri and Brown, 2010). Data governance is central to data management and controls, plans and monitors all data management activities (Seiner, 2014; Brous, Janssen and Vilminko-Heikkinen, 2016; DAMA International, 2017). Data management, including data governance, is an integrated domain of interdependent sociotechnical data governance and management functions (DAMA International, 2017; Legner, Pentek and Otto, 2020) that interact across the enterprise at an individual, team, and organisational level (Brous, Janssen and Vilminko-Heikkinen, 2016; Seiner, 2019). In practice, technology vendors and open source software offer a diverse array of advanced, specialised technology solutions to support and facilitate the implementation and execution of data management, as shown in Figure 2-3 on page 22. This study considered EDM to include all data management activities and the oversight or governance of those activities.

An enterprise's data management capabilities perform specialised technical functions, data lifecycle, usage and governance activities within and across diverse data management disciplines (DAMA International, 2017; Legner, Pentek and Otto, 2020). These activities traverse operational, tactical and strategic levels (Seiner, 2014; Brous, Janssen and Vilminko-Heikkinen, 2016), often under conditions of uncertainty, disruption and change (Park, El Sawy and Fiss, 2017; Davenport and Bean, 2018; Al-Ruithe, Benkhelifa and Hameed, 2019). Data management comprises many diverse social and technical interacting agents constantly adapting to changes in the internal and external environment (Böhmer, Dabrowski and Otto, 2017; DalleMule and Davenport, 2017).

Benfeldt, Persson and Madsen (2020) define data governance as a problem that requires collective action implementing enterprise-wide principles and processes for governing data as an organisational asset. EDM is defined for this study as *inclusive of data and information management and governance from an enterprise-wide perspective*. Agile EDM is pursued as *the collective agility outcomes and consequences for the enterprise from the whole EDM organisation's data and information management and governance efforts*.

IT is required to enable organisational agility (Galliers, 2006; Overby, Bharadwaj and Sambamurthy, 2006; Park, El Sawy and Fiss, 2017; Tallon *et al.*, 2019). Data management is sociotechnical (Brous *et al.*, 2014; DAMA International, 2017; Legner, Pentek and Otto, 2020), and EDM's social and technical agents must collectively enable the overall enterprise

to achieve organisational agility. Therefore, the data management functions must respond to the enterprise's requirement for timeous, accurate information enabling its sensing and responding capabilities in fast-paced, unpredictable environments (DalleMule and Davenport, 2017; Park, El Sawy and Fiss, 2017). EDM is not immune to the turbulence and uncertainty experienced by the enterprise as a whole. EDM must sense and respond in concert with the enterprise as it senses and responds to change and uncertainty, dealing with opportunities and threats in the internal and external environment.

This study adopts an organisational perspective of EDM, viewing EDM as *a strategic organisational structure within the enterprise that is required to enable enterprise agility*. However, at a lower level, it takes into account that EDM comprises teams of practitioners with specialised data management domain skills and specialised technologies that manage and execute data management work to create data management solutions that serve the information requirements of the enterprise. Thus, the data management teams and technologies need to be agile to enable the overall EDM organisation to achieve agility which, in turn, enables enterprise agility.

1.4 RESEARCH OBJECTIVES

The primary objective of this study of agile EDM is to develop a framework for assisting organisations in achieving agile EDM. However, the requirement for agile EDM first had to be confirmed by conducting a literature review to understand the current state of and need for agile EDM.

The framework for agile EDM aims to propose a practical model and method for organisations to identify, assess and utilise opportunities to amplify agility in their data management functions for the collective benefit of the business. Successful data management frameworks bring structure to data management practices, address the challenges and practical requirements of data management, and constitute a substantial body of design knowledge established and synthesised through ongoing efforts by practitioners and researchers (Legner, Pentek and Otto, 2020). The framework for agile EDM must enable its users to integrate and co-evolve the framework's elements with existing data management frameworks in practice to achieve the desired agility consequences and outcomes for EDM practices.

This study aims to address the research problem of achieving agile EDM by developing a framework for agile EDM founded on scientific literature and theory, and empirical case study research.

1.5 RESEARCH QUESTIONS

The main objective of this study is to develop a framework for agile EDM that can be applied in real-world EDM settings to achieve agile EDM. As prior, relevant literature formed the foundation of this study, a coherent structure was first created for approaching the concepts underlying the research topic (Webster and Watson, 2002) by defining the problem space, including its boundaries, nature and rationale, for agile EDM (Pentek, Legner and Otto, 2017). This approach provides a structure to build an understanding of what an investigation of the research problem requires, and to raise sub-questions as the research process unfolds (Ravitch and Riggan, 2017).

The lack of practical, scientifically founded methods to fulfil the identified requirement for agile EDM in organisations presents the main research question of this study:

Main-RQ:	*How* can agile enterprise data management be achieved?

However, the main research question presents a need to understand and explain the structural components of agile EDM, requiring an answer to the first sub-question (which was further broken down into two additional sub-questions) to the main research question:

Sub-RQ1:	*What* are the structural components of agile enterprise data management?
SQ1.1:	What are the characteristics of agility in Information Systems?
SQ1.2:	What are the characteristics of agility in enterprise data management?

The second sub-problem to the main research question requires an understanding of, and explanation for, the dynamic components of agile EDM, thus posing the second sub-question (which was further broken down into five additional sub-questions) to the main research question:

Sub-RQ2:	*What* are the dynamic components of agile enterprise data management?

SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?
SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?
SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?
SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?
SQ2.5:	How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?

1.6 RESEARCH STRATEGY

Benfeldt Nielsen (2017) calls attention to the limited use of practice-oriented methods such as action research, research experiments and design science in data governance studies. This despite an existing representation of practitioners in scientific research and the valuable contributions that scientific studies to data governance could bring to data governance practice.

This research used DSR as the strategy to develop a framework founded on existing scientific theories, which was then refined through a qualitative case study to provide a perspective and approach to achieving agile EDM. Due to the iterative approach used to explore the sub-questions of the main research question, this study adopted the DSR process proposed by Vaishnavi, Kuechler and Petter (2004) to develop a framework for agile EDM in two DSR cycles (including sub-cycles), presented in Figure 1-1 (a larger diagram is presented in Figure 3-4 on page 60). Each DSR cycle starts with the awareness of a problem and a suggestion to solve it, thereby iteratively moving from the problem space towards the solution space, intending to deliver the final DSR artefact: a framework for agile EDM. Using a DSR strategy, this study proposes that a framework to support business data value delivery with sustained, relevant agility can be developed.

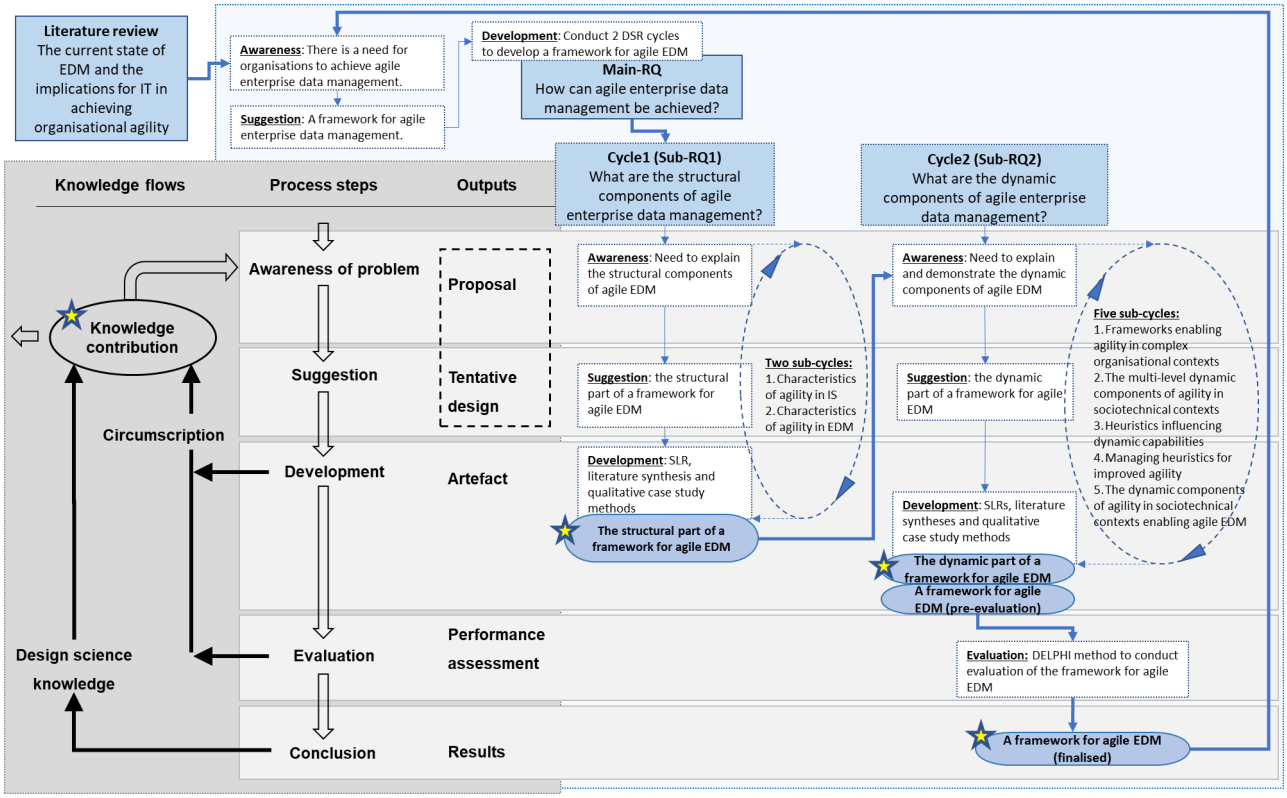


Figure 1-1: Overview of the adopted design science research strategy (based on Vaishnavi and Kuechler (2015, p. 15))

1.7 LIMITATIONS

This study attempts to draw on the relatively uncharted area of agility in governance and management. A search and review of the literature indicated that the topic of agility in EDM has not been widely researched despite the growing importance of data management and agile EDM in organisations (Marchand and Peppard, 2013; Tallon, Ramirez and Short, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019).

Bolman and Deal (2017, p. 31) explain that organisations are complex because "[t]he behavior of the people who populate them is notoriously hard to predict. Large organizations in particular include a bewildering array of people, departments, technologies, strategies and goals. Moreover, organizations are open systems dealing with a changing, challenging, and erratic environment. Things can get even messier across multiple organizations". Therefore, from the outset, this study had to recognise the difficulties and complexities that organisations face in managing their data assets and consider the implications of these for the research approach and strategy.

Data pervades entire business and technology domains within and across organisations and industries (Marchand and Peppard, 2013). Since this research attempted to focus on agility in EDM, the challenge lay in narrowing the scope of the research while simultaneously identifying relevant scientific knowledge related to business, organisational behaviour and IS that underpin agility in EDM contexts. Such being the case, this research topic is ambitious, and there is a risk that this study does not provide enough in-depth knowledge about the full extent of essential areas relevant to achieving agile EDM.

1.8 METHODOLOGY

To develop a DSR artefact (such as a framework) that is relevant for addressing an identified real-world problem, the artefact's construction should be founded in scientific knowledge and its functionality tested in real-world contexts, adding new knowledge to the scientific body of knowledge (Hevner, 2007).

Systematic literature reviews can provide rigour by embedding existing scientific knowledge and theory in the DSR artefact's design. In IS research, the rigour and replicability of SLRs are emphasised (Levy and Ellis, 2006; Okoli and Schabram, 2010; Boell and Cecez-Kecmanovic, 2015). Myers (2013) states that case study research demonstrates the practical relevance of theory in the real world, bringing a research topic and its theoretical underpinnings to life. An in-depth qualitative case study conducted at a large enterprise could refine the artefact's relevance by applying the scientifically founded constructs of the artefact to real-world data, and using thematic analysis techniques, evidencing the artefact's relevance. Therefore, these methods and techniques could be applied to develop a practical yet scientifically grounded solution for achieving agile EDM.

1.9 CHAPTER OUTLINE AND MAP

Table 1-1 provides a brief summary of each chapter.

Table 1-1: Chapter outline

Chapter 1: Introduction	Chapter 1 provides the background, problem statement, research objectives, research questions, strategy and methodologies of this study.
Chapter 2: Literature review — data management and agility in organisations	Chapter 2 first reviews the scientific and practitioner literature on the current state of data/information management/governance, existing practitioner frameworks for data management, and the strategic importance of managing organisational data. Next, scientific literature about agility in organisations is reviewed. Lastly, the scope of EDM is defined for this study of agile EDM. Chapter 2 concludes with the identified research problem for this study.
Chapter 3: Research methodology	Chapter 3 describes, motivates, and explains the strategy and methodologies used in this research.
Chapter 4: DSR Cycle 1: The structural components of agile enterprise data management	Chapter 4 documents the development of the structural components of agile EDM. A systematic literature review investigated agility in IS to understand the characteristics of agility in IS that were subsequently applied to a qualitative case study of EDM, concluding with the structural components of agile EDM. Chapter 4 answers the following sub-questions: **SUB-RQ1**: What are the structural components of agile enterprise data management? **SQ1.1**: What are the characteristics of agility in Information Systems? **SQ1.2**: What are the characteristics of agility in enterprise data management?
Chapter 5: DSR Cycle 2 Part I: The dynamic components of agile enterprise data management	Chapter 5 documents the development of the dynamic components of agile EDM based on theories from the scientific literature to explain how agility emerges and evolves in complex and complicated sociotechnical contexts. Chapter 5 answers the first four sub-questions of **SUB-RQ2**: What are the dynamic components of agile enterprise data management? **SQ2.1**: What scientific frameworks, models or methods enable agility in complex organisational contexts? **SQ2.2**: What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts? **SQ2.3**: How do heuristics influence dynamic capabilities in organisational contexts? **SQ2.4**: How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?

Chapter 6: DSR Cycle 2 Part II: A framework for agile enterprise data management	Chapter 6 documents the development of the framework for agile enterprise data management by applying the structural and dynamic components of the framework for agile EDM to a qualitative case study at a large financial services organisation (using the pseudonym BankGroup). Chapter 6 answers the fifth and final sub-question for **SUB-RQ2**, producing a proposed framework for agile EDM ready for the DSR artefact evaluation phase. **SQ2.5:** How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?
Chapter 7: Evaluation of the framework for agile enterprise data management	Chapter 7 presents the evaluation of the framework for agile EDM by an expert panel using the Delphi method. The results were analysed to further refine the framework and produce the final version of the framework for agile EDM, answering the **MAIN-RQ**: How can agile enterprise data management be achieved?
Chapter 8: Research contributions and finalised artefact	Chapter 8 presents this research's primary and secondary contributions to scientific and practitioner knowledge. The finalised framework for agile EDM is presented as a model and a method for achieving agile EDM in real-world EDM contexts.
Chapter 9: Conclusion and future research	Chapter 9 concludes this study of agile enterprise data management and suggests possible future research opportunities stemming from the primary and secondary contributions produced and put forward in this thesis.

Figure 1-2 presents a chapter map used at the start of each chapter to indicate its location within the research process.

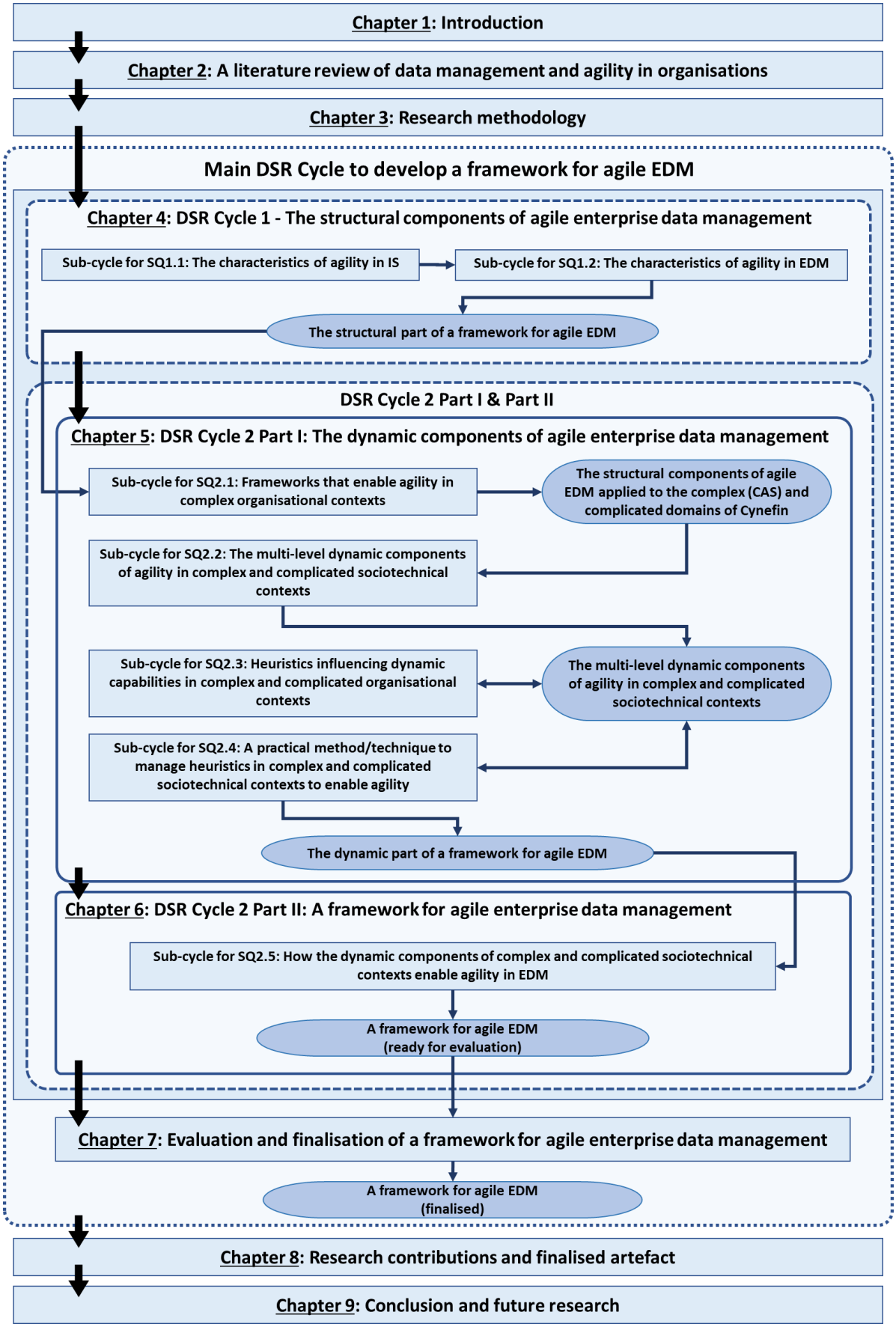


Figure 1-2: Chapter map

2 LITERATURE REVIEW – DATA MANAGEMENT AND AGILITY IN ORGANISATIONS

In this chapter, the current state of the management and governance of data and information in organisations is reviewed from scientific and practitioner literature. Subsequently, the literature about the requirement for agility in organisations and the role of IS in enabling organisational agility is reviewed. Lastly, the research problem is identified, confirming the relevance of the main research question. The chapter map for Chapter 2 is presented in Figure 2-1.

Legner, Pentek and Otto (2020) provide an overview of the evolution of data management in enterprises: The early stages of data management primarily involved data bases supporting automated data processing for operational business processes, such as inventory and accounting systems. Subsequently, the requirement for integrated information emerged in organisations, and the scope of data management expanded from serving individual business functions to enabling end-to-end processing and integration of data across the enterprise. With the prevailing rapid increase in data volumes, and expeditious technological advancements, data management has evolved into a strategic capability that is crucial in providing timely, accurate data to inform strategic decision-making in enterprises (Legner, Pentek and Otto, 2020; Castro *et al.*, 2021).

Organisations are becoming “data-driven” because they increasingly rely on data analytics and the interpretation of analytics’ results to inform their decision-making (Jia, Hall and Song, 2015; Davenport and Bean, 2018; Castro *et al.*, 2021; Hupperz *et al.*, 2021). However, practical difficulties seem to prevail in organisations when managing data as a strategic asset (DalleMule and Davenport, 2017; Benfeldt, Persson and Madsen, 2020) and deriving value from data management efforts (Otto, 2015). Nonetheless, data analytics and data management are third among the top 10 biggest IT management concerns for organisations (Kappelman *et al.*, 2020). Research exploring the discourse of data governance could contribute to understanding the definition and scope of data governance and how this might impact implementation approaches and the efficiency of data governance (Benfeldt Nielsen, 2017).

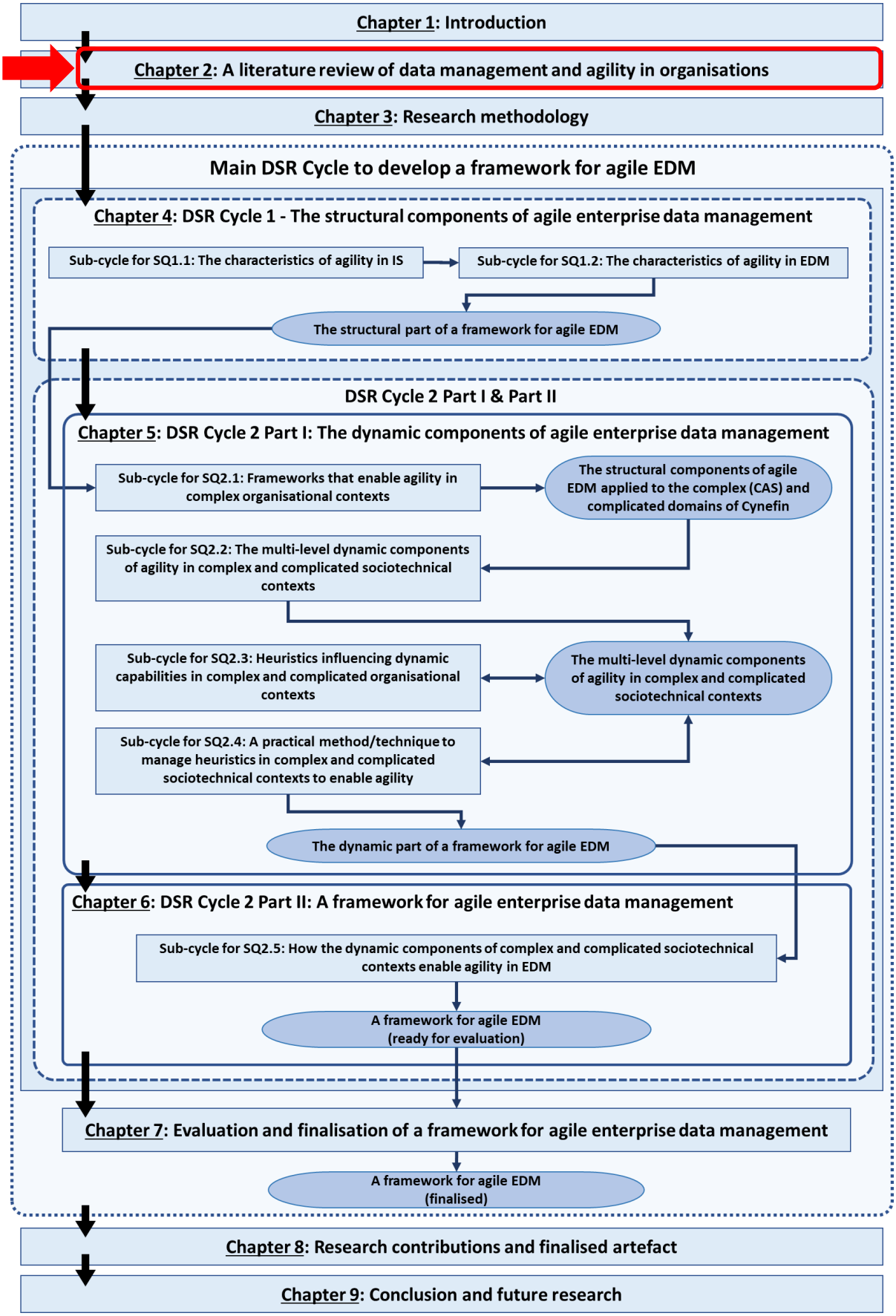


Figure 2-1: Chapter map — Chapter 2

2.1 THE CURRENT STATE OF THE MANAGEMENT AND GOVERNANCE OF DATA AND INFORMATION IN ORGANISATIONS

Publications in the field of data governance are firmly rooted in IT governance, and are less concerned with the fields of organisation and management (Benfeldt Nielsen, 2017). According to Benfeldt Nielsen (2017), this lack of concern with organisation and management could influence how data governance is framed, resulting in it being a continued responsibility performed by IT. Furthermore, this might hinder data management from developing into a general management discipline. According to Al-Ruithe, Benkhelifa and Hameed (2019), research in data governance is insufficient and needs to be advanced to contribute to scientific knowledge and to strengthen data management practice. Therefore, this literature review included scientific and practitioner literature about data and information management, as well as data and information governance.

Regulatory compliance, risk management and financial reporting have been a significant focus of academic research relating to the management and governance of data, particularly in the financial services industry (Chakravorty, 2015; Gozman, Currie and Seddon, 2018; Karkošková, 2023). The direct influence of effective and efficient data and information management on decision-making in organisations has also been well researched (Marchand and Peppard, 2013; DalleMule and Davenport, 2017; Hupperz *et al.*, 2021).

With organisations storing more data for longer and a growing reliance on artificial intelligence learning from large data sets (Jernite *et al.*, 2022), and data analytics for decision-making, the exponential increase in the volume and complexity of data and information are likely to continue (Marchand and Peppard, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019; Hupperz *et al.*, 2021). Davenport, Barth and Bean (2012, p. 22) define big data as “an expanding sea of data that is either too voluminous or too unstructured to be managed and analyzed through traditional means”. Big data and analytics projects should not be approached in the same manner as traditional IT projects, as simply implementing analytic technology will not necessarily result in the organisation deriving value from its data (Marchand and Peppard, 2013). Shamim, Zeng, Shariq and Khan (2019) identified leadership focus, talent management, technology and organisational culture as challenges for the management of big data, which influences the effectiveness and efficiency of decision-making that utilises big data.

The processes used to govern and manage data are becoming more complex, and the inescapable importance of the efficiency and effectiveness of these processes for organisations worldwide is increasingly evident (Tallon, Ramirez and Short, 2013). Data was traditionally merely a byproduct of operational business processes with limited value beyond the applications creating the data (Al-Ruithe, Benkhelifa and Hameed, 2019). However, information has evolved into a strategic asset requiring governance and management different from physical IT assets, posing new managerial and technical challenges to organisations (Tallon, Ramirez and Short, 2013). Currently, the cost of data management solutions is increasing, yet these solutions are unable to keep up with the volume and complexity of the data (Al-Ruithe, Benkhelifa and Hameed, 2019).

2.1.1 Organisational structures for data and information management and governance

Data governance is central to and oversees all the data management functions, exercising control and authority over the organisation's data assets (Ladley, 2012; Seiner, 2014; DAMA International, 2017). Data governance commands the coordination of activities across all the functional areas of data management (DAMA International, 2017). According to Weber, Otto and Osterle (2009), data governance enables the implementation of enterprise-wide accountabilities for managing data quality by defining and assigning roles and responsibilities for decision areas to IT specialists and business professionals. Data governance establishes enterprise-wide standards and guidelines for data quality management to ensure compliance with corporate strategy and data regulations (Weber, Otto and Osterle, 2009; Karkošková, 2023).

Otto (2011c) found that the configuration of data governance is contingent upon factors in the internal and external organisational environment. These factors are crucial to governing data as a valuable organisational asset: organisational goals (formal data governance goals aligned to business goals, functional data governance goals); organisational structure (data processes and allocation of data mandates, enterprise-wide data governance body); and organisational transformation (process and plan for data governance transformation, engagement of data governance at all organisational levels and provision of data governance training and support) (Otto, 2011c).

Seiner (2014) proposes a practitioner framework for a non-invasive operating model of data governance roles and responsibilities (Figure 2-2) that emphasises data ownership, leveraging of existing organisational structures, and decision-making across organisational levels and data teams for effective data governance.

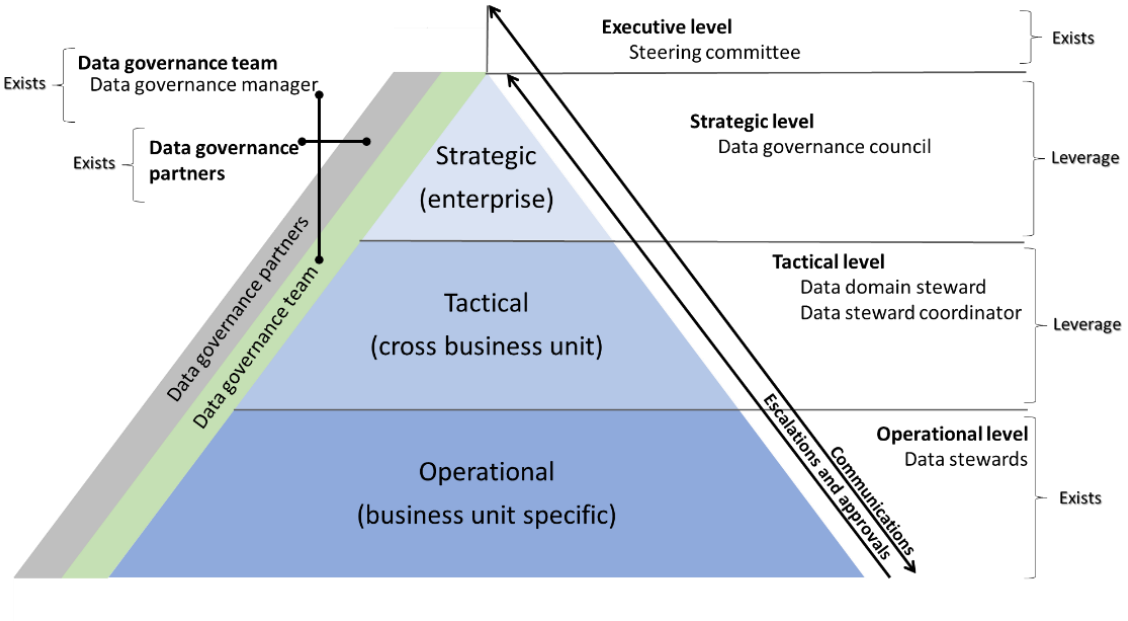


Figure 2-2: Non-invasive operating model of roles and responsibilities (reproduced from Seiner (2014, p. 59))

Practitioner authorities, such as DAMA and Gartner, offer various definitions of data or information management and governance: Data governance oversees data management and is defined as "[t]he exercise of authority, control, and shared decision-making (planning, monitoring, and enforcement) over the management of data assets" (DAMA International, 2017, p. 69). Data management is "the development, execution, and supervision of plans, policies, programs, and practices that deliver, control, protect, and enhance the value of data and information assets throughout their lifecycles" (DAMA International, 2017, p. 17). Hausmann, Williams, Hardy and Schubert (2014, p. 43) adopt the definition of enterprise information management offered by Gartner (2022, n. p.) as "an integrated discipline for structuring, describing and governing information assets, regardless of organizational and technological boundaries, to improve operational efficiency, promote transparency and enable business insight". Hausmann *et al.* (2014) elaborate that enterprise information management is an initiative that spans the entire enterprise, applies to the information's whole life cycle from creation to destruction, must ensure compliance with information

regulations and standards, and aims to create value from the information assets for the enterprise.

Data management teams comprise people with specialised practice and technological knowledge to improve productivity in deriving value from the organisation's data assets (DAMA International, 2017; Peppard, 2018). The ongoing coordination and integration of specialised knowledge allow for the collective use and maturation of the data management processes and methods across multiple business units to serve the enterprise's data and information requirements (Peppard, 2018; Legner, Pentek and Otto, 2020).

Each data management function uses one or more of a vast number of data management technologies available from various specialist vendors. For illustrative purposes, Figure 2-3 includes a few examples of data management technology vendors as compiled by Gartner (2021/2, n. p.), providing the industry with rankings based on vendors' completeness of vision and ability to serve specialised data management requirements with specialised technologies.



Figure 2-3: Examples of the variety and number of available data management technologies
(reproduced from Gartner (2022, n. p.))

Figure 2-4 depicts DAMA International's (2017) representation of relationships between people, process and technology, placing data management goals and principles at the centre to guide data management practitioners in executing activities and using data management tools effectively.



Figure 2-4: DAMA Environmental Factors Hexagon (reproduced from DAMA International (2017, p. 36))

2.1.2 Data and information management frameworks

Legner, Pentek and Otto (2020) found that the longitudinal design processes and knowledge accumulation of data management reference models and frameworks were cross-disciplinary and combined input from researchers and practitioners as they evolved first to support business processes and eventually business strategies. Legner, Pentek and Otto (2020, p. 754) highlight the vital role of researcher-practitioner collaboration in data management, as "from a content perspective, researchers contribute relevant academic concepts and theories that help frame the problem and solution spaces and develop theoretically grounded artifacts. While practitioners are good at providing their ideas and experiences with specific practices and their knowledge of situational designs, most of their design knowledge is tacit".

The data management field currently offers multiple frameworks and reference models that provide organisations with overall guidance, support and prescriptions for managing data (DAMA International, 2017; Pentek, Legner and Otto, 2017; EDM Council, 2018), considering the ever-increasing importance of data's role in the digitalisation of businesses (Legner, Pentek and Otto, 2020). Other data management frameworks focus on specific aspects of data management and governance, such as data strategy, data quality, master

data management and business intelligence. Khatri and Brown (2010) designed a framework for the decision domains of data governance, and Otto (2011) proposed a framework for how data governance should be organised and what it should be organising. Brous, Janssen and Vilminko-Heikkinen (2016) proposed a framework for coordinating decision-making in data governance activities. The data value map proposed by Nagle and Sammon (2017) represents a framework for organisations to develop a shared understanding of their data initiatives by reducing the emphasis on IT and creating a shared language for understanding data and its value in the organisational context. The framework proposed by Knabke and Olbrich (2013) aimed to create an understanding of agility in IS in general and in business intelligence specifically. DalleMule and Davenport (2017) proposed a framework for constructing a robust data strategy applicable across industries and varying levels of data maturity, assisting organisations to understand their data as an asset and guiding them towards strategic data management.

Jia, Hall and Song (2015) proposed a Data-Driven Decision Making Capability Framework that is dependent on the organisation's data governance, integration and analytics capabilities. The conceptual framework for designing data governance for cloud computing put forward by Al-Ruithe, Benkhelifa and Hameed (2016) intends to address concerns about the loss of control and governance that adopters of cloud-based data storage have. The framework proposed by Shamim *et al.* (2019) could assist organisations in improving their big data decision-making capabilities, improving the quality of data-driven decision-making.

Creating a data strategy is the initial functional goal of data management (Otto, 2011a) and should originate from understanding the business' data needs based on the business strategy (DAMA International, 2017). Otto (2012) emphasises the strategic importance of master data management and suggests an approach to designing a master data management architecture, while DAMA International (2017) explains the importance of master data management for data quality. Wang, Li and Wang (2015) proposed a framework that can guide an organisation to define a focused executive role for their Chief Data Officer (CDO), recognising the strategic importance of data for the organisation's success.

In response to the evolving role of technologies in business, data management reference models and frameworks continuously require updating and publication to remain relevant as frameworks and maturity models that are actively used by businesses to build and mature their data management capabilities that support the organisation's value propositions and

business models (Legner, Pentek and Otto, 2020). Legner, Pentek and Otto (2020) identified 12 reference models for data management in their research. Nine are purely for maturity assessment and, in some cases, specialise in a narrow scope of data management, such as data quality, master data management, or big data management. Only 3 of the 12 are capability models that address a broad scope of data management capabilities and are actively kept up-to-date and accessible for use in the industry. Figure 2-5 presents these three frameworks that apply to a broad scope of data management functions and activities.

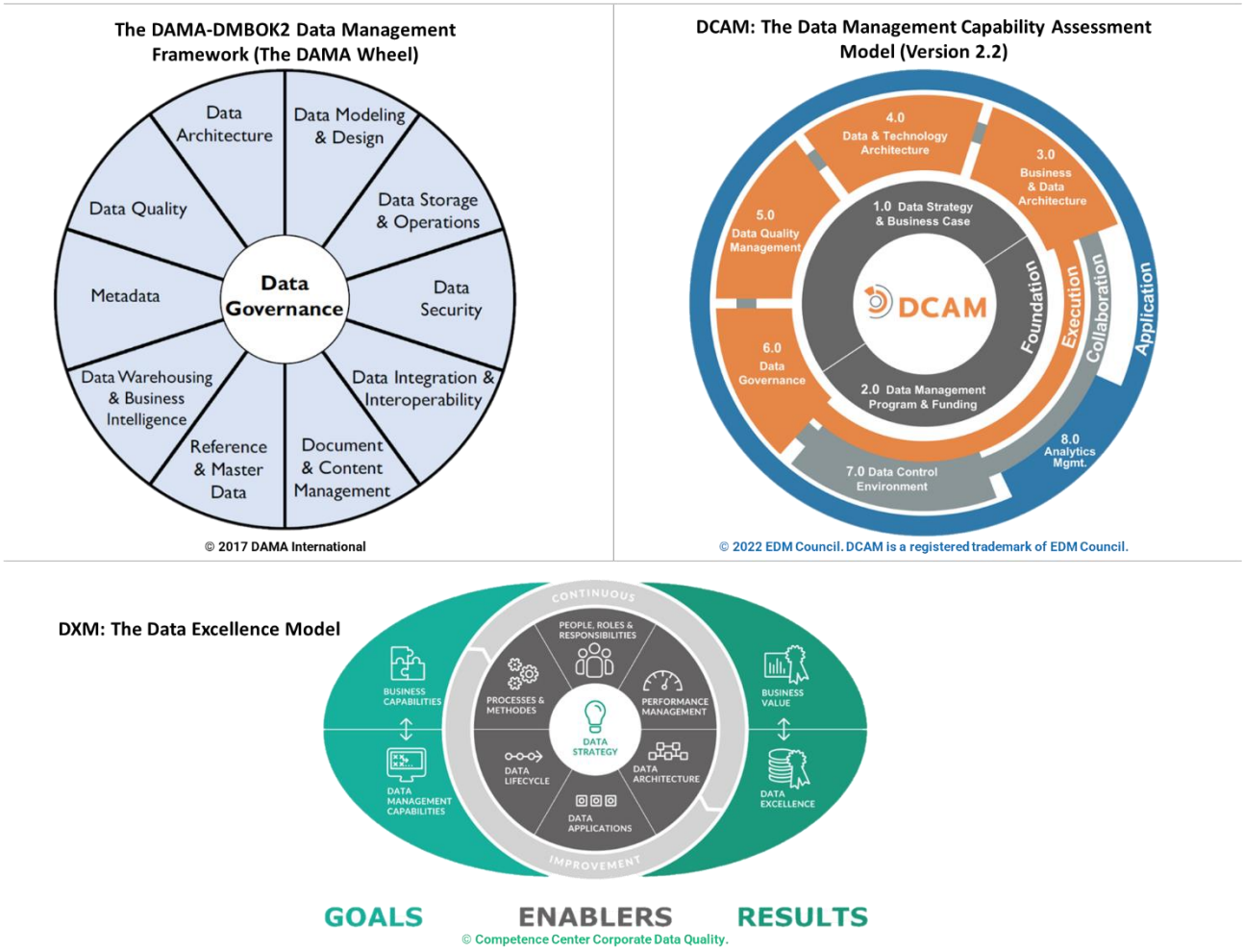


Figure 2-5: Current frameworks for data management (reproduced from CDQ Competence Center (2017, n. p.); DAMA International (2017, p. 36); EDM Council (2018, n. p.))

From the literature, it is plausible to state that DAMA-DMBOK (DAMA International, 2017) is the most widely used data management practitioner framework (Böhmer, Dabrowski and Otto, 2017; Fleckenstein and Fellows, 2018; Legner, Pentek and Otto, 2020). Other practitioner frameworks referenced in the literature are The DGI Data Governance

Framework (Thomas, 2006), the EDM council's DCAM framework (EDM Council, 2018), and Seiner's (2019) Non-invasive Data Governance Framework.

DAMA (Data Management Association International), founded in 1980 in Los Angeles, United States of America, is a vendor-independent industry consortium of data management experts promoting advancement in information and data management practices (Legner, Pentek and Otto, 2020; DAMA International Inc., 2022). The DAMA-DMBOK is a data management body of knowledge in book form that provides data management professionals with: (1) a functional framework for implementing enterprise data management practices, (2) a common vocabulary of data management concepts in practice, and (3) the fundamental reference guide for certified data management professionals (DAMA International, 2017, pp. 44–45).

The EDM council's DCAM framework defines the scope of what an organisation needs to implement and sustain to establish mature data management capabilities. The framework's scope includes strategies, organisational structures, technologies and operational best practices for EDM that support advanced analytics, digital transformation and data ethics (EDM Council, 2018). At the time of this study, the DCAM framework, as documented on the EDM Council's DCAM web page, did not include any specific references to agility.

The Data Excellence Model (DXM) originates from a research and industry consortium and provides a maturity and capability model for data management (Legner, Pentek and Otto, 2020). The DXM framework provides practitioners with guidance and support in implementing data management, covering the main design areas of EDM and guidance on transforming businesses into digital and data-driven organisations (CDQ Competence Center, 2017). At the time of this study, no specific references to agility were found for the DXM framework on CDQ's DXM web page.

Of the three frameworks presented in Figure 2-5 on page 25, the DAMA-DMBOK framework provides the most detailed definitions and descriptions for the functions, roles, activities and interactions that constitute an organisation's data management. DAMA International (2017) is the leading practitioner organisation for data management (Böhmer, Dabrowski and Otto, 2017; Legner, Pentek and Otto, 2020). Even though the DAMA-DMBOK framework was developed by an industry consortium of data management experts, researchers have successfully applied it in scientific studies (Hendrawan, Kusumasari and Fauzi, 2022; Ruslan, Alby and Lubis, 2022; Karkošková, 2023).

DAMA International (2017, p. 33) emphasises that “data management involves a set of interdependent functions, each with its own goals, activities, and responsibilities”. Interdependencies between data management functions require effective coordination mechanisms to enable proper functioning and adaptability to changes in the organisational environment (Brous, Janssen and Vilminko-Heikkinen, 2016). Otto (2012) views master data as representative of an organisation’s key business objects, such as customer, product and supplier, rendering it of strategic importance to the enterprise. However, master data management relies on data quality management, and its implementation is contingent on the heterogeneity of data, data models, diverse business processes, connections between systems, and prioritisation of business requirements (Otto, 2012).

Wixom, Yen and Relich (2013) emphasise the importance of developing data standards. According to Wixom *et al*. (2013), implementing a data standards layer enables the automation of data take-on, data quality and integration processes. Wixom *et al*. (2013) advise that organisations consider a master data management initiative if standardising data sources is not feasible. Master data management refers to a process that is application-independent and owns, describes and manages data entities of strategic importance to the business (Otto, 2012). The functional view of data management activities defined by DAMA International (2017) is presented in Figure 2-6 and shows the three overarching areas of data management: data governance (providing oversight), data lifecycle management, and foundational data management activities.

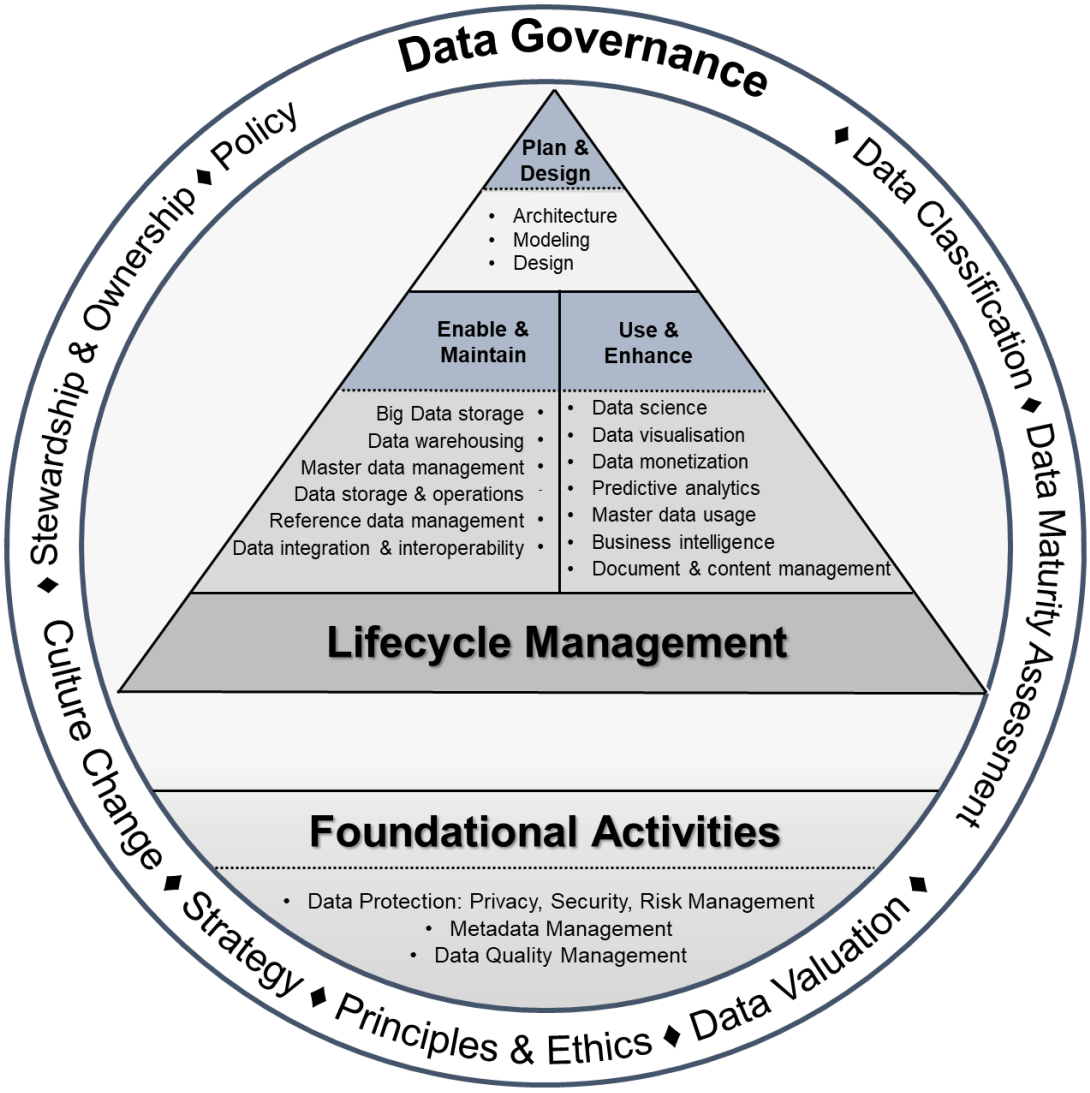


Figure 2-6: DAMA DM-BOK — A functional view of data management activities (reproduced from DAMA International (2017, p. 44))

Data management activities require resources with specialist knowledge and organisational structures that provide learning opportunities, nurture decision-making capabilities, and coordinate and integrate data management capabilities for all the organisation's data and information stakeholders (Brous, Janssen and Vilminko-Heikkinen, 2016; DAMA International, 2017).

2.1.3 The strategic importance of managing and governing data and information

Recognising data as a strategic organisational asset from which business can derive value (Jia, Hall and Song, 2015; DalleMule and Davenport, 2017) underlines the importance of effective enterprise data governance (Otto, 2011a; DAMA International, 2017; Benfeldt, Persson and Madsen, 2020). Data governance efforts should align with business goals across the enterprise (Böhmer, Dabrowski and Otto, 2017; DalleMule and Davenport, 2017). By specifying decision rights and accountabilities regarding the data assets, data governance provides a framework that promotes constructive behaviour in using and managing the organisation's data (Böhmer, Dabrowski and Otto, 2017; DAMA International, 2017; Seiner, 2019).

A data governance programme enables an organisation to become data-driven by implementing a data strategy with supporting policies, principles and data stewardship practices. Such a programme enables the organisation to recognise and benefit from opportunities to derive value from its data assets (DAMA International, 2017). According to DalleMule and Davenport (2017), an organisation's data strategy should dynamically adjust to competitive pressures and shifts in corporate strategy, requiring flexible data architectures. Data strategy interrelates with corporate strategy and thus has interdependencies across the business, data function, and divisional strategies (Legner, Pentek and Otto, 2020).

According to Briggs, Nunamaker and Sprague (2010, p. 13), "the purpose of information systems (IS) is to provide information to people who must make choices about the disposition of scarce resources". Even though exploiting enterprise data for managerial decision-making and competitive advantage is emphasised in the literature (Weber, Otto and Osterle, 2009; Jia, Hall and Song, 2015; DalleMule and Davenport, 2017; Knabke and Olbrich, 2018), data governance plays a vital role in corporate governance (Bank for International Settlements, 2013; Chakravorty, 2015; Institute of Directors Southern Africa, 2016; Gozman, Currie and Seddon, 2018; Basel Committee on Banking Supervision, 2020).

The King IV Report sets a benchmark for corporate governance in South Africa. Principle 12 of the King IV Report specifies that, "[t]he governing body should govern technology and information in a way that supports the organisation setting and achieving its strategic objectives" (Institute of Directors Southern Africa, 2016, pp. 62–63). Point 14 under Principle

12 specifically calls for organisations to continuously oversee technology and information management, ensuring the integration of people, technologies, information, and processes across the organisation (Institute of Directors Southern Africa, 2016, p. 62).

The Bank for International Settlements (2013) published the *Principles for Effective Risk Data Aggregation and Risk Reporting* (BCBS 239) in January 2013. These 14 principles aim to guide G-SIBs (Global Systemically Important Banks) to strengthen their risk-data aggregation and internal risk-reporting capabilities. The BCBS 239 expects banks to implement robust data management frameworks and measure their sustained compliance with the BCBS 239 requirements (Bank for International Settlements, 2013). By implementing these principles and complying with the requirements, banks enhance their decision-making processes and risk management capabilities resulting in an increased ability to cope with crises and stress (Chakravorty, 2015). The Basel Committee on Banking Supervision (2020) found that by the end of 2018, none of the banks had fully complied with implementing the BCBS 239 principles. This noncompliance is due to many banks experiencing challenges in establishing the necessary data architecture and information technology (IT) infrastructures (Basel Committee on Banking Supervision, 2020). Nonetheless, the compliance efforts by banks thus far have resulted in material improvements, including overarching governance, financial and regulatory reporting practices, and risk data aggregation capabilities (Basel Committee on Banking Supervision, 2020).

The drivers for implementing enterprise information management include complying with regulatory requirements and creating business value from data (Hausmann *et al.*, 2014). Reliance on accurate, reliable data enabled through sound data governance, and data analytics is preferable to relying on intuition for effective decision-making in the organisation (Jia, Hall and Song, 2015). However, Marchand and Peppard (2013) point out that managers' decisions are not automatically improved by simply providing them with high-quality data. The data users are the people who create meaning from the data and must be at the heart of the data initiative. How they use data in drawing conclusions and making decisions, what assumptions they make and to what extent they rely on formal data analysis versus gut feel should be challenged (Marchand and Peppard, 2013).

The United Nations (UN) identifies reporting and data as a required internal capability to deliver on the *UN Global Compact Strategy 2021–2023* (United Nations Global Compact,

2021). Furthermore, the UN calls on participants from all business sectors to provide business data and insights that can enrich global datasets and deepen collaboration and monitoring to achieve the UN's sustainable development goals (United Nations Global Compact, 2021).

The study conducted by Williams, Hausmann, Hardy and Schubert (2014) identified the top three drivers of enterprise information management: (1) obtaining greater business value from data, (2) meeting legal and regulatory compliance requirements, and (3) recognising that the nature of enterprise information management is sociotechnical and complex. Williams *et al.* (2014) also identified that the most essential activities in enterprise information management are improving and upgrading the organisation's existing information management technologies and building human capacity for performing the essential activities.

The process of human interaction with technologies and data to derive knowledge is complex, as seen in the case of data analytics (Douglas and Peppard, 2013). These processes usually include structured data managed by data management functions. However, such formal data must be integrated with its contextual reality for analytics to be effective. These non-formal forms of data and knowledge include verbal and non-verbal exchanges, human cognitive processes and observations related to the formal data (Douglas and Peppard, 2013). Therefore, no matter how well the data management functions manage the data, it must be managed and understood within the context of where it exists and where and when it is needed to derive valuable knowledge for the organisation. Although data can be viewed as a concrete independent resource that can exist as codified knowledge, it is the complex social construction processes and human sensemaking that create organisational information and knowledge that enables effective action (Douglas and Peppard, 2013; Legner, Pentek and Otto, 2020).

2.1.4 Conclusion

Even though researchers and practitioners recognise data as a strategic organisational asset (DalleMule and Davenport, 2017) that requires reference models (Legner, Pentek and Otto, 2020) and collective action to manage (Otto, 2012; Brous, Janssen and Vilminko-Heikkinen, 2016; Benfeldt, Persson and Madsen, 2020), many organisations are failing to

reap the benefits of their data endeavours (Marchand and Peppard, 2013; Nagle and Sammon, 2017; Davenport and Bean, 2018).

2.2 AGILITY IN ORGANISATIONS AND IMPLICATIONS FOR INFORMATION TECHNOLOGY AND DATA MANAGEMENT

The word “agile” can be defined as “marked by ready ability to move with quick easy grace” and “having a quick resourceful and adaptable character” (Merriam-Webster Incorporated, 2022, n. p.). Other definitions include “quick and well-coordinated in movement” and “marked by an ability to think quickly; mentally acute or aware” (Dictionary.com LLC, 2022, n. p.). Dictionary.com LLC (2022, n. p.) defines agility as “the power of moving quickly and easily; nimbleness” and “the ability to think and draw conclusions quickly; intellectual acuity”. Dictionary.com LLC (2022, n. p.) does, however, provide a definition that is more germane to information systems and organisations: “noting or relating to a philosophy of product development and production intended to create and distribute batches of working products in a short period of time with subsequent batches planned in a cyclical schedule of improvement, production, and distribution”.

Despite the pressing requirement for leaders in increasingly dynamic and difficult organisational environments to enable adaptability in organisations and people, this topic has received limited attention (Uhl-Bien and Arena, 2018). Due to rapid, unexpected changes in business environments, agility in organisations has become a critical imperative, requiring IT to enable organisational capabilities for sensing and responding timeously and effectively to threats and opportunities (Sambamurthy, Bharadwaj and Grover, 2003; Galliers, 2006; Overby, Bharadwaj and Sambamurthy, 2006; Tallon and Pinsonneault, 2011; Tallon *et al.*, 2019). However, there is currently limited research on what constitutes agility in organisations and how agile capabilities and a culture of agility actualises in organisational teams and practices (Wendler, 2016; Appelbaum *et al.*, 2017; Walter, 2021). According to Bolman and Deal (2017, pp. 242, 253), “[c]ulture forms the superglue that bonds an organization, unites people, and helps an enterprise to accomplish desired ends”; additionally “[r]ituals [...] bond a group together and imbue the enterprise with traditions and values”.

2.2.1 Agility in organisations

Over the past few decades, management, strategy, and IS literature have adopted a congruent view of agility as a synergy between sensing and responding capabilities (Tallon *et al.*, 2019; Nazir and Pinsonneault, 2021), and researchers often synonymously use the term "flexibility" (Teece, Peteraf and Leih, 2016; Walter, 2021). Teece, Peteraf and Leih (2016, p. 17) define "agility" as "the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant". Smart management combined with new technology may enable fewer people to achieve more. However, short-term gain on cost savings needs to be balanced with the risk of long-term deterioration in capability (Bolman and Deal, 2017).

Hypercompetition, unpredictable disruption and turbulence result in uncertainty in the business environment, requiring enterprises to successfully manage such uncertainty, which is a key feature of organisational agility (Teece, Peteraf and Leih, 2016). Van Oosterhout, Waarts and van Hillegersberg (2006, p. 132) suggest that the goal of agility is to cope with change in a highly dynamic business environment, and offer the following definition: "[b]usiness agility is the ability to swiftly and easily change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes". However, agility is costly to realise and maintain, is not required in all organisational situations and, in some cases, can be detrimental to the organisation's success (Teece, Peteraf and Leih, 2016; Walter, 2021). Responsiveness should be stimulated by changes in the organisation's environment instead of driving excessive transformation without stimulus (Appelbaum *et al.*, 2017).

For management to be effective and sustainable in an increasingly turbulent business environment, agility should be considered an overarching principle that guides operational and strategic activities (Appelbaum *et al.*, 2017; Pinsonneault and Choi, 2022). Furthermore, capabilities that enhance agility should be developed continuously to successfully integrate agility as a performance-enhancing paradigm (Appelbaum *et al.*, 2017), enabling the business to respond to change effectively and also to create change (Conboy, 2009).

According to Kappelman and Zachman (2013, p. 15), organisations will be more likely to succeed and thrive over the next few generations of the Information Age if they are able to

"do more with less, faster, while traditional boundaries blur, and the rules of engagement change". Such enterprises will comprise people who are effective and efficient communicators, quickly establishing a shared vision to construct their infrastructures and processes, thereby being responsive, adaptable, integrated, interoperable, agile, secure, efficient, effective, lean, and agile (Kappelman and Zachman, 2013). Bolman and Deal (2017) remind us that excellence in organisations requires more than steadfast exhortations from top management; instead, commitment and autonomy are required at all levels of the organisation.

2.2.2 The requirement for agility in information systems

A substantial body of knowledge exists in IS literature related to Agile software development approaches and methods (Sidky, Arthur and Bohner, 2007; Conboy, 2009; Conboy and Carroll, 2019; Baham and Hirschheim, 2022; Edison, Wang and Conboy, 2022). It has been over two decades since the Manifesto for Agile Software Development was published by Beck *et al.* (2001), providing organisations' software development teams with values and principles for Agile software development approaches that practitioners have since widely adopted. Agile software development approaches are intended for small teams to deliver more value to the business in less time through short prioritised iterations (Boehm and Turner, 2004). Nonetheless, what it means to "be agile" remains elusive (Baham and Hirschheim, 2022).

Conboy (2009, p. 340) defines agility in the context of information systems development (ISD) as "the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment". In their Manifesto for Agile Software Development, Beck *et al.* (2001) proposed 12 principles for Agile software development. To guide organisations to adopt agile practices, Sidky, Arthur and Bohner (2007) distilled these 12 principles into 5 essential elements for agile solution delivery: (1) deliver customer value by embracing change; (2) plan and deliver solutions in short iterations; (3) acknowledge the vital role of people and their interactions; (4) deliver high-quality solutions; and (5) frequently collaborate and interact with all stakeholders.

Agility is an emergent phenomenon at the team level (Werder and Maedche, 2018), and problems arise in attempts to scale agility to the enterprise level (Limaj and Bernroider, 2022), as simply having more Agile teams does not produce organisational agility (Sidky, 2017). Sidky (2017) defines organisational agility as a culture founded in the principles and values of Agile that is supported by the organisation's leadership, strategy, structure, processes and people and manifested through adoption by people and embedment in organisational habits. Denning (2016) explains that large-scale Agile frameworks, such as the Scaled Agile Framework (SAFe), often fail as they attempt to "align" Agile teams with corporate goals, such as increasing the stock price and meeting quarterly targets, whereas Agile practices focus on delivering value for their customers in short iterations. This discrepancy results in constant friction between the enterprise and the Agile team levels in the organisation (Denning, 2016).

Denning (2018, p. 23) offers a summary of how "Agile", introduced by Beck *et al.* (2001), has evolved from a set of values and principles, including antecedents like "design thinking" and "quality", for approaching software development, to a "mindset" that pursues organisational agility: "In due course, the [Agile] Manifesto spawned various management methodologies including Scrum, DevOps, Lean, and Kanban. Over time, it evolved into a movement of people with a specific mindset. The mindset focuses on delivering continuous value to customers as the primary goal of work. It embraces iterative, incremental approaches to working in small teams and aims at enterprise-wide agility by operating as a network".

Approaches and methods for achieving organisational agility remain intangible (Sanchez and Nagi, 2001; Teece, Peteraf and Leih, 2016; Wendler, 2016; Sidky, 2017; Walter, 2021). Sanchez and Nagi (2001, p. 3561) propose the following aspects to represent the essence of agility in enterprises: "agility is characterized by cooperativeness and synergism (possibly resulting in virtual corporations), by a strategic vision that enables thriving in face of continuous and unpredictable change, by the responsive creation and delivery of customer-valued, high quality and mass customized goods/services, by nimble organization structures of a knowledgeable and empowered workforce, and facilitated by an information infrastructure that links constituent partners in a unified electronic network".

Overby, Bharadwaj and Sambamurthy (2006, p. 121) define "enterprise agility" as an organisation's ability to "sense environmental change and respond readily. As such,

enterprise agility consists of two components: sensing and responding". In addition, they found that the deployment and management of IT play a crucial role in realising enterprise agility. Crick and Chew (2020) propose that by disaggregating the organisation into a complex sociotechnical system that comprises finer-grained sociotechnical objects at lower levels, such as routines, individuals and technologies, the microfoundations of organisational agility can be understood and explained.

To an ever-increasing degree, organisations depend on IT agility to respond timeously and effectively to unforeseen threats and opportunities in the environment (Tallon *et al.*, 2019). Tallon *et al.* (2019) identified four broad categories for antecedents of IT-enabled agility in organisations: technological, behavioural, organisational or structural, and environmental. As a technological enabler, IT facilitates agility at the process-level, for example, supplier agility, operations agility and partnering agility (Sambamurthy, Bharadwaj and Grover, 2003). IT agility could have knock-on effects, for example, where technology is improved to increase production but results in overloading the logistical process that supplies the products to the customer (Tallon *et al.*, 2019).

Strategic planning and managerial foresight are crucial to benefiting from the behavioural enablers of agility due to IT investment risks (Tallon and Pinsonneault, 2011; Ravichandran, 2018). Managers should promote calculated risk-taking (Tallon *et al.*, 2019) and consider the cost, timing, availability, accuracy and accessibility of the information needed for sensing, deciding and acting in response to opportunities and threats in the environment (Park, El Sawy and Fiss, 2017). Data operations platforms and data streaming capabilities are structural enablers of organisational agility. However, often batching, transformation, and integration processes are prerequisites to making the information available to decision-makers, and thus the timeliness and richness of the source data are potentially lost (Tallon *et al.*, 2019).

Tallon and Pinsonneault (2011) found that alignment between IT and business strategy enabled organisational agility in turbulent organisational environments provided the IT was flexible, for example, flexible IT infrastructure that is scalable and adaptable to changes in the environment. However, Chakravarty, Grewal and Sambamurthy (2013) found that, even though IT competencies enable organisational agility, the positive effects of IT competencies diminished as the rate of change in the organisational environment increased. In the highly-competitive business environment where digital markets are converging, enterprises are

required to combine organisational with IS agility, thus taking a more integrative view of the organisation and its IS (Salmela, Baiyere, Tapanainen and Galliers, 2022).

2.2.3 The requirement for agility in data and information governance and management

Despite the strong emphasis on studies of agile software development, there is currently insufficient research on organisational agility (Wendler, 2016). Wendler (2016) found that scientific research has no consensus on what defines an “agile organisation”. Existing scientific research on agility in organisations primarily focuses on the characteristics of agile organisations and less on how organisations can develop and embed agile capabilities enabling them to thrive in continuously changing environments (Appelbaum *et al.*, 2017). Nonetheless, the requirement for organisational agility (Teece, Peteraf and Leih, 2016) presents a demand for new data management strategies (DalleMule and Davenport, 2017) that can achieve agility in those organisational structures and activities that deliver valuable data and information to the business (Marchand and Peppard, 2013).

Recent research has found that organisations are experiencing difficulty deriving value from their data initiatives (Nagle and Sammon, 2017; Karkošková, 2023). Information is evolving into a strategic resource that requires governance and management different from governing physical IT artefacts (Tallon, Ramirez and Short, 2013). Organisations today are having to cope with increasing complexity in their internal and external environments (Lapalme *et al.*, 2016; Teece, Peteraf and Leih, 2016) and are increasingly having to rely on IT to enable organisational agility in order to cope with volatility and uncertainty in the business environment (Tallon *et al.*, 2019; Salmela *et al.*, 2022). Lapalme *et al.* (2016, p. 105) define Enterprise Information Systems (EIS) as “all the information systems (composed of people, technology and data) that support the integrated functions of an enterprise”, making data management inextricable from the enterprise, its technologies and its environment.

The presence of technologies in data management practices is pervasive, whether for database management, data integration, master data management, advanced analytics and artificial intelligence, data quality, metadata management, information security, data storage platforms for big data or data warehouses, or any other data management function (DAMA International, 2017). The technology choices are vast and involve specialised capabilities that are often interdependent. For example, master data management requires data quality

management (Otto, 2015). Therefore, decision-makers need to consider the organisation's data requirements, interdependencies and ever-changing contexts (Barlette and Baillette, 2022). Data and data management are profoundly entangled with IT and IT management (DAMA International, 2017).

When considering all the activities involved in data management, as shown in Figure 2-6 on page 28 (DAMA International, 2017), it is immediately apparent that many specialised technologies and specialists are required within the enterprise to perform data management activities such as data quality management, metadata management, data architecture, business intelligence (BI) and data analytics. Human and technological actors interact to perform the activities required to manage data. Hausmann *et al.* (2014) and Legner, Pentek and Otto (2020) view enterprise information management as a complex sociotechnical phenomenon where human agencies and technology affordances overlap and interweave to deliver data management requirements to the business. According to Leonardi (2011), "[i]mbrication of human and material agencies creates infrastructure in the form of routines and technologies that people use to carry out their work". Each data management discipline must combine specialist knowledge and skills with specialised information technology (IT) to deliver data and information requirements to the business (Hausmann *et al.*, 2014; DAMA International, 2017; Legner, Pentek and Otto, 2020).

It is evident from the reviewed literature that, despite an increasing awareness that data is an imperative business asset, many organisations fail to govern their data with the agility required in a highly competitive and turbulent business environment (Ofner, Huener and Otto, 2009; DalleMule and Davenport, 2017). Effective and efficient data management is required to support the business goals of risk management and regulatory compliance (Otto, 2011a; Bank for International Settlements, 2013; Chakravorty, 2015), enhanced decision-making (Jia, Hall and Song, 2015; Otto, 2015), improved customer satisfaction, increased operational efficiency and improved business integration (Otto, 2011a).

The DAMA International (2017) DAMA-DMBOK guide suggests using waterfall, iterative or Agile approaches to integrate and coordinate project data roles and activities. The guide includes multiple references to Agile literature relating to software development approaches and proposes five brief guidelines relating to agility (DAMA International, 2017): (1) the data storage and operations functions should identify opportunities for automation and adopt Agile development and iterative approaches in collaboration with data architecture and data

modellers; (2) data warehousing should facilitate incremental delivery and collaboration with business stakeholders; (3) data virtualisation technology and techniques can enable data management to deliver valuable data to the business agilely; (4) data architects should act as agents for organisational effectiveness and agility; and (5) it is crucial to use Agile approaches and engage data architects early in projects when using disruptive technology to innovate with data. However, DAMA International (2017) DAMA-DMBOK offers no specific guidelines or methods for achieving collective agility across all data management functions of an organisation's EDM.

Flexibility is required in Risk data aggregation capabilities to enable flexible reporting that is easy to adapt as needed to meet BCBS 239 aggregation requirements (Chakravorty, 2015). If managed correctly, data can be the ultimate reusable asset (Panian, 2010). It is essential to avoid duplication of data and information collection. Available information should be reused where possible. However, there is often a reluctance to use information where another party owns it in the organisation (Kettinger and Marchand, 2011). A centralised data integration platform enables scalable enterprise data governance (Panian, 2010). Speed refers to how quickly and effectively raw data can be made available to the business as usable information (Wixom, Yen and Relich, 2013).

2.2.4 Conclusion

Agility is an abstract concept, and the scientific perspectives and theoretical constructs for organisational agility are diverse in their content and structure in management, strategy and IS literature (Tallon and Pinsonneault, 2011; Teece, Peteraf and Leih, 2016; Wendler, 2016; Appelbaum *et al.*, 2017; Sidky, 2017; Knabke and Olbrich, 2018; Werder and Maedche, 2018). Furthermore, there is no consistent definition of agility in organisational contexts (Wendler, 2013, 2016).

Data management practitioners and technologies perform data management functions within the enterprise and are, therefore, inclusively subject to the uncertainty and rapid change in the internal and external environments of the enterprise within which it resides. IS includes not only software, hardware and data but also people and their work practices required for producing timely, accurate information from the systems to inform choice, and are, thus, not just characterised as technical but sociotechnical (Briggs, Nunamaker and

Sprague, 2010). IT, which includes all the sociotechnical aspects of data management, needs to be agile to enable organisational agility.

2.3 CONCLUSION AND AWARENESS OF THE PROBLEM

The literature reviewed in this section established that EDM is a defined field of practice comprising specialised roles, functions and technologies which serve specific organisational goals (DAMA International, 2017; Peppard, 2018; Legner, Pentek and Otto, 2020), spanning operational, strategic and tactical levels (Seiner, 2014; Brous, Janssen and Vilminko-Heikkinen, 2016), for collective benefit across the enterprise (Otto, 2015; Peppard, 2016; DalleMule and Davenport, 2017). Therefore, EDM's human and technological activities and interactions are perpetually entangled, presenting complex sociotechnical situations. The requirement for IT agility to enable organisational agility has been researched extensively (Sambamurthy, Bharadwaj and Grover, 2003; Roberts and Grover, 2012; Park, El Sawy and Fiss, 2017; Queiroz, Tallon, Coltman and Sharma, 2022). Technology is pervasive in data management (Marchand and Peppard, 2013; DAMA International, 2017).

Data governance ensures that data management functions coordinate to enable collective alignment between work execution and outcomes for data management (DAMA International, 2017). So far, few organisations have established a well-coordinated and integrated approach to enterprise information management that spans the whole organisation (Hausmann *et al.*, 2014). Data management and governance support business decision-making and require decision-making according to data management roles and decision rights (Otto, 2011a; Brous, Janssen and Vilminko-Heikkinen, 2016). Maximising business value from data requires continuous learning and engagement with specialists to exploit the latest data management technologies (Wixom, Yen and Relich, 2013). The governance and management of data need a coherent strategy that balances a defensive approach (supporting corporate governance and data security) with an offensive approach (driving increased profits and market share through predictive analytics) and should implement technologies that support agility and scalability (DalleMule and Davenport, 2017).

Searching the data and information governance and management literature indicated that there is currently a lack of research on agility in EDM. In addition to the lack of scientific literature that addresses the agility problem in EDM, the data management practitioner

frameworks (DAMA-DMBOK, DCAM and DXM) reviewed in this chapter do not provide a holistic and deliberate approach to pursuing agility in EDM.

Despite evidence in the literature that there is a clear requirement for agility in EDM (Marchand and Peppard, 2013; Tallon, Ramirez and Short, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019), there seems to be minimal scientific research on agility in EDM and how organisations might go about achieving agile EDM. This literature review identified an existing practical problem and a gap in documented research on how organisations can achieve agility in EDM.

This study views EDM as a strategic sociotechnical organisational structure within an enterprise that is required to achieve agility to enable enterprise agility and proposes that a framework for agile EDM could potentially address this requirement. The main research question is, therefore:

Main-RQ:	*How* can agile enterprise data management be achieved?

The following chapters in this study set out to develop a framework founded on scientific theory and research to address the requirement for agile EDM in organisations.

3 RESEARCH METHODOLOGY

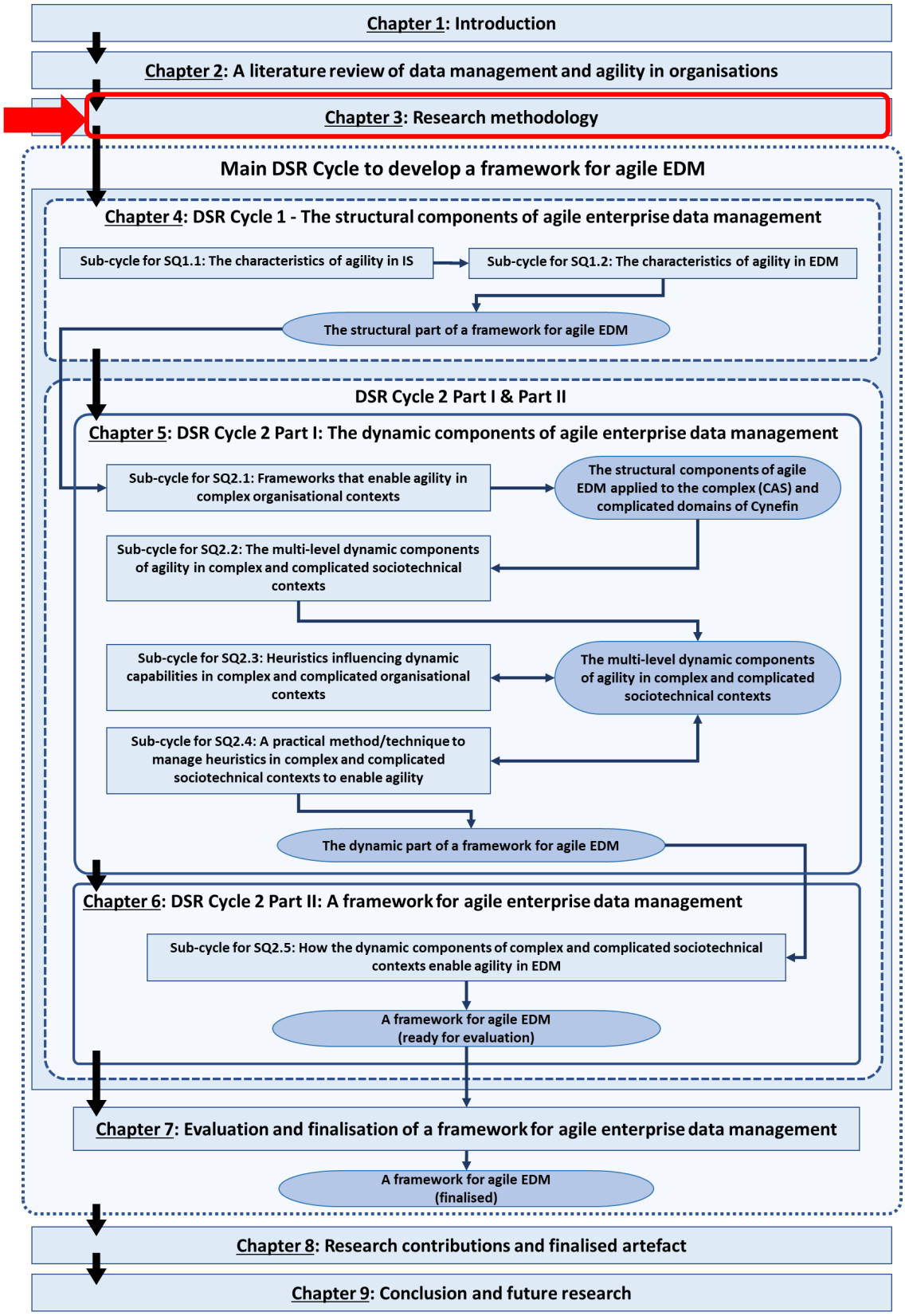


Figure 3-1: Chapter map — Chapter 3

Prior, relevant literature forms the foundation of this study. A coherent structure is first created for approaching the concepts underlying the research topic (Webster and Watson, 2002) by defining the problem space, including its boundaries, nature and rationale, and solution space (Pentek, Legner and Otto, 2017) for agile EDM. This approach provides a scaffold for developing an understanding of what an investigation of the research topic requires, prompting excavation of the sub-questions as the research process unfolds (Ravitch and Riggan, 2017) to develop a framework for agile EDM.

The research topic of agility in EDM presents a challenge as the literature review must span multiple scientific disciplines and draw on theories from diverse fields (Webster and Watson, 2002). Using an approach similar to that used by Legner, Pentek and Otto (2020) in their definition of an ontology for quality-oriented data management, Table 3-1 defines the problem space and the solution space for agile EDM:

Table 3-1: The problem space and solution space for agile enterprise data management (based on Legner, Pentek and Otto (2020, p. 745))

The problem space:	
Fundamental concepts	What are the boundaries, nature and rationale of agile EDM?
Boundaries	With social and technical agents, EDM is situated in the IS field. However, EDM is a strategic sociotechnical organisational structure within an enterprise and thus also involves the fields of strategy, management and decision sciences. **The structural components of agile EDM** need to be explained. **The dynamic components of agile EDM** need to be explained.
Nature	The nature of the contexts and situated structural and dynamic components of agility in EDM need to be explained.
Rationale	There is a requirement for organisations to achieve agile EDM.
Implementation	What could be developed as a solution to the problem of achieving agile EDM in the real world?
The solution space:	
Artefact	**A framework for agile EDM**

The research questions and the methods for this study were shaped first by understanding the nature of the phenomenon being investigated, as it raises the question of how to probe the nature of the phenomenon (Ravitch and Riggan, 2017). By identifying the specific characteristics of agility in IS, its nature can be understood and the characteristics can be

applied to investigate agility in EDM. Simon (1996) advises that any effort to solve an identified problem should first define the problem space, thus creating a frame within which to search for the solution.

3.1 PROBLEM STATEMENT AND RESEARCH QUESTIONS

The literature review in Chapter 2 confirmed that there is a requirement for organisational agility (Tallon and Pinsonneault, 2011; Teece, Peteraf and Leih, 2016; Wendler, 2016; Appelbaum *et al.*, 2017; Sidky, 2017; Knabke and Olbrich, 2018; Werder and Maedche, 2018). In turn, IT agility is required to support and enable organisational agility (Sambamurthy, Bharadwaj and Grover, 2003; Galliers, 2006; Roberts and Grover, 2012; Park, El Sawy and Fiss, 2017; Queiroz *et al.*, 2022). At the same time, technology is pervasive in data management (Marchand and Peppard, 2013; DAMA International, 2017), and organisations are required to develop effective data management strategies (DalleMule and Davenport, 2017) that enable agility in those organisational structures and activities that deliver valuable data and information to the business (Marchand and Peppard, 2013). Based on these indications in the literature, this study identified a research problem for which a practical solution is required to answer the main research question:

Main-RQ:	*How* can agile enterprise data management be achieved?

However, there is limited consensus on the characteristics of agile organisations (Wendler, 2013, 2016). In addition, there is limited scientific research on the processes for achieving agility in organisations (Park, El Sawy and Fiss, 2017; Walter, 2021; Limaj and Bernroider, 2022), and the literature review indicated that limited knowledge exists about agility in EDM.

Practitioner data management frameworks provide prescriptive knowledge for pragmatic solutions to data management problems (CDQ Competence Center, 2017; DAMA International, 2017; EDM Council, 2018; Legner, Pentek and Otto, 2020). However, at the time of this study, there was limited scientific literature and only some practitioner literature presenting practical models and methods for how organisations can achieve agility in the management of their data.

Frameworks and reference models in data management constitute design knowledge that accumulates over time, evolving alongside technology-related change and maturation of

practice and design (Legner, Pentek and Otto, 2020). Frameworks for data management answer “how” questions, producing prescriptive knowledge, particularly when seeking a pragmatic solution to a problem (Pentek, Legner and Otto, 2017).

This study proposes that the research problem can be addressed by offering organisations a practical framework for achieving agile EDM. Designing and building a framework for agile EDM requires an understanding of *what* agile EDM is and *how* (by which processes) agile EDM can be achieved, thus raising two sub-questions to the main research question of this study. As the research process unfolds, each sub-question is answered, and further sub-questions are raised as underlying problems are identified and addressed, iteratively contributing to solving the main research question.

First, the structural components of agile EDM are developed (Sub-RQ1) from existing IS literature (SQ1.1) and applied to a qualitative case study of EDM (SQ1.2):

Sub-RQ1:	What are the structural components of agile enterprise data management?
SQ1.1:	What are the characteristics of agility in Information Systems?
SQ1.2:	What are the characteristics of agility in enterprise data management?

Secondly, the dynamic components of agile EDM (Sub-RQ2) are founded on the structural components of agile EDM and developed (SQ2.1 to SQ2.4) from the literature across diverse scientific domains (including IS, Decision Sciences, Strategic management and Organisational Science) due to the limited consensus in the literature on how organisations achieve agility. The dynamic components of agile EDM developed from the literature are then applied to a qualitative case study of EDM (SQ2.5):

Sub-RQ2:	What are the dynamic components of agile enterprise data management?
SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?
SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?
SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?

SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?
SQ2.5:	How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?

This chapter presents the methodology for addressing the research questions to develop a framework for agile EDM as a practical solution to the real-world problem of how organisations can achieve agile EDM.

3.2 A FRAMEWORK AS AN ARTEFACT

IGI Global (2022, n. p.) offers the following definition for a framework: “A framework is an instrument to identify relevant variables and the relationship between them for a specific practical question. It consists of a combination of deductive models and inductive based case studies. A framework needs to be adapted to many different situations and therefore delivers a set of alternatives”.

Simon (1996) describes an artefact as something that is created and adapted by humans to serve human goals and purposes. Furthermore, an artefact is not exempt from natural law. It has an internal environment, the essence and composition of the artefact itself, and an external environment comprising its operational surroundings. The artefact’s interface operates where the artefact performs its function as provisioned by its internal environment within a particular external environment (Simon, 1996).

In their ground-breaking work, March and Smith (1995) first indicated various types of artefacts produced by IS design research as models, methods, constructs and instantiations. The purpose of design science is to design IT artefacts (March and Smith, 1995; Hevner, March, Park and Ram, 2004). However, in their review of the literature, Offermann, Blom, Schönherr and Bub (2010) found an insufficiently unified understanding of what an IT artefact in IS research is, identifying eight different types of design artefacts: system design, method, language/notation, algorithm, guideline, requirements, pattern, and metric.

The processes governing and managing data are becoming more complex (Tallon, Ramirez and Short, 2013). Frameworks in data management are artefacts that aim to support and guide data management specialists in their data management practices in complex and complicated organisational contexts (Brous *et al.*, 2014; DAMA International, 2017; Legner,

Pentek and Otto, 2020). Legner, Pentek and Otto (2020) propose an artefact perspective to data management reference models and frameworks, such as DAMA-DMBOK, DCAM, and DXM, because they represent design boundary objects.

Design boundary objects are design products with four distinct features: “capability to promote shared representation, capability to transform design knowledge, capability to mobilize for action, and capability to legitimize design knowledge” (Bergman, Lyytinen and Mark, 2007, p. 546). These four features promote the alignment, integration and transformation of domain and technical knowledge across disparate organisational realities and align, coordinate and mobilise stakeholder power (Bergman, Lyytinen and Mark, 2007). Successful data management frameworks bring structure to data management practices, address the challenges and practical requirements of data management, and constitute a substantial body of design knowledge established and synthesised through ongoing efforts by practitioners and researchers (Legner, Pentek and Otto, 2020).

Process studies investigate how organisational and managerial phenomena change, emerge and unfold over time (Langley, Smallman, Tsoukas and van de Ven, 2013). Frameworks that deal with complexity provide a way to gain different perspectives on an existing situation, thereby creating alternative approaches to proceed in the desired direction (Snowden, 2018, pt. 05:04). To achieve agile EDM, the framework developed by this study should enable the integration and co-evolution of its elements with existing practitioner data management frameworks.

In DSR, a framework is defined as an artefact type that is “both a model and a closely interrelated method to use/implement the model” (Kotze, van der Merwe and Gerber, 2015, p. 3). March and Smith (1995, p. 256) define a model as “a set of propositions or statements expressing relationships among constructs”. A method provides a means to perform goal-directed activities and is underpinned by a set of constructs, providing steps as algorithms or guidelines used to perform a task (March and Smith, 1995).

A formal model provides a visual/graphical representation of a theory that supports the parsimony and completeness of the theory (Whetten, 1989). Whetten does not distinguish between a model and a theory and defines the “what” in a model as, “Which factors (variables, constructs, concepts) logically should be considered as part of the explanation of the social or individual phenomena of interest?” (Whetten, 1989, p. 490). The “how” of a

model describes how the identified factors are related, typically introducing causality and delineating patterns (Whetten, 1989, p. 491). A cause is an action or an event that results in a change of some kind (Gregor and Hovorka, 2011).

This study adopts the definition of a framework as a model and its related method that can be used to implement the model to achieve its goal of agile EDM. Therefore, a framework for agile EDM is the artefact that will be developed by the research.

3.3 RESEARCH IN INFORMATION SYSTEMS

Lee (2001, p. iii) makes an important point about research in IS that is relevant to this study: "research in the information systems field examines more than just the technological system, or just the social system, or even the two side by side; in addition, it investigates the phenomena that emerge when the two interact". Thus, IS as a discipline is concerned with researching phenomena at the intersection of knowledge of technologies and human behaviour, comprising a body of knowledge that draws on social science, natural science and design science (Gregor, 2006).

Rich phenomena emerge from the interaction of teams, individuals and technology in organisations (Klein and Myers, 1999). Qualitative assessment of these phenomena may be required to gain a deep understanding that can be used for problem-solving and theory development (Klein and Myers, 1999). When conducting case studies, behavioural science researchers can understand the organisational phenomena within a particular real-world context (Myers, 2013). In aiming to generate prescriptive knowledge, DSR contributes to theory and solves real-world practice problems (vom Brocke, Winter, Hevner and Maedche, 2020).

The IS field is concerned with the relevance of research to practice as it spans the multiple scientific and practice fields of business, management and IT (Peffers, Tuunanen, Rothenberger and Chatterjee, 2007; Kuechler and Vaishnavi, 2011). From the outset, there have existed two separate approaches to academic research in IS: behavioural research (relating to management) and constructivist research (relating to the building and evaluation of artefacts) (Kuechler and Vaishnavi, 2011). Over the last few decades, the constructivist approach to academic research in IS has become known as design science research (DSR), which rigorously attempts to ensure research relevance to practice (Kuechler and Vaishnavi, 2011). As this study proposed to solve the research problem of achieving agility in EDM

practice by constructing a framework founded on scientific knowledge and theory, DSR was considered an appropriate strategy for this study.

3.4 RESEARCH PHILOSOPHY

Pragmatism is a research paradigm that acknowledges truth while developing a practical (not purely theoretical) solution to a real-world problem (March and Smith, 1995). The pragmatist researcher proposes solutions to research problems through interventions, actions and constructive knowledge to bring change and improvement (Goldkuhl, 2012b). The epistemological orientation of pragmatism is to aim for intervention and change in real-world contexts, whereas interpretivism in IS research aims to interpret and understand the real world (Goldkuhl, 2012b). A pragmatist does not merely aim to understand possible future states but to intervene by constructing an improved future state of a problem space (Goldkuhl, 2012a). The identified requirement for a practical solution to the agility problem in EDM firmly roots this study in pragmatism.

A philosophy of pragmatism underpins design science (Hevner, 2007; Goldkuhl, 2012a; Levy and Hirschheim, 2012; Deng and Ji, 2018), and the DSR researcher takes an epistemological stance as “a pragmatist who believes in ‘knowing through making’” (Deng and Ji, 2018, p. 7). As Simon (1996, p. 111) points out, “[e]veryone designs who devises courses of action aimed at changing existing situations into preferred ones”. According to Deng and Ji (2018), DSR values control and creative manipulation of the environment in addition to traditional research’s pursuit of understanding and truth. The DSR process takes the researcher through iterations of philosophical perspectives where they are an interpretive observer, positivist observer or constructive intervener (Deng and Ji, 2018). Table 3-2 presents the philosophical assumption of DSR.

Table 3-2: Philosophical assumption of DSR (adopted from Vaishnavi, Kuechler and Petter (2004, p. 9))

Basic belief	**Design research perspective**
Ontology is the study that describes the nature of reality.	Multiple, contextually situated alternative world-states. Socio-technologically enabled
Epistemology is the study that explores the nature of knowledge.	Knowing through making; objectively constrained construction within a context. Iterative circumscription reveals meaning

Basic belief	Design research perspective
Methodology comprises the research strategies and methods.	Developmental Measure artefactual impacts on the composite systems
Axiology is the study of values.	Creating solutions for real-world problems, thus bringing about progress (i.e. improvement), and building shared understanding and knowledge for researchers and practitioners.

This study adopts a pragmatist perspective on artefact construction as it intends to produce an artefact, a framework for agile EDM, that has practical validity in the real world, improving insufficiently agile EDM practices by providing an interventional process whereby EDM can become more agile. The epistemological stance of this study is constructivist, as the construction of a practical artefact, including qualitative methods, drives the knowledge-creation process of this study (Goldkuhl, 2012a). In this study, knowledge is built iteratively by synthesising, investigating and understanding how agility emerges over time through the situational actions and interactions of EDM's human actors and technological aspects in the real-world. An artefact is constructed and evaluated using a pragmatic process that aims to inform EDM's human actors and technological aspects on achieving agile EDM.

The research paradigm of pragmatism derives truth and meaning from the practical consequences of applying solutions to problems in the real world (Hevner, 2007; Levy and Hirschheim, 2012). Hevner (2007, p. 91) defines good DSR as “the synergy between relevance and rigor and the contributions along both the relevance cycle and the rigor cycle”. A problem is considered relevant if it is important to business and worth solving (Hevner *et al.*, 2004), but good DSR cannot be based on practical utility alone (Hevner, 2007).

At the same time as drawing from existing scientific knowledge, this study aims to contribute new knowledge to the IS research field during its investigation of how agility can be achieved in real-world EDM contexts. Probing the real world through a qualitative case study using the structural and dynamic parts of the framework for agile EDM is a critical alignment of this study's DSR strategy with a pragmatist ontology.

3.5 DESIGN SCIENCE RESEARCH IN INFORMATION SYSTEMS

Design science research focuses on the “design” of an artefact and creating something that does not yet exist (Gregory, 2010). The artefact, as the artificially designed and developed

product of a DSR process, is pivotal to DSR (van der Merwe, Gerber and Smuts, 2020). Merriam-Webster Incorporated (2022, n. p.) defines the verb “design” as “to create, fashion, execute, or construct according to plan” and the noun as “a particular purpose or intention held in view by an individual or group” or “a mental project or scheme in which means to an end are laid down”. Baskerville, Kaul and Storey (2015, p. 546) define science as “a systematic investigation and validation resulting in new knowledge”.

Non-constructivist researchers across multiple fields define design science as “the study of how artifacts are designed and the characteristics of designers and their practices” (Kuechler and Vaishnavi, 2011, p. 126). Design scientists do not strive to produce general theoretical knowledge but instead aim to create effective, valuable and innovative artefacts by applying knowledge of situations and tasks to create the artefacts (March and Smith, 1995). The two foundational activities of design science are (1) building, which involves the construction of a purposeful artefact and; (2) evaluating, which requires assessment of the artefact's performance (March and Smith, 1995) and provides feedback generating new knowledge about the research problem (Gregory, 2010).

In their review of DSR literature, van der Merwe, Gerber and Smuts (2020) found that DSR methods invariably include identification, design, development and testing as the general design and development stages. Design in DSR includes both a new product as the outcome of the design and the design process itself (Gregory, 2010). Design comprises the product of the design process and the process itself, which is a planned execution of constructing and assembling the product to fulfil its purpose (Baskerville, Kaul and Storey, 2015). Thus, design is “a noun and a verb” (Walls, Widmeyer and El Sawy, 1992, p. 42). At each stage of the design process, the incomplete design reflected in the artefacts produced thus far serves to influence and inspire what the designer should consider in the next phase of the design process while producing the artefacts (Simon, 1996, p. 92).

Peffers *et al.* (2007) state that based on the literature, a DSR artefact can be defined as “any designed object with an embedded solution to an understood research problem”, which may take the form of models, methods, instantiations and constructs, including social innovations. “An IS artifact is itself a system, in which the whole (the IS artifact) is greater than the sum of its parts (the IT artifact, the social artifact, and the information artifact), where the constituents are not separate, but interactive, as are any subsystems that form a larger system” (Lee, Thomas and Baskerville, 2015, p. 7).

Complexity in sociotechnical domains stems from the combination of human and technological components of which the quality and functional attributes are not necessarily known separately or as an integrated whole (Baskerville, Baiyere, Gregor, Hevner and Rossi, 2018). In a DSR project, this complexity needs to be managed by concurrently constructing a problem space and a solution space, and evolving the completeness of both spaces during the multiple DSR iterations (Baskerville *et al.*, 2018). Legner, Pentek and Otto (2020) suggest framing the problem space for data management reference models and frameworks using the artefact's rationale, boundaries and nature, and its solution space through design decisions.

Different types of DSR artefacts have been described in the DSR literature: An artefact could be a method, model, construct or instantiation (Hevner *et al.*, 2004). March and Smith (1995) defined four types of design science artefacts: (1) constructs provide a fundamental language characterising the phenomena being studied; (2) models are combinations of constructs forming higher-level constructions that describe situations, tasks or artefacts; (3) methods explain how goal-oriented activities should be performed; and (4) implementations instantiate the constructs, models and methods as operationalised, physical products that intend to achieve the goals of the design science artefact. However, an instantiation might precede the “final”, fully-understood version of the artefact as its constructs, models, and methods might only materialise through its use and investigation (March and Smith, 1995). The artefacts produced through DSR (frameworks, models, architectures, constructs, methods, design principles, instantiations, and design theories) manifest DSR knowledge (Vaishnavi, Kuechler and Petter, 2004). Kotze, van der Merwe and Gerber (2015, p. 3) define a framework as a DSR artefact type that is “both a model and a closely interrelated method to use/implement the model”. Pentek, Legner and Otto (2017) suggest that data management frameworks provide prescriptive knowledge for pragmatic solutions to problems. Therefore, the DSR artefact produced by this study aims to create a model and a method for implementing a framework that enables organisations to achieve agile EDM in real-world contexts.

Design science and behavioural science are two research domains, amongst others, that can be considered as foundational to the discipline of IS research (Hevner *et al.*, 2004). Where behavioural science aims to develop and substantiate theories about human and organisational phenomena, the design science paradigm strives to expand the boundaries

of social and human capabilities through the creation of innovative artefacts that have the potential to transform organisations into a new, desired state (Hevner *et al.*, 2004). Vaishnavi, Kuechler and Petter (2004) define DSR as a "lens" or set of analytical and artificial perspectives and techniques serving as a strategy to conduct research in IS and complementing interpretive, critical and positivist research.

As previously mentioned, it is essential to understand that the term "design" is simultaneously a verb and a noun and describes both action (processes) and contextualisation (artefacts) (Walls, Widmeyer and El Sawy, 1992; Hevner *et al.*, 2004). By continuously shifting between creating processes and building artefacts, this perspective of design provides a problem-solving paradigm for an identified complex problem (Hevner *et al.*, 2004). Hevner *et al.* (2004) propose a framework for IS research, as shown in Figure 3-2.

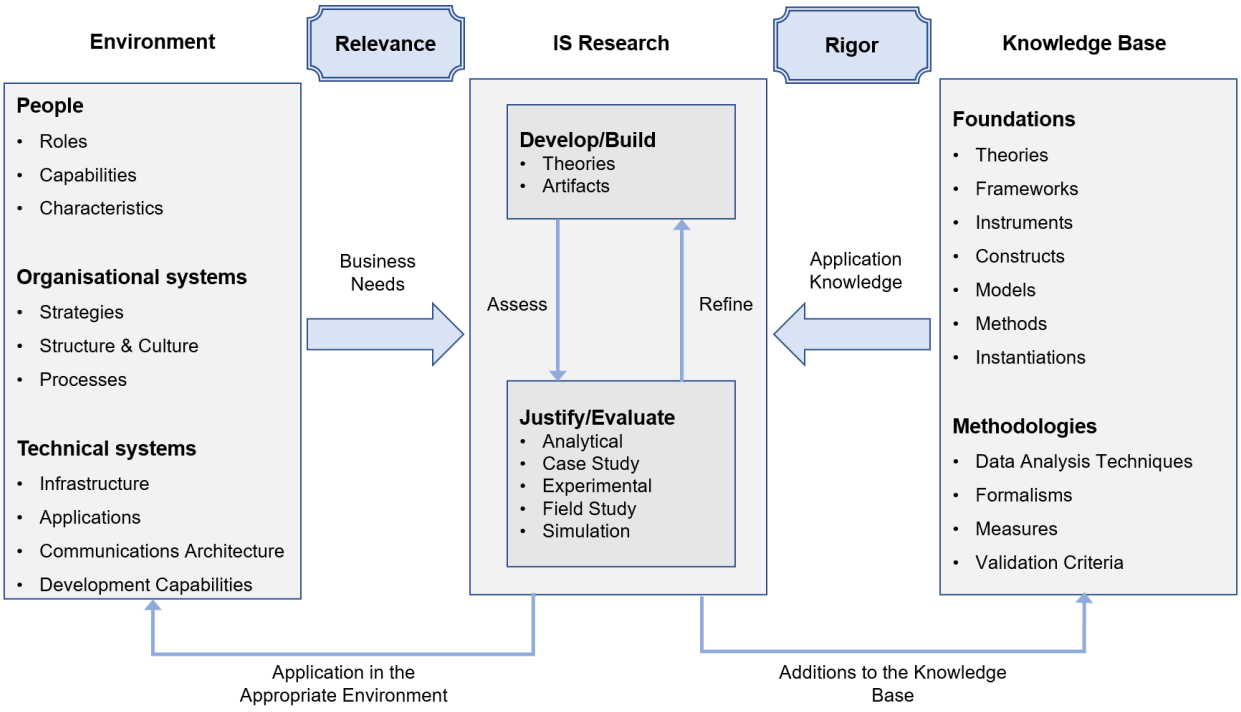


Figure 3-2: Information Systems Research Framework (reproduced from Hevner *et al.* (2004, p. 80))

DSR studies in IS propose to solve "wicked problems", which are problems typically proceeding from (1) constraints and capricious requirements founded in insufficiently defined environmental contexts; (2) complex interactions between sub-elements of the problem and its solution; (3) malleable (flexible) design processes and artefacts; (4) a critical reliance on the cognitive abilities of people to produce effective solutions, for example,

creativity; (5) a critical reliance on the social abilities of people to produce effective solutions, for example, teamwork (Hevner *et al.*, 2004). The governance and management of data within an organisation must deal with uncertainty and environmental volatility, relies on human competency and technologies to deal with ever-increasing volumes of data, and involves complex interactions between processes, individuals and teams (Tallon, Ramirez and Short, 2013; Brous *et al.*, 2014; Peppard, 2018; Al-Ruithe, Benkhelifa and Hameed, 2019; Lillie and Eybers, 2019). Therefore, DSR was well suited to this study of how organisations can achieve agility in the complex and complicated contexts of the organisation and execution of sociotechnical activities, such as EDM.

Hevner and Chatterjee (2010) offer the following definition of DSR: “Design science research is a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The designed artifacts are both useful and fundamental in understanding that problem”. Vaishnavi and Kuechler (2015, p. 61) define DSR in IS as a “research methodology in the information systems discipline in which new knowledge is produced by the construction and evaluation of ‘artifacts’, broadly defined as software, composite systems of software, users and use processes, and *IS-related organizational methodologies and interventions*” [emphasis added]. Vaishnavi and Kuechler's (2015) definition of DSR in IS is adopted by this study that aims to solve the research problem, “How can agile EDM be achieved?”, by providing an IS-related organisational method and model in the form of a practical framework for intervening in organisational contexts where agility in EDM is inadequate and needs to be improved.

The seven guidelines for DSR, as proposed by Hevner *et al.* (2004), provide an understanding of what effective DSR is. These guidelines are presented in Table 3-3. The fundamental principle underlying these seven guidelines is that understanding and knowledge about a design problem and a solution for a design problem are attained through the building and application of the artefact (Hevner *et al.*, 2004).

Table 3-3: Design science research guidelines (adopted from Hevner *et al.* (2004, p. 83))

Guideline	**Description**
Guideline 1: Design as an Artefact	A viable artefact, which could be a method, model, construct or instantiation, is produced from the DSR.

Guideline	Description
Guideline 2: Problem Relevance	The artefact produced by the DSR should aim to solve a relevant, “real world” and important business problem.
Guideline 3: Design Evaluation	The methods used for evaluating the DSR artefact should be well-executed and rigorously demonstrate the artefact’s quality, utility and effectiveness in solving the problem.
Guideline 4: Research Contributions	The design artefact, the design methodologies, and the design's foundations should afford clear contributions that can be substantiated.
Guideline 5: Research Rigour	Rigorous methods should be employed to create and evaluate the artefact produced by the study.
Guideline 6: Design as a Search Process	To produce an artefact with the desired utility, the available means to achieve the desired ends must be utilised while adhering to the laws prescribed by the problem environment.
Guideline 7: Communication of Research	The DSR should be communicated effectively and be comprehensible to audiences from both a technical/practitioner and a management perspective.

In aiming to produce prescriptive knowledge, DSR contributes to theoretical and practical knowledge for solving real-world problems (vom Brocke *et al.*, 2020).

3.6 RESEARCH STRATEGY

The literature review in Chapter 2 motivated the necessity for achieving agile EDM and proposed developing a framework for agile EDM as a solution to the problem. However, “every problem-solving effort must begin with creating a representation for the problem a problem space in which the search for the solution can take place”, especially if no existing problem space seems to fit the situation to be investigated (Simon, 1996, p. 108).

When researchers apply deductive reasoning, they use a ”top-down” approach, starting with either hypotheses or a theory they wish to confirm or prove. On the other hand, when using inductive reasoning, a “bottom-up” approach is used to build a theory from empirical data (Myers, 2013). Where “[d]eduction proves that something *must be*”, “induction shows that something *actually is operative*”, and “abduction merely suggests that something *may be*” (Peirce, 1931-1958, (CP) 5:171; emphasis added). Locke, Golden-Biddle and Feldman (2008) argue that, in research, doubt stimulates abductive reasoning and spurs creativity, and thus generates new ideas.

3.6.1 Design science research process

In this study, the main DSR cycle develops the DSR artefact, a framework for agile EDM, in two DSR cycles, with two and five sub-cycles, respectively. The problem space for agile EDM implied interdependencies among the questions raised by the research problem of how to achieve agile EDM. The structural components of agile EDM must first be identified and understood using existing knowledge, thus initiating the construction of the DSR artefact. Secondly, the dynamic components of agile EDM must be framed by the structural components of agile EDM and also be grounded in scientific knowledge to ensure the integrity of the DSR product that aims to solve the problem of achieving agile EDM in the real world. However, a DSR product, a framework for agile EDM born from its structural and dynamic parts, must be refined further in the real world before being evaluated as a proposed solution to the problem of achieving real-world agile EDM. Therefore, the research process constructed the sub-questions iteratively as the investigation of agile EDM progressed to produce the DSR artefact, a framework for agile EDM.

Using a consensus-building approach based on well-accepted elements, Peffers *et al.* (2007) designed a methodology for conducting DSR in IS that includes six steps:

1. *Identify the problem and motivate the hypothesis*: In this step, the specific research problem is defined, and the value of its solution is justified. The importance of the problem should be highlighted. In order to capture the complexity of the problem, it may be helpful to break the problem down into sub-components, which can be used to develop the artefact (Peffers *et al.*, 2007). The systematic literature review in Chapter 2 identified the problem that organisations have in achieving agile EDM and its extant importance, and concluded that a framework for agile EDM could potentially address this problem. Table 3-4 on page 61 presents the breakdown of the research problem into sub-questions on which to base the artefact development.

2. *Define the objectives of the solution*: The solution's objectives are rationally inferred from the problem specification and based on an understanding of what is feasible and possible. The current state of related problems, the known solutions to these problems and their efficacy should be considered in this step. The objectives of the solution could be qualitative (for example, *how* a new artefact is expected to support solutions to the identified problem) or quantitative (for example, *to what extent* the new solution will be

better than the existing solutions) (Peffers *et al.*, 2007). The problem and solution space for developing a framework for agile EDM is presented in Table 3-1 on page 43.

3. *Design and develop the artefact(s)*: The new artefact is created in this step by drawing on existing theoretical knowledge (Peffers *et al.*, 2007). This study systematically reviews scientific literature and theories (primarily from the IS, management, decision and organisational sciences) to design and develop the structural and dynamic components of a framework for agile EDM.

4. *Demonstrate how the artefact solves the identified problem*: In this step, the use of the artefact in solving one or more instances of the problem is demonstrated. In order to achieve this, practical knowledge of how to use the artefact is required (Peffers *et al.*, 2007). In both DSR cycles, qualitative case study research probes whether the artefact confirms and addresses the problem in a real-world situation.

5. *Evaluate the artefact*: In this step, the objectives of the solution are compared with how well the artefact solves the problem by using actual observed results from the demonstration. The evaluation could comprise any logical proof or empirical evidence (Peffers *et al.*, 2007). For this phase of the DSR study, the usability, applicability, completeness, functionality and accuracy of the DSR artefact is evaluated (Hevner *et al.*, 2004) by a panel of experts, using the Delphi method (Okoli and Pawlowski, 2004).

6. *Communicate the design processes and artefact*: This step aims to disseminate the knowledge resulting from the DSR. The definition and importance of the problem being addressed, the uniqueness and utility of the artefact, the rigour of the artefact's design and its usefulness to stakeholders and other interested parties is communicated. Knowledge of the particular disciplinary culture is required for effective communication (Peffers *et al.*, 2007). At least two articles based on the two DSR cycles are planned for submission to relevant accredited academic journals.

Originating from the DSR process proposed by Vaishnavi, Kuechler and Petter (2004), Vaishnavi and Kuechler (2015) further refine the five phases through which a DSR process cycles iteratively:

1. *Awareness of problem*: Identify an interesting research problem and shape an informal or formal proposal for a solution, including a tentative design and explicit or implicit

evaluation criteria. The main DSR cycle and each of its DSR sub-cycles start with an awareness of a problem.

2. *Suggestion:* New functionality or even a nascent idea is envisioned, creating a tentative design to address the identified problem based on the novel configuration of new or existing and new components.

3. *Development*: The tentative design is further developed and implemented in the development phase. A development phase iteration can produce various types of novel artefacts, including design theories, models, concepts, processes, and instantiations. The new knowledge lies primarily in the artefact's design, not in its construction.

4. *Evaluation*: Evaluate the developed artefact using the proposed evaluation criteria. This phase makes hypotheses about the artefact's behaviour, and deviations from expectations must be analysed and tentatively explained, potentially correcting the hypotheses for the next iteration. This process can result in additional knowledge contributions.

5. *Conclusion*: The conclusion phase occurs for each DSR cycle and the overall research effort (the main DSR cycle), confirming that the design and development results of the artefact creation process are "good enough". The artefact's design is consolidated and written up. Knowledge contributions are explained as repeatable or containing open-ended aspects that inhibit repeatability or present limitations to the artefact's implementation.

Vaishnavi and Kuechler (2015) emphasise that new and true knowledge contributions should be a central focus of DSR and that DSR includes both knowledge-use and knowledge-building processes. Furthermore, iterative circumscription is a crucial part of the DSR methodology that discovers or uncovers the knowledge and reality that emerges from the research process (Vaishnavi and Kuechler, 2015). Vaishnavi and Kuechler (2015, p. 19) explain that circumscription interrupts the DSR process, forcing it back to an awareness of a problem, and thus, "contributes valuable constraint knowledge to the understanding of the always-incomplete-theories that abductively motivated the original research".

Figure 3-3 presents this study's adoption of the DSR process proposed by Vaishnavi and Kuechler (2015). This iterative process to create a framework for agile EDM suits this study's

requirement for addressing the unexplored problem of achieving agile EDM in organisations. With each iteration, the tentative design presents an incomplete idea, a concept or a proposed framework that requires novel configurations of existing or new elements spanning multiple scientific domains to iteratively create the DSR artefact, a framework for agile EDM.

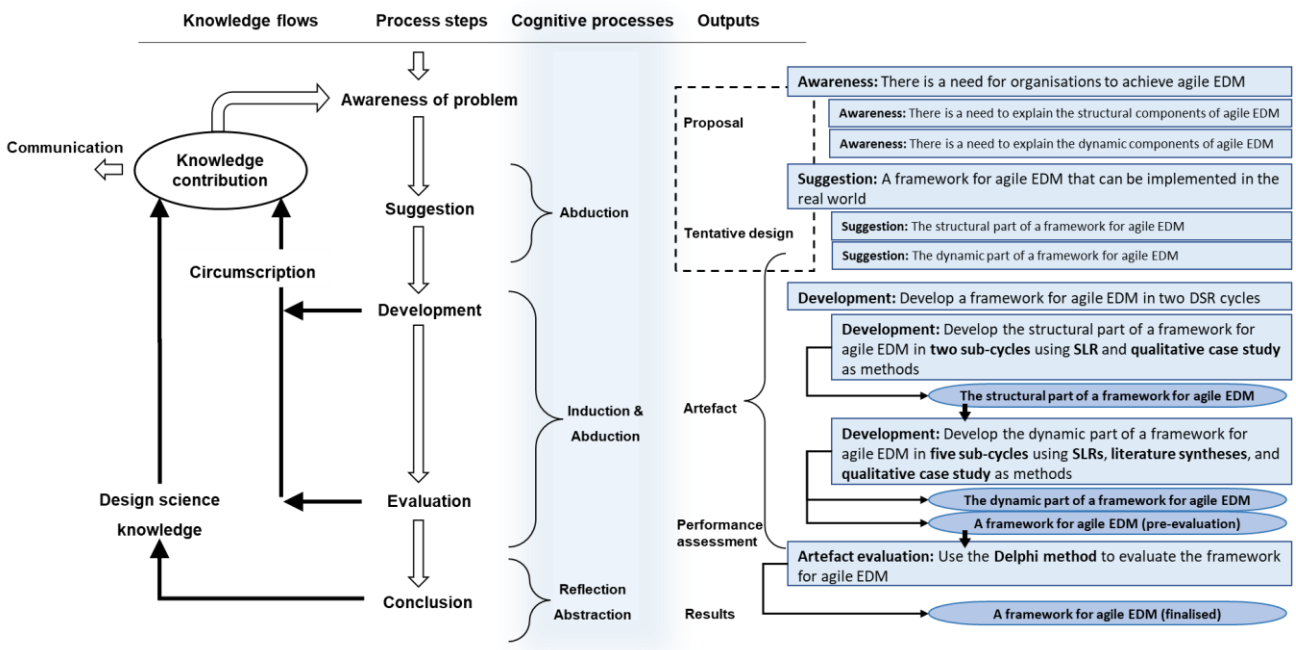


Figure 3-3: DSR process model and cognitive processes for developing a framework for agile EDM
(based on Vaishnavi and Kuechler (2015, pp. 15, 17)

Figure 3-4 on page 60 and Table 3-4 on page 61 present the DSR strategy adopted in this study for developing a framework for agile EDM in iterative cycles and sub-cycles whilst the research questions and sub-questions unfolded as the artefact design and construction progressed.

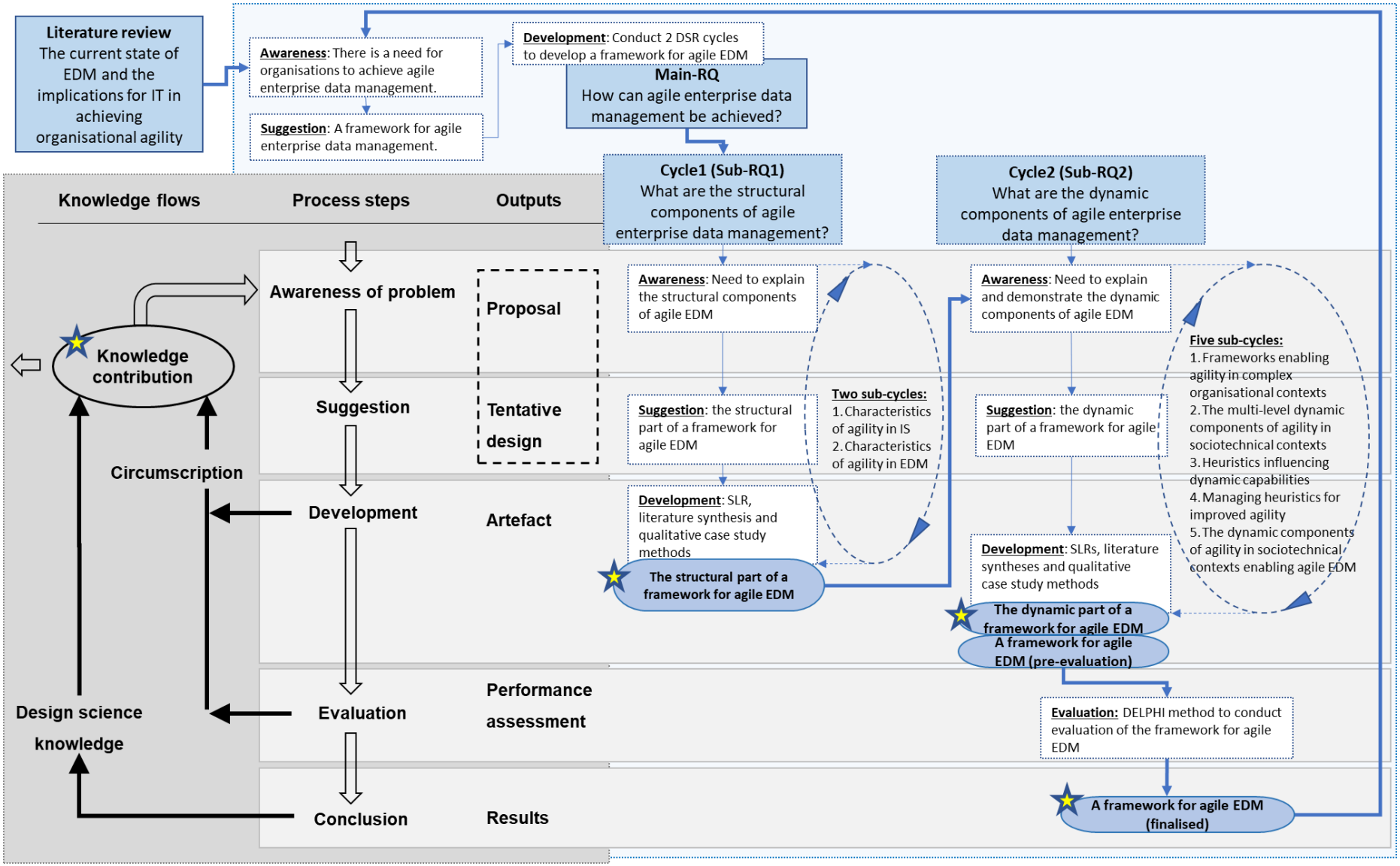


Figure 3-4: High-level strategy for developing a framework for agile enterprise data management (based on Vaishnavi and Kuechler (2015, p. 15))

Table 3-4: Iterative construction of the research questions, DSR cycles, methods and output

Awareness of the problem		Research questions	DSR cycle	Methods	Output	Chapter
There is a need for organisations to achieve agile EDM.	➔ ↙	**Main-RQ:** How can agile enterprise data management be achieved?	**Main**	Conduct SLRs (rigour), an in-depth qualitative case study (relevance), and the Delphi method to evaluate the artefact for its practical relevance to real-world EDM contexts.	**A framework for agile EDM.**	**Chapters 4, 5 and 6**
There is a need to explain the structural components of agile EDM.	➔ ↙	**Sub-RQ1:** What are the structural components of agile enterprise data management?	**1**	Conduct an SLR (rigour) and a qualitative case study using thematic analysis (relevance).	**The structural part of a framework for agile EDM.**	**Chapter 4**
There is a need to explain the characteristics of agility in IS.	➔ ↙	**SQ1.1**: What are the characteristics of agility in Information Systems?	**1**	Conduct an SLR of agility in IS to inductively identify the characteristics of agility in IS.	The characteristics of agility in IS.	Chapter 4
There is a need to explain the characteristics of agility in EDM.	➔ ↙	**SQ1.2**: What are the characteristics of agility in enterprise data management?	**1**	Apply the characteristics of agility in IS to a qualitative case study to determine the characteristics of agility in EDM.	The structural components of agile EDM.	Chapter 4
There is a need to explain the dynamic components of agile EDM.	➔ ↙	**Sub-RQ2:** What are the dynamic components of agile enterprise data management?	**2**	Conduct SLRs (rigour) and a qualitative case study using thematic analysis (relevance).	**A framework for agile EDM (pre-evaluation phase)**	**Chapters 5 and 6**

Awareness of the problem		Research questions	DSR cycle	Methods	Output	Chapter
There is a need to understand existing frameworks that enable agility in complex organisational contexts.	➔ ↙	**SQ2.1**: What scientific frameworks, models or methods enable agility in complex organisational contexts?	**2**	Conduct an SLR of frameworks that enable agility in complex organisational contexts.	The structural components of agile EDM were applied to the domains of the Cynefin framework (Kurtz and Snowden, 2003).	Chapter 5
There is a need to explain the multi-level dynamic components of agility in complex and complicated sociotechnical contexts.	➔ ↙	**SQ2.2**: What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?	**2**	Synthesise the literature of complex adaptive systems (CAS), Cynefin dynamics and the structural components of agile EDM to build the multi-level model.	The multi-level components of agility in complex and complicated sociotechnical contexts.	Chapter 5
There is a need to explain how heuristics influence dynamic capabilities in complex and complicated organisational contexts because of challenges to decision-making in complex organisational contexts.	➔ ↙	**SQ2.3**: How do heuristics influence dynamic capabilities in organisational contexts?	**2**	Conduct an SLR of heuristics and dynamic capabilities using inductive reasoning to determine how heuristics influence dynamic capabilities.	Refine the multi-level components of agility in complex and complicated sociotechnical contexts.	Chapter 5

Awareness of the problem		Research questions	DSR cycle	Methods	Output	Chapter
There is a need for a practical method/technique to manage heuristics in complex and complicated sociotechnical contexts to enable agility.	➔ ↙	**SQ2.4**: How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?	**2**	Synthesise the literature of Cynefin and Critical Systems Heuristics to hypothesise abductively that boundary critique can be used to manage heuristics.	The dynamic part of a framework for agile EDM.	Chapter 5
There is a need to explain how the dynamic components of complex and complicated sociotechnical contexts enable agility in EDM.	➔	**SQ2.5**: How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?	**2**	Apply the dynamic part of a framework for agile EDM inductively to a qualitative case study of EDM.	A framework for agile EDM (ready for evaluation)	Chapter 6

3.6.2 Relevance and rigour in design science research

IS researchers are increasingly accepting and adopting DSR as an authoritative research paradigm due to its effectiveness in balancing research relevance and rigour in IS (Deng and Ji, 2018). Hevner (2007) proposes a “three cycle view” of DSR: (1) the *relevance cycle* feeds requirements into the research from the contextual environment and introduces the research artefact into the real-world environment for testing; (2) in the *rigour cycle,* foundational knowledge, grounding theories and methods are employed from the existing knowledge base and new knowledge resulting from the research is added to the knowledge base; (3) in the central design cycle the detailed research activities of constructing and evaluating the design artefacts and processes are performed. The embodiment of these three cycles in a research study differentiates DSR from the other more traditional research approaches (Hevner, 2007).

The “three cycle view” of DSR proposed by Hevner (2007) comprises three tightly associated cycles of activities: the relevance cycle, the rigour cycle, and the central design cycle to construct an artefact that has practical validity. This DSR study of agile EDM adopts the relevance and rigour guidelines proposed by Hevner (2007), as shown in Figure 3-5.

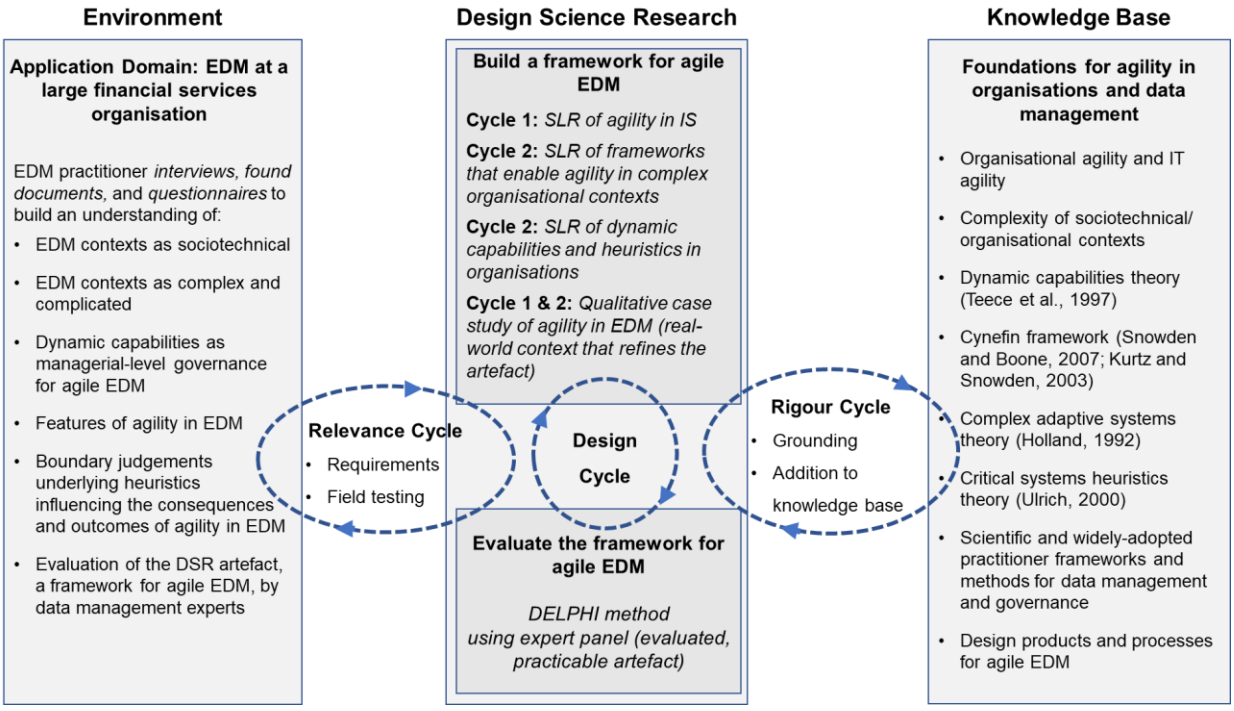


Figure 3-5: Relevance and rigour in building and evaluating a framework for agile EDM (based on Hevner (2007, p. 88))

Artefacts produced by DSR have a foundational purpose of creating something new that proposes to improve the world (Hevner *et al.*, 2004). The framework produced from this study aimed to provide an implementable means whereby agility can be achieved in the organisation and functioning of EDM practices, thus improving EDM value delivery to the business in real-world organisational contexts.

Artefact evaluation is essential to a DSR contribution (Hevner *et al.*, 2004). Evaluation of the design artefact is crucial because it assures the research's rigour and provides valuable feedback to inform the artefact's further development (Venable, Pries-Heje and Baskerville, 2016). This study's DSR artefact, a framework for agile EDM, was evaluated using the Delphi method to substantiate its relevance to EDM practice in organisations.

3.6.3 Research strategy conclusion

In the construction of the study's DSR artefact, the structural components of agile EDM first have to be explained based on agility in IS before the dynamic components of agility in complex and complicated sociotechnical contexts can be investigated, which, in turn, is required for investigating how agility can be achieved in real-world EDM contexts. To this end, SLRs must first be conducted in each of the DSR cycles to ground the DSR artefact in

scientific knowledge and theory. Subsequently, qualitative case study methods can be employed to refine, explain and demonstrate the artefact's relevance to EDM practice. The DSR cycles and sub-cycles contribute towards solving the main research question by starting with an awareness of a problem, concluding with contributions to the artefact construction, and raising awareness of the subsequent problem, as shown in Table 3-4 on page 61.

Kuechler and Vaishnavi (2011) explain that a unique understanding is gained through circumscription because each segment of knowledge produced during the artefact construction process is part of the design and is only valid under particular circumstances. This new knowledge often cannot be predicted or framed in advance through theoretical perspectives of the research topic (Kuechler and Vaishnavi, 2011). Figure 3-6 presents the process map for the strategy adopted for constructing the DSR artefact for this study.

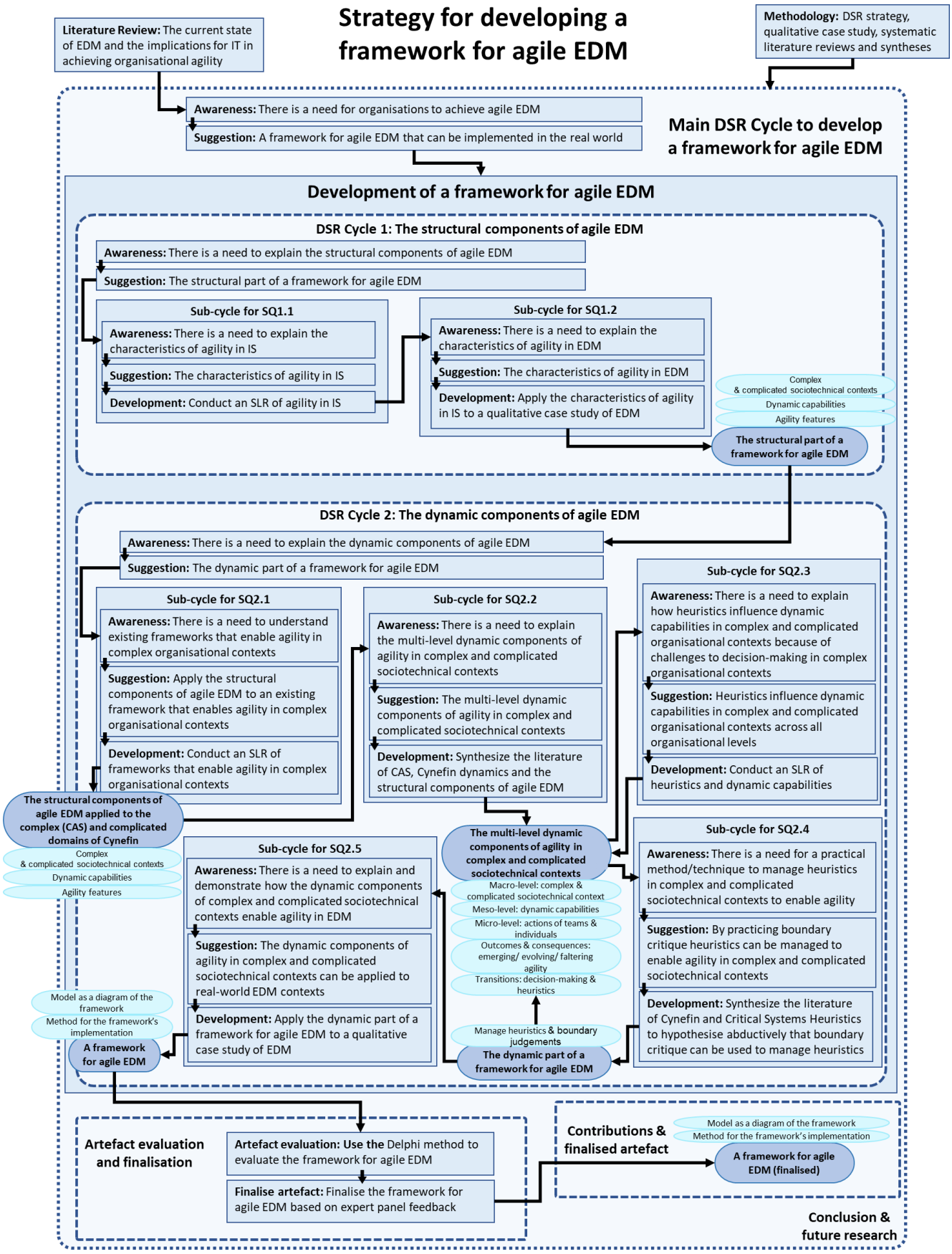


Figure 3-6: Strategy process map for developing a framework for agile enterprise data management (based on Vaishnavi and Kuechler (2015, p. 15))

3.7 SYSTEMATIC LITERATURE REVIEWS

The literature review in Chapter 2 concluded that there is limited published scientific or practitioner knowledge on agility in EDM and how organisations might achieve agile EDM. For this reason, an SLR will be conducted as the first step for each of the two DSR cycles, thereby grounding the artefact's structural and dynamic components in existing scientific knowledge.

As the first sub-cycle of DSR Cycle 1, an SLR can explain the characteristics of agility in IS to answer SQ1.1:

Sub-RQ1:	What are the structural components of agile enterprise data management? **SQ1.1: What are the characteristics of agility in Information Systems?**

The first and third sub-cycles of DSR Cycle 2 adopt SLRs to answer the first and the third sub-questions:

Sub-RQ2:	What are the dynamic components of agile enterprise data management? **SQ2.1: What scientific frameworks, models or methods enable agility in complex organisational contexts?** **SQ2.3: How do heuristics influence dynamic capabilities in organisational contexts?**

Okoli and Schabram (2010, p. 7) remind researchers that "[i]nformation systems is a combination of social science, business, and computing science, whose research methods are different from those of the health sciences, from which the systematic review methodology has largely been developed". The original application of SLRs in medical science, as presented in Figure 3-7, aimed to summarise identifiable evidence concerning particular medical treatments, thus emphasising comprehensive coverage (Boell and Cecez-Kecmanovic, 2015). Although IS research has adopted this process, in IS research, the emphasis in SLRs is placed on rigour and replicability (Levy and Ellis, 2006; Okoli and Schabram, 2010; Boell and Cecez-Kecmanovic, 2015).

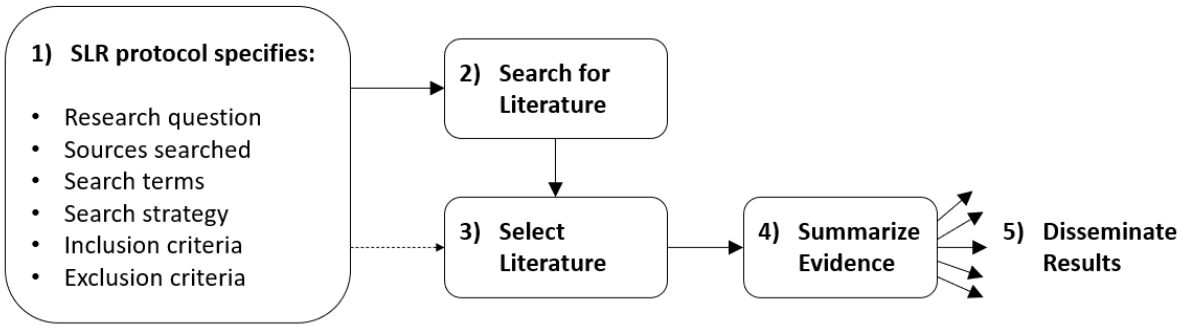


Figure 3-7: Overview of the SLR process (reproduced from Boell and Cecez-Kecmanovic (2015, p. 163))

For each of the three SLRs in the two DSR cycles, the search terms for finding relevant articles are directly shaped by the keywords contained in the research question being addressed. Okoli (2015) proposes guidelines that this study adopts for conducting each SLR: (1) identify the purpose of the SLR, (2) define the SLR protocol, (3) define the inclusion and exclusion rules, (4) conduct the literature searches, (5) extract the data, (6) appraise the quality of the found articles, (7) synthesise the literature, and (8) write the review. Scopus is the preferred library for conducting the literature searches for this study due to its inclusion of all the top IS journals and its advanced search and export capabilities. Limitations of the approach for conducting the literature searches and the analysis and synthesis of the found articles include the researcher's bias in the search terms, code words, synonyms and word-parts related to the aspects being investigated.

3.8 A QUALITATIVE CASE STUDY OF AGILE ENTERPRISE DATA MANAGEMENT

Yin (2014) suggests five essential components for a qualitative case study: the research question(s), the propositions, the unit(s) of analysis, the logic to link the data to the propositions, and the criteria used for interpreting the findings. Case study research demonstrates that theory has practical application in the real world, bringing a research topic and its theoretical underpinnings to life (Myers, 2013). Myers (2013) emphasises the importance of clearly describing how a case study was conducted and including multiple sources of evidence. To answer the main question for each DSR cycle and support the DSR artefact's relevance, a qualitative case study of agility in EDM will be conducted to collect interview data and organisational data management documents at BankGroup.

The first DSR cycle develops the structural components of agile EDM by explaining the characteristics of agility derived from the IS literature. The characteristics of agility in IS are

then applied in the qualitative thematic analysis of the case study data to explain the characteristics of agility in EDM:

Sub-RQ1:	What are the structural components of agile enterprise data management? **SQ1.2: What are the characteristics of agility in enterprise data management?**

The units of analysis are based on the findings of the SLR that produced the characteristics of agility in IS and applied to the case study data. In addition, the qualitative case study aims to confirm the research problem that there is a real-world requirement for organisations to achieve agile EDM.

The second DSR cycle develops the dynamic components of agile EDM from scientific literature and theory to ground the framework for agile EDM in existing science. The dynamic part of a framework for agile EDM is built through SLRs and literature synthesis, and applied to the qualitative data collected at the case study organisation for an in-depth analysis that aims to answer the fifth sub-question of DSR Cycle 2:

Sub-RQ2:	What are the dynamic components of agile enterprise data management? **SQ2.5: How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?**

Inductive reasoning is applied to an in-depth thematic analysis of the qualitative case study data to refine the structural and dynamic components of agile EDM, producing a framework for agile EDM as the DSR artefact ready for evaluation.

3.8.1 The case study organisation

BankGroup (the pseudonym used to protect the identity of the case study organisation) is a large financial services enterprise consisting of multiple companies within a group with operations in South Africa, sub-Saharan Africa, the United Kingdom and India, with a customer base of 8.2 million and over 47 000 employees at the time of this study. BankGroup has a strong focus on innovation and digitising its customer and business services platforms, offering a broad range of integrated financial products and services that aim to create shared prosperity for its customers, staff and the larger society within which it operates. BankGroup's portfolio of integrated businesses offers financial services, including retail and commercial banking, corporate and investment banking, instalment credit and fleet

management, specialised lending services, vehicle financing, asset management, secured and unsecured lending services, and insurance services. Additionally, BankGroup is committed to complying with best reporting practices set out by the Basel Committee for Banking Supervision (BCBS 239) and all regulatory and legal requirements within the ambit of its operations. The nature of BankGroup's businesses, regulatory and compliance requirements, and its strategic goals necessitate an ongoing emphasis on the comprehensive and successful management of its data assets.

At the time of this research, the case study organisation adopted the DAMA framework (DAMA International, 2017) to manage its data. EDM at BankGroup comprises multiple data management specialists and technologies performing the organisation's data management functions. As the organisation has extensively adopted the DAMA framework, Figure 3-8 presents the data management function framework that structures the data management organisation for the data management roles at the case study organisation. At the time of this research, BankGroup employed about 2 500 data management specialists in more than 150 data management roles to perform the data management functions for the enterprise.

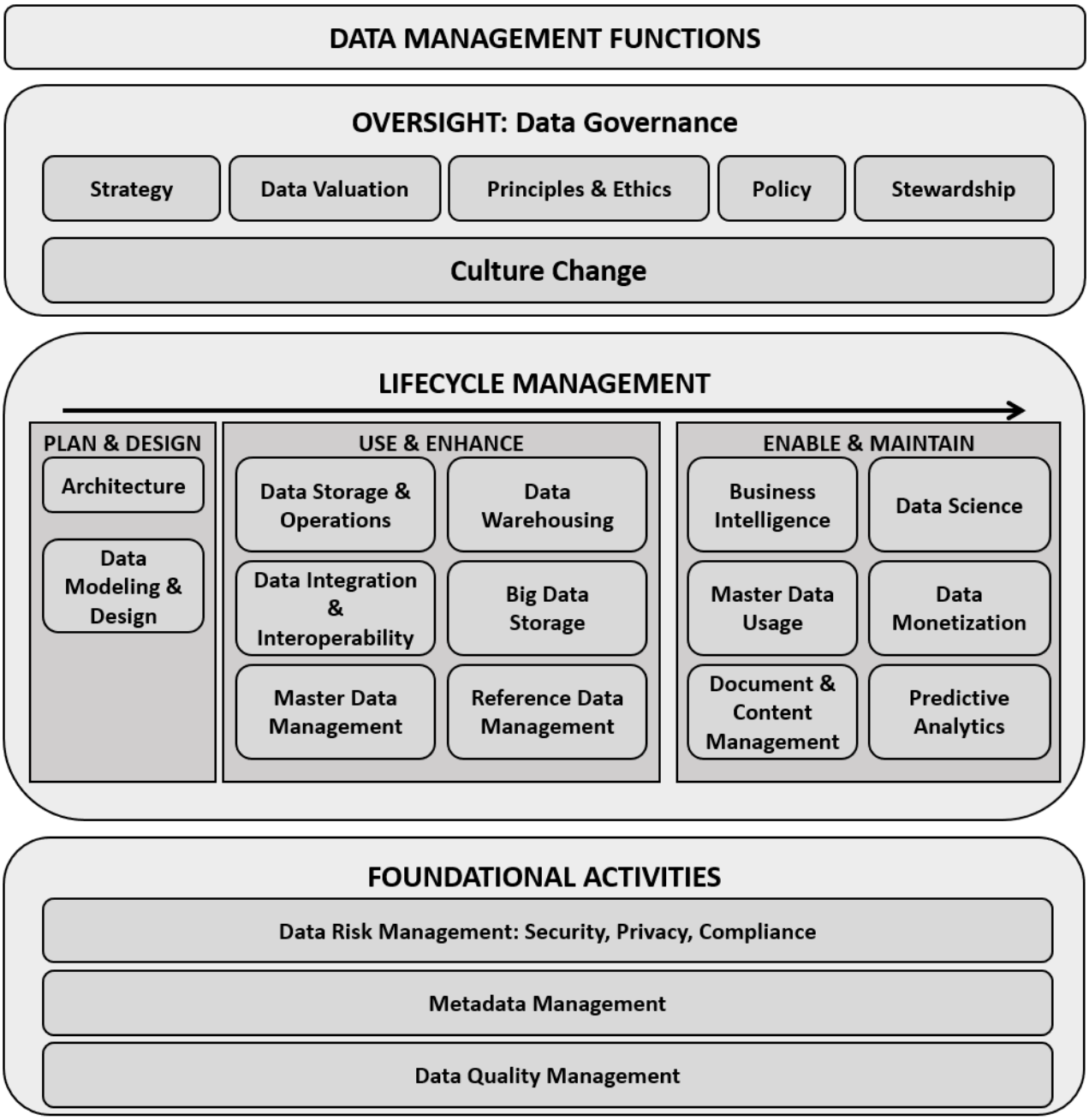


Figure 3-8: DAMA data management function framework adopted by BankGroup (reproduced from DAMA International (2017, p. 42))

The following extracts from BankGroup's Information Governance Framework[1] document highlight the organisation's stance on the management of its data and information:

> *"Information, whether BankGroup Limited's own or that entrusted into its care by customers, staff or business partners, is a valuable and strategic asset and essential to its business. The information landscape is complex, and the expectation is that the exponential growth in information, availability*

> *of information on a range of devices, Big Data, advanced analytics, digitisation, personalised experience expectations and ensuring the ethical use of information, will further complicate the environment."*
>
> *"Not all information is equally important and it is thus important to ensure that BankGroup maintains and protects all the information it uses or stores in accordance with its value, sensitivity and the risks to which it is exposed, and in a manner, consistent with business objectives, all relevant legal, regulatory, contractual, environmental and operational requirements."*
>
> *"Information governance is BankGroup's co-ordinated, inter-disciplinary approach to satisfying information compliance requirements and managing information risks while optimising information value. Information governance is a corporate governance responsibility, focusing on and directing the management of information."*

The case study organisation applied the following data management principles, adopted from DAMA International (2017, p. 22), spanning strategic, tactical and operational levels: (1) effective data management requires leadership commitment; (2) data is a valuable asset with unique properties holding economic value; (3) data management requirements are business requirements that depend on the proper planning and management of data quality, metadata and suitable IT decisions for their successful implementation; (4) data management depends on diverse skills that operate cross-functionally requiring an enterprise perspective and broad stakeholder view; (5) data management is lifecycle management that must consider the unique characteristics of different types of data and the risks associated with the data.

[1] "BankGroup" Information Governance Framework (March 2021) – Note that this is a confidential document which may not be published.

At the time of this study, BankGroup was embarking on a journey to improve agility in its data and information management functions across the enterprise, which is reflected in the following statement by BankGroup's Chief Data and Analytics Officer (CDAO):

> *"[…] making our people as productive as possible is a major priority — much of the competitiveness of the big tech firms is built on the quality of people they hire and the agile, empowered culture and working environment they create. Similarly, we are gearing up to extend the agile way of working across our segments, pillars, domains and functions to step up delivery […] there is no shortage of work with a veritable mountain of data assets and business improvement opportunities ahead."*

The extent and complexity of the case study organisation's information assets, the size of the enterprise, its organisation of and approach to information and data management, and its strategic commitment to become more agile in its data management endeavours presented this study with a uniquely valuable opportunity for conducting an in-depth qualitative case study of agile EDM.

3.8.2 Approach to data collection

Although qualitative interviews are an excellent and effective method for gathering qualitative data, they can prove problematic and not as straightforward as the researcher might expect (Myers and Newman, 2007). In preparing for the interviews, the researcher considers the potential problems summarised by Myers (2013) as adapted from Myers and Newman (2007), presented in Table 3-5 on page 75. These potential difficulties can be mitigated: a short presentation can provide an overview of the interview protocol and agenda, as well as the research topic and objectives. The interview agenda is presented as a single slide, displayed for the entire interview duration, containing the focus concepts. Additionally, the interview process is scripted, and a question guide keeps the interviews on track to collect complete and reliable data. Myers and Newman (2007) suggests the approach to prepare for and perform each interview as a drama: (1) the stage is the virtual meeting environment; (2) the actors are the interested interviewer and the knowledgeable interviewee; (3) the audience comprise the interviewer, listening carefully to the interviewee's responses, and the interviewee listening carefully to the interviewer's questions, and ultimately the readers of the research publication(s); (4) the script is

composed of introductions, an overview of the research and interview objectives and process, and guideline questions; (5) the entry is virtual, which nonetheless provides enough time for informal introductions and any preliminary clarifications or concerns from the interviewee's viewpoint; (6) the exit is managed through reliable timekeeping and includes requesting the interviewee's permission for follow-up questions, suggestions of who else would be valuable as a participant to interview, and an offer to provide feedback to the interviewee; (7) all the elements of the drama constitute the performance and the quality of the performance influences the quality of the experiential narratives and views disclosed by the interviewee which, in turn, impacts the quality of the data collected (Myers and Newman, 2007; Myers, 2013).

Appendix C includes the documents used in the semi-structured qualitative interviews. Table 3-5 summarises the strategy employed by this study to mitigate potential issues in the interviewing process.

Table 3-5: Mitigation of potential difficulties, problems, and pitfalls of interviews (based on Myers (2013, p. 125))

Potential issue	Description	Mitigation strategy
Artificiality of the interview	The interview participant is a total stranger to the interviewer and is expected to provide opinions and experiential accounts under time pressure.	In the invitation to participate in the research, the researcher introduces herself to the candidate and explains her current role in the organisation, the interview process, the ethics involved, and the purpose of the research.
Lack of trust	The interviewee does not know the interviewer and is uncomfortable providing them with potentially sensitive information. This concern can result in the collected data being incomplete.	At the start of the interview, the researcher explains the ethics process, including assurance of anonymity and no collection of sensitive data, and presented the interviewee with the signed company permission letter. In addition, the researcher presents and sends the informed consent form to the interviewee for their signature and subsequently provides a counter-signed copy for the participant's records.
Lack of time	Having insufficient time to conduct the interview can result in the interview participant providing incomplete or unreliable data under time pressure.	By following the interview script, even though not strictly adhering to question inclusion, wording or sequence, the researcher keeps time and is flexible where rescheduling or scheduling of additional time is required and agreed to by the interviewee.

Potential issue	Description	Mitigation strategy
Level of entry	Some restrictions imposed by organisational structures, such as unions and gatekeepers, can prevent access to senior managers once employees at the lower levels have been interviewed and vice versa.	Due to the nature of the research topic, which primarily investigates how people do their EDM work and how that affects agility, there are no discussions or data collected pertaining to structure-sensitive information or information subject to non-disclosure, for example, customer, employee-related or sensitive business information.
Elite bias	Only informants of high status are selected and interviewed, thus giving a skewed data set that fails to provide a broad view of the organisational situation.	The researcher selects candidate participants based on their EDM specialisation and reach, for example, working in teams across business units within the organisation, not their status or power.
Hawthorne effects	The interviewer is part of the interactions they are studying and is not invisible and neutral in the situation. Therefore, the researcher may influence the very context and interactions under investigation.	At the time of this study, the researcher had worked closely with only two of the fourteen participants and did not hold a position with direct reports. Thus her influence on ongoing or future interactions is limited.
Constructing knowledge	Qualitative interviewing is not only a process that collects data but also actively constructs knowledge. In their responses, interviewees might reflect on an issue they have not previously explicitly considered. The interviewee constructs knowledge under time pressure by composing their response as a rational, coherent story.	In this in-depth case study, the researcher is explicitly interested in each interviewee's existing and constructed knowledge. The idiosyncratic and nuanced nature of the collected data will bring the level of detail that this in-depth qualitative case study requires to develop the DSR artefact.
Ambiguity of language	Ambiguity in the meaning of the interviewer’s words is perpetually a problem for the interviewee, influencing their answers to questions that are assumed to be clear.	Leading into the questionnaire part of each interview, the researcher gives a short presentation explaining the objectives and concepts of the study. The interviewee is given the opportunity to ask for any clarifications at all times, at any point before, during or after the interview process. A diagrammatic agenda provides a constant and concise guide to focus on throughout the questioning part of the interview.

Potential issue	Description	Mitigation strategy
Interviews can go wrong	Interviews can go disastrously wrong, ending abruptly should the participant feel intentionally or unintentionally offended by the interviewer.	The researcher should not encounter any personal conflicts during the interviews because the nature of the data collected is not prone to stressful discussions as it does not require the interviewee to disclose any personal or sensitive information. The researcher consciously avoids contriving the participant's narratives to fit precisely the theoretical constructs and definitions of the DSR artefact under construction.

Each interview starts with a short presentation providing the participant with an overview of the research topic, objectives and a brief explanation of the underlying concepts of agile EDM. Explanations focus on the concepts of the characteristics of agility in IS, as these are the main themes of the interview questions used to prompt narratives that would provide rich data on the research topic.

Eisenhardt and Graebner (2007) point out that deductive studies that are large-scale traditionally first present theory followed by empirical evidence in condensed numerical tables of summarised statistical analyses of large data sets. In contrast, qualitative case studies apply inductive reasoning to data comprising narratives and other forms of qualitative data that are rich in detail that cannot be compacted into quantitative summaries. Flyvbjerg (2006, p. 19) notes that case study research has the advantage that "it can 'close in' on real-life situations and test views directly in relation to phenomena as they unfold in practice". In a qualitative case study, rich detail is rendered from the story in the text, comprising interwoven quotations from informants' narratives and evidence from other qualitative data sources collected from the case study (Eisenhardt and Graebner, 2007). Through writing the story, the researcher's ideas achieve structure and form and conclude with most of the puzzles and contradictions ultimately explained to a satisfactory level (Myers, 2013). By intertwining the story with the theory, the close connection between emergent theory and the empirical evidence is demonstrated while keeping evidence and theory at the leading edge of the unfolding story (Eisenhardt and Graebner, 2007).

3.8.3 Research instruments

Qualitative data is collected at the case study organisation by conducting semi-structured interviews and collecting existing organisational documents (sources of evidence) to

investigate the application domain, opportunities, and problems (Hevner, 2007) for achieving agility in delivering valuable data and information to the business.

This DSR study first grounds the structural and dynamic parts of the framework for agile EDM in scientific literature and then uses qualitative methods to further develop and evaluate the framework for agile EDM. Kuechler, Park, and Vaishnavi (2009) identified multiple similarities in the literature, which were also supported by other researchers, between DSR and qualitative research (QR) that aims to develop a theory or theoretical construct:

- DSR and QR both have an inherently iterative research process, as stated for DSR by Vaishnavi and Kuechler (2015) and supported by Hevner (2007), and explained for QR by Ravitch and Riggan (2017);
- DSR and QR both emphasise the crucial role of formal and substantive theory as well as the generalisability of theory (Kuechler, Park and Vaishnavi, 2009; Baskerville *et al.*, 2018);
- DSR and QR both use processes of induction to discover important emergent regularities in the data (Braun and Clarke, 2006; Kuechler, Park and Vaishnavi, 2009; Myers, 2013; Ravitch and Riggan, 2017);
- DSR and QR both exhibit reliance on an understanding of a real-world context for the problem to be solved (Hevner, 2007; Kuechler, Park and Vaishnavi, 2009; vom Brocke *et al.*, 2020);
- DSR and QR both require researchers to create hypotheses or a model that relates to phenomena that are occurring within a particular context (Hevner, 2007; Kuechler, Park and Vaishnavi, 2009);
- DSR and QR both require continuous developmental data analyses (Kuechler, Park and Vaishnavi, 2009; Ravitch and Riggan, 2017; vom Brocke *et al.*, 2020);
- DSR and QR both apply flexible research design approaches (March and Smith, 1995; Kuechler, Park and Vaishnavi, 2009; Baskerville, Kaul and Storey, 2015).

3.8.4 Data collection

Interviewing is one of the most prevalent methods used in qualitative research for generating data in interpretative case studies (King, Horrocks and Brooks, 2019), and is used in this study of agile EDM. The data collection process aims to collect the interview participants' narratives of their lived experiences, views and opinions on the characteristics of agility and how actions and interactions in EDM contexts are influenced, resulting in intended and unintended consequences and outcomes for agility in EDM. In addition, the documents

describing the case study organisation's data management policies, standards and guidelines are also collected.

The characteristics of agility in IS are based on the SLR findings in the first DSR cycle and provide a conceptual framework for the data collection process of this qualitative case study at BankGroup. Miles, Huberman and Saldaña (2020, p. 40) explain that "[c]onceptual frameworks are simply the current and evolving version of the researcher's 'map' of the qualitative territory being investigated. As the explorer's knowledge of the terrain improves, the map becomes correspondingly more differentiated and integrated. Thus, conceptual frameworks are developed at the beginning of a study and evolve as the study progresses".

Collecting rich narrative data and subsequently performing detailed coding and intricate analysis of interrelationships of concepts found within the data is an approach well-suited to the qualitative study of complex real-world contexts (Tsoukas and Hatch, 2001). Here, the researcher conducts fourteen semi-structured one-on-one interviews with leading specialists from the various EDM disciplines within the case study organisation to collect detailed narratives of their views, and past and present experiences as data management specialists.

In preparation for the semi-structured qualitative interviews, the researcher sends invitation emails to prospective participants, which include a brief overview of the research. A concise document outlining the research topic and the interview agenda are presented during the interviews. These documents are included in Appendix C of this thesis. The narratives and conversations are mainly driven by the participant, allowing free exploration of what comes up at any point during the interview. By taking this approach, the researcher aims to collect rich data that could be analysed in detail, providing diverse perspectives on agility in EDM. Even though the "Interview Agenda" included definitions of the characteristics of agility, the question guide avoids limiting the participant by forcing them to adopt specific definitions of the constructs or speak about only one construct at a time.

It is important to note that the interview questionnaire provides a guideline to prompt participants to share their narratives instead of being rigidly followed as a fixed, pre-prepared script. For data collection that will be sufficient for investigating the research problem, each interview conducted should be in-depth, lasting between 60 and 120 minutes. Interviews can be conducted in person or online, using tools such as Microsoft Teams or Skype. The

interviews must follow a protocol that ensures compliance with the ethical clearance obtained from the University in advance (see Appendix A).

Interviews can be seen as “speech events or activities and as jointly constructed discourse” (Mishler, 1991, p. 66), and when we engage in conversations, we necessarily share our stories (King, Horrocks and Brooks, 2019). However, as Chase (2003, p. 274) advises, “If we want to hear stories rather than reports then our task as interviewers is to invite others to tell their stories, to encourage them to take responsibility for the meaning of their talk. A successful interviewer manages to shift the weight of responsibility to the other in such a way that he or she willingly embraces it”. The researcher aims to hear the participants’ stories of their lived experiences as data management practitioners and is interested in their viewpoints on agility in EDM instead of expecting a report on agile EDM. Thus, the interview topics for discussion and the questions are phrased using everyday language (Chase, 2003), albeit data management specific, rather than expressed in scientific language. Therefore, the interview process uses descriptions of agility as desired outcomes of the actions and interactions in EDM. Through this approach to data collection, the theoretical underpinnings of the research artefact can be held loosely, thereby limiting the risk of constructing the interviewees’ narratives (Mishler, 1991) and allowing the participants to express their experiences and opinions freely instead of overwhelming them with specific expectations driven by the underlying scientific theories (King, Horrocks and Brooks, 2019).

The interview participants are asked to provide their views on the requirement for agile EDM. All questions posed to the interview participants are bounded by the structural components of agility in IS as they apply to EDM, and the same question guide is used for all the interviews. Although participants are free to answer the questions as they wish, the order and stems of the questions are consistent across all the interviews (Morse, 2015). The interview question guide for collecting the qualitative data is presented in Appendix C.

The rich narrative descriptions collected through this approach subsequently allow advancement of the artefact, producing a framework for agile EDM through an inductive process during the primary qualitative thematic analysis phase. The researcher uses the constructs of the dynamic part of a framework for agile EDM to create a coding scheme for the collected data. Then, inductive reasoning further develops and refines the themes and codes applied to the participants’ narratives and the organisation’s EDM policy documents.

Organisational categories for the data collection process are shown in Table 3-6.

Table 3-6: Organisational categories considered for data collection

Organisational category	Description
Industry	Participants from the financial services industry are invited to share their lived data management experiences and opinions relating to their current role in the case study organisation as well as their previous data management roles in other organisations and industries.
Data role or responsibility	The participant's role in, or responsibility for, data is considered, for example: • Chief Data Officer • Head of data governance • Head of data management • Enterprise data architect • Data architect • Information architect • Data quality management specialist • Master data and reference data specialist • Business intelligence and data warehousing specialist • Data project/programme manager • Head of information security (Seiner, 2014; DAMA International, 2017)
EDM discipline/domain	Specific EDM disciplines and domains are considered for the interviews, for example: • Strategy • Policies • Principles • Standards • Data ownership • Data architecture • Data modelling and design • Data storage and operations • Data security • Data integration and interoperability • Documents and content • Reference and master data management • Data warehousing and business intelligence • Data analytics and data science • Metadata • Data quality • Culture • Organisation of EDM (Ladley, 2012; Seiner, 2014; DAMA International, 2017)

Organisational category	Description
Level	The level at which agility is experienced by the participant, for example: • Strategic • Managerial (tactical) • Operational • Organisational (enterprise architectural) • IT infrastructure: Application (software) platform • IT infrastructure: Systems integration (hardware and software) platform • IT infrastructure: Technology (hardware) platform (Seiner, 2014)

After collecting the data, the interview recordings are transcribed, anonymised and dated. In addition, the existing documents (sources of evidence) relating to EDM policies, guidelines and standards collected from the case study organisation are anonymised prior to their coding and analysis. This approach fulfills the researcher's ethics commitments (see Appendix A).

3.8.5 Interview transcription process

The data analysis phase of this research starts with transcribing the audio recordings of the interviews. The dictate option in Microsoft Word can provide a means to automate the initial transcriptions. Subsequently, the transcriptions are edited to correct the spelling and split the interviewer's questions and explanations from the interviewee's responses. At the same time, the data is anonymised to comply with the ethical requirements. The quality of the recordings of the online meetings and the dictation tool's interpretation of the voice recordings from the online meetings means that the automatic transcriptions process potentially requires hands-on tending. Although this can be a time-consuming process, it offers valuable opportunities to listen and reflect on what was said and discussed during each interview, make notes on links to the literature, and initialise the thought processes on how to code and analyse the data. Thus, the transcription process contributes to the researcher becoming immersed in the data, reflecting while "reliving" each interview and forming synergistic links between the participants' descriptions and narratives of EDM contexts and events (Myers, 2013; Ravitch and Riggan, 2017). Notwithstanding the risk of bias, as noted in the previous section, the researcher's position as a data architect at the

case study organisation implies her ongoing participation in the EDM culture, providing more in-depth ways of knowing and understanding the participants' narratives.

During and after the data collection process, the literature is continuously referenced to build an understanding of the data in the context of the scientific knowledge and theory underlying the structural and dynamic parts of the framework for agile EDM. Continuously switching between the data and literature enables linking the real-world data to scientific and theoretical constructs in the literature, thereby continuously contextualising and refining the definitions of the framework's components.

3.8.6 Data coding and analysis

The collected data is coded and analysed in two phases: (1) The qualitative thematic analysis phase of the first DSR cycle investigates the characteristics of agility in EDM. The characteristics of agility in IS provide the units of analysis. These are used to code and analyse the narrative data collected from the semi-structured interviews at the case study organisation to produce the structural components of agile EDM, thereby answering Sub-RQ1. (2) Using the data set collected in the first DSR cycle and further including data management policy and standards documents found at the case study organisation, the in-depth thematic analysis, is conducted as part of the qualitative case study in the second DSR cycle, applying the dynamic part of a framework for agile EDM to the case study data, and explaining how agile EDM could be achieved. The coding scheme for the qualitative data analysis is directly based on the structural and dynamic components of the framework for agile EDM developed in the two DSR cycles.

The coding and analysis process examines the research problem's relevance and reality: the need for agility in EDM and how agility emerges and evolves in EDM. Additionally, the coding and analysis process continuously assesses the validity of the artefact and its application in a real-world EDM context. Any inconsistencies in the artefact's design encountered during the coding and analysis activities revert to the design phase of the DSR artefact development for further refinement of the artefact. Therefore, the relevance, design, and rigour cycles iteratively improve the artefact's design for relevance and groundedness in the theoretical knowledge base relating to agility in EDM (Hevner, 2007). This process continuously refines the artefact's design by drawing on the existing theoretical base to solve

the research problem and applying this knowledge to the data analysis, integrating findings back into the artefact's design (Peffers *et al.*, 2007).

Data collected from interviews and documents (sources of evidence) is coded and analysed using the qualitative research tool Atlas.ti and applying the thematic analysis (TA) method. Thematic analysis is a qualitative data coding and analysis method for systematically identifying and organising themes, representing patterns of meaning across a data set (Braun and Clarke, 2012). “Themes are recurrent and distinctive features of participants’ accounts, characterising particular perceptions and experiences, which the researcher sees as relevant to the research question” (King, Horrocks and Brooks, 2019, p. 200).

The unfolding, dynamic processes described in the narrative data illuminate the perspectives of the actual present, past and desired future states of how agility in EDM is or was and how it should ideally be. Acknowledging that the present embodies the past and the future is required to account sufficiently for what the researcher finds in the data (Cecez-Kecmanovic, Galliers, Henfridsson, Newell and Vidgen, 2014). Cecez-Kecmanovic *et al.* (2014) explain that when analysing data gathered from dynamic unfolding processes, new units of analysis emerge from the data as the inquiry progresses. Approaching the data with the structural and dynamic components based on scientific literature implies a top-down approach to the TA process (Braun and Clarke, 2012). However, the qualitative case study's purpose is to refine and further develop the dynamic part of the framework produced by the fourth sub-cycle of DSR Cycle 2. This process implies an inductive approach driven by the semantic content of the data (Braun and Clarke, 2012).

The TA process for this study follows the six phases proposed by Braun and Clarke (2006), presented in Table 3-7:

Table 3-7: The phases of thematic analysis (reproduced from Braun and Clarke (2006, p. 87))

Phase	Description
1. Familiarisation with the data	Transcribing data, reading and re-reading the data, making notes of initial ideas
2. Generating initial codes	Systematic coding across the entire data set of interesting aspects of the data and collating data relevant to each code
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme

Phase	Description
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (level 1) and the entire data set (level 2) and generating a thematic map of the analysis
5. Defining and naming themes	Ongoing analysis to refine the details of each theme and the overall story revealed by the analysis, generating clear definitions and names for each theme
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, the final analysis of selected extracts, relating the analysis to the research questions and the literature, producing a scholarly report of the analysis

The six-phase method described in Table 3-7 is used for all text-format documents, including interview transcriptions and found sources of evidence (the organisation's policy, standards and guideline documents), to import, code and analyse the data using Atlas.ti. During the coding phase of the data analysis, the researcher associates logical sections of text (units of meaning or quotations) with codes grouped by and founded on the constructs and attributes of the scientifically-grounded structural and dynamic parts of the framework for agile EDM.

Defining meaning units is a pragmatic, subjective process in which the researcher identifies the apparent, rather than rule-based, meaning for each section of data where there is a transition in meaning (King, Horrocks and Brooks, 2019). This process enables the researcher to produce a structural description of the data. Transformation involves multiple stages whereby the researcher assesses what the unit of meaning suggests regarding the aspects of the phenomenon under investigation. The structural description defines the typically essential, identifiable element or aspect that pertains to the phenomenon being studied (King, Horrocks and Brooks, 2019).

3.8.7 Researcher bias and limitations

Potential interview participants are identified based on their level of expertise and position of influence in their data management role. The initial interview participants are data and information architects that the researcher knows well from frequent work-related interactions, and are asked to identify additional potential participants. This approach to participant selection is appropriate as this study requires a view of agility at the detailed level

of data management work and how agility outcomes impact the overall agility of EDM in the organisation.

Architects are seen as particularly well-positioned to contribute to this research as architects in IS are typically tasked with solving complex problems without having complete knowledge of all underlying detail, despite having to design for ongoing changes and communicate solutions and possible alternatives to stakeholders at all levels of the organisation (Kappelman and Zachman, 2013). However, the researcher herself was a data architect in the Chief Risk Office of BankGroup at the time of this study. Despite the semi-structured, conversational and organic nature of the interviews, her own beliefs and experiences relating to agility in the data management functions at BankGroup poses a risk of biased collection and interpretation of the data.

Such a risk is mitigated, to some degree, by focusing the interviews on the characteristics of agility in IS as identified in the SLR of the first DSR cycle. For this purpose, the researcher displays the “interview agenda” for the duration of the interview to maintain focus on the topics of interest in every-day (non-scientific) language, thereby stimulating unconstrained experiential narrative and sharing of opinions by the participant. Additionally, the researcher does not ask the interviewees to explicitly agree or disagree with any hypotheses posed by the researcher. Instead, the researcher allows participants to freely express their views and narrate their experiences of dynamic capabilities and agility features in their present and past EDM contexts, including experience gained outside the case study organisation in previous positions held. The researcher also asks the participants whether the definitions and descriptions of the characteristics of agility presented to them make sense based on their present and past EDM experiences.

The researcher’s experience in BankGroup as a data architect contributes to her understanding of the participants’ narratives and explanations. In the hermeneutics of this study, the researcher interprets descriptions of the participants’ lived experiences of agility in EDM. Therefore, the researcher’s prior knowledge of the topic is essential (Myers, 2013). Nonetheless, “pink elephant” bias, which is the risk of the researcher anticipating what was to be found in the data based on their insidious or overt thoughts (Spiers, 2002), poses a potential issue to this research's data collection and analysis processes (Morse, 2015). “Pink elephant” bias can subvert the inductive process, leading the researcher to miscategorisation or misattribution of the data (Spiers, 2002). As Tsoukas and Hatch (2001,

p. 1001) point out, “an actor’s understanding of a situation influences the situation, such an understanding is always imperfect”. Awareness of this imperfection enables the researcher to reflect on her role in shaping the ongoing interview process and avoid limiting the participant's descriptions and narratives (Tsoukas and Hatch, 2001) of agility in EDM.

The conversations during qualitative interviewing can easily be viewed as a straightforward sharing and discussion of opinions and ideas between two or more people (King, Horrocks and Brooks, 2019). However, this technique relies on participants to willingly provide accurate and complete information about the topic of discussion. Therefore, there is an underlying assumption that accurate information can be supplied by interviewees who describe and make sense of their experiences as they relate to the topic being explored (King, Horrocks and Brooks, 2019).

3.9 ETHICS

As stipulated by the University of Pretoria, the ethics process is adhered to. The researcher respects all participants' intellectual property and privacy rights in this study. The required approval must be granted before data collection commences at the case study organisation. Appendix A includes the letter from BankGroup granting permission to the researcher for conducting the qualitative case study, and the ethics approval letter obtained from the University prior to collecting any data.

The data collection for this study does not pose any significant ethical risk to individuals as no personal information will be collected, and the participants are not from vulnerable groups. At the start of each interview, the participant will be requested to sign a written consent form indicating their voluntary participation, and the researcher will subsequently provide them with a countersigned copy for their records. A copy of the interview consent form is included in Appendix C.

For the artefact evaluation process, ethics approval was obtained (see Appendix B) through the stipulated process from the University of Pretoria’s ethics committee to collect qualitative data from a panel of EDM and agility experts. A questionnaire is developed to collect the expert's views and opinions on whether the proposed artefact (produced by the qualitative case study in the second DSR cycle) is fit for application in the real world and is likely to solve the practical problem of achieving agile EDM. The data collection for this Delphi study does not pose any significant ethical risk to individuals, and the participants are not from

vulnerable groups. Before requesting participants to complete the artefact evaluation questionnaire, the researcher asks them to sign a written consent form indicating their voluntary participation. The researcher subsequently provides them with a countersigned copy for their records. Appendix D includes a copy of the letter of invitation and consent form to be sent to the Delphi panel members.

3.10 CONCLUSION

This chapter presented the research methodology, strategy and rationale for the selected methods for developing the DSR artefact (Gregor and Hevner, 2013), a framework for agile EDM. Gregor and Hevner (2013) suggest that DSR as a research strategy places a strong emphasis on research rigour by drawing on and adding to the existing theoretical knowledge base and substantiating the relevance of the research to the real world. To remain valuable and relevant, a framework for agile EDM would need to integrate and mature alongside practitioner data management frameworks and reference models.

There is currently limited practical knowledge on how to establish agile capabilities and embed a culture of agility in organisations (Appelbaum *et al.*, 2017). Furthermore, organisations are struggling to manage the value and complexity of their data assets (Otto, 2015; Al-Ruithe, Benkhelifa and Hameed, 2019), and empirical research is still limited in the field of data governance (Benfeldt Nielsen, 2017). Hence, academic research on agility in the organisation and functioning of EDM is limited overall. This research aims to develop a framework that solves a real-world problem. The approach to developing the framework is to embed existing scientific theory in its design and refine its relevance through an in-depth qualitative case study conducted at BankGroup to provide a practical yet scientifically grounded solution to achieve agile EDM.

DSR is an appropriate approach to this study as the research problem could be addressed by developing and evaluating an artefact that could potentially improve the value delivered by the EDM functions of the organisation. Guided by the relevance, design and rigour cycles of DSR (Hevner, 2007), a framework will be developed, having the potential to provide an implementable means of improving agility and agile capabilities in the practices that deliver data requirements to the business.

This study adopts the definition of a framework as a model and a method to develop and describe an artefact, a framework for agile EDM, consisting of a model as a visual

representation, and a prescriptive method of how to implement the framework in a real-world EDM context. First, this study aims to explain the “what” as the structural components of agile EDM to include the real-world aspects and qualities of agile EDM. Secondly, this study aims to explain the “how” of the dynamic components of agile EDM to include the relationships and interactions between the structural components of agile EDM, resulting in outcomes and consequences for thriving or faltering agility in EDM.

This study adopts the DSR process proposed by Vaishnavi, Kuechler and Petter (2004) to develop a framework for agile EDM in two DSR cycles. The first cycle develops the structural part of a framework for agile EDM based on an SLR of the characteristics of agility in IS applied to a qualitative case study of agile EDM. The second DSR cycle develops the dynamic part of a framework for agile EDM, which is then applied to the qualitative case study to produce the evaluation-ready version of a framework for agile EDM. The output of each cycle (or sub-cycle) informs the next cycle's problem awareness and solution suggestion to refine and further develop the DSR artefact. Using a DSR approach, this research develops a framework for EDM that potentially delivers value to the business with sustained, relevant agility in EDM. The framework for agile EDM is the artefact produced and evaluated through this DSR study.

4 DSR CYCLE 1: THE STRUCTURAL COMPONENTS OF AGILE ENTERPRISE DATA MANAGEMENT

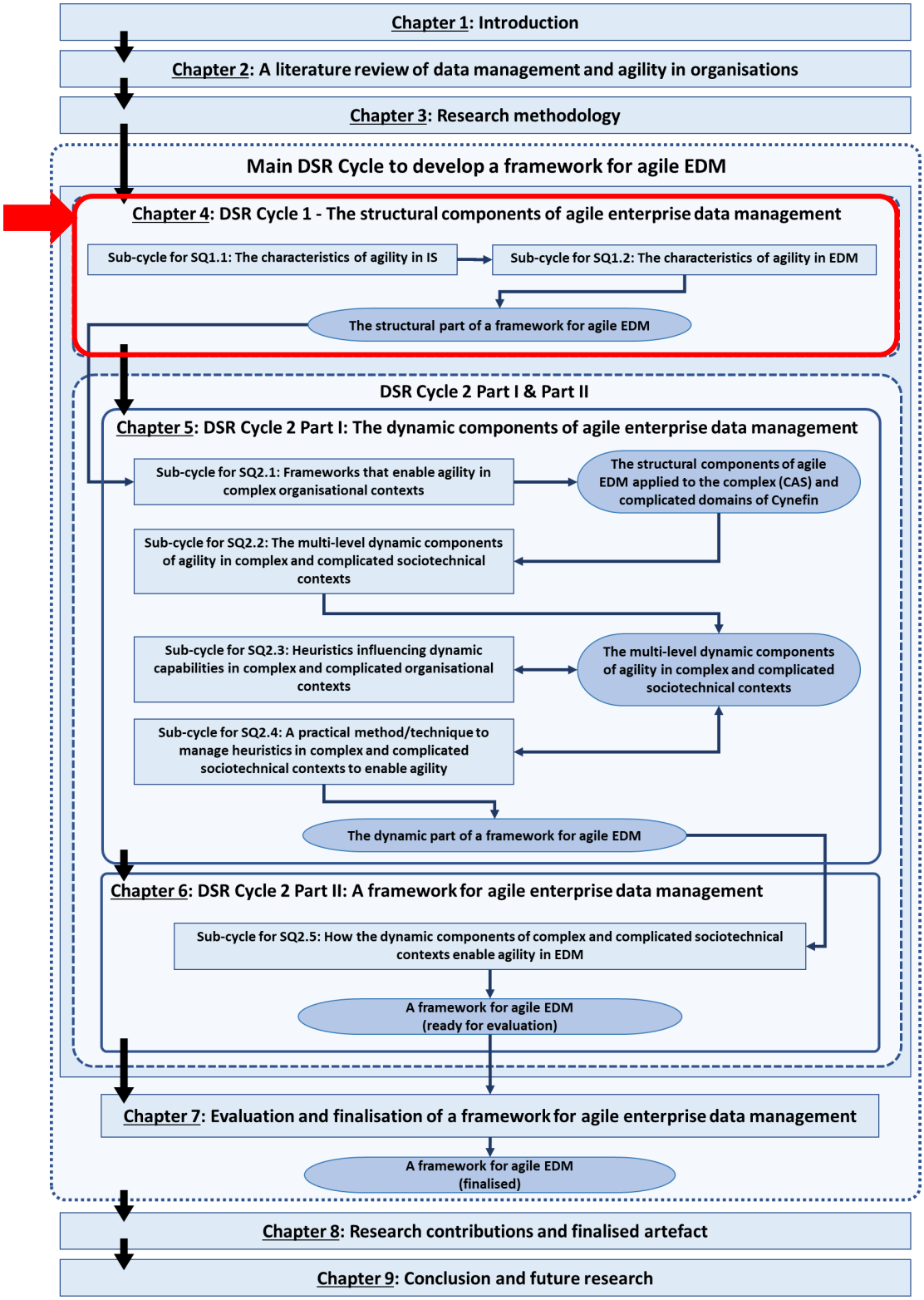


Figure 4-1: Chapter map — Chapter 4

Enterprise data is seen as a strategic asset (Jia, Hall and Song, 2015; DalleMule and Davenport, 2017). An organisation's data assets are managed through EDM, which involves experts and specialised technologies performing functions that manage data for the entire enterprise (Khatri and Brown, 2010; Otto, 2011a; Seiner, 2014; DAMA International, 2017; Ashrafi, Ravasan, Trkman and Afshari, 2019). To enable organisational agility, IT agility is required (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Chakravarty, Grewal and Sambamurthy, 2013; Tallon *et al.*, 2019). The use of data in organisations spans functional and hierarchical boundaries across the enterprise (Brous, Janssen and Vilminko-Heikkinen, 2016; Park, El Sawy and Fiss, 2017; Knabke and Olbrich, 2018). This research understands EDM as a sociotechnical organisational structure within an enterprise that is required to achieve agility to support enterprise agility. As established from the literature reviewed in Chapter 2, there is currently insufficient knowledge of how organisations can achieve agility in EDM. Nonetheless, a substantial body of scientific knowledge about agility exists in the IS literature (Tallon *et al.*, 2019; Salmela *et al.*, 2022).

Following the relevance and rigour cycles proposed by Hevner (2007), as shown in Figure 3-5 on page 65, the rigour of the DSR artefact's design is first established by conducting an SLR to identify the characteristics of agility in IS. Subsequently, relevance is incorporated in the DSR artefact's design by applying the characteristics of agility in IS to EDM in a qualitative case study at BankGroup. The output of this first DSR cycle was the structural components of agile EDM, which was the first step towards developing the DSR artefact.

4.1 BACKGROUND AND APPROACH

Goldkuhl (2012b, p. 7) proposes that "the essence of a pragmatist ontology is actions and change; humans acting in a world which is in a constant state of becoming". This research aims to understand how agile EDM can continuously be achieved, thus how it is in a continuous state of becoming agile. This presents an interesting real-world research problem, and this study sets out to construct an artefact for application in the real world (Vaishnavi and Kuechler, 2015). Agility is an abstract concept that first needs to be broken down into contextualised, recognisable, perceivable characteristics before it can be empirically studied to produce a practical solution for achieving agile EDM in real-world contexts.

To construct a framework, the structural components (the "what") need to be developed first to frame the development of the dynamic components of the framework (the "how"). This first DSR cycle developed the structural components of agile EDM by answering the first sub-question of this research, including its two underlying questions:

Sub-RQ1:	*What* are the structural components of agile enterprise data management?
SQ1.1:	What are the characteristics of agility in Information Systems?
SQ1.2:	What are the characteristics of agility in enterprise data management?

The first sub-question was addressed by conducting an SLR of agility characteristics in IS research. To answer the second sub-question, the characteristics of agility in IS were applied to a qualitative case study of EDM at BankGroup.

4.2 SQ1.1: THE CHARACTERISTICS OF AGILITY IN INFORMATION SYSTEMS

Scientific researchers have investigated how information technology can support organisational agility (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Tallon and Pinsonneault, 2011; Tallon *et al.*, 2019) and the crucial role of data management in achieving organisational agility (Larson and Chang, 2016; Park, El Sawy and Fiss, 2017; Knabke and Olbrich, 2018; Barlette and Baillette, 2022). However, as identified in Chapter 2, it seems that researchers have not yet extensively studied agility in enterprise data management. Therefore, this first DSR cycle systematically reviewed the literature on agility in IS to develop an understanding of its characteristics that would serve as the foundation for understanding and explaining the structural components of agile EDM:

SQ1.1: What are the characteristics of agility in Information Systems?

4.2.1 Method: A systematic literature review of agility in Information Systems

The systematic literature search and review of agility in IS was directly shaped by the keyword "agile", which is contained in the main research question: How can agile enterprise data management be achieved? The guidelines proposed by Okoli (2015) for conducting an SLR in IS were adopted, and are presented in Figure 4-2.

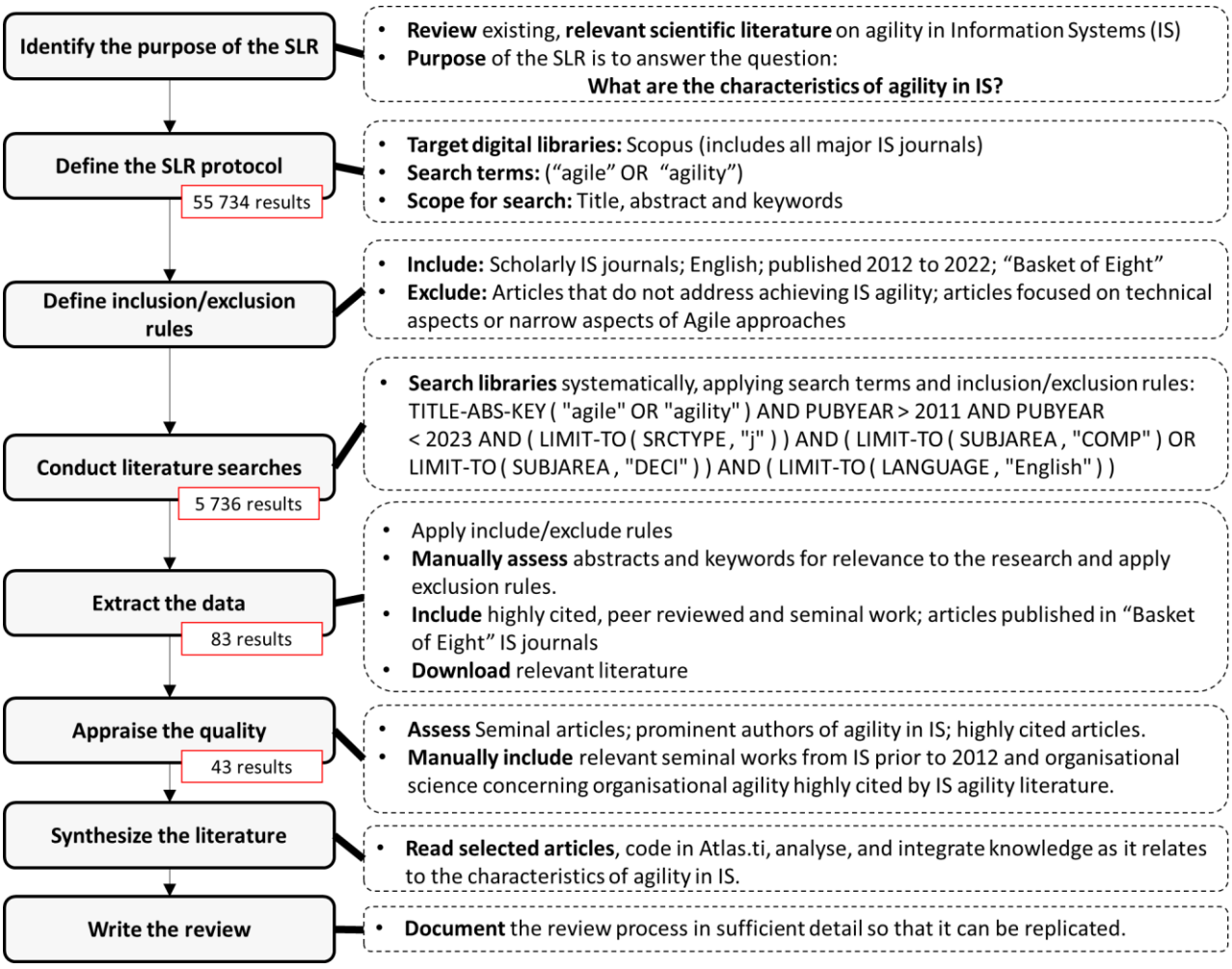


Figure 4-2: Systematic literature review process (based on Okoli, 2015 (pp. 883–884))

Scopus was selected as the research database for its inclusion of peer-reviewed articles from top-rated IS journals, advanced search options, and comprehensive export capabilities.

The search terms for "agile" or "agility" produced an overwhelming number of articles that needed to be assessed for accuracy and relevance. Boell and Cecez-Kecmanovic (2015, p. 165) explain that "[i]deally, a good query has a high recall as well as high precision", where "[r]ecall refers to the number of relevant documents retrieved by a specific query compared with the number of relevant documents that could potentially be found in a database" and "precision reflects how many relevant documents are among the documents found".

To balance the pay-off between relevance and accuracy, articles from the IS "Basket of Eight" journals were preferred for their quality, and articles by the main authors of agility in IS were included. The "Basket of Eight" comprises the eight top IS journals as determined by the AIS College of Senior Scholars (Association for Information Systems, 2023).

Abstracts, titles and keywords from the found articles were manually assessed to identify the relevance to the research question. Additionally, the references of particularly relevant works were scanned for seminal and additional articles and proceedings, and used for backward literature searches (Webster and Watson, 2002), including those in other disciplines, such as strategic management and decision sciences. Through this manual process of refining the data set of relevant literature, the qualitative assessment of the found articles was, however, subject to the researcher's bias and thus could not ensure absolute relevance and accuracy (Boell and Cecez-Kecmanovic, 2015). Nonetheless, biases and systematic miscues inevitably result from the researcher's choices of journals, conferences and databases (Boell and Cecez-Kecmanovic, 2015, p. 166).

The found articles were extracted and perused to verify their quality and relevance to the research topic and to build an integrated understanding of the field. Mendeley folders and Excel were used to include, exclude, sort, rank, tag and annotate articles. Articles were included where they provided descriptions and explanations of the agility phenomenon in IS, including its processes, capabilities, contexts and features. Additionally, articles were of interest where agility was discussed as a collective pursuit of importance to the whole organisation and its stakeholders.

Limitations of the approach taken for conducting the SLR and data analysis include the researcher's bias in identifying words, synonyms and word-parts related to agility and its characteristics. Future research could refine the process to further clarify the definition and implications of agility in IS and organisations in general.

4.2.2 Agility in information systems

For over 20 years, strategy, management, and IS literature have adopted a perspective on organisational agility as a cohesion of sensing and responding capabilities (Tallon *et al.*, 2019). These two determinants of a firm's success refer to its ability to sense important changes in its strategic and operating environment and to respond readily to the opportunities and threats presented by the changing environment (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Tallon *et al.*, 2019). Agility is the continuous adaptation required by organisations in rapidly changing markets (Salmela *et al.*, 2022). A capability is considered dynamic if it allows the organisation to reconfigure its resources in concert with a shift in environmental conditions

(Tallon *et al.*, 2019). Organisations that can adapt and thrive in rapidly changing, highly dynamic business environments are considered to "be agile" and rely on IT as a key enabler of agility (Sambamurthy, Bharadwaj and Grover, 2003; Dove, 2005; van Oosterhout, Waarts and van Hillegersberg, 2006).

Park, El Sawy and Fiss (2017) investigated three types of agility (sensing agility, decision-making agility and acting agility), adopting a configurational perspective that considers the complex interrelationships between environments, organisations and IT. They argue that a linear perspective of IT's effect on organisational agility is insufficient to explain the complex dynamics of IT agility in organisations as changes in the organisation's environment increase in speed and become more unpredictable and discontinuous. IT infrastructures are often heterogeneous and complex but need to be maintained over time to continuously enable organisational agility (van Oosterhout, Waarts and van Hillegersberg, 2006). In more predictable, stable organisational environments, agility, including IT-enabled agility, could be excessive and thus not worth pursuing (Tallon *et al.*, 2019).

Teece, Peteraf and Leih (2016, p. 17) define "agility" as "the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value-creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant". IS research that studied how the strategic management of IT in rapidly changing organisational contexts enables organisational agility has adopted the concept of dynamic capabilities, originating from strategic management literature (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000; Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016; Park, El Sawy and Fiss, 2017; Salmela *et al.*, 2022). Salmela *et al.* (2022) found that dynamic capabilities are arguably the most significant concept to emerge from studies of managerial behaviour in volatile organisational environments.

Studies of IT-enabled agility in organisations consider management and its ability to cope with changing situations and reconfigure organisational resources as crucial agility enablers (Salmela *et al.*, 2022). The dynamic capabilities of sensing, learning, integrating and coordinating enable the creation and evolution of operational capabilities, reconfiguring them in response to environmental changes (Pavlou and El Sawy, 2011). Dynamic capabilities govern how an organisation builds, reconfigures and integrates resources in rapidly changing business environments (Teece, Pisano and Shuen, 1997).

4.2.3 Data theming, coding and analysis

Agility in organisations lacks a clear definition (Appelbaum *et al.*, 2017; Walter, 2021), and in IS literature, the concept of agility lacks clarity and theoretical cohesion outside of the information systems development field (Conboy, 2009). The objective of this study is to provide a clear and consistent definition of the structural components of agile EDM based on the characteristics of agility in IS. Merriam-Webster Incorporated (2022, n. p.) defines "characteristic" as "a distinguishing trait, quality, or property". The initial reading of article abstracts and conclusions guided the strategy for coding and analising the collected literature.

Characteristics of agility in IS are those traits and qualities that co-exist with the achievement of agility in IS in the physical/real world that collectively enable agility for the enterprise. For example, "[w]e now need to understand how specific IT characteristics (such as integration, flexibility, […]) affect the two key capabilities of agility: sensing and responding", and "there could be several important IT characteristics of interest (such as scalability, reconfigurability, and so forth)" (Nazir and Pinsonneault, 2012, pp. 161–162).

Agility in IS is associated with sensing, decision-making and responding capabilities in organisations under high-speed, predictable and unpredictable environmental conditions (Park, El Sawy and Fiss, 2017). Dynamic capabilities have been reliably used in IS studies of how agility in IT supports organisations to sense, decide and respond to opportunities and threats in an uncertain business environment (Tallon *et al.*, 2019). Thus, agility in IS is relevant to rapidly changing, predictable and unpredictable organisational contexts.

Walter (2021) considers organisational agility to be a specific type of dynamic capability and emphasises the importance of clarifying what agility and its drivers are and the role of management in achieving agility in the organisation. Walter (2021, p. 354) conceptualises agility capabilities within an organisation as "specific abilities for providing the required power and competence to react to changes; they include responsiveness, competency, flexibility, and speed". According to Teece, Peteraf and Leih (2016), flexibility is a near-synonym for agility. Salmela *et al.* (2022) identified descriptions of agility in IS and general management research as manifestations in actions: "quickly", "rapidly", "flexibly", "swiftly", and "with speed". Dynamic capabilities have been defined as sensing, learning, coordinating and integrating to support organisations with making sound decisions quickly in turbulent

environments, enabling the fast reconfiguration of organisational resources (Pavlou and El Sawy, 2011).

Leanness as an underlying concept of agility stems from The Toyota Production System in the 1950s (Conboy, 2009). Zhang and Sharifi (2000, p. 507) define leanness as a competency for "operations efficiency and effectiveness". Repeatable routines and reusable resources support efficiency, leanness and responsiveness (Nazir and Pinsonneault, 2021).

Based on the main research question, "How can agile EDM be achieved?", a first-principle approach was adopted to make sense of the multiple descriptions and levels of agility found in the literature. The characteristics of agility identified in the IS literature were considered from three perspectives that served as overarching units of analysis: capabilities that are required to "achieve agility", what "achieved agility" looks like, and the nature of the contexts applicable to "achieving agility".

The 43 found articles were coded and analysed using the qualitative research tool Atlas.ti, applying the thematic analysis (TA) method. Thematic analysis is a qualitative data coding and analysis method for systematically identifying and organising themes, representing patterns of meaning across a data set (Braun and Clarke, 2012). Word and word-part regular expression searches, including synonyms, were used in Atlas.ti to identify agility characteristics in the IS literature and apply inductive coding, as shown in Table 4-1.

Table 4-1: Inductive coding of the characteristics of agility in IS

Codes for characteristics of agility	**Regular expression search terms used**
Competence	competen|effective|expert|knowledge creation|knowledge management|knowledge shar|learn|speciali
Flexibility	flexib|adapt|reconfigur
Leanness	leanness| lean |cost| efficient|waste|wastage
Responsiveness	responsive| respond | responding|proactive|react
Reusability	reusab|adopt|repeatab|routin|standardi
Scalability	scalab|scaling
Speed	speed|fast|quick|rapid|swift|timeous|timel|velocity

Codes for characteristics of agility	**Regular expression search terms used**
Coordinating	coordinat| plan|align|shared understand|collaborat|standardi
Integrating	integrat|combine|combination|incorporat
Learning	learn|knowledge creat|knowledge manage|knowledge shar|understand
Sensing	sense|sensing|environmental change|opportunit|threat
Decision-making	decision|decide|deciding
Complex	complex|difficult|environmental change|instability|interdependen|turbulen|uncertain|unexpected|unforeseen|unpredictab|unstable|volatil|wicked problem
Complicated	complicated|expert|speciali| stabili| stable

This SLR of agility characteristics in IS adopted the concept-centric approach proposed by Webster and Watson (2002) to synthesise the literature. The concept matrix, including the emphases of the concepts in the literature based on document and code co-occurrence analysis in Atlas.ti, is presented in Table 4-2. The intensity of each cell's background colour indicates the level of code occurrences per article to highlight the emphasis on each concept. Darker cells denote a higher count, and lighter cells a lower count.

Table 4-2: Concept matrix of characteristics of agility in IS literature (including document/code co-occurrences and emphases)

Articles	Coordinating	Sensing	Competence	Integrating	Complex	Responsive-ness	Speed	Learning	Reusability	Flexibility	Decision-making	Leanness	Complicated	Scalability
Totals:	**1762**	**1560**	**1346**	**1251**	**1247**	**1130**	**1103**	**1083**	**1066**	**831**	**800**	**484**	**295**	**172**
1. Nazir and Pinsonneault (2021)	92	94	41	189	24	120	20	43	31	21	8	10	15	0
2. Park, El Sawy and Fiss (2017)	43	127	45	44	100	32	102	26	19	16	77	2	2	0
3. Roberts and Grover (2012)	96	174	39	52	22	110	42	37	11	12	11	2	3	1
4. Nazir and Pinsonneault (2012)	58	89	32	190	24	80	18	34	16	28	8	13	13	1
5. Tallon *et al.* (2019)	72	116	43	19	44	59	41	30	15	39	47	17	9	1
6. Liang, Wang, Xue and Ge (2017)	312	23	29	12	26	19	14	32	29	6	15	14	7	0
7. Walter (2021)	20	35	31	31	76	66	49	31	8	24	21	36	8	2
8. Barlette and Baillette (2022)	57	37	29	17	38	32	59	32	15	34	51	12	3	0
9. Richardson, Kettinger, Banks and Quintana(2014)	63	52	42	36	27	22	42	18	16	22	34	13	19	2
10. Knabke and Olbrich (2018)	29	17	27	60	11	13	17	76	77	16	35	2	13	2
11. Overby, Bharadwaj and Sambamurthy (2006)	24	140	13	15	36	105	16	2	4	17	2	7	9	0
12. Salmela *et al.* (2022)	36	61	21	29	29	33	47	12	23	62	7	2	8	4
13. Chakravarty, Grewal and Sambamurthy (2013)	24	30	163	9	23	21	11	21	3	59	4	1	1	0
14. Teece, Peteraf and Leih (2016)	25	39	30	16	70	8	30	23	5	41	17	52	8	0
15. Ravichandran (2018)	30	25	91	24	10	55	35	25	25	17	2	15	0	0
16. Gregory, Keil, Muntermann and Mähring (2015)	93	16	27	57	30	4	6	25	28	7	28	12	20	0
17. Werder and Maedche (2018)	18	7	35	9	86	15	11	52	19	46	27	8	10	1
18. Karimi-Alaghehband and Rivard (2019)	41	94	19	19	21	4	26	25	37	13	18	6	12	1
19. Conboy (2009)	9	9	50	9	15	31	23	42	17	29	8	70	5	0
20. Limaj and Bernroider (2022)	23	2	22	17	18	6	18	25	18	10	13	7	7	119
21. Baham and Hirschheim (2022)	38	8	32	14	19	37	9	68	21	33	7	13	3	2
22. Ashrafi *et al.* (2019)	17	20	23	8	67	28	26	23	12	19	46	5	8	0
23. Edison, Wang and Conboy (2022)	53	13	32	12	10	1	15	23	62	8	17	19	6	23
24. Sambamurthy, Bharadwaj and Grover (2003)	15	55	55	35	24	9	23	31	2	17	9	9	7	0

Articles	Coordinating	Sensing	Competence	Integrating	Complex	Responsive-ness	Speed	Learning	Reusability	Flexibility	Decision-making	Leanness	Complicated	Scalability
25. Huang, Pan and Ouyang (2014)	49	14	12	24	61	17	27	13	10	10	35	13	4	0
26. Kwak, Lee and Lee (2020)	101	11	18	9	15	11	4	22	65	17	3	4	2	0
27. Chen *et al.* (2014)	30	14	20	19	62	19	27	12	26	23	12	15	3	0
28. Larson and Chang (2016)	42	3	20	18	13	3	94	29	11	1	20	1	9	1
29. Huang, Niu and Pan (2021)	14	30	22	39	15	46	30	17	11	7	21	5	6	0
30. Hong, Chan, Thong, Chasalow and Dhillon (2014)	6	5	13	61	9	3	38	37	63	8	13	0	2	0
31. Tiwana and Kim (2015)	42	12	23	20	11	1	9	14	3	6	86	6	17	0
32. Fischer and Baskerville (2022)	25	11	15	8	62	3	10	20	32	28	3	3	28	0
33. Gutierrez, Boukrami and Lumsden (2015)	9	3	6	8	22	1	8	6	120	11	19	15	5	4
34. Wang, Conboy and Pikkarainen (2012)	28	4	17	21	9	3	8	20	82	21	5	4	4	0
35. Crick and Chew (2020)	9	9	10	5	30	10	10	21	65	37	1	9	3	0
36. Queiroz, *et al.* (2022)	42	14	45	11	11	17	12	11	6	11	16	9	0	1
37. Queiroz, Tallon, Sharma and Coltman (2018)	25	16	27	21	16	11	25	11	10	11	8	11	1	0
38. Ghasemaghaei, Hassanein and Turel (2017)	7	16	19	16	10	12	34	23	7	7	31	5	1	0
39. Pinsonneault and Choi (2022)	9	79	14	5	12	11	21	13	2	3	3	3	4	0
40. Lee, Sambamurthy, Lim and Wei (2015)	7	19	26	28	12	18	15	20	10	10	1	7	4	0
41. Zhou *et al.* (2018)	5	2	28	5	17	16	19	17	7	5	7	22	5	0
42. Lowry and Wilson (2016)	14	11	36	8	5	18	9	17	8	12	1	3	0	1
43. Conboy and Carroll (2019)	10	4	4	2	5	0	3	4	15	7	3	2	1	6

The data analysis indicated a strong emphasis on the capabilities of coordinating, sensing, integrating and learning, and less on decision-making. The agile features of competence, responsiveness, speed, reusability and flexibility were prominent, and leanness and scalability were less significant. Complex contexts were more strongly associated with agility than complicated contexts. Dynamic capabilities were used as a theoretical lens or discussed in multiple studies indicating the sense-respond focus in achieving organisational agility, which demands IT agility. The context relevant to organisational and IT agility was frequently described in terms of complexity, such as uncertainty and turbulence.

Based on capabilities that are required to "achieve agility", what "achieved agility" looks like, and the nature of the contexts relevant to "achieving agility", overarching themes were created to categorise and synthesise the characteristics of agility in IS literature: (1) **dynamic capabilities** govern organisational activities, for example, Sambamurthy, Bharadwaj and Grover (2003), and Teece, Peteraf and Leih (2016), (2) **agility features** as action qualifiers that enable agility by manifesting the features in the actions, for example, Salmela *et al.* (2022), and (3) the **sociotechnical contexts** associated with agility in IS as complex and complicated, for example, the contingency perspective of Park, El Sawy and Fiss (2017) and the unstable equilibrium perspective of Fischer and Baskerville (2022).

4.2.4 Findings — dynamic capabilities associated with agility in IS

While there might be a consensus amongst researchers that agility involves sensing and responding to changes in the organisational environment, there are differences in perspectives about the level at which to consider agility (enterprise, business unit, process or team) and how to compose the construct of agility (Tallon *et al.*, 2019). Tallon *et al.* (2019) suggest four categories of agility enablers: technological, behavioural, organisational and environmental. Technological agility enablers include IT hardware and software resources and data supported by flexible architecture (Tallon *et al.*, 2019). Huang, Pan and Ouyang (2014) suggest information processing capability as an enabler of agility when the organisation can collect, integrate and disseminate information effectively to deal with uncertainty.

Innovative data operations platforms can enable agility through real-time data streaming to support decision-making (Tallon *et al.*, 2019). Eisenhardt and Martin (2000) and Pavlou and

El Sawy (2011) view decision-making as a dynamic capability required for effective sensing and responding in turbulent organisational environments.

The capabilities of sensing and acting (learning, integrating, coordinating) govern actions that support agility when reconfiguring organisational resources in response to turbulent, high-speed environments (Pavlou and El Sawy, 2011; Teece, 2014). Therefore, dynamic capabilities are a crucial consideration at the managerial levels of IS to support organisational agility. Some authors view organisational agility as a higher-order dynamic capability (Sambamurthy, Bharadwaj and Grover, 2003; Lee *et al.*, 2015; Ghasemaghaei, Hassanein and Turel, 2017; Walter, 2021).

Sensing

Sensing and responding are components of organisational agility that are both enabled by IT, extending the richness and reach of the enterprise's processes and knowledge (Sambamurthy, Bharadwaj and Grover, 2003). Knowledge-oriented IT supports sensing, and process-oriented IT enables responding (Overby, Bharadwaj and Sambamurthy, 2006). For example, IT facilitates knowledge creation through the synergistic interactions between web-based customer platforms and the enterprise's analytics capability (Roberts and Grover, 2012).

Agile organisations have the ability to continuously sense and respond to opportunities by marshalling the required assets and knowledge to seize those opportunities (Sambamurthy, Bharadwaj and Grover, 2003). The organisational capability of sensing to respond includes scanning the environment (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011). Invariably, sensing includes gathering and importing disorganised and unstructured information from the external environment into the organisation (Teece, 2018). Scanning the environment is a sub-capability to the sensing capability that identifies opportunities and threats. However, it also contributes to agility because it informs, facilitates and speeds up the ensuing processes (Karimi-Alaghehband and Rivard, 2019).

Decision-making

Decision-making agility is a core requirement for achieving IT agility, requires sensing and precedes acting (Park, El Sawy and Fiss, 2017). A firm's decision-making capability builds organisational capabilities over time (Sambamurthy, Bharadwaj and Grover, 2003).

Eisenhardt and Martin (2000) explain that strategic decision-making is a dynamic capability whereby managers make collective choices by combining their diverse personal, functional and business expertise to shape the enterprise's significant strategic moves. Tiwana and Kim (2015) differentiate between IT decision-making for infrastructure and apps, and found that IT governance enhances IT strategic agility. However, it requires decision rights to be located where the relevant knowledge to make those decisions resides, regardless of the coordination needs of the initiative.

Decision-makers in organisations can capture and respond to untapped opportunities by exploiting insights gained from integrating and analysing large volumes of customer data to uncover patterns that provide valuable market intelligence (Huang, Niu and Pan, 2021). Park, El Sawy and Fiss (2017) emphasise decision-making as a distinct element of organisational agility and combine an information-processing view of organisations with dynamic capabilities to build an understanding of the dynamics between IT agility, organisational agility and the organisational environment.

Leveraging data analytics for improved decision-making with consequential agility is often practised in organisations (Ghasemaghaei, Hassanein and Turel, 2017). Ghasemaghaei, Hassanein and Turel (2017) propose that data analytics is a lower-order dynamic capability, influencing firm agility that is viewed as a higher-order dynamic capability and that agility outcomes are dependent on the fit between data analytics tools, tasks, users, business processes and the data itself.

Learning

Turbulence in the organisational environment increases uncertainty and requires organisations to process new information more rapidly to sustain the enterprise's competitive advantage (Ashrafi *et al.*, 2019). In fast-changing, dynamic organisational environments, top managers experience high levels of uncertainty and have an increased need for information and the capability to process it (Chen *et al.*, 2014).

Processes in organisations change through the organisational learning loop, whereby learning occurs through performing and embedding practices and routines involving social and technological agents, which might not always align with managerial intentions (Crick and Chew, 2020). A core concept in IS development agility is "learning from and creating change in response to discovered changes" (Baham and Hirschheim, 2022, p. 118). It is

more important for IT functions to have business knowledge than it is for business functions to possess IT knowledge (Tiwana and Kim, 2015).

Coordinating

Creating shared, corporate-sponsored IT platforms for sufficiently predictable processes that are standardised across business units enables quick deployment, enhancing agility for the business unit (Queiroz *et al.*, 2022). Standardisation supports inter-team coordination and enhances team performance (Kwak, Lee and Lee, 2020). Liang et al. (2017) found that high levels of social alignment between business and IT executives improve coordination at the strategic and sub-ordinate levels across functions when solving unforeseen problems.

Organisational agility and IT alignment are viewed as concurrent and critical organisational goals (Tallon and Pinsonneault, 2011). Challenging the widely-adopted view that alignment between IT and business always positively influences organisational agility, Liang *et al.* (2017) found that the formal alignment of IT and business strategy can impair organisational agility due to inertia stemming from an unwillingness to deviate from the strategy even when rapid environmental changes demand adaptation. However, social alignment between IT executives and business stakeholders positively influences coordination and organisational agility because their shared understanding enables swift responses to environmental changes as adaptations can be coordinated between business units and flexible, improvisational IT functions (Liang *et al.*, 2017).

Integrating

Integration capability enables an organisation's two primary agile capabilities of sensing and responding (Nazir and Pinsonneault, 2021). Nazir and Pinsonneault (2012) propose that electronic integration enhances communication and facilitates sharing of specialised knowledge between distinct organisational components (internal integration) and customers and suppliers (external integration). Huang, Niu and Pan (2021) found that system integration resulted in high levels of flexibility, enabling responses to changes in customers' online shopping needs. Integrating systems fulfils business needs by enabling a seamless exchange of information (Huang, Niu and Pan, 2021).

Shorter development iterations in Agile teams enable the team to integrate new knowledge from discussing the releases with changing requirements based on user feedback (Werder and Maedche, 2018).

4.2.5 Findings — features associated with agility in IS

The features of agility in IS manifest in the actions and interactions of people and technology in the sociotechnical contexts of IS (Salmela *et al.*, 2022).

Competence

Functional competencies that are adaptable form part of an organisation's capability to respond to change (Teece, Pisano and Shuen, 1997). IT competence and a firm's innovation capacity enable organisational agility (Ravichandran, 2018). IT expertise, knowledge, and learning from change build IT competencies (Conboy, 2009). IT competencies, in turn, facilitate the firm's ability to sense and seize opportunities in rapidly changing business environments, enabling the organisation's strategic agility (Chakravarty, Grewal and Sambamurthy, 2013).

IT capability is the enterprise's foundation of IT resources and capabilities that determine the organisation's capacity for innovation when IT resources, services and assets can be converted into strategic applications (Sambamurthy, Bharadwaj and Grover, 2003). An IT function with superior capability can execute IT projects faster and cost-effectively, enabling the organisation to respond effectively to market opportunities (Lowry and Wilson, 2016).

Responsiveness

Organisational structures must constantly respond to changes in the competitive environment and regulatory compliance requirements (Conboy and Carroll, 2019). The speed of response must match the nature of the changes in the environment instead of responding reactively (Conboy, 2009). Agility implies the organisation's ability to sense and respond to opportunities and threats (Roberts and Grover, 2012; Nazir and Pinsonneault, 2021), and the ability to respond depends on how well operational processes can be coordinated and executed (Dove, 2005).

Overby, Bharadwaj and Sambamurthy (2006) explain that when an organisation senses change in its environment, a high response capability depends on strong operating

capabilities and the organisation's ability to adjust its strategy and reconfigure and mobilise the appropriate resources, including IT.

Speed

The priority of Agile approaches is to satisfy the customer by delivering early and continuously to short timescales (Beck et al., 2001). Pure speed should not be used to measure agility because sometimes a slower suitable response to change is better than a rushed, unsuitable response (Conboy, 2009). Instead, Conboy (2009, p. 337) defines speed that is effective for achieving agility as the organisation's ability "to rapidly or inherently, create change, or to proactively or reactively embrace change through its internal components and relationships with its environment". Park, El Sawy and Fiss (2017) define the speed of change as the rate at which new opportunities emerge, and events occur in the organisational environment.

With the onset of big data, the velocity of data has increased, accelerating the need for the fast acquisition and processing of data by IT functions in the enterprise (Larson and Chang, 2016). The effective use of data analytics contributes to speed in decision-making which, in turn, improves the organisation's speed in responding to opportunities and threats in the environment (Ghasemaghaei, Hassanein and Turel, 2017). Speed is required in change management processes that can quickly identify and differentiate key strategic IT assets from those no longer generating value for the business (Queiroz *et al.*, 2018). Speed is strongly influenced by reuse (Martini, Pareto and Bosch, 2012).

Reusability

Reusability is an essential aspect of IT exploitation, which Lee *et al.* (2015, p. 401) describe as "the ability of a firm to manage its current portfolio of IT assets, leverage and reuse them in different business activities, invest in complementary technologies to improve their effectiveness, and integrate the technologies with the firm's business processes". Using existing IT capabilities to solve new business problems enhances organisational agility (Queiroz *et al.*, 2022).

Established ready-for-use agile processes provide an organisation with quick access to resources enabling a rapid and flexible response (Sambamurthy, Bharadwaj and Grover, 2003). Standardisation enhances organisational resource utilisation and positively

influences teams' coordination, thereby improving team agility (Kwak, Lee and Lee, 2020). By implementing a reusable, flexible IT platform, an organisation can enable its operational agility and reduce costs (Richardson et al., 2014). Reuse strongly influences speed through repeatability (Martini, Pareto and Bosch, 2012).

Flexibility

Reconfigurable assemblages of skills, processes, decision rules and structures provide managers with flexible IT solutions and services for responding to environmental changes (Karimi-Alaghehband and Rivard, 2019). Flexibility implies that IT infrastructure, such as network bandwidth, memory, storage, and processor capacity, can scale as demand increases (Tallon *et al.*, 2019). Flexible IT can enable dynamic IT and business strategy alignment, enhancing process agility (Tallon and Pinsonneault, 2011). Chakravarty, Grewal and Sambamurthy (2013) state that although flexible IT infrastructures enhance IT competencies that can offer multiple solutions to problems, increased volatility in the organisational environment presents situations in which pre-planned solutions are irrelevant, and, instead, building new knowledge and understanding of IT competencies are required.

Autonomy and flexibility are fundamental to successful agile practices in organisations (Conboy and Carroll, 2019). Flexibility characterises the readiness and propensity to adapt to ever-changing situations to respond to threats and opportunities while acting under time constraints (Salmela et al., 2022). Large-scale adoption of agility frameworks is increasingly popular in organisations but often lacks flexibility at scale, presenting coordination and communication challenges (Sidky, 2017).

Leanness

Teece, Peteraf and Leih (2016, p. 13) emphasise that agility should not be pursued irrespective of its cost because “change is costly and achieving agility often involves sacrificing efficiency”, and businesses cannot be in a constant state of organising for agility as cost-effective delivery is a crucial managerial capability.

Leanness is not just about simplicity and cost-saving but also quality. The definition of leanness is “contribution to perceived customer value through economy, quality, and simplicity” (Conboy, 2009, p. 339). Simplicity is an essential agile principle that relates to efficiency and is “the art of maximising the amount of work not done” (Baham and

Hirschheim, 2022, p. 126). However, striving for simplicity and leanness should not inhibit the ability to respond to change (Beck et al., 2001). Lean Agile approaches aim to reduce resource wastage, including time and effort (Edison, Wang and Conboy, 2022). Adopting cloud computing provides organisations with options that minimise the implementation time for IT services and reduce IT costs (Gutierrez, Boukrami and Lumsden, 2015). IT efficiency and IT innovation present tensions and paradoxes in organisations trying to achieve both (Gregory et al., 2015).

Scalability

To achieve agility at scale in an enterprise, practices, methods, and values must be scaled for their broader use (Limaj and Bernroider, 2022). Scaled agility can be initiated at the strategic, middle management or individual "agile advocate" level in the organisation and shifts the organisation away from working in functional silos towards more interdisciplinary, cross-functional ways of working (Limaj and Bernroider, 2022). However, scaling up teams in the organisation for improved agility presents challenges as transparency amongst stakeholders decreases accordingly (Edison, Wang and Conboy, 2022) and having more agile teams does not imply that more agility will be achieved (Sidky, 2017).

The scalability of IT infrastructure supports flexibility (Tallon et al., 2019). By implementing digital platforms, integrated systems can be built from commoditised technological components enabling swift scaling and adaptation to meet a broad range of business requirements (Richardson et al., 2014).

4.2.6 Findings — sociotechnical contexts associated with agility in IS

The sociotechnical contexts relevant to agility frame the type of response required. Unpredictable contexts are complex and require a different approach to predictable contexts, which are complicated and are best solved by experts and "good practices" (Snowden, 2002; Park, El Sawy and Fiss, 2017). Park, El Sawy and Fiss (2017, p. 666) found that agility is context-specific: "high speed & unpredictable" and "high speed & predictable".

Briggs, Nunamaker and Sprague (2010, p. 13) explain that "the purpose of information systems (IS) is to provide information to people who must make choices about the disposition of scarce resources" and "at the heart of IS research, then, is a complex

optimisation problem". In IS research, IT system artefacts are central to theorising, and a fundamental feature of IT is its essential concern with artefacts as complex systems involving technical and social components, and at the same time, Social Science refers to "social systems" (Gregor, 2009).

Crick and Chew (2020) propose a perspective of an organisation as a complex and complicated sociotechnical system that has interdependent finer-grain sociotechnical components of routines and individuals' and technologies' agencies. Park, El Sawy and Fiss (2017) found that the larger an organisation, the higher the complexity and interdependencies in the sense-decide-act process, presenting managers with challenges in sharing information and coordinating tasks, thus there is variability in organisations' paths to achieving agility.

Organisational agility is only relevant to high-speed environments, which can be predictable or unpredictable, influencing the levels of complexity and direction of environmental change (Park, El Sawy and Fiss, 2017). Uncertainty and volatility present complexity where new dynamic capabilities and organisational patterns can emerge, whereas existing capabilities and patterns can evolve in more stable contexts (Eisenhardt and Martin, 2000).

Complex sociotechnical contexts

It is seldom possible to remove all sources of uncertainty in the organisational environment, and enterprises must build new capabilities to cope with ongoing uncertainty (Ashrafi *et al.*, 2019). Enterprises with a resilient IT capability are better equipped to effectively coordinate the collection, analysis and dissemination of market information, thus enabling agility in the organisational business processes (Chen *et al.*, 2014). Chen *et al.* (2014) found that the higher the level of complexity in the environment, the greater the influence of IT capability on business process agility is because complexity demands more agility from processes to sustain the organisation's survival.

Proficiency in dynamic capabilities fosters the agility required for an organisation to manage deep uncertainty by enabling managers to make improved decisions resulting in effective "asset orchestration" and integration (Teece, Peteraf and Leih, 2016). According to Agile Alliance (2022, n. p.), agility is inherently related to capabilities that deal successfully with uncertainty and turbulence: "[agility is] the ability to create and respond to change. It is a way of dealing with, and ultimately succeeding in, an uncertain and turbulent environment".

Fischer and Baskerville (2022) emphasise that dealing with complexity requires diversity and flexibility. However, "[t]heories on sociotechnical change that are predominantly aimed at stabilising the setting for longer periods, seem to be inadequate responses to the current complex and unpredictable environment" (Fischer and Baskerville, 2022, p. 3). The future is increasingly data-driven and will require IS managers who are able to deliver in complex sociotechnical contexts of "unstable equilibrium" (Fischer and Baskerville, 2022, p. 15).

The high speed, unpredictable environments of large organisations involve many unexpected, unclear events, increased complexity due to high levels of interdependence amongst sociotechnical components, many new questions, fewer rules and knowledge, and the emergence of new processes (Park, El Sawy and Fiss, 2017).

Complicated sociotechnical contexts

Expert knowledge and skills are required for big data analytics to support business agility in turbulent organisational contexts (Barlette and Baillette, 2022). Managers struggle to overcome difficulties related to increasingly sophisticated analytics and work-related time constraints, and analytics specialists are unavailable to assist due to increasing demands from the business to deliver on analytics requirements (Barlette and Baillette, 2022).

Park, El Sawy and Fiss (2017) explain that the high-speed, predictable environments of large organisations involve high levels of interdependence amongst sociotechnical components resulting in some complexity. However, well-understood events, clearly defined questions, applicable rules and knowledge, and routines provide some control and stability to managers and experts.

Sensing, decision-making and acting in complex and complicated sociotechnical contexts

Galliers (2006) views strategising as an emergent process of visioning, planning, acting and assessing outcomes that must continuously balance imperatives and changing circumstances regardless of any formal plan or strategy. Park, El Sawy and Fiss (2017) suggest that IT can support organisational agility by supporting the three strategic tasks of sensing, decision-making and acting (reconfiguring organisational resources to adjust to rapid changes and uncertainty in the organisational environment). The sense-respond framework proposed by Park, El Sawy and Fiss (2017) provides a holistic, top-down

perspective of the agility-building process with three primary strategic tasks of sensing, decision-making, and acting, thereby explaining the process of seizing events and making decisions that enable actions.

The sense-respond framework proposed by Park, El Sawy and Fiss (2017) acknowledges the complex dynamics of IT agility and provides an agility-building process of sensing, decision-making and acting, founded in theory and existing scientific research that can be used to conceptualise the structural components of agility in IS as dynamic capabilities governing IS activities, complex and complicated sociotechnical contexts, and agility features as action qualifiers, manifesting the features in the actions and enabling IS agility.

When strategising for agility, Galliers (2006, p. 3) states that "information itself may usefully be perceived as a medium through which alignment might take place, with necessary information being provided 'top-down' in support of the business strategy and 'bottom-up' in terms of learning from on-the-ground realities associated with the use made and impact of existing systems and platforms". Thus, agility in IS enables agile IS from the bottom up, whereas agile IS can be strategised from the top downward.

4.2.7 Conclusion — the characteristics of agility in Information Systems

Due to the increasing volatility in the external environment of organisations, there is an increased requirement for agility that enables businesses to respond to change swiftly and effectively (Brown and Eisenhardt, 1997; Sambamurthy, Bharadwaj and Grover, 2003; Tallon and Pinsonneault, 2011; Appelbaum *et al.*, 2017; Orgeldinger, 2018). Teece, Peteraf and Leih (2016) propose that the ability to manage uncertainty through effective and swift sensing and response to opportunities and threats in the environment is a crucial feature of organisational agility. Dynamic capabilities have been applied reliably as a theoretical lens in IS research on IT and organisational agility (Tallon *et al.*, 2019) and, as found in the SLR of agility in IS, seem highly relevant to IS research on agility.

As an organisation's internal or external environment changes, teams and individuals are under pressure to adapt and evolve continuously to cope with the volatility (Teece, Peteraf and Leih, 2016). According to Teece, Peteraf and Leih (2016), the organisation can only address deep uncertainty if it is understood to be different from risk and if strong dynamic capabilities are fostered to enable organisational agility. Risk is more predictable and can,

thus, be managed through planning processes and risk management protocols (Teece, Peteraf and Leih, 2016).

The research articles included in the SLR strongly emphasised the agility characteristics of responsiveness, sensing, integrating and decision-making. In addition, agility is considered relevant to complex contexts and less relevant, or even superfluous, in stable contexts where sufficient expertise and knowledge exist to respond to events. The literature was synthesised to derive the characteristics of agility in IS, grouped into three overarching structural components: dynamic capabilities of agile IS, the nature of contexts relevant to agile IS, and the features of agile IS.

Interrelationships amongst the characteristics of agility were found in the IS literature, for example, between speed and reusability (Sambamurthy, Bharadwaj and Grover, 2003; Martini, Pareto and Bosch, 2012), learning and competence (Conboy, 2009; Tiwana and Kim, 2015; Crick and Chew, 2020), scalability and flexibility (Richardson *et al.*, 2014; Tallon *et al.*, 2019), reusability and coordination (Kwak, Lee and Lee, 2020), flexibility and complexity (Park, El Sawy and Fiss, 2017; Fischer and Baskerville, 2022).

The sense-respond framework proposed by Park, El Sawy and Fiss (2017) explains the complex relationships between the multiple elements of the environment, organisation and IT, and was adopted to position the characteristics of agility in IS within an agility-building process presented in Figure 4-3.

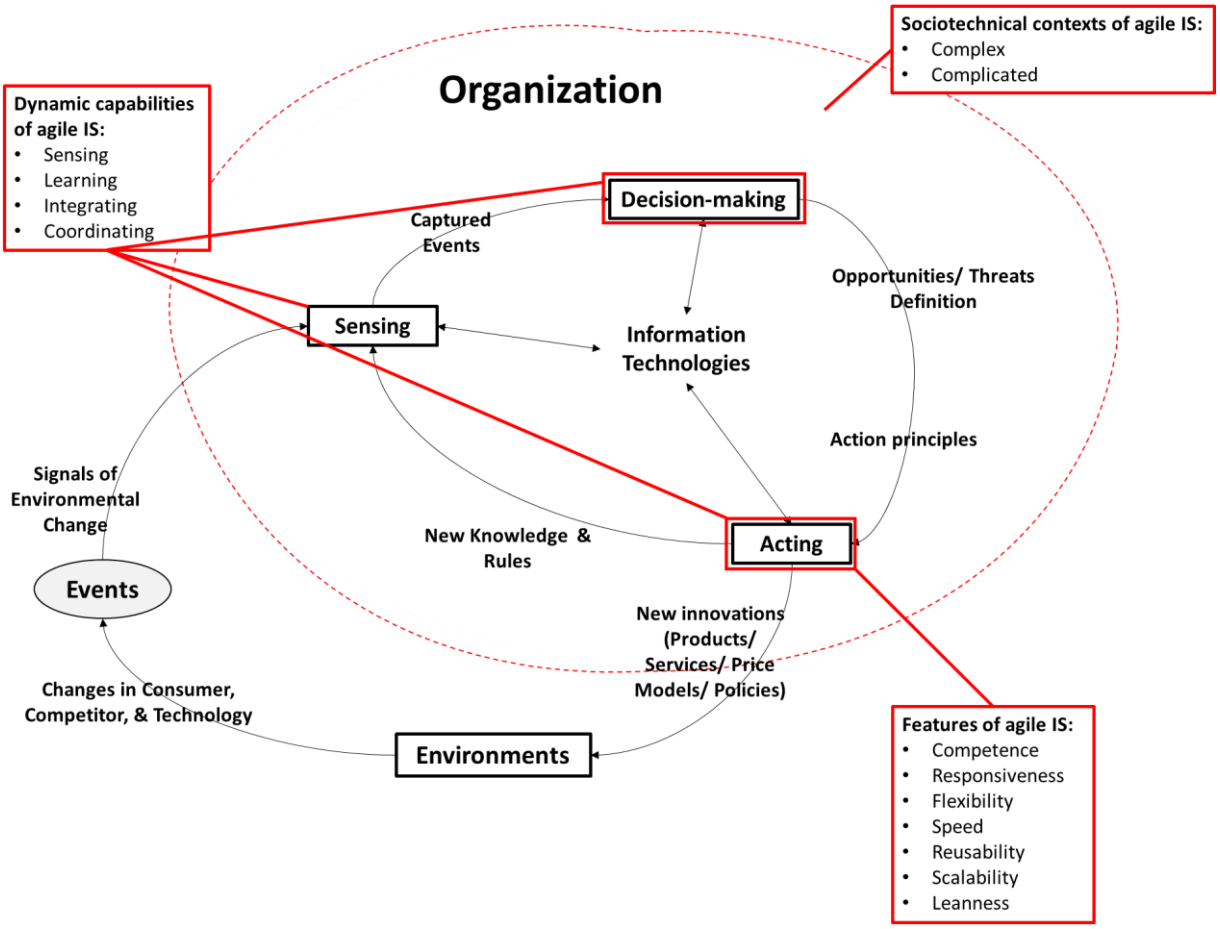


Figure 4-3: The characteristics of agility in IS mapped onto the Organisational Sense-response Process Loop (adapted from Park, El Sawy and Fiss (2017, p. 653))

To test the relevance of the characteristics of agility in IS to EDM, these characteristics were applied to a qualitative case study of EDM at BankGroup to develop the structural components of agile EDM as the product of this first DSR cycle, which will be discussed in the following section.

4.3 SQ1.2: THE CHARACTERISTICS OF AGILITY IN ENTERPRISE DATA MANAGEMENT

Having established the characteristics of agility in IS in the previous section, the second part of research sub-question one is addressed using a qualitative case study at BankGroup:

SQ1.2: What are the characteristics of agility in enterprise data management?

4.3.1 Method: A qualitative case study

The qualitative case study conducted for this research of agile EDM is described in Chapter 3, section 3.8 on page 69.

The following hypotheses were based on the characteristics of agility in IS, and provided the overarching concepts from which to develop the structural components of agile EDM:

- There is an existing requirement for agile EDM.
- Dynamic capabilities govern EDM activities: **learning** (while being productive and creating solutions), **sensing** (scanning for and making sense of opportunities to improve agility), **coordinating** (collaborating and working collectively towards a shared purpose) and **integrating** (combining work effort and outcomes for collective benefit).
- **Decision-making** is a core requirement for achieving EDM agility, requires sensing and precedes acting.
- The sociotechnical contexts of agile EDM are **complex and complicated**.
- Agility in EDM has recognisable features of **flexibility, responsiveness, competence, reusability, leanness, scalability** and **speed**.

4.3.2 Data collection

The strategy for data collection, presented in Figure 4-4, was framed by the characteristics of agility in IS as they would apply to EDM contexts, enabling the collection of rich data from the narratives offered by the interview participants. Larger formats of the interview agenda and question guide are provided in Appendix C.

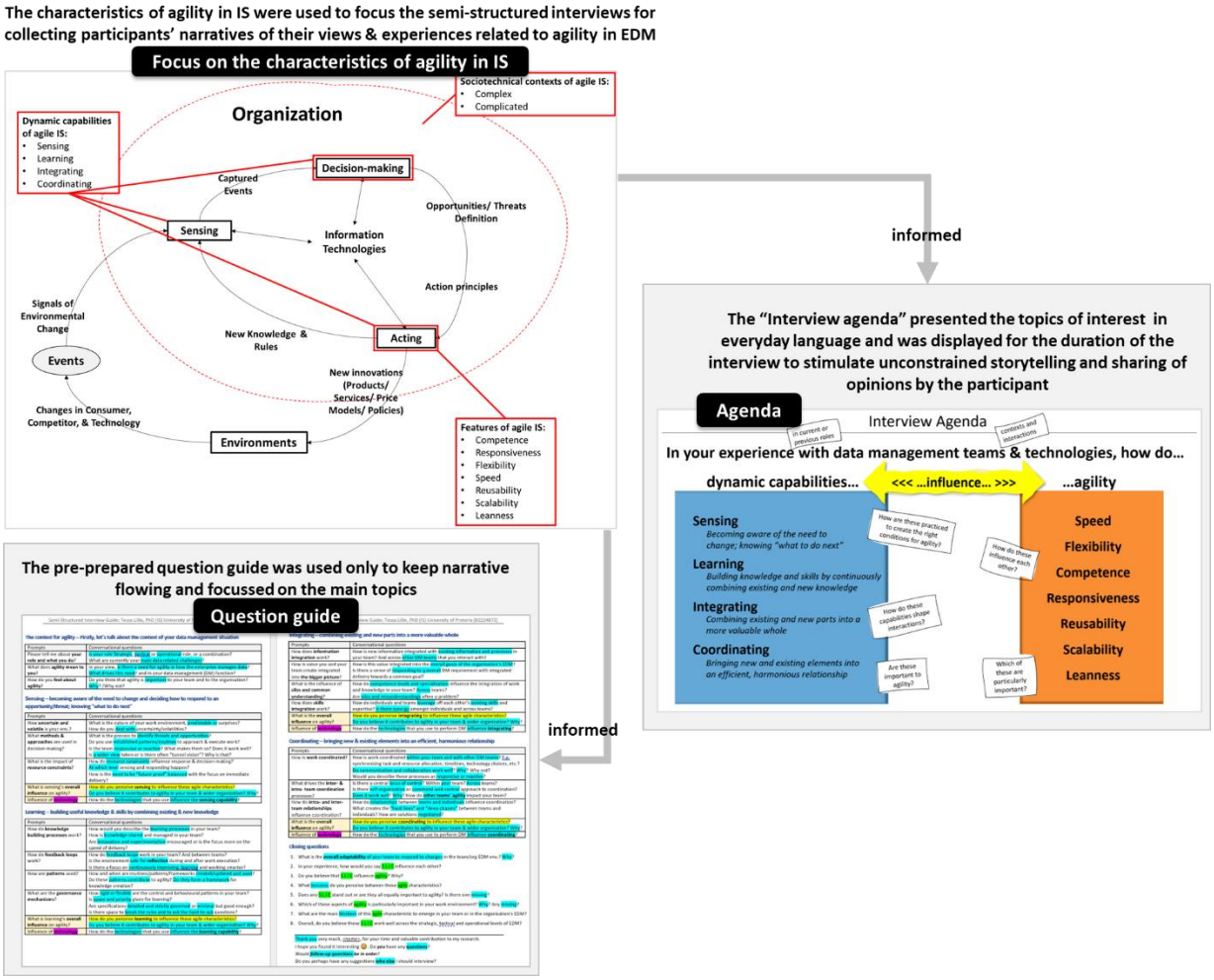


Figure 4-4: Strategy for collecting data management practitioners' narratives in semi-structured qualitative interviews

The data collection process is described in detail in section 3.8.4 on page 78. The initial aim was to interview 20 participants. However, as the data collection and analysis process unfolded, it became apparent from the large number of structural and dynamic components in the framework for agile EDM, that the data coding would be too dense, making it impractical to conduct 20 interviews. Additional data management experts were identified within the case study organisation by asking each interview participant at the end of the interview to recommend suitable candidates. Of the 16 potential interview participants who were invited, 14 participants accepted to partake in the study, and 17 hours of interview data were collected.

4.3.3 Data theming, coding and analysis

The units of analysis for investigating the structural components of agile EDM were based on the SLR findings that produced the agility characteristics in IS. The objective of the data theming process was to analyse the collected data by applying the characteristics of agility in IS to the collected data. Codes were created for the agility characteristics derived from the SLR of agility in IS which were adopted and defined for EDM contexts. Table 4-3 presents the codebook comprising the set of codes applied to the data using Atlas.ti. The codes were applied to the interview transcriptions for *a priori* coding of the data (Miles, Huberman and Saldaña, 2020).

Table 4-3: Codebook for characteristics of agility in EDM

Code	Code meaning
AGILITY: speed	Minimise delivery time of EDM value to the business
AGILITY: flexibility	Adapt to unforeseen changes in the internal or external EDM environment
AGILITY: competence	The ability to perform the EDM role/function effectively and efficiently
AGILITY: responsiveness	Respond under conditions of uncertainty in the internal or external EDM environment
AGILITY: reusability	Reusing an existing EDM pattern or artefact for a new requirement
AGILITY: scalability	Reusing an existing EDM pattern or artefact for a broader requirement
AGILITY: leanness	Minimise the amount of work to be done based on a fit-for-purpose or “good enough” approach
DC: sensing	Becoming aware of the need to change; knowing “what to do next”
DC: learning	Building knowledge and skills by continuously combining existing and new knowledge
DC: integrating	Combining existing and new parts into a more valuable whole
DC: coordinating	Bringing new and existing elements into an efficient, harmonious relationship
Complex	Complex contexts in EDM are unordered situations with high levels of uncertainty.

Code	Code meaning
Complicated	Complicated contexts in EDM are ordered situations with sufficient levels of certainty for experts and specialised technologies to solve EDM problems.

4.3.4 The requirement for agility in enterprise data management

The literature review of agile EDM in Chapter 2 concluded that there is a requirement for agility in EDM and that, despite its importance in practice (Marchand and Peppard, 2013; Tallon, Ramirez and Short, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019), there is a lack of scientific research on the topic (Wendler, 2016; Appelbaum *et al.*, 2017), and limited incorporation of how to achieve agile EDM in data management practitioner frameworks.

The examples in Table 4-4 are extracts from the qualitative interview data, confirming the requirement for agile EDM in a real-world context.

Table 4-4: Examples from the case study supporting the need for agile EDM

Unit of meaning (P# is the interview/participant number; T is the researcher's initial)	Support for the need for agile EDM
P1: There are quite a few challenges getting people onboarded into a highly complex environment is one of the challenges given the extreme requirement for speed and agility. So you can't transplant what has been learned in an informal way and haphazard way without [patterns] using some structured way of doing that and even then that will take time. The expectation these days is that you onboard almost at a fully functional level […] The biggest challenge today is to respond to market changes and changes in competitors and their strategies and all of that has data as its point of departure.	The complexity of BankGroup's environment requires extreme speed and agility, particularly from its data management specialists, because data is foundational to supporting organisational strategy and responding to changes in the organisation's environment.
T: Do you feel there is a need for agility in your current environment? *P3: Yeah, definitely* *T: What drives that do you think?* *P3: The need for it?* *T: Yes. Why is there pressure on the data management from an infrastructure perspective? Why does that need to be agile? Where's the pressure coming from for that?* *P3: Constant changes, projects coming along. changes in technologies, I guess.* *T: So technology as well as, when you said projects, meaning business demands?* *P3: Business demands, yeah. They're changing the way they're doing things all the time. everything is getting faster at this point in time, so we've got to be able to [handle it]*	Continuous changes in technologies and business requirements necessitate agility in data management activities.
T: In your view, is there a need for agility in how the enterprise manages its data? *P6: Without a doubt.* *T: okay and what drives that need?* *P6: So I think right now is there are so many moving parts that we stagnate rather than move forward because these moving parts become interdependent on each other and the way we currently approaching this is through trying to get through a project management life cycle. A project management life cycle is very linear so in order to understand what you want to achieve*	The requirement for agile EDM stems from the many moving parts and their interdependencies. Linear approaches are not working because changes continuously disrupt the understanding of what business requires and what needs to be done. Additionally, agility does not work if there is no overall coordination of

Unit of meaning (P# is the interview/participant number; T is the researcher's initial)	**Support for the need for agile EDM**
with a project you sort of ring-fencing to understand what everything does. And while we're trying to understand that or plan that there is all these emergent things that come up. Did I answer your question? *T: So it's clearly important to your team and to the organization? I mean the agility, there is a big need for it, but you also mentioned there are interdependencies and, yes, that's then exactly what makes it complex. How do you feel about agility? What are your frustrations and challenges with it?* *P6: So, agility can't just happen in one area. I'm trying to create agility in my area and the interlocking and other components of DataPlatform there's more of a linear or Waterfall approach. So I think that's my frustration with agility. Everybody needs to be doing it so make the whole process agile not just this sort of siloed approach that we currently have.*	agile processes and teams continue to work in silos.
T: Do you have a lot of uncertainty and volatility? *P10: There's always an element of that. I think you know there's always an element of not knowing what's going to change but always expecting change. So I think there's always that. and I think from where I sit, you know, the complexity is really in the dynamics that play out across the different areas in the group you know. so there's BankX there's BankY, there's BankZ. There are all these different, ok I know we moving into all these pillars now. We went from brands to segments to pillars, so there'a all these different organisational constructs and having to navigate that, sometimes, I think is because there's always change, you know, you have to find your way. But I think the ultimate goal in terms of just having alignment around how we manage our data, I think that stays the same. Like, you know, that's your ultimate goal. Things could move around as you getting there, but you just have to manoeuvre with the change and still try and achieve what you set out to do.*	There is a need to be able to navigate complexity resulting from constant change and the dynamics that play out across all the different business areas in BankGroup. Coordination of data management across all the business areas in the enterprise can act as a stabilising factor to enable the achievement of data management goals.
P14: As we are in a data driven world and not just in my area but I mean, it's all about data. The whole platform idea going forward with X, it's all about data. It's all about having the data, understanding the customer and knowing, before the customer knows what he wants, knowing what he's going to want, so that we can give them what they want right before they know they want it. So it's all about that. *T: It does encapsulate agility, the requirements for the platform?*	Agility in BankGroup's data management is required to serve its customers with available, high-quality data where and when they request it. BankGroup has made big investments in the ongoing implementation of a data platform to

Unit of meaning (P# is the interview/participant number; T is the researcher's initial)	**Support for the need for agile EDM**
P14: Absolutely! *T: I mean we have to have speed flexibility, I mean there's gotta be all of the things on the right [orange block on Interview Agenda]. Obviously the customer would want speed and leanness. they want to see what they need and they want to see it when the need it quickly and of course quality is really important?* *P14: Exactly.*	provide high levels of data-related capabilities.
T: In your view is there need for agility in how the organisation manages its data? *P13: Yes I think there is, but for me, what I've seen [with] agility in data management, it being a real game changer, is when it's driven by one or more crises. Right now, if you remember when we had the SteinH issue, we needed to see what our exposures were towards SteinH and everything else. Everybody at that time required data. So if you then applied your management principles across where you getting that data, who is the trusted source for that data away, where do you pull it from, where is the client [i.e.] which Department owns the client, how are you able to pull that in time. I think you can apply the speed the flexibility, everything at that particular point in time, provided you've done the work for organising your data.*	Even though agility in EDM is required, it is often driven by crises that arise and need quick responses from BankGroup's data management teams. However, the proper organisation of data is required to respond to crises in an agile manner.
T: In your view is there a need for agility in how the enterprise manages its data? *P7: So absolutely. I mean the problem, the thing that we find, is that all the components are moving very quickly. your regulatory framework can change overnight with a new like POPIA [Protection of Personal Information Act]. So I mean it kind of changes slowly in a sense, you don't get legislation coming around that impacts you heavily all the time. But you know all of a sudden you got RDARR [Risk Data Aggregation and Risk Reporting]. Now you've got to run around doing a whole bunch of things to support RDARR. Then you've got POPIA, you've got to run around doing a whole bunch of things to support POPIA. When the regulatory environment changes, so it doesn't change holistically all that quickly, but when something comes in then you have to adapt very quickly. Data in the organization is changing constantly. Massive, massive data is being generated all the time. new data, we've got to understand what it is. The people in the community change all the time. Always people leaving, new people coming in. How do we get those people upskilled? how do they get to learn what they need to know? That's another component and then same with the [technology] vendor.*	Although changes in regulatory compliance requirements affecting data are not that frequent, quick response and adaptation of data management processes are essential. Additionally, the volume of the organisation's data and the scale and relentlessness of changes and additions to the data requires data management to be agile.

Unit of meaning (P# is the interview/participant number; T is the researcher's initial)	**Support for the need for agile EDM**
T: In your view, is there a need for agility in how the enterprise manages its data? *P4: Because of the way this organization works the agility and flexibility is required and adaptability. I think adaptability is quite important for us as well along with agility, because otherwise what you find is, and I see it almost everyday with every project, yes, if you don't have your ducks in a row if these things aren't built in the people just leave the data management aspects behind and then they go, oh, we will do it later, and later never comes. So you need to be as agile as your development teams.*	The pace of agility in the organisation's data management must match that of ongoing data development, thus building data management requirements into projects instead of fulfilling those as an afterthought.
T: In your view is there a need for agility in how the enterprise manages its data? *P8: It's a difficult question to answer because of the size of the organisation. in my experience because you have 40,000 people at BankX, somewhere up there, anyway it's a lot. They all have varying degrees of understanding, so you have pockets of experts like the P4's of the world who understand everything like to death, which is fantastic as they drive an consult trying to align people. in terms of programme management that expectation [for agility] is not there. I don't ever have that expectation […] so if you're integrating programmes across BankGroup, which is normal, so if we take PCI [Payment Card Industry] as an example. that started off as 75 business units now we sitting at 12, I think that are actually implementing something. they all have varying degrees, firstly of understanding of what we're trying to do, and that's in the data protection space that we talking now. even down to how to manage a project was questionable. So your expectation needs to be that no one knows what on earth are you talking about, from a programme management perspective. So you gotta start off with basics and layer it up otherwise you lose people constantly. I mean PCI's got 275 stakeholders all with different contexts, all with different backgrounds, all with different objectives, all with different workloads on their plates.*	Although agility in EDM is required, it is not something that can be expected due to the size of the organisation, the large number of data stakeholders, the diversity in levels of understanding data requirements and misalignments in priorities and objectives amongst data project teams and team members.

4.3.5 Agility features in enterprise data management contexts

Participants mostly agreed with the definitions of the agility features but raised subtle differences depending on the context, for example, leanness in the context of IT decisions regarding redundant systems or building efficient design into the data practices:

> *P3: "Leanness, that's me talking about keeping it [the data] to a minimum. if you got old stuff there that's not necessary and it's just getting in the way of queries and taking up capacity that's just, yeah…[wastage]"*

> *P9: "To me leanness, is making the thing efficient, it's actually what we're doing in our data engineering disciplines."*

Participants were asked whether they believed the agility features were relevant to agility in EDM. The following two examples illustrate the relevance of the structural components of agility in IS to EDM contexts but indicate tensions between agility features and dynamic capabilities:

> *P12: "So speed is a difficult concept for me because it depends on what you're doing, and flexibility is really important because the stuff changes and you need to be able to change with it. Competence, yeah so if you don't have that nothing's gonna happen. Responsiveness, that's very much linked to speed, for me. Reusability again links to speed and potentially flexibility because if you have a component that fulfils a specific role and that component needs to change and it's reused and it won't have any impact downstream as it can be changed, then obviously you are flexible and everything using that will then automatically have [incorporate] the changes inside. Then your speed and responsiveness on that is linked. I think flexibility and reusability are probably the two most important things for me. then scalability, again is kind of linked to speed if the competence is good enough you should be able to scale. and then leanness is also very important because you need to try and keep the components as small as possible, as decoupled from each other as far as possible so that you stay lean in the different areas so it's not a big thing with a change we need to do."*

> *P5: "What we're more concerned with is are we able to promptly change in relation to changes in the internal external and environment and make sure that everything we're doing is giving value back to the business which is the kind of competence one. sometimes we don't mind throwing extra resources at it which is kind of the leanness and the reusability. We might repeat stuff more than we need to reuse it but as long as it's giving value people don't seem to mind it as much. So the concepts that business would put, or the characteristics which business would put more value on, would be speed, responsiveness, competence. [Then] flexibility not as much. I think I'll put that almost down to like a second bullet and then the last ones reusability and leanness."*

Agility in EDM stems from the ongoing activities of data management's social and technical agents, bringing the ongoing context to a boundary between what is knowable and what is unknown, presenting an opportunity to improve agility. However, such opportunities are not always utilised, as illustrated by this example of lost learning and reuse opportunities:

> *P10: "…because one of the other things is trying to achieve once data has become a product is reusing that data. at the moment we have a lot of people working in a very siloed way and so there's a lot of you know, they're sitting in a prototyping exploration space for a long time which may not necessarily be required. If they understood that someone's already figured this out for the data perspective, they don't have to figure it out again. and I think that kind of sharing isn't happening in the organisation because everybody is working on their own problems that they trying to solve and the sharing of things that have been solved using data, that to me isn't really happening in a constructive way yet."*

The dynamics whereby transitions between complex and complicated contexts occur could not be clarified using the methods in this analysis, which applied the codes for characteristics of agility in IS to the data. The findings from the TA of agility features in complex and complicated EDM contexts are presented in Figure 4-5.

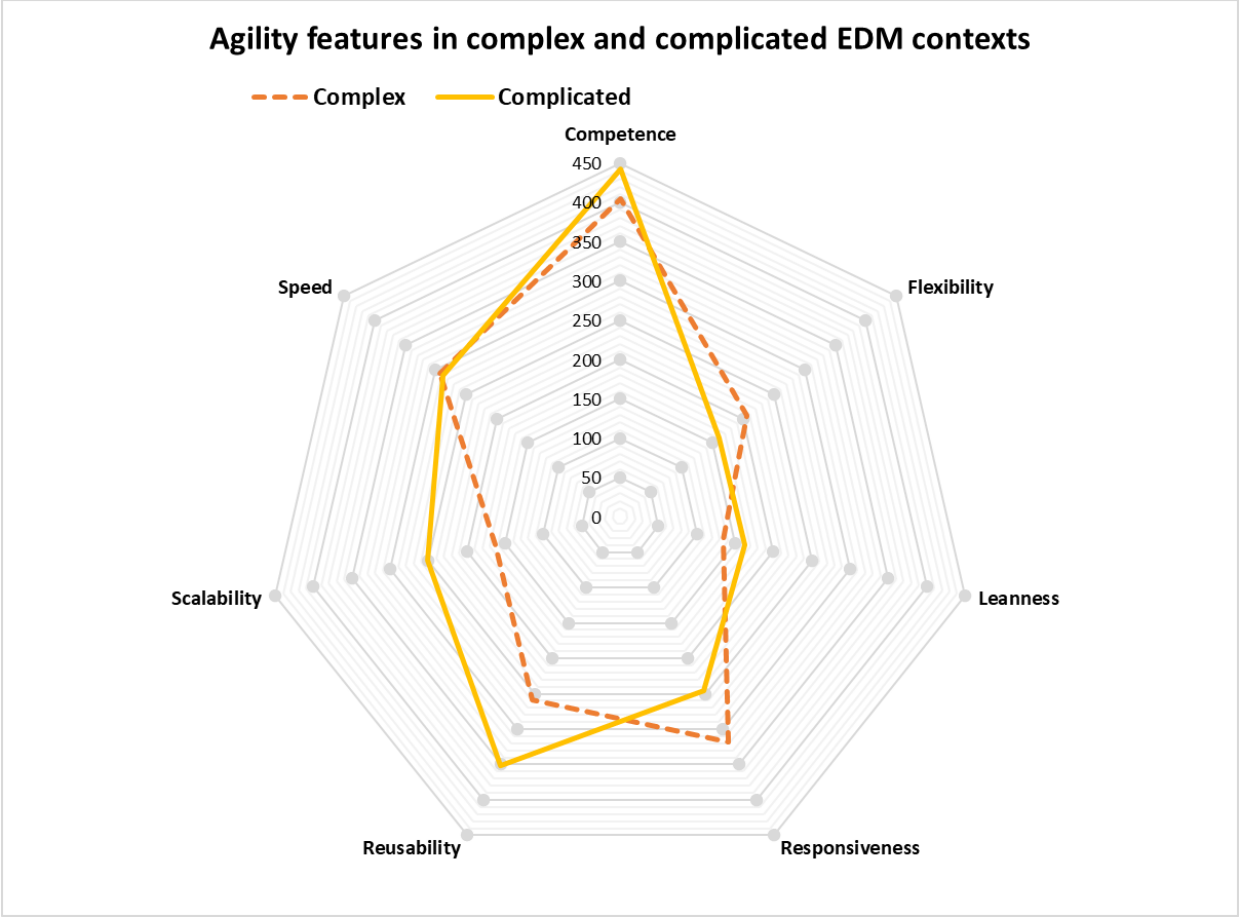


Figure 4-5: Agility features in complex and complicated enterprise data management contexts

4.3.6 Dynamic capabilities in enterprise data management contexts

Teece, Peteraf and Leih (2016) propose that robust dynamic capabilities, underpinned by knowledge, are needed to foster agility, which, in turn, is required to "address deep uncertainty". Most learning in organisations takes place in teams of interacting colleagues, and a collaborative culture where knowledge is freely shared and failures are tolerated is essential to knowledge creation in organisations (Marchand and Peppard, 2013). The following example from the case study indicated relationships between dynamic capabilities, such as misalignment of learning and coordinating capabilities across data management functions and business units resulting in diminished agility features. ("P#" is the interview/participant number; "(x:y)" provides x as the interview/participant number and y as the unit of meaning number within the transcribed text; "T" is the researcher's initial).

Unit of meaning (5:53): learning was an afterthought; IM (P4's team) are very innovative, but BU's are being trained in a classroom style and are slow to adopt	**Codes applied**
"P5: so as I said I think the education one was an afterthought and it should be more carefully planned out. They're trying to address it at the moment with very strong education campaigns but it's still very much, like I say, driven from a classroom type learning environment and less practical on-the-job type of training and encouraging innovation etcetera. *T: So is that in the information management team or also across into the business units?* *P5: so the information management team are very much innovation driven in my opinion. It's is more from the business unit side."*	**Dynamic Capabilities:** • DC: sensing • DC: learning • DC: integrating • DC: coordinating **Agility features:** • AGILITY: flexibility • AGILITY: competence • AGILITY: responsiveness **Context:** • Complex • Complicated

In the following example, coordination issues caused challenges with integration and reusability due to specialist teams working in siloes:

Unit of meaning (2:5): agility is harder to achieve when managing data changes; lack of integration and team coordination	**Codes applied**
"On a release night everything was automated, the regression testing ran, so it was basically just a process that got overseen but if we had data changes [that] complicated the whole process because now we had no	**Dynamic Capabilities:** • DC: sensing • DC: learning

way of automating the data deployment. So that was still sort of a manual thing and I think a lot of that …. The one issue was with the way that IT was managed in, is that the database administration still fell outside of our domain and that they were never interested in releasing that… *T: So they were "over there" and your were "over there" [no proper coordination to guide fruitful interaction]* *P2: …yeah, so that was a coordination issue."*	• DC: integrating • DC: coordinating **Agility features:** • AGILITY: expertise • AGILITY: reusability **Context:** • Complicated

In most cases, the participants' narratives confirmed that their EDM activities and interactions involved all four of the dynamic capabilities (sensing, learning, coordinating and integrating) in their experienced complex and complicated EDM contexts.

The co-occurrence data analysis was extracted from Atlas.ti and imported into Excel to produce visualisations of the findings. The dynamic capabilities of sensing, learning, coordinating and integrating were involved in most EDM situations explained by the interview participants. However, integrating and coordinating were emphasised more in complicated contexts, whereas sensing and learning were of higher importance in complex contexts (See Figure 4-6):

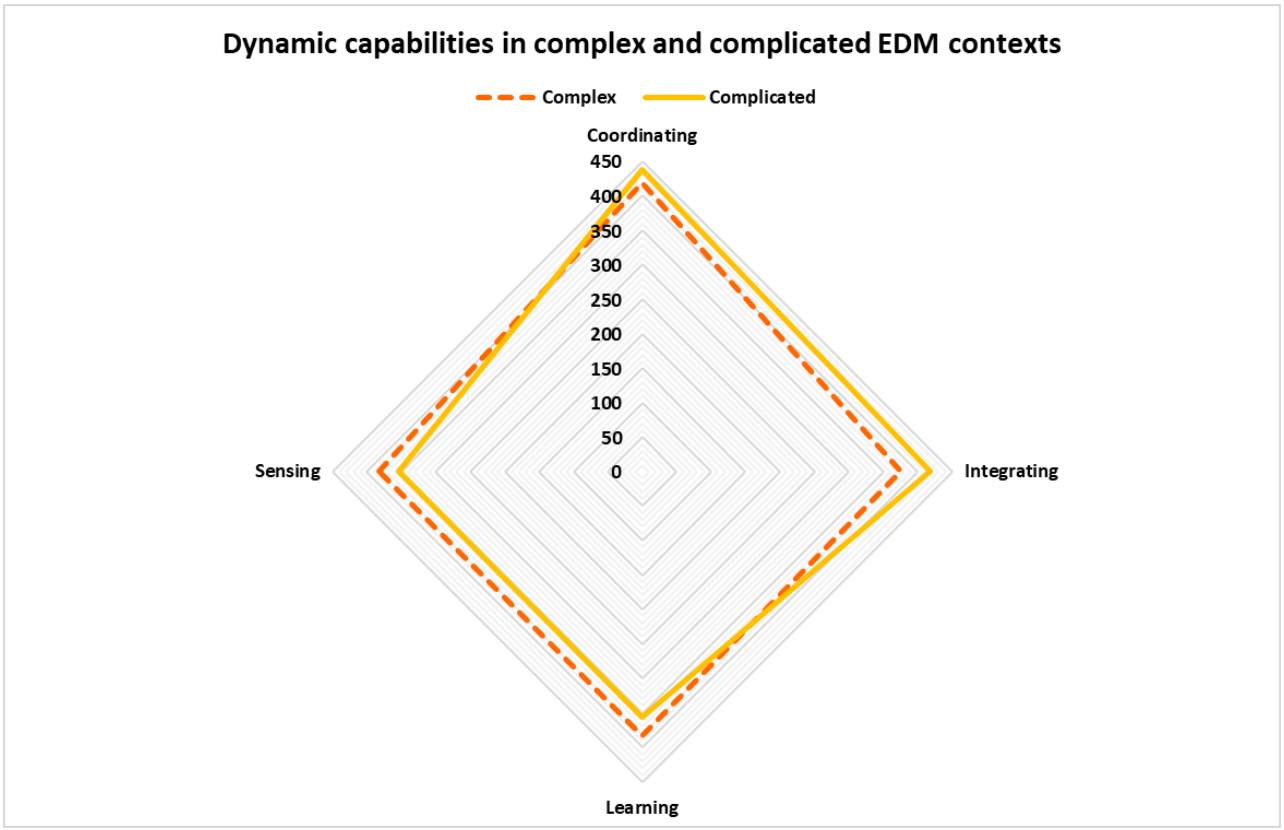


Figure 4-6: Dynamic capabilities in complex and complicated enterprise data management contexts

As presented in Figure 4-7, it was clear from the data to what extent (level of importance) each agility feature related to each dynamic capability. However, **how** agility was realised and **why** could not be directly explained by the structural components of agile EDM. Even though the relevance of the characteristics of agility in IS to agility in EDM was evident in the data, the structural components of agile EDM could not explain the dynamics of the relationships between the agility features and the dynamic capabilities in complex and complicated EDM contexts.

Table 4-5: Co-occurrences of dynamic capabilities and agility features

	Competence	Flexibility	Leanness	Responsiveness	Reuse	Scalability	Speed
Coordinating	**438**	177	157	291	316	223	299
Integrating	**405**	169	153	240	316	218	267
Learning	**363**	160	104	248	235	150	280
Sensing	**363**	162	103	249	235	152	278

Highest / lowest (by agility feature)

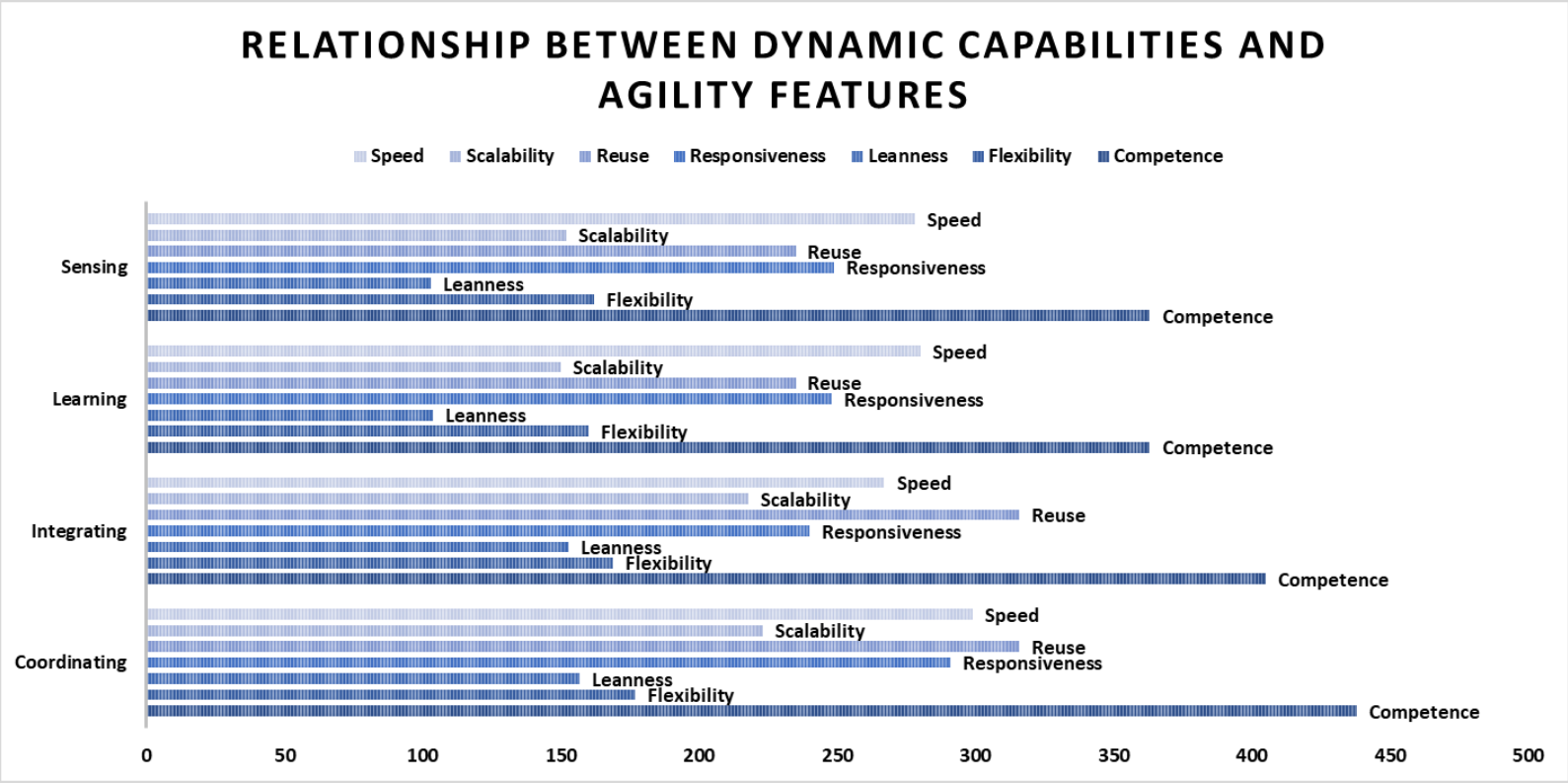


Figure 4-7: Relationships between dynamic capabilities and agility features

4.3.7 Decision-making in enterprise data management contexts

BankGroup's formal EDM decision-making capability is aimed at ensuring aligned, compliant and coordinated decision-making for data management. However, as illustrated by the following example, making decisions at the lowest possible level improves agility:

> *P5: "you need to put decision-making as lower level as what you possibly can while ensuring kind of alignment to the organizational objectives. So, it's a balancing act […] you also want to put a level of control over that and around that. The higher you put the level of the decision-making, the less or lower the speed to have that decision taken."*

From the data analysis, it is evident that the data management practitioners mostly had the autonomy to make decisions as they saw fit for the given situation based on their competence and guiding principles, which is illustrated in the example below:

> *P7: "We create simple solutions. Simplicity was one of our keys and a lot of what we do, we keep it simple. It is definitely one of our principles, if we're not keeping it simple, at least initially, like I mentioned earlier we got projects where I want to say we keep the first phase simple, use existing configuration capabilities and then we can see what we can deliver with that and then we can make a decision whether you want to add additional complexity on top of that and you know what I'm telling you half the time people say that's good enough we can work with that. Because they want something quicker as well they don't want to wait another six months to get everything. They're happy to say, okay we will sacrifice this a little bit of additional complexity because we now got a solution we can use immediately and then if we come back in six months' time or a year and we do want to add additional that is a new project."*

The following example presents a situation where autonomy to make decisions caused problems for coordination and integration.

> *P10: "Yes, that's exactly, but that's what I'm saying is like you know because what you find is like what I've seen happen is people would make decisions because you do have autonomous teams when you working in an Agile*

> *manner, and they can make certain decisions. so they've made a decision either not understanding the impact on the architecture, so they'll think it's like a really small thing, but it [then] actually ends up becoming a problem. Because that discussion doesn't happen right there and then and get debated and way forward worked out, you then end up with not implementing what was in mind because people have kind of changed things along the way instead of feeding back up saying we're having these issues and working out the best way to accommodate for those things. So I've also seen that happening."*

A decision that specific data was valuable could originate in a data management activity and subsequently become of strategic importance, as shown in the following extract from an interview:

> *P10: "You've understood how you can use that data. The minute you start using that data to make a decision, to build a machine learning model that does a prediction in terms of fraud or whatever the case may be, then that data has become valuable to the organisation and then you start managing it like you would any asset that you have in the organisation. For data to be managed that way means you need to understand what the data is, so how would you define that data, what rules are being applied to the data."*

As indicated in these examples, decision-making occurred at all levels of the EDM organisation. Decision-making at the work execution level was found to be more relevant to agility as the decisions were made in conjunction with taking the actions and not necessarily following a time-consuming, formalised decision-making process. Decision-making was most often associated with the dynamic capabilities of coordinating and integrating, as shown in Figure 4-8:

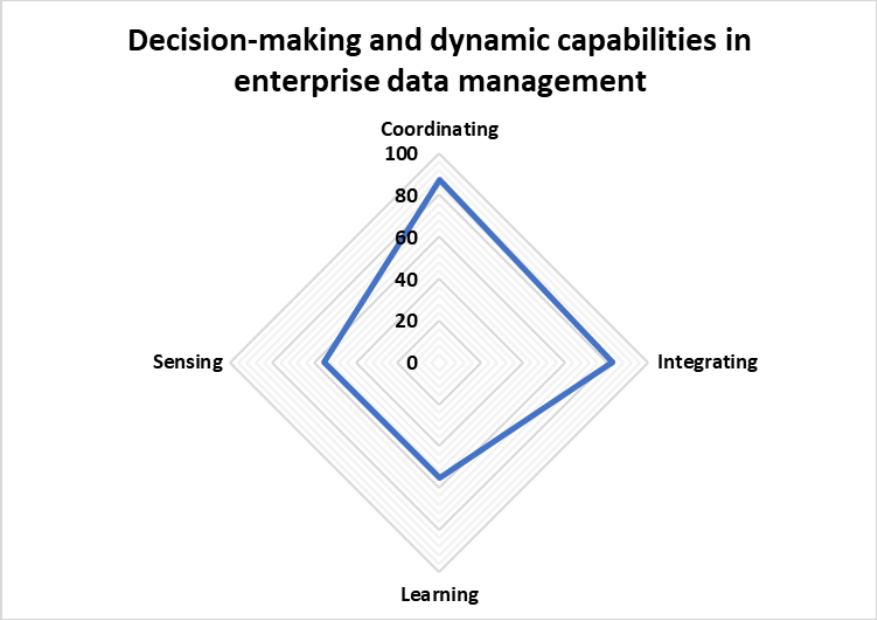


Figure 4-8: Decision-making and dynamic capabilities in enterprise data management

4.3.8 Agility in complex and complicated enterprise data management contexts

As supported by the following two participant statements, agility can only thrive in EDM situations when there is an extant requirement for agility in the ongoing context.

> *P13: "What I've seen [with] agility in data management, it being a real game changer, is when it's driven by one or more crises."*

> *P7: "Agility is being leveraged for things that I want to get done. The things that I put a priority on. Not always the things that maybe, if the organisation took a step back or if DataPlatform took a step back, and say we've got ten projects. They can't all be equally important because I can't work on two tasks at the same time. I have to prioritise: this task versus that task. Give me the list of one to 10. so yes, I suppose in a sense I do operate unconsciously in a very agile way. But it's out of necessity. There's not some organisational drive to be agile per se."*

Appelbaum *et al*. (2017) pointed out that deliberate efforts to amplify agility are generally unsuccessful. The results are artificial and inert when they do not relate to a context requiring nimbleness.

4.4 CONCLUSION — THE STRUCTURAL COMPONENTS OF AGILE ENTERPRISE DATA MANAGEMENT

In this first DSR cycle, the structural components of agile EDM were developed from the characteristics of agility in IS and answered the first sub-question of this research, including its two underlying questions:

Sub-RQ1:	*What* are the structural components of agile enterprise data management?
SQ1.1:	What are the characteristics of agility in Information Systems?
SQ1.2:	What are the characteristics of agility in enterprise data management?

The thematic analysis phase of the qualitative case study of agility in EDM at BankGroup achieved its objectives by confirming the hypotheses using the characteristics of agility in IS: (1) there is an existing requirement for agile EDM in the real world, (2) the dynamic capabilities of learning, sensing, coordinating and integrating are relevant to agility in EDM, (3) decision-making is a core requirement for achieving agility in EDM, requires sensing and precedes acting, (4) the sociotechnical contexts of agile EDM are complex and complicated, and (5) the agility features of flexibility, responsiveness, competence, reusability, leanness, scalability and speed are relevant to agility in EDM.

The qualitative analysis found that the participants agreed with the definitions of dynamic capabilities and agility features. However, nuances were found in the definitions depending on whether the context described by the interviewee was complex or complicated. The results could not explain how these differences emerged from the contexts, and further scientific grounding and empirical analysis of the qualitative data were needed to explain the dynamics of the structural components in real-world contexts.

The structural components of agility in IS applied to the case study data of agility in EDM contained influences on dynamic capabilities not yet contextualised for complex and complicated EDM contexts. Nor were the agility features, as characteristics of agility in EDM, differentiated based on whether the context was complex or complicated. The thematic analysis found that agility features were distinctive in complex and complicated contexts, falling into two categories: (1) repeatable agility, such as reuse and scalability occurring in complicated contexts, and (2) non-repeatable agility, such as responsiveness and flexibility

occurring in complex contexts. However, the dynamics of the complex and complicated EDM contexts needed to be understood before distinctions of characteristics' states could be attributed to the agility features and dynamic capabilities.

This section defined the structural components of agile EDM using the characteristics of agility in IS and a qualitative case study of agility in EDM at BankGroup. The output of this process was the artefact for DSR Cycle 1 – the structural part of a framework for agile EDM, presented in Figure 4-9.

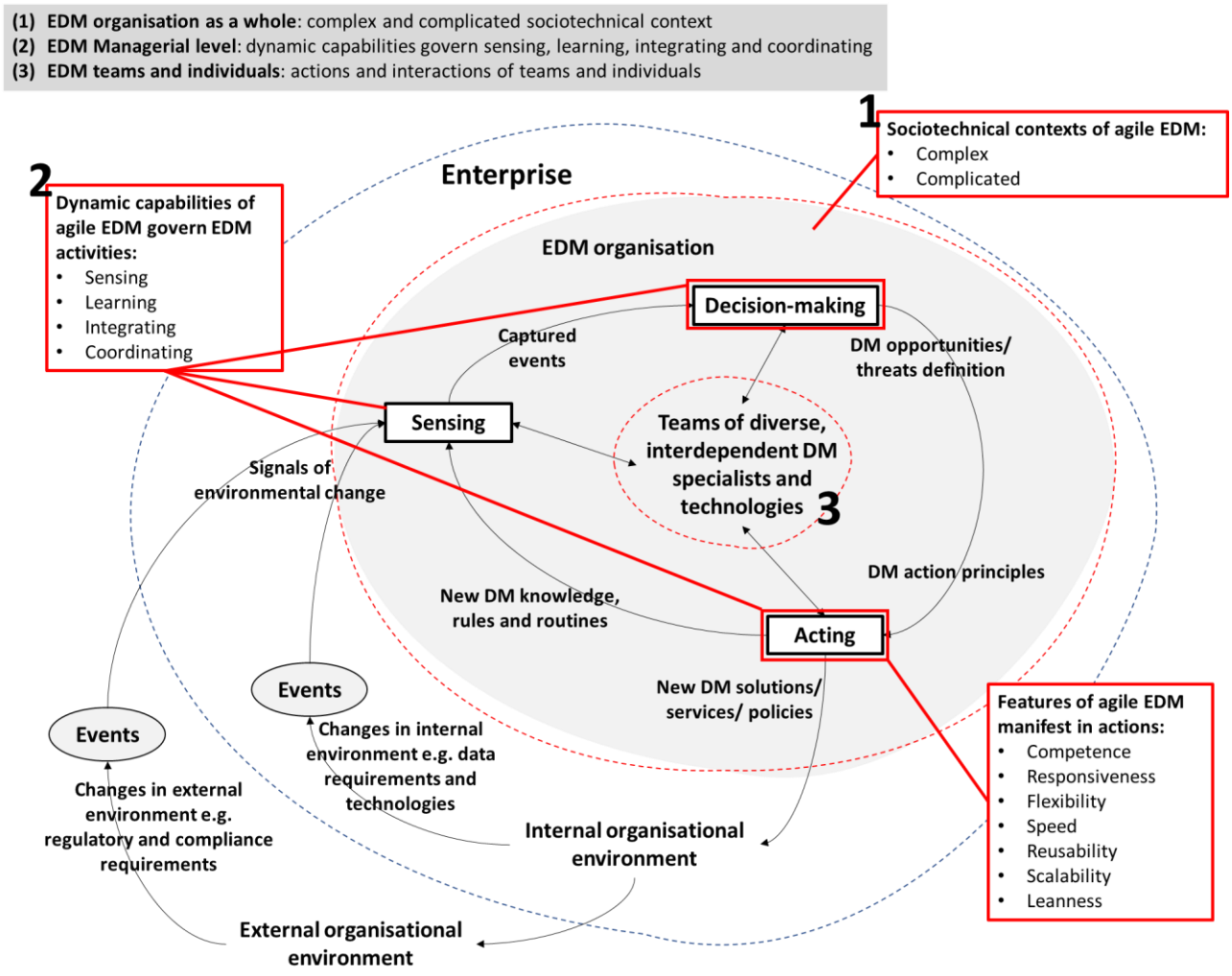


Figure 4-9: The structural part of a framework for agile enterprise data management (based on Pavlou and El Sawy (2011); Park, El Sawy and Fiss (2017, p. 653))

The data showed clear co-occurrences of dynamic capabilities and agility features, and the initial coding scheme was refined during the thematic analysis phase. However, it was apparent from these initial findings that the structural components of agile EDM required

further development as it could not yet explain how the mechanisms for achieving agility work between the complex and complicated domains in EDM.

The characteristics of agility in EDM were found to have interactions and “causal” relationships, for example, between “learning” and “competence”, and “speed” and “flexibility”. In addition, agility failed for underlying causes or influences that could not be explained by the characteristics of agility in EDM or the three overarching categories alone. Furthermore, the characteristics of agility in EDM could not explain how the complex and complicated sociotechnical contexts influenced dynamic capabilities and agility features. Therefore, how agile EDM “works” could not be explained by the structural components of agile EDM alone.

This first DSR cycle produced the structural components of agile EDM as a first step towards constructing a framework for agile EDM. The structural components could not address the interactions and relationships between the characteristics of agility in EDM and, thus, raised the second sub-question of this study, “what are the dynamic components of agile EDM?”, which is addressed in the second DSR cycle in the next two chapters.

5 DSR CYCLE 2 – PART I: THE DYNAMIC COMPONENTS OF AGILE ENTERPRISE DATA MANAGEMENT

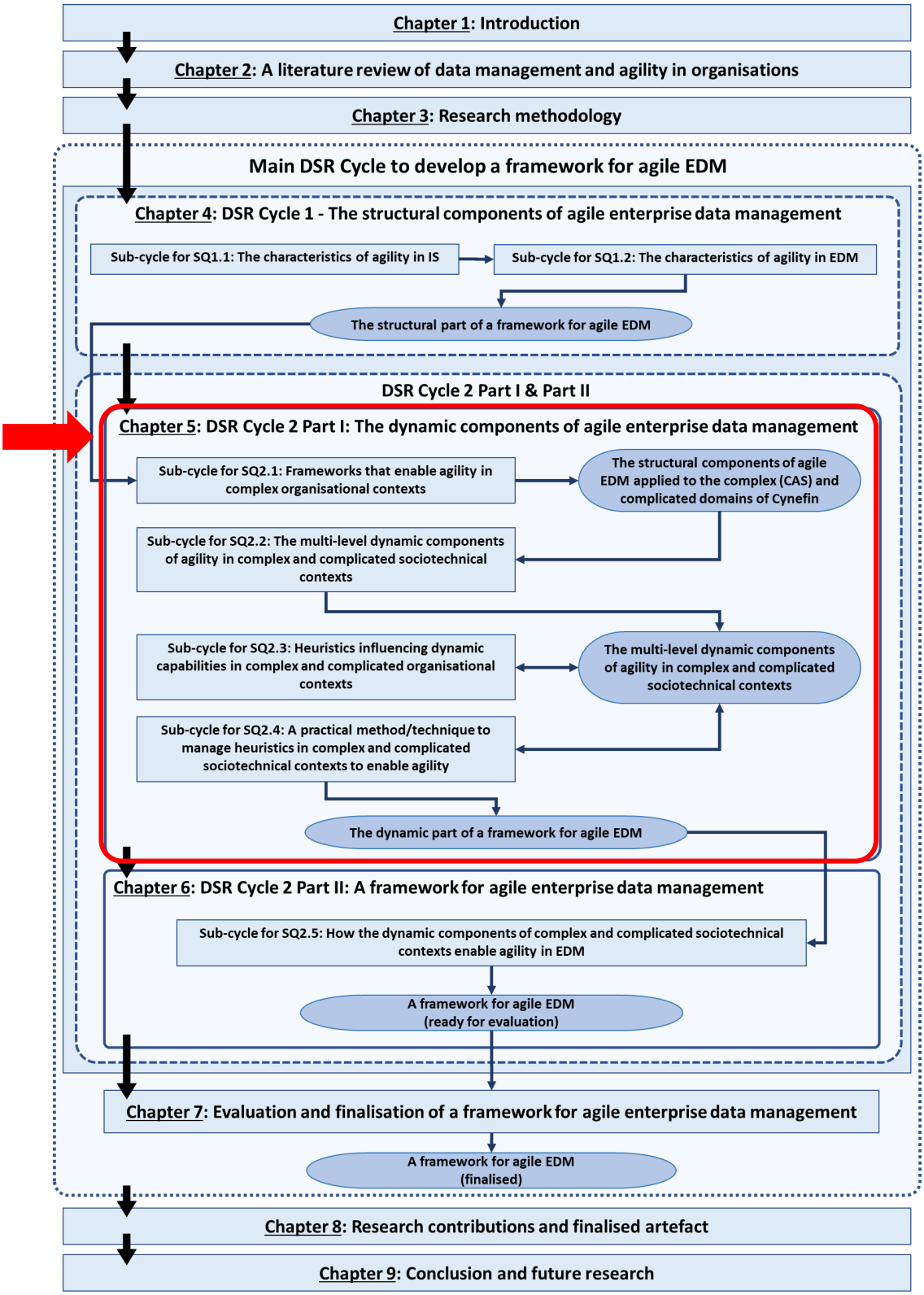


Figure 5-1: Chapter map — Chapter 5

The literature review in Chapter 2 and the findings of the case study in DSR Cycle 1 concluded that EDM is an organisational structure comprising team structures for the different data management domains and oversight functions, collectively serving the data requirements of the enterprise. Therefore, EDM is subject to the enterprise's context, and the data management teams are all subject to the sociotechnical context of the EDM organisation within the enterprise. Agile EDM (at the strategic level) and agility in EDM (at the managerial and activity levels) are interrelated. In addition, the data management agents of EDM, the teams of specialists and specialised technologies, are diverse and interdependent. Nonetheless, the structural components of agile EDM developed in the first DSR cycle could not explain the dynamics of these interrelationships and interdependencies.

According to Legner, Pentek and Otto (2020), data management is an integrated domain of interdependent sociotechnical data governance and management functions. Peppard (2018) challenges the conventional view that the information systems organisation exists as a separate organisational unit and proposes that it is, instead, a pervasive construct within the enterprise. Managing an enterprise's data should not be viewed simplistically as teams of humans coordinating the various activities of managing data and then merely using the data management technologies to implement the data requirements for the business. The process of providing the business with valuable information and knowledge moves and curates data along a continuum of increased relationships, structures and complexity far removed from its original state (Douglas and Peppard, 2013; Marchand and Peppard, 2013). To reap benefits from their data assets, organisations must continuously reorganise to conciliate work practices, social and technical capability structures, and stakeholder interests (Günther, Mehrizi, Huysman and Feldberg, 2017).

Sensing and responding capabilities are central themes for agility in strategy, management, and IS literature (Tallon *et al.*, 2019). Decision-making capability and dynamic capabilities enable organisational agility by enabling managers in organisations to sense, decide and act in high-speed predictable and unpredictable contexts (Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016; Park, El Sawy and Fiss, 2017). The development of the structural components of agile EDM in DSR Cycle 1 concluded that (1) decision-making and dynamic capabilities are capabilities that are required to achieve agile EDM, (2) agility features

manifest in the actions of data management agents, and (3) the sociotechnical context of agile EDM is complex and complicated.

This study adopted the definition of a “framework” as being both a model and a method that describes and explains the “what” and the “how” of a practical solution to the real-world problem of achieving agile EDM. In this chapter, Part I of DSR Cycle 2, the “how” or dynamic part of a framework for agile EDM was developed based on the structural part of a framework for agile EDM and the findings and synthesis of two SLRs that answered the first four sub-questions of DSR Cycle 2.

An SLR of existing scientific frameworks that enable agility in complex organisational contexts addressed SQ2.1. The second sub-question was answered by synthesising the findings of DSR Cycle 1 and SQ2.1, including deeper scientific explanations of the multi-level dynamics of complex adaptive systems (CAS), dynamic capabilities and decision-making in complex and complicated sociotechnical contexts. To answer SQ2.3, an SLR was conducted to explain how heuristics influence dynamic capabilities. Building on the findings of DSR Cycle 1, and the first three sub-questions, abductive reasoning was applied to answer SQ2.4. Answering these four sub-questions produced the dynamic part of a framework for agile EDM:

Sub-RQ2:	What are the dynamic components of agile enterprise data management?
SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?
SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?
SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?
SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?

The dynamic part of a framework for agile EDM, which was produced in this chapter, was applied to a qualitative case study to test the dynamic components of agile EDM in the real world in the next chapter (Part II of DSR Cycle 2), producing a framework for agile EDM as the output of DSR Cycle 2, ready for the artefact evaluation phase of this study.

5.1 SQ2.1: FRAMEWORKS FOR ENABLING AGILITY IN COMPLEX ORGANISATIONAL CONTEXTS

EDM is a complex sociotechnical organisation within the enterprise and thus presents a complex organisational context. For over 20 years, strategy, management, and IS literature have taken an accordant perspective on organisational agility as a cohesion of sensing and responding capabilities (Tallon et al., 2019). IT can support organisational agility by supporting the three strategic tasks of sensing, decision-making and acting in response to rapid changes and uncertainty in the organisational environment by reconfiguring organisational resources (Park, El Sawy and Fiss, 2017). Agility is of strategic importance to organisations (Pavlou and El Sawy, 2011; Teece, 2016; Park, El Sawy and Fiss, 2017) and is required from the strategic level of the enterprise down through to the IT organisational structures within the enterprise. In other words, enterprise agility is enabled by IT agility (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Tallon et al., 2019). Therefore, agility in the sensing, decision-making and acting capabilities of the complex sociotechnical contexts of EDM is required to support overall enterprise agility.

As highlighted in the research design in Figure 5-2, a systematic literature search, review and synthesis of existing scientific frameworks, models and methods that enable agility in complex organisational contexts answered the first sub-question of DSR cycle 2:

SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?

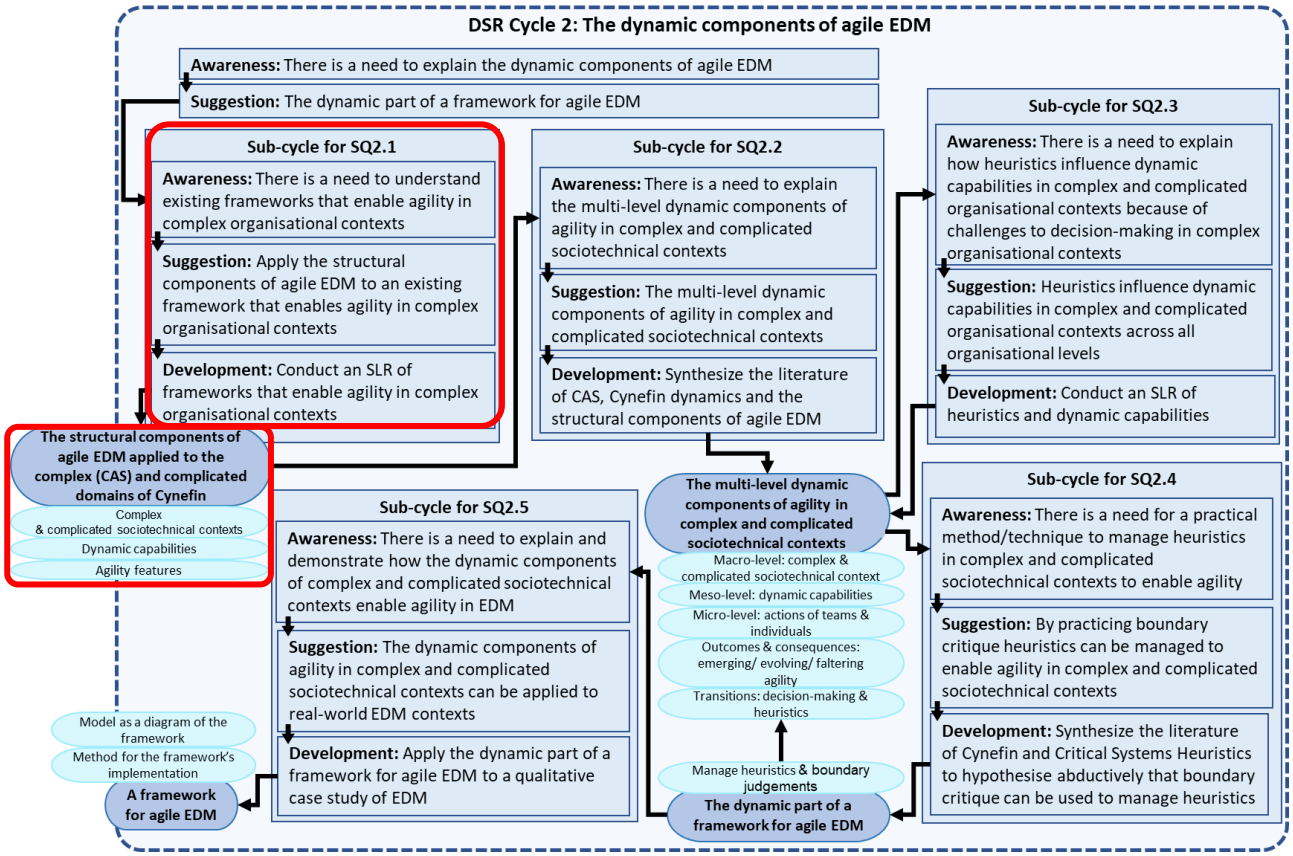


Figure 5-2: Research design — sub-cycle for SQ2.1

5.1.1 Method: A systematic literature review of frameworks and models enabling agility in complex organisational contexts

The systematic literature search and review of frameworks, models, methods and strategies that enable agility in complex organisational contexts was directly shaped by the keywords contained in SQ2.1: “framework”, “model”, method”, or “strategy” (to find implementable constructs), “sense” and “respond” (implies agile capabilities in organisations), “complexity”, “uncertainty” or “unpredictability” (all relate to complex organisational contexts). The SLR process was based on the guidelines proposed by Okoli (2015) and is presented in Figure 5-3.



Figure 5-3: Systematic literature review process to find existing frameworks, models, methods and strategies for enabling organisational agility (based on Okoli, 2015 (pp. 883–884))

5.1.2 Analysis, synthesis and findings

The articles found through the SLR process were read and summarised based on the concepts relevant to how agility can be achieved in complex organisational contexts. Adopting the concept-centric approach of Webster and Watson (2002), concepts were identified to create a conceptual structure to analyse the articles' relevance to the research question's topic: (1) the construct's objectives, (2) the construct's theoretical foundations, (3) the construct's applicable contexts, (4) the construct's components, and (5) the construct's scope of application. Table 5-1 presents a summary of the findings in a concept matrix, including the main points from each article, which have been highlighted to emphasise their importance to this study of agile EDM.

Table 5-1: Frameworks, models, methods and strategies for enabling agility in complex organisational contexts

Articles	Construct type	Construct objectives	Theoretical foundations	Contexts to which the construct applies	Construct components	Scope of application for the construct
Ramnath and Landsbergen (2005)	Strategy	**Enable unified IT and organisation sense and respond strategy.**	Evolutionary theory of economic change; Public Administration Theory	Change, uncertain demand, and reduced budgets	Strategic plan and execution process	**IT and city government departments, taking a "fractal" view of "organisations-within-organisations"**
Mathiassen and Vainio (2007)	Framework	Approach to understanding dynamic capabilities in small software firms; proposes principles for managers to apply the framework.	**Dynamic capabilities**	**Highly complex and turbulent**	**Capabilities and principles for sense-and-respond**	Small software firms
Snowden and Boone (2007)	Framework	**Enable leaders at any organisational level to sense and decide on appropriate action in a prevailing operative context.**	**Complex systems**	**Complex, complicated, clear & chaotic**	**Describes dynamics between complex, complicated, clear and chaotic domains with awareness of the context**	**Contextualised application to any organisation/ part of an organisation**
Collins, Worthington, Reyes and Romero (2010)	Framework	Enable a deeper understanding of relationships between knowledge management capabilities, supply chain technology investments, and overall firm performance enabling managers to effectively adapt to changing environments.	Knowledge management	Supply chain complexity	Resources, keys to effective utilisation, operational result, strategic result; output measures	Firms with complex supply chains

Articles	Construct type	Construct objectives	Theoretical foundations	Contexts to which the construct applies	Construct components	Scope of application for the construct
Strachan (2011)	Strategy	Question strategy as being underpinned by an actionable plan providing long-term predictability. Avoid conflating strategy with grand-strategy.	Theories of strategy and contingency	Uncertainty	**Infinite flexibility; embrace contingency and long-term interests; strategy requires context and awareness of the effect on stakeholders**	Military and national security contexts
Thiel, Bagdasarov, Harkrider, Johnson and Mumford (2012)	Model	A sensemaking model that enables leaders to make ethical decisions.	**Sensemaking**	**Complex and high-stakes situations**	**Sensemaking strategies based on personal, situational, and environmental constraints**	**Leadership in organisations**
Liu (2013)	Model	Enable sustainable competitive advantage by integrating manufacturing strategy, transformational leadership, and technology.	Resource based view of the firm	**Dynamic, complex, and turbulent business environments**	Manufacturing strategy, technology strategy, dynamic decisions, sense & respond, transformational leadership	Manufacturing operations
Brookfield (2018)	Framework	Enable risk mitigation through adaptation of the organisation from the interactions between accounting technologies and risk as an environmental factor.	Theory of the firm	Uncertainty as a general representation of risk; complexity	Nature of the firm, accounting as risk management IT, transaction cost economics	Financial risk management in organisations
Tilabi *et al.* (2019)	Tool	**Enable decision-making and strategy-making about firms' technologies for product and process development.**	Miles and Snow Typology; Resource based view of the firm; Competitive advantage	Uncertainty and turbulence	**Prospector, analyser, defender, and reactor. Responsiveness, agility, leanness, and flexibility. Quality, time, and cost.**	High-tech startup organisations in large mass-production industries

Articles	Construct type	Construct objectives	Theoretical foundations	Contexts to which the construct applies	Construct components	Scope of application for the construct
Øvrelid and Sanner (2020)	Model	Lightweight IT extends digital infrastructure and enables organisations to sense and respond continuously to the effects of process innovation.	Dynamic complexity in information infrastructures	**Complex organisational settings**	**Sense-able process innovation to digitalise, visualise, manage, and re-evaluate information infrastructures**	General hospital as a complex organisational setting
Lane, Clay-Williams, Johnson, Garde and Barrett-Beck (2021)	Framework	Enable pragmatic leadership with a sense-making framework to "act-probe-sense-respond" in time-critical crisis situations.	**Complex systems**	Volatility, uncertainty, chaos, and ambiguity (VUCA)	Describes act-probe-sense-respond actions in chaotic healthcare contexts	Complex and time-critical medical emergency scenarios
Heino and Kalalahti (2021)	Framework	**Enable understanding of experts' decision-making in critical situations, considering the potentially detrimental effects of relying on pre-established procedures.**	Naturalistic decision making; Cognitive task analysis	**Complexity, uncertainty, and ambiguity**	Notice unusual circumstances, identify the bigger picture, make decisions, improvise to overcome obstacles, start immediate action	Expert professional first responders in unexpected situations
Mero and Haapio (2022)	Model	**Enables effectual decision-making in executing dynamic capabilities under unexpected uncertainty.**	**Effectuation; Dynamic capabilities**	Unexpected uncertainty	**Describes activities for reconfiguration of organisational capabilities and processes**	Business-to-business firms

The systematic search found scientific articles that described frameworks, strategies and models proposing practical ways to support and enable organisational sense and response capabilities in complex, uncertain or unpredictable situations. The articles were synthesised to identify which construct could be adopted by this study to explain the dynamics of how to achieve agile EDM.

Construct objectives

The objectives of each article's proposed construct were assessed for their relevance to the structural components of agile EDM and their potential generalisability to complex and complicated EDM contexts. The construct proposed by Ramnath and Landsbergen (2005) aims to enable a unified IT and organisational sense and response strategy. The Cynefin framework proposed by Snowden and Boone (2007) enables leaders at any level in the organisation to sense the nature of the ongoing context and decide on an appropriate course of action. Tilabi et al. (2019) proposed a practical method whereby decision- and strategy-making about technologies for product and process development can be enabled in firms. The framework suggested by Heino and Kalalahti (2021) enables the understanding and decision-making of experts in complex critical situations, but warns of the risks when relying too heavily on pre-established procedures. The model developed by Mero and Haapio (2022) proposes to enable effective decision-making in executing dynamic capabilities under conditions of unexpected uncertainties. The other eight articles proposed constructs applicable to a narrow scope of organisational situations such as small software firms, supply chain technology investments, time-critical medical emergencies, and manufacturing strategy.

Theoretical foundations of the construct

The theoretical foundations of the constructs proposed by the reviewed literature were considered for their relevance to the structural components of agile EDM and their potential to explain the dynamics for achieving agility in complex organisational contexts, such as EDM. In the first DSR cycle, dynamic capabilities and complexity were identified, indicating foundational theoretical considerations for the dynamic part of a framework for agile EDM. The framework proposed by Mathiassen and Vainio (2007) is underpinned by dynamic capabilities and their use in small software firms for managers' effective sense-and-respond capabilities. The Cynefin framework proposed by Snowden and Boone (2007) is

underpinned by complexity theory and systems thinking. Lane et al. (2021) propose a variation of Snowden's Cynefin framework for its specific application to chaotic medical emergencies. The sensemaking model proposed by Thiel et al. (2012) is grounded in Karl Weick's sensemaking theory, enabling organisational leaders to make ethical decisions. Mero and Haapio's (2022) model is founded on the theories of dynamic capabilities and effectuation, aiming to enable business-to-business firms to navigate unexpected uncertainty. The other theories applied in the constructs reviewed were less relevant to the structural components of agile EDM.

Contexts for construct application

The search terms applied in the boolean expression included "unpredictability" and "uncertainty" as near-synonyms of "complexity". However, seven of the articles found did not refer specifically to complexity, and terms such as "turbulent", "volatility", "chaos" and "ambiguity" were also used. In some cases, the context to which the construct was applied was narrowed down to a specific scope, thus less generalisable, such as reduced budgets (Ramnath and Landsbergen, 2005), supply chain complexity (Collins et al., 2010) and unexpected uncertainty (Mero and Haapio, 2022). The framework proposed by Snowden and Boone (2007) differentiates between complex, complicated, clear and chaotic domains within which leaders at all levels of an organisation must make sense of the operative contexts to decide and respond appropriately.

Construct components

Most of the constructs reviewed provided descriptive representations, including strategic plans and process steps (Ramnath and Landsbergen, 2005), capabilities and principles (Mathiassen and Vainio, 2007), required resources and measurable results (Collins *et al.*, 2010), sensemaking strategies based on constraints (Thiel *et al.*, 2012), and activities for the reconfiguration of organisational capabilities and processes (Mero and Haapio, 2022). Snowden and Boone's (2007) Cynefin framework specifically described the dynamics of how to navigate the complex, complicated, chaotic and clear domains of organisational contexts.

Scope of application of the construct

The constructs proposed by the authors of each of the 13 articles reviewed were, in most cases, applicable to a specific organisational context, for example, military and national

security contexts (Strachan, 2011), high-tech startup organisations in large mass-production industries (Tilabi *et al.*, 2019), business-to-business firms (Mero and Haapio, 2022), and firms with complex supply chains (Collins et al., 2010). Ramnath and Landsbergen (2005) provide an interesting "fractal" perspective of "organisations-within-organisations", which is similar to the perspective of EDM as an organisation within the enterprise. However, the construct that they propose is a strategy that is idiosyncratic to IT and city government departments. Of all the constructs reviewed, the Cynefin framework proposed by Snowden and Boone (2007) had the widest scope for contextualised application to any type of organisation or any part of an organisation.

5.1.3 The Cynefin framework

Having considered the objectives, theoretical foundations, contexts, components and scope of application for each of the constructs reviewed in the SLR, the Cynefin framework proposed by Snowden and Boone (2007) offered the most relevant and generalisable explanation for how sensing and responding, which are the key capabilities of organisational agility, can be enabled across all levels of complex and complicated organisational contexts.

The Cynefin framework's development originated from the knowledge management field and has evolved over the past 21 years (Snowden, 2021a, pp. 22–25) through broad application in scientific research and practice, including health care, management, strategy, and IS. In David Snowden's words: "[t]here is no single academic discipline behind Cynefin — it interweaves the sciences and the humanities" and is an entanglement of theory and practice that is, at its heart, a decision support framework (Snowden, 2021a, p. 34).

Cynefin is a decision support framework, not a model or a method, that enables organisations to sense and respond effectively in complex, complicated, clear and chaotic contexts (Kurtz and Snowden, 2003; Snowden and Boone, 2007; Snowden, 2021c; Snowden and Rancati, 2021). Cynefin describes three primary types of systems: Ordered, Complex and Chaotic/un-ordered, presented in Figure 5-4. An ordered system describes the clear and complicated domains (Snowden, 2021c, p. 59). When actors in an organisational context are cognisant of the nature of the ongoing situation in terms of the domains proposed by the Cynefin framework, they can critically assess when and how to appropriately adopt or adapt methods and approaches for favourable outcomes (Snowden and Rancati, 2021).

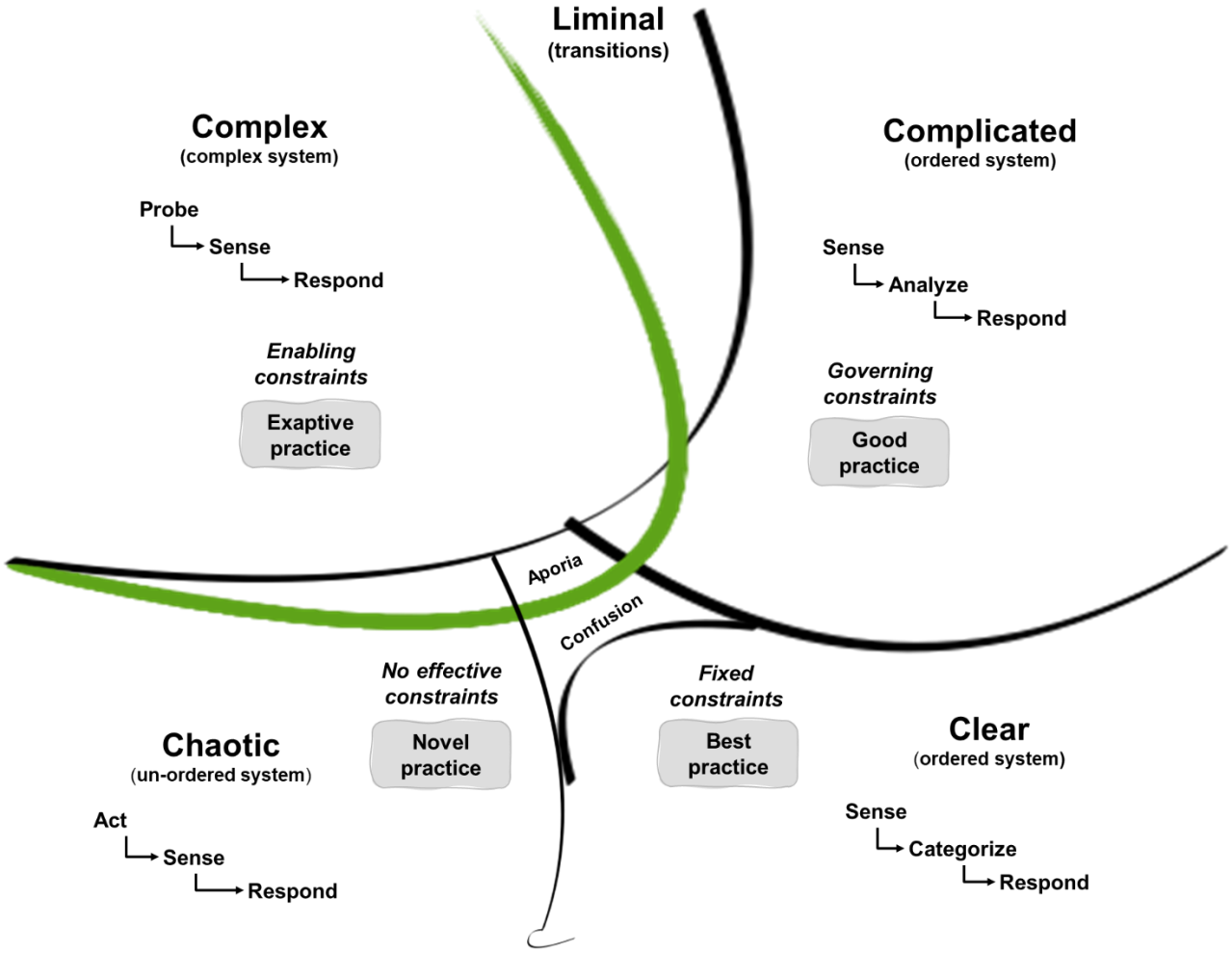


Figure 5-4: The Cynefin framework (reproduced from Snowden (2021c, p. 58))

Complex and complicated organisational contexts

Systems involving human agents are invariably complex, comprising many interacting agents who can have multiple identities depending on their role in the unfolding context (Snowden, 2002). Kurtz and Snowden (2003) define complicated contexts as the domain of "known unknowns" where experts can solve problems. In contrast, they define complex contexts as the domain of "unknown unknowns", where uncertainty hinders expert approaches to solutions.

Systems theory is suitable for understanding complicated contexts but cannot be applied to complex situations (Turner and Baker, 2019, p. 15) because "wicked problems", problems for which no "right" or "wrong" answer exists (Rittel and Webber, 1973), resist linear approaches to solutions (Kurtz and Snowden, 2003) and thus, cannot provide a theoretical

basis for complex EDM contexts. Complicated problems can be solved by experts and specialised technologies (Kurtz and Snowden, 2003). Even so, there is no sharp demarcation separating that which is complicated and that which is complex (Kurtz and Snowden, 2003; Holland, 2014). The phrase “Houston, we have a problem” and its associations, instantaneously transition the ongoing situation into the complex domain, requiring more communication and interaction than the complicated or clear domains do to spur innovative ideas and execute complex strategies, attempting to move the system towards a favourable outcome (Snowden and Boone, 2007).

In a system where all events have an equal probability of occurring, all events are random, and nothing can emerge from its chaotic state (Juarrero, 2015a, pt. 09:30). Emergence is also irrelevant when a system is in perfect equilibrium where all events are perfectly predictable, and nothing can emerge from its clarity (Juarrero, 2015a, pt. 09:30). In the “clear” domain, agility is unnecessary, and in the “chaotic” domain, it is impossible. Therefore, only the complex and complicated domains of Cynefin are relevant to this study of agility in EDM.

Under conditions of certainty in organisations, the whole comprises the sum of the parts. However, in complexity, the whole is irreducible and transcends the sum of its parts (Simon, 1996). Thus, in the domain of order, the whole can be optimised by optimising the parts, and problems are solved using reductionist approaches (Kurtz and Snowden, 2003). However, in the unordered domain, the sum of the parts can never add up to the whole because all attempts at characterisation, identification or intervention modify the system itself (Simon, 1996; Kurtz and Snowden, 2003). Therefore, suboptimal performance in complex contexts must be allowed for each component to optimise the whole, as problems can only be resolved through emergence (Kurtz and Snowden, 2003).

Decision-making and transitions between complex and complicated organisational contexts

The Cynefin framework provides a complexity science perspective on decision-making (Snowden and Boone, 2007). Uncertainty is the hallmark of complexity, disrupting stable organisational practices and bringing established patterns of practice into question (Orlikowski and Scott, 2021). In the liminal space where the system transitions between complicatedness and complexity, it is crucial to avoid imposing rigid rules while attempting

to stabilise the system (Kurtz and Snowden, 2003). Instead, an ordered state should not be assumed, and a degree of freedom should be allowed so that interventions can emerge, evolve and stabilise desirable patterns, and eliminate undesirable ones (Kurtz and Snowden, 2003). While the system is in a liminal state, embedded enacted routines are suspended, presenting opportunities to question how things are and experiment with new ways of working, adapting to the changing environment (Orlikowski and Scott, 2021).

As shown in Figure 5-5, Cynefin offers explanations for the dynamics of transitioning between the complex, complicated and clear domains through key decision points at the liminal boundaries between complex and complicated contexts.

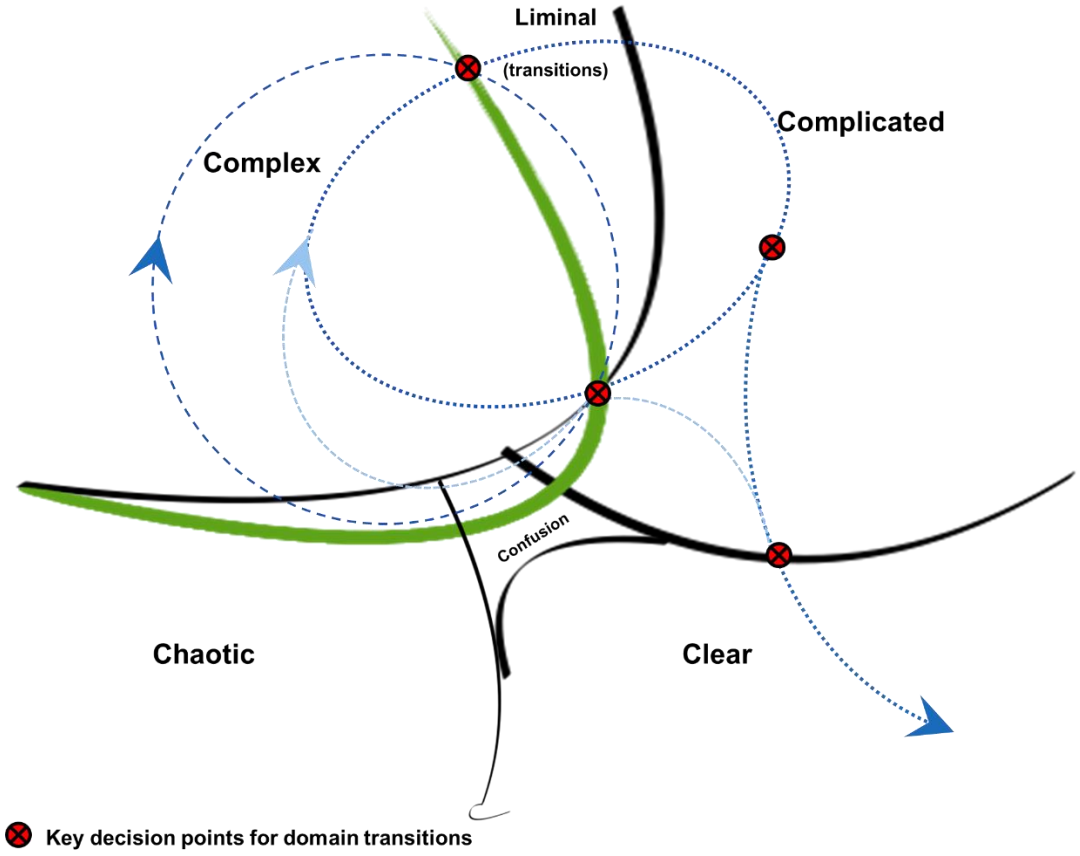


Figure 5-5: The dynamics of Cynefin (reproduced from Snowden (2021c, p. 61))

Stable patterns emerging from the continuous iterations between the complex and complicated domains can evolve sufficiently to be routinised for longer-term embedment in best practice, thus moving into the clear domain (Snowden and Rancati, 2021). Some patterns cannot be stabilised, resulting in continuous iteration between complex and complicated, for which the flow must be constantly navigated to keep the system moving towards a favourable state (Juarrero, 2000; Kurtz and Snowden, 2003; Snowden and

Boone, 2007). The complex domain requires pattern management, and the patterns are the phenomena that emerge from the interactions of the agents in the system (Snowden, 2002).

Cynefin defines a liminal area at the boundaries of its different domains, and transitioning from the complex to the complicated domain occurs when actors are still uncertain but stabilising patterns are emerging (Snowden and Rancati, 2021). Transitioning from complicated to complex occurs when expert solutions (or “good practice”) are called into question and are not providing the desired outcomes (Snowden and Rancati, 2021). Turner, Snowden and Thurlow (2022) emphasise that it is crucial to discern the need for applying different methods as the context transitions from one domain to another. By assigning the situation to the appropriate Cynefin domain, effective decisions can be made, enabling contextually appropriate interventions (Snowden and Boone, 2007).

Reaching decisions in the complicated domain often requires a trade-off between the time required to find the right answer with simply making a decision. If the right answer eludes the decision-maker, and only incomplete data is available, then the context is most likely complex rather than complicated (Snowden and Boone, 2007). Most organisations’ decision-making contexts are complex because any significant organisational changes — for example, management changes, mergers and acquisitions — result in flux and unpredictability (Snowden and Boone, 2007).

5.1.4 Conclusion — The structural components of agile enterprise data management applied to the Cynefin framework

This study of agile EDM adopted the Cynefin framework because it provides definitions and explanations for complex and complicated contexts and the transition dynamics between these two domains. Furthermore, Cynefin offers a practical framework for navigating an organisational context towards achieving desired outcomes in a broad scope of organisational settings.

The qualitative case study conducted in DSR Cycle 1 concluded that, even though the dynamic capabilities and agility features were relevant to real-world EDM contexts, there were differences in the characteristics of agility in EDM, depending on whether the context was complex or complicated. Cynefin differentiates between how complex and complicated situations should be approached to enable desired outcomes from decisions made and actions taken, including the critical assessment of when the approach should change,

thereby transitioning between the complex and complicated domains (Snowden and Rancati, 2021).

Figure 5-6 below maps the structural components of agile EDM onto the complex and complicated domains of Cynefin, indicating transitions between these two domains through key decision points.

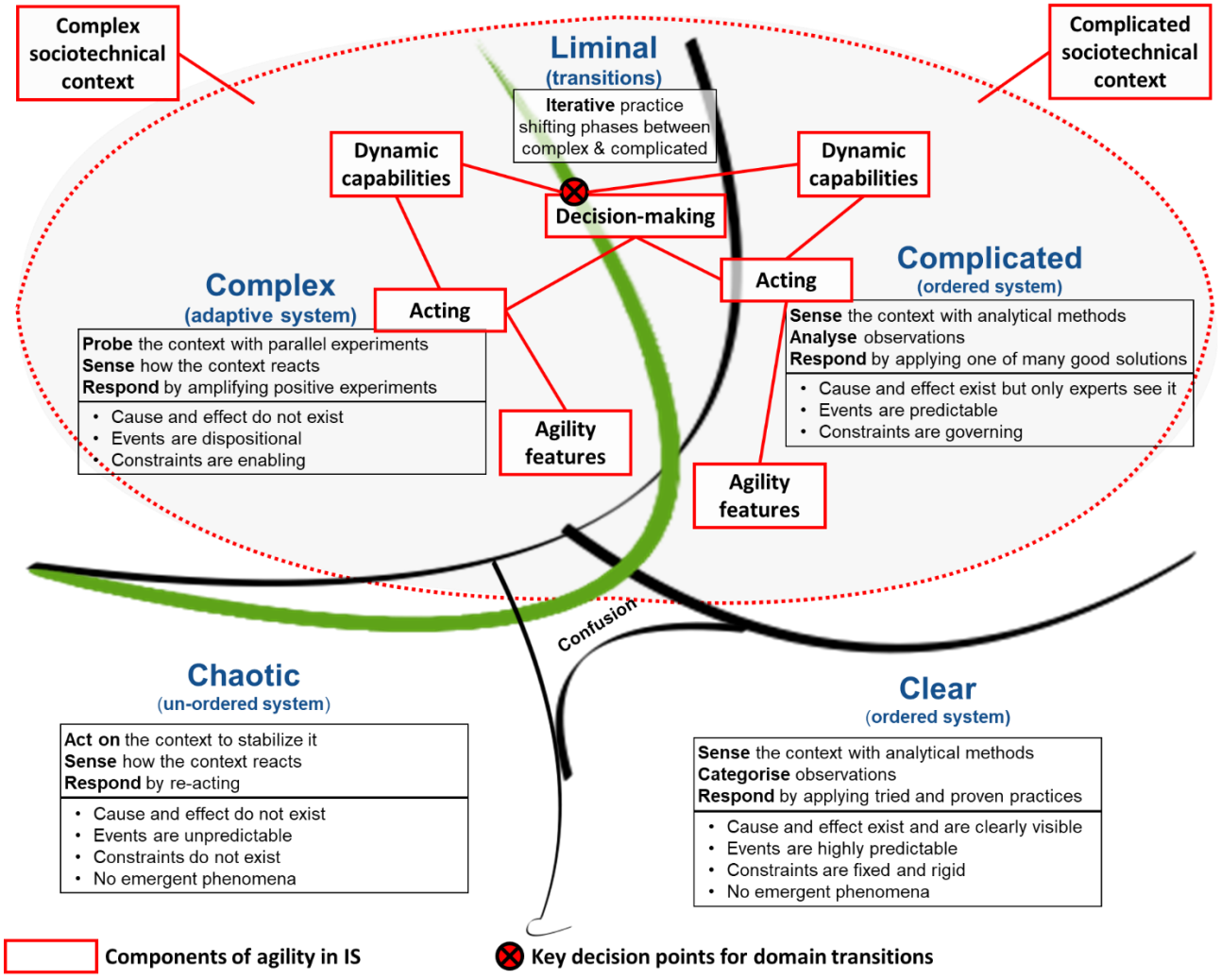


Figure 5-6: The structural components of agile enterprise data management mapped to the Cynefin framework (based on Kurtz and Snowden (2003, pp. 464–466); Snowden and Rancati (2021, pp. 60–63))

Cynefin explains the dynamics of transitions through the liminal area between complex and complicated domains based on the actors' sensing, decision-making and responding actions, with resulting outcomes and consequences. Snowden (2002), Kurtz and Snowden (2003), and Snowden and Rancati (2021) specifically include complex adaptive systems (CAS) theory, authored by Holland (1992), to underpin Cynefin for explaining the nature and

dynamics of complex and complicated decision-making environments. Therefore, the adoption of Cynefin naturally requires the adoption of CAS to explain the dynamic components of complex sociotechnical contexts and to develop the dynamic components of agile EDM.

Even though the structural components of agile EDM present organisational levels and a sense-response process flow, they do not explain how the different components relate across levels. In addition, the Cynefin framework does not present its dynamics across the multiple levels of complex sociotechnical contexts, management and individual agents' interactions. Therefore, to further progress the development of the dynamic components of agile EDM, an explanation of the multi-level dynamics of agility in complex adaptive organisational contexts is sought in the next section.

5.2 SQ2.2: THE MULTI-LEVEL DYNAMIC COMPONENTS OF AGILITY IN COMPLEX AND COMPLICATED SOCIOTECHNICAL CONTEXTS

The structural components of agile EDM developed in the first DSR cycle were based on the organisational sense-response process loop proposed by Park, El Sawy and Fiss (2017), which acknowledges that sense-respond capabilities are foundational to agility in IS, supporting organisational agility (Sambamurthy, Bharadwaj and Grover, 2003; Tallon *et al.*, 2019). The sense-decide-act process incorporates the whole agility-building process from a top-down strategic perspective (Park, El Sawy and Fiss, 2017).

The structural components of agile EDM present the contexts of agile EDM as complex and complicated. The preceding section of this chapter identified the Cynefin framework as appropriate for explaining how decision-making in complex and complicated organisational contexts can steer an organisation towards desired outcomes, and mapped the structural components of agile EDM onto the Cynefin framework's domains (see Figure 5-6 on page 151).

This sub-cycle aims to answer the second sub-question of DSR Cycle 2 by conceptualising agile EDM as a dynamic multi-level construct based on a synthesis of the findings of DSR Cycle 1 and findings of the SLR conducted in the preceding section of frameworks that enable agility in complex organisational contexts:

SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?

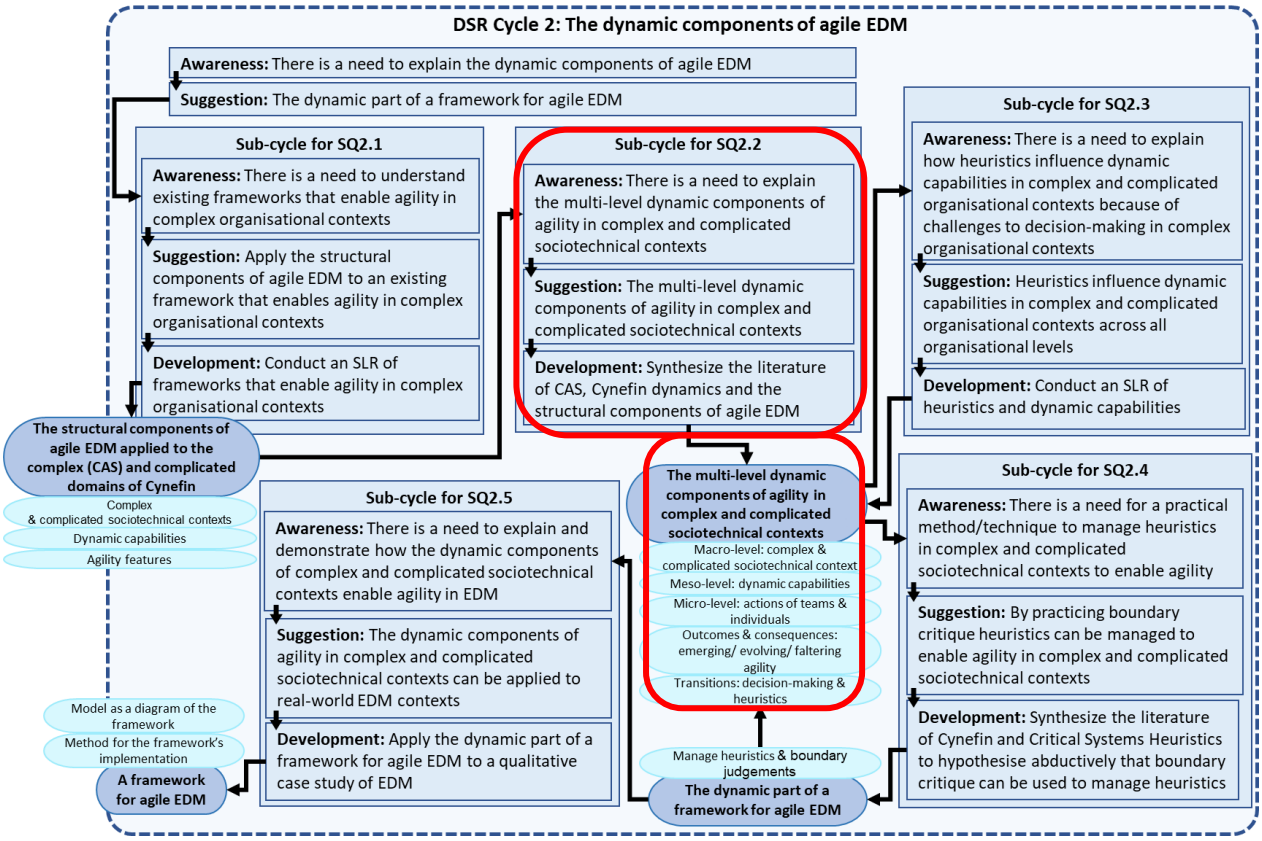


Figure 5-7: Research design — sub-cycle for SQ2.2

5.2.1 Agile enterprise data management as a multi-level construct

The structural components of agile EDM developed from the organisational sense-response process loop by Park, El Sawy and Fiss (2017) in DSR Cycle 1 incorporate three organisational levels: (1) the sociotechnical context level that is the EDM organisational environment within which EDM strategy and leadership steer the EDM organisation towards achieving agile EDM as a strategic objective; (2) the dynamic capabilities level, comprising managerial capabilities that govern the organisation's data management operations and initiatives/projects towards achieving agility; and (3) the team and individual action level where data management work practices can achieve agility in the operational and project/initiative activities of data management. In addition, DSR Cycle 1 concluded that agility features manifest in the actions of data management teams and individuals, and vary depending on whether the context is complex or complicated. The three organisational levels of the structural components of agile EDM are shown in Figure 5-8.

(1) Overall organisational level: sociotechnical context

(2) Managerial level: dynamic capabilities govern sensing, learning, integrating and coordinating

(3) Team and individual level: actions and interactions of teams and individuals

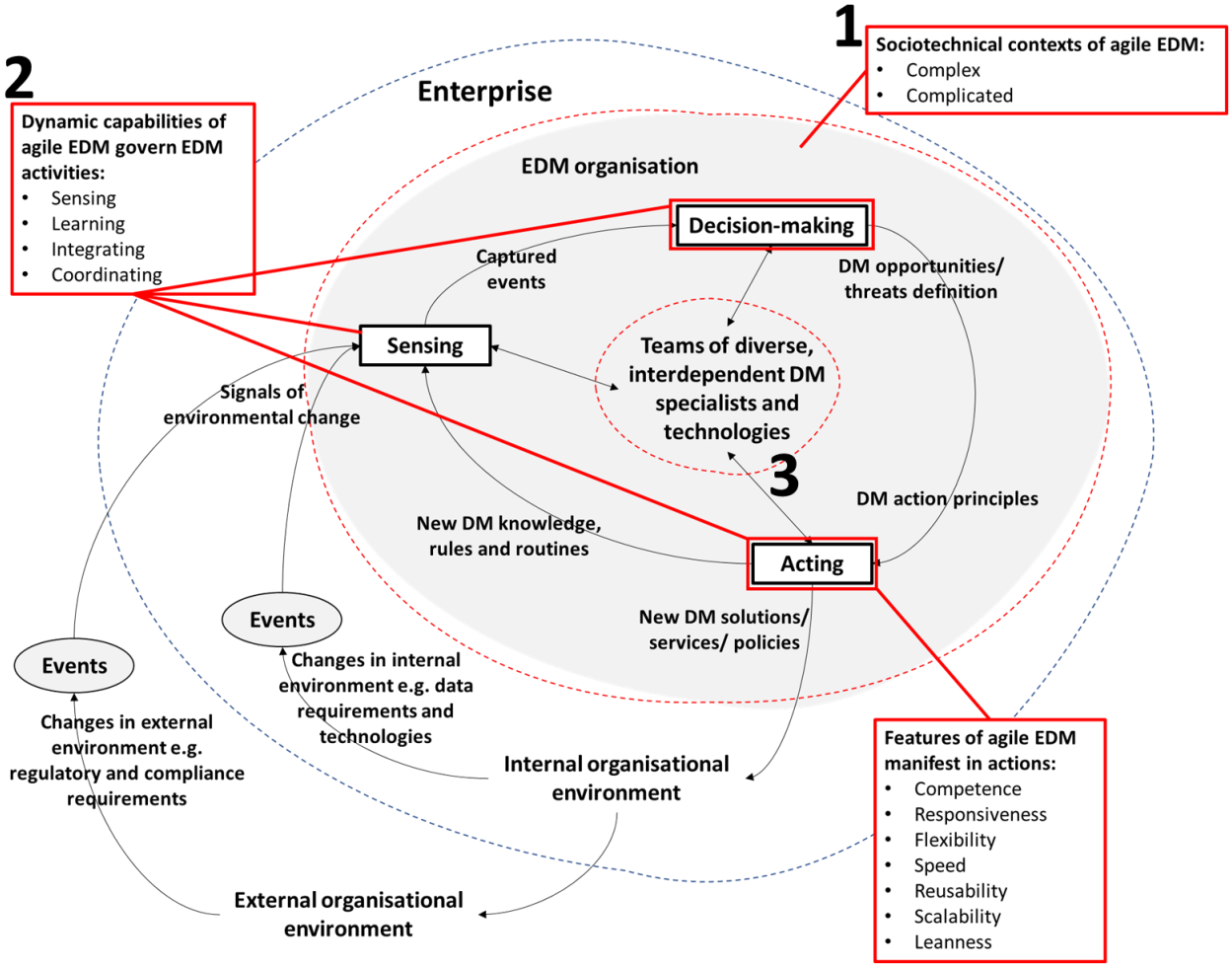


Figure 5-8: The three organisational levels of the structural components of agile EDM (based on Pavlou and El Sawy (2011); Park, El Sawy and Fiss (2017, p. 653))

Meyer, Gaba and Colwell (2005) describe the nature of change processes in organisations as multi-level, presenting different systems with dynamics driven by different forces at each level, for example, strategy at the organisational level and rivalry at the industry level. Organisational change can be achieved when managers use dynamic capabilities to govern the activities and actions of their teams (Teece, 2014).

Hierarchy is a fundamental theme in complex systems architecture, meaning that any complex system is organised into multiple levels (Simon, 1962). The Cynefin framework's complex domain is founded on CAS theory (Snowden and Rancati, 2021). CASs in organisations present fractal architectures because they are multi-level and exhibit self-

repeating patterns up and downward through the levels, for example, equivalent variables applied at the organisational and individual levels (Ramos-Villagrasa *et al.*, 2018). Therefore, a CAS cannot be meaningfully investigated from a single-level perspective as this would contradict the fractal nature of complexity (Cilliers, 2001; Salthe, 2012; Juarrero, 2015b; Ramos-Villagrasa, Marques-Quinteiro, Navarro and Rico, 2018; Snowden and Rancati, 2021).

Organisations that include social agents cannot be explained or described as aggregations of coexisting micro-situations, nor are macro-processes the aggregated product of interactions at the micro-level despite the profound implication of embodied behavioural patterns at the micro-level (Giddens, 1984, p. 141). Interactions at the micro-level allow collective constructs to change over time (Eisenhardt, Furr and Bingham, 2010). In other words, nonlinear evolutionary processes and interactions at a micro-level stimulate the emergence of phenomena at a macro-level. Even though the change processes at each level of the CAS are distinct, events occurring in the CAS influence each other across levels (Meyer, Gaba and Colwell, 2005).

Meyer, Gaba and Colwell (2005, p. 471) explain that "[n]onlinear systems cannot be understood without conceptualizing and studying them at multiple levels. […] [o]rganizations are entangled in an ecology in which one agent's actions help construct another agent's environment, generating forces that connect social structures at different levels". Therefore, Meyer, Gaba and Colwell (2005) encourage researchers to apply a CAS lens to organisational studies and advocate an approach to organisational research that takes a contextual, coevolutionary, processual, multi-level and emergent perspective.

5.2.2 Agile enterprise data management as a complex adaptive system

In this study of agile EDM, the sociotechnical contexts of EDM are represented by the complex and complicated domains of Cynefin, as concluded in the previous section that answered SQ2.1. Complicated things can be intricate and consist of many parts, but they can be analysed by experts (Snowden and Boone, 2007), and the relationships between the parts are clearly defined and stable (Cilliers, 2000a). On the other hand, many nonlinear, dynamic interactions result in complexity (Cilliers, 2000a).

In IS research, systems involving technical and social components are considered complex, and Social Science involves "social systems" (Gregor, 2009). Thus, sociotechnical contexts,

such as EDM, should be considered from a Systems perspective and consider theories related to Systems Theory and Complex Systems Theory to explain the dynamic components of complex and complicated sociotechnical contexts. Meadows (2008, p. 205) defines a "system" as "[a] set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviour, often classified as its 'function' or 'purpose'". Systems theory in organisational science is an antecedent of dynamic capabilities theory and understands organisations as social systems comprising subunits that interrelate congruously and harmoniously, supporting the organisation's effectiveness (Teece, 2018).

CAS models afford a means to simplify an understanding of complexity and have four key characteristics: (1) agents applying schemata, (2) networks of self-organisation sustained by importing energy, (3) emergence from the chaordic state (coevolution at the edge of chaos), and (4) system evolution through recombination (Anderson, 1999). Snowden and Boone (2007) and Lissack (2016) warn of the dangers of oversimplification in complex contexts. The word "complexity" comes from the Latin word "complexus", meaning "what is woven together", and implies disorder, disintegration and dispersion that will disrupt any strategy that assumes perfection, determinism and order (Morin, 2007). It is, therefore, essential to consider the appropriateness in context rather than force simplification onto complexity, thereby compromising the ability to cope with changes and future contexts (Lissack, 2016).

When applying CAS models to strategic management, an approach unfolds whereby systems can be built to swiftly evolve effective adaptive solutions in a dynamic environment (Anderson, 1999). In reality, order and chaos, or "un-order", are intertwined and coexist (Kurtz and Snowden, 2003), and there is no clear divide between what is complex (less ordered) and what is complicated (more ordered) (Holland, 2014). However, according to Kurtz and Snowden (2003, p. 465), "we are capable of shifting a system from complexity to order and maintaining it there in such a way that it becomes predictable".

The Cynefin framework incorporates CAS as the theoretical foundation for the complex domain, and Systems Thinking guides understanding and navigation of the complicated domain (Kurtz and Snowden, 2003; Snowden, 2015a; Snowden and Rancati, 2021). A CAS is a complex system that is an open dynamical system, continually reconfiguring its structure through self-organisation, requiring the exchange of energy and information (Juarrero, 1999;

Turner and Baker, 2019; Snowden and Rancati, 2021). Holland (2014, p. 24) explains that "[c]omplex adaptive systems (CAS) are composed of elements, called agents, that learn or adapt in response to interactions with other agents."

CAS theory provides a lens through which to perceive systems of interacting agents and how order emerges from the interactions in dynamic organisational environments that require responsiveness and adaptation, such as information systems (Onik, Fielt and Gable, 2017). "[C]omplex adaptive systems are understood from the bottom up, built from interactions of the individual elements" (Teece, 2018, p. 362).

Recognising and acknowledging whether a context at hand is complex or complicated is essential (Cilliers, 2000b; Snowden, 2002). As the name suggests, CASs have the unique ability to adapt and operate between complexity (unorder) and complicatedness (order) (Turner and Baker, 2019). All the individual parts, including their relationships, are knowable in a complicated context, and causes and effects are linked, making outcomes controllable (Snowden, 2002). In contrast, a complex context presents an open system that is unbounded and influenceable by internal and external forces (Turner and Baker, 2019), resulting in changes and mutations of the system which are unknowable in advance (Snowden, 2002). As Snowden (2002, p. 106) explains: "[a] feature of a complex system is the phenomenon of retrospective coherence in which the current state of affairs always makes logical sense, but only when we look backwards. The current pattern is logical, but is only one of many patterns that could have formed, any one of which would be equally logical".

The CAS agents' schemata, or mental maps, contain combinations of descriptions, predictions and prescriptions that inform and shape agents' actions in the real world (Gell-Mann, 1999). Self-organising systems learn from past experiences and thus must retain information from previous experiences to compare those to new situations as they arise (Cilliers, 1998).

Feedback loops provide information about the real-world performance of schemata, thereby mutating the systems' processes, extending agents' experience and evolving the CAS over time (Gell-Mann, 1999). A constant flow of energy is required for a complex system to resist entropy and, at the same time, maintain its complex structure, as it can only survive and

exist as a process. In other words, it survives by what it does and not through its goals or origins (Cilliers, 1998).

A system is a CAS when it adapts to and evolves with changes in its environment (Holland, 2006). The tenets of a CAS are path-dependence, system history, nonlinearity, emergence, irreducibility, adaptability, switching between order and chaos and self-organisation (Turner and Baker, 2019). The adaptive interactions amongst the components of a CAS generate its behaviour and hierarchical structures (Holland, 1992, 2014). According to Kurtz and Snowden (2003), humans continuously flex their collective and individual identities. Therefore, an agent in a CAS can be modelled either as an individual or as a group. The CAS agents form networks of bounded subsystems that learn and adapt through their interactions (Holland, 2012). This representation of a CAS is shown in Figure 5-9:

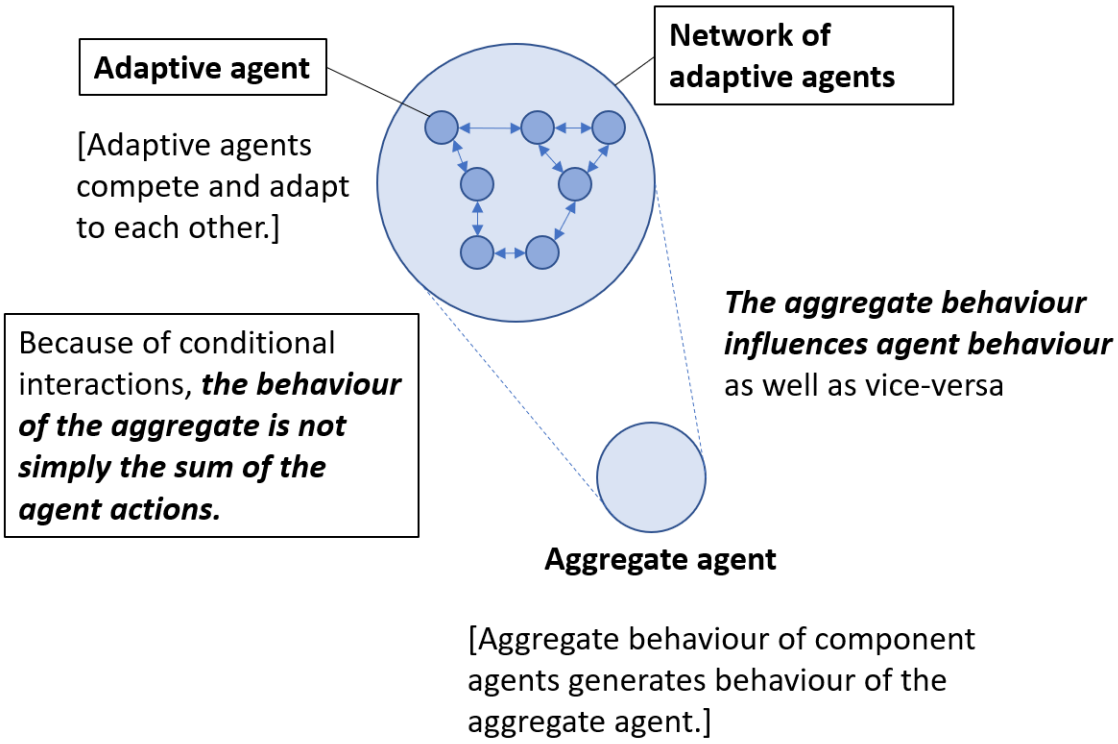


Figure 5-9: Complex Adaptive Systems (reproduced from Holland (2012, p. 2))

CASs coevolve and continuously self-adapt towards a state of optimised fitness, producing stability and sustainability without being centrally controlled (Anderson, 1999). CASs repurpose themselves through emergent processes of learning and self-organisation, forming coherent structures that sustain the system's fitness by continuously adapting to changes in their internal and external environment (Turner, Snowden and Thurlow, 2022).

Examples of CASs are organisations, social networks, swarms, stock markets, ecosystems and pandemics. Such systems have limited predictability (Levin, 2003; Holland, 2006). As proposed in this study, the heterogeneous agents of a CAS can be human individuals, teams of individuals, organisations of teams, technological components, or collections of technologies acting and interacting in EDM contexts. In such socially complex systems, human agents can create their own "adjacent possibilities" and, through creativity stemming from their sentient nature, can consciously influence the dynamics of the complex system (Beckage, Kauffman, Zia, Koliba and Gross, 2013). The remainder of this section synthesises the mechanisms that underlie dynamics in CAS from the literature.

Path-dependence and systems history

The agents in a CAS are continuously learning and adapting in search of opportunities to collectively move the system to an improved or sustained overall state (Holland, 2002), for example, improved agility in EDM. Agents in a CAS coevolve with the environment, each other and the emergent phenomena of the CAS. This process of coevolution embeds the system's history in its present constitution and state (Jenal and Cunningham, 2015).

A CAS is, at its core, historical because it integrates the conditions under which it arose into its structure, including the unpredicted events driving the reorganisation of its self-organised iterations (Juarrero, 2000). Therefore, the emergence and evolution of phenomena in CAS are path-dependent, with possibilities of multiple stable states, chaotic dynamics, and "frozen accidents" (inherited patterns that have become static) (Gell-Mann, 1999; Levin, 2003; Salthe, 2012). The nature of the connections in the network "retains" the states through which the system has transitioned, thus embodying the system's past in its present (Cilliers, 2006). Holland (1992, p. 20) points to the continuous iterative flow of CASs in that they "never get there" in contrast to linear, predictable systems that target an optimal end-point.

Path-dependence is a constraint for change, but at the same time, the organisation's existing embedded processes provide a foundation and fulcrum for change in the future (Teece, 2014). Outcomes, or paths, in a CAS, are not always to the satisfaction of all stakeholders of the CAS, and pathways shaped by past decisions are often challenging to reverse, such as sunken costs and long-term consequences (Waddock, Meszoely, Waddell and Dentoni, 2015).

Pre-setting an intention for taking a specific action increases the agent's probability of taking that particular action and renders taking a conflicting action unlikely (Juarrero, 2000). However, despite interactions transpiring in contexts as a flow of purposive action, acts often produce unintended consequences that feed back into the system providing unrecognised conditions for subsequent acts (Giddens, 1984, p. 8).

Purposeful human action and cognition is a continual flow of interactive conduct and not simply an aggregation of unconnected motives, reasons and intentions. Furthermore, humans continuously monitor their own and each others' actions in a reflective process of rationalisation that involves the agents' competence and the "history" that led up to the given context (Giddens, 1984, p. 3). However, the focus should be on feedback loops observable in the current context instead of deriving the nature and direction of feedback loops from theories or agents' past experiences, which are most likely irrelevant to the existing context (Snowden and Rancati, 2021).

Through the lens of information theory, action can be seen as "informationally dependent and constrained behavior", and intention must withstand distraction and ambiguity to issue action, thereby becoming embedded in the action (Juarrero, 2000, p. 30). However, intention does not always realise as action, and patterns can develop in the absence, or despite the presence, of intentions (Mintzberg, 1987). Nonetheless, when stable, the organisation of the CAS, as a whole, is self-governing and limits its individual components' degrees of freedom in their interactions (Juarrero, 2000).

Nonlinearity and self-organisation

Juarrero (2000, p. 27) suggests that agents' behaviour constitutes action when the dynamics of their self-organisation are intentional (conscious and meaningful), while originating and constraining the CAS's processes in ways that meaningfully integrate the agents' behaviour with the complex dynamics from which it originated. Juarrero (2000, p. 27) further explains that "by serving as the order parameter, those contextual constraints that embody an intention (acting top down) would provide the behavior with continuous, on-going control and direction by modifying in real time the probability distribution of lower-level processes and, as a consequence, the behavioral alternatives available to and implemented by the agent".

Tsoukas and Hatch (2001, p. 980) state that "in order for cognitive beings to be able to act effectively in the world we must organize our thinking". People typically use patterns shaped

by their understanding and experience, rather than analytical reasoning, as the basis for making decisions (Klein, 1999). However, rather than envisioning the desired future state as a deterministic goal, acknowledging and understanding complexity instead sets a sense of direction and openness to opportunities, novelties, and threats (unknown or unknowable) upfront (Snowden and Rancati, 2021, p. 66). Therefore, it is essential to understand the multiplicity of possible paths, how patterns emerge, and how to influence them when managing behaviour in organisational settings within their internal and external environmental contexts (Snowden, 2002).

Change in organisations is nonlinear when an outcome is not inversely or directly proportional to its cause and involves the emergence of novelty, state transitions, and system jolts and oscillations (Meyer, Gaba and Colwell, 2005). However, as Meyer, Gaba and Colwell (2005) point out, organisational science has thus far focused more on stability than dynamics and incremental change than discontinuous change.

The interactions between agents in a CAS are nonlinear instead of cumulative in their effects on the system's overall state (Holland, 1992, 2002). Therefore, when studying complex organisational situations, such as EDM, it is essential to consider the connection patterns between the agents of the CAS and how the behaviour of an agent at t (the current point in time) influences the behaviour of other agents at $t + 1$, the next iterative point in time (Anderson, 1999).

A linear system can be wholly understood by first understanding its subcomponents individually, and then reintegrating them into a single system (Mitchell, 2009). In contrast, it is impossible to understand a nonlinear system as the sum of its parts as the system itself continually emerges and evolves from its changing contexts and interactions (Mitchell, 2009). The relationships, interdependencies and interconnections among the agents of a CAS result in nonlinear consequences where even small changes can result in disproportionate effects (Jenal and Cunningham, 2015).

Self-organisation is a feature of a CAS whereby the system can spontaneously and adoptively change and develop its internal structure to manipulate or cope with its environment (Cilliers, 1998). The ongoing self-organisation of a dynamic system makes it, to some degree, independent of its parts as these become replaceable components through the system’s continual self-organising processes of destruction and renewal (Juarrero,

2000). Juarrero (2000) adds that when the CAS is in an organised state, its attractors are its final and formal cause that preserves the system's identity and integrates behaviour into its overall organisation. Attractors in a complex and complicated system are phenomena that arise when micro stimuli resonate with actors in the system and, as their adoption strengthens, bring structure and coherence to the CAS (Snowden and Boone, 2007).

Self-organisation at the lower levels results in emergent patterns at the higher level, constraining the system and maintaining the coherence of the system's overall structure at the higher level (Salthe, 2012; Juarrero, 2015b). Self-organising systems cannot be described in crude reductionist terms because agents at the micro-level are not aware of emerging and evolving phenomena at the macro-level of the system despite the large-scale effects being collective manifestations that originate from the micro-level interactions (Salthe, 2012). Therefore, the levels in a CAS are entangled, and it is impossible to describe them independently in terms of their effects (Cilliers, 1998; Salthe, 2012). Self-organisation implies that the system is simultaneously organised, organising and being the organiser and, through this process, emerging new properties and qualities of the whole system (Morin, 2007).

In a self-organising dynamic system, such as a CAS, the organisation itself regulates the stimuli to which the agents will respond and eliminates inefficiencies (Juarrero, 2000). This recursivity makes the system's components interdependent, thus constraining variability in their behaviour and enhancing and preserving the system's identity, organisation, integrity, and cohesion (Juarrero, 2000). Cohesion emerges at the collective level of the CAS from the closure of context-sensitive constraints, which Juarrero (2015b) describes as "recursive constraint dynamics" that close the constraint production loop of self-causality in the CAS. Culture, mindset, and organisation are examples of cohesiveness that emerge from a closed loop of context-sensitive constraints (Juarrero, 2015a, pt. 21:18).

Constraints

The complex dynamic wholes of CAS exercise top-down constraining power, in a distributed manner, on their components to enhance and maintain the system's overall state (Juarrero, 1999). CASs are highly nonlinear, adapting and evolving simultaneously through multiple domains, dimensions and levels, and any effort to effect changes to the system must

consider the controls that stabilise the system and the underlying mechanisms that enable the system to change (Waddock *et al.*, 2015, p. 1004).

A complex system with predefined probabilities, for example, a language, is governed by context-free (governing) constraints (Juarrero, 2015a, pt. 10:30). Context-free constraints exist independently of the context of the system and are restrictive in that they increase the probabilities of certain events occurring. Thus, they are always consistently applied, for example, assumptions, presuppositions, cultural biases and bounding rules. More positive examples of context-free constraints are shared goals, purposes and understanding (Juarrero, 2015a, pt. 12:48). In an ordered state of complicatedness, the system constrains its agents, and analysis efforts can evolve an understanding of consequences across multiple system levels (Snowden and Boone, 2007). Context-free constraints can produce assemblages and conglomerates and can faithfully reproduce structures. Nonetheless, they are sensitive to change and can serve to perpetually move a system away from homogeneity while evolving an ordered structure (Juarrero, 2015b).

Context-free (governing) constraints restrict the emergence of novelty, such as emerging new approaches to teamwork (Snowden and Rancati, 2021), because agents continue to operate under the same rules. For example, data management teams apply data governance rules or quality standards. Context-free constraints also create interdependencies between the components within the CAS as the occurrence of one event increases the probability of another event occurring (Juarrero, 2015b). For example, if the data leadership updates the data management policies, all data management teams should adopt the required changes to their data management practices. The transpiring of interrelationships between the components in a complex dynamic system creates a foundation for emergence in the system (Juarrero, 2015a, pt. 14:35).

Each CAS, from its global level downwards, contextually constrains the behaviour of all its parts at all levels (Juarrero, 2000). The recursive process of constraints stemming from intention and capacity, acting top-down from the global level of the CAS, keeps the system operating close to the edge between complicated (more control) and complex (less control) (Cilliers, 1998; Juarrero, 2000; Kurtz and Snowden, 2003).

During a transition in a CAS, the constraints operating in the preceding system state undergo a qualitative reconfiguration, renewing relationships among the system’s internal

components and between the system and its environment (Juarrero, 2000), for example, defining new or changed sociotechnical structures for improved data governance (Otto, 2011b). When a CAS transitions between complexity and complicatedness, it is crucial to use the opportunity to switch management approaches in concert with the changes in the system if the organisation is to survive (Snowden and Boone, 2007).

Enabling constraints in a CAS are context-sensitive, operating bottom-up (or part-to-whole), supporting the emergence of phenomena and, on closure, expanding the probability space of the system (Juarrero, 2015b). In contrast, governing constraints in a CAS are restrictive and function top-down (or whole-to-part), incorporating isolated and independent components into a coherent unit, thus maintaining, regenerating and evolving the whole system (Juarrero, 2015b).

Governing constraints are context-free and act as rules that iteratively evolve emergent novelty towards adoption and embedment as good practice in the complicated domain (Snowden and Rancati, 2021). In contrast, enabling constraints are context-sensitive and flexible, adapting to the changing context (Snowden and Rancati, 2021), and allowing new phenomena and system states to emerge (Juarrero, 2000). Snowden (2015, n. p.) offers the following metaphor to explain the difference between governing constraints and enabling constraints: “The external constraint of an insect’s skeleton bounds its nature [it serves as a governing constraint], while the endoskeleton of a mammal allows for significant variation around a coherent centre [it serves as an enabling constraint]”.

Juarrero (2015b) proposes that catalysts (elements that increase the rate of change) and feedback loops stimulate reactions in the CAS and are, through autocatalysis, effective as first-order context-sensitive constraints that, on closure, precipitate transitions that restructure the CAS’s probability space. In other words, “context-sensitive constraints function like a land developer’s bulldozers, shaping a higher dimensional space within which not only do future events become more or less likely, different types of events and constraints are created in the process” (Juarrero, 2015b, p. 514).

Feedback loops

When seeking endurance and stability, cadence is more important than velocity (Snowden and Rancati, 2021). Short iterative cycles of work execution increase the frequency of interaction among agents in a CAS, supporting a better understanding of stakeholder

requirements and thus enhancing the integration of new knowledge in the process (Werder and Maedche, 2018). In traditional approaches to IS work, projects are typically governed by up-front business requirement specifications and checkpoints and linearly follow fixed procedures with people working in silos on discrete tasks. Conversely, even though shaped by responsibilities and priorities, more successful organisations execute teamwork in a more iterative and ad hoc style (Brown and Eisenhardt, 1997).

Feedback loops in a CAS are dynamic mechanisms that offer opportunities to transition the system state between the complex and complicated domains (Snowden and Rancati, 2021). Heeding feedback loops in a CAS can shift the system state from the complex to the complicated domain as previous unknowns become knowable through improved experience and expertise gained within the current timeframe and context (Snowden and Rancati, 2021).

In a CAS, information is acquired, propagated, updated and fed back into the CAS's process flow (Turner and Baker, 2019). As the variability of inputs into the system increases, the system gravitates towards a critical point of optimised flexibility (Cilliers, 1998). However, if the information inputs exceed the system's capability to cope, the system can no longer produce stable attractors and shifts beyond the critical point towards a state of chaos. Therefore, resources in a self-organising system should be balanced, not under-extended or over-extended (Cilliers, 1998).

Juarrero (2000, p. 26) explains that "complex adaptive systems are typically characterized by positive feedback processes in which the product of the process is necessary for the process itself". Feedback and catalysts in a CAS influence how the components in a CAS interconnect and combine, providing the system with context-sensitive constraints, and changing the probability landscape of future events (Juarrero, 2015b).

Negative feedback suppresses large perturbations in a CAS, causing the system to stabilise, whereas positive feedback drives autocatalysis, amplifying even small fluctuations, thus moving the system far from equilibrium (Heylighen, Cilliers and Gershenson, 2007). Positive feedback stimulates and enhances ongoing behavioural patterns, increasing deviation, whereas negative feedback inhibits and detracts from behavioural patterns, thus decreasing deviation (Cilliers, 1998; Morin, 2007).

Positive feedback allows for transformation in social systems when mechanisms that regulate the system can no longer exterminate or suffocate deviations, thus allowing them to amplify, leading to future transformations (Morin, 2007). Thus, feedback changes the probability landscape for subsequent transformations, shaping how change happens in complex dynamic systems, such as CAS (Juarrero, 2015b).

Transitions

In organisations, phase shifts, or transitions, imply significant changes to the nature of internal relationships, which require energy to effectuate the transition (Snowden and Rancati, 2021). Nguyen Huy and Mintzberg (2003, p. 84) propose that change be managed in short iterations with an appreciation for continuity because "lasting, effective change arises from the natural, rhythmic combination of organic and systematic change with the well-placed syncopation of dramatic transformation".

When a CAS is poised on the edge of criticality, its number of stable states is optimised, and it can transition between states, expending a minimum amount of energy (Cilliers, 1998). However, when stable attractors must heavily constrain the system, all degrees of freedom are limited, and many agents are engaged to maintain the system's stability, thereby deteriorating the system's capacity to adapt promptly to changes in its environment. In addition, transitioning the system from one stable state to another will necessitate extreme perturbations (Cilliers, 1998).

Traditional management theories propose methods and approaches to identify problems and match them with solutions (Snowden, 2021b, pt. 34:21). Complex systems, such as CAS, are open systems that can interact with their environment and are more resilient than stable, complicated or simple systems (Juarrero, 1999). Juarrero (2015a, pt. 03:55) explains that in complexity, it is crucial to strive for "safe-to-fail" instead of stable, "fail-safe" outcomes as this makes the CAS more adaptable, evolvable and resilient, which are required features for survival in real-world contexts. Microdiversity enhances the overall robustness and resilience of the CAS. Furthermore, distributed instead of centralised control is preferable, and agents who manage and create solutions should enable the conditions that allow favourable outcomes to emerge. This approach allows the CAS to survive over time, avoiding stagnation and enabling continued emergence and evolution through subsequent iterations and transitions (Juarrero, 2015a, pt. 03:55).

The liminal area between complicated and complex contexts has a transitionary and iterative nature, where good practice can establish in the complicated domain through a transitionary process requiring energy to shift and adopt new emergent practices from the complex domain (Snowden and Rancati, 2021). Between phase shifts, all the constraints of the system's internal dynamics and its context's initial and ongoing conditions govern the complex system's behaviour (Juarrero, 2000, p. 51).

The daily realities of organisational life are rife with multiplicity, contingency and emergence (Feldman and Orlikowski, 2011), and change is the prevailing organisational state (Tsoukas and Chia, 2002). Nguyen Huy and Mintzberg (2003) advise that it is essential to understand that organic change does not occur as a blatant consequence of intention, nor is it initiated in an organised, systematic way or dependent on change specialists and managerial authority. Albeit challenging to expertise and authority, the results of organic change can be dramatic and innovative leadership can stimulate change in the organisation by instilling, through socialisation, an appreciation for its benefits (Nguyen Huy and Mintzberg, 2003). By intentionally understanding the system's environment and changing attributes within its context, transition to a more manageable domain, for example, shifting from complex to complicated, is achievable (Turner, Snowden and Thurlow, 2022).

Emergence and evolution

Agility is an organisational phenomenon that emerges from complexity and evolves in complicatedness (Werder and Maedche, 2018; Crick and Chew, 2020). Adopting a CAS view of software development teams, Werder and Maedche (2018) found agility to be a phenomenon that emerges from self-organisation in teams. Bleda (2017) argues that viewing an organisation as a CAS provides explanations for how organisational capabilities and routines emerge and evolve through organisational learning processes. According to Crick and Chew (2020), sociotechnical organisational routines are repeatable patterns of interaction, applying existing organisational capabilities to execute business processes that evolve and embed in practice, intending to align with managerial goals.

Complexity literature describes "emergence" as various phenomena in CAS whereby the system transforms into a new state by learning to adapt to its changing environment (Turner and Baker, 2019). The notion of "emergence" stems from the system's nonlinear, rich and

dynamic interactions implying that the system's behaviour cannot be predicted by inspecting its individual parts (Cilliers, 2000b).

Emergence occurs when the system's behaviour, as a whole, amounts to more than a simple aggregation of its parts (Holland, 2002). Emergence cannot be deduced from the qualities of its parts because it emerges from the complex system and its organisation as a whole (Morin, 2007). Holland (2002) describes the phenomenon of emergence as "perpetual novelty generated by finite means". Morin (2007, p. 5) encapsulates Jacques Monod's definition of emergence as "qualities and properties that appear once the organization of a living system is constituted, qualities that evidently do not exist when they are presented in isolation". Thus, emergence stems from the irreducibility and self-organisation of the CAS.

Applying a CAS lens to agile EDM provides a way to explain the dynamic components of how agility, as the desired outcome, emerges and evolves from the actions and interactions of agents in the complex and complicated sociotechnical contexts of EDM. Juarrero (2000, p. 33) offers a summary of the emergence and evolution processes in a CAS: "complex adaptive systems exhibit true self-cause: parts interact to produce novel, emergent wholes; in turn, these distributed wholes as wholes regulate and constrain the parts that make them up".

Without constraints that govern and enable the system, there cannot be the emergence or evolution of phenomena in a CAS (Juarrero, 2015b; Snowden and Rancati, 2021). The process of emergence and evolution of phenomena in complex systems — for example, a new mindset or organisational culture — is iterative because, once the newly emergent phenomenon has constituted itself, it becomes a context-free (governing) constraint that embeds in the system — for example, as bias or knowledge — to govern the emergence of new phenomena in subsequent iterations (Juarrero, 2015a, pt. 23:40). In a continual iterative process, context-sensitive (enabling) constraints allow the system to adapt and, at closure, emerge context-free (governing) constraints that evolve the system through the embedment of knowledge, rituals and practices (Juarrero, 2015a, pt. 23:38, 2015b; Snowden and Rancati, 2021).

Complicated contexts hold multiple suitable solutions, and it is the domain where experts who understand the causes and effects involved must analyse the options to provide governing constraints that increase the probabilities for favourable outcomes. However, in

complex contexts, the system and the agents constrain each other continually, and enabling constraints empower agents to allow phenomena to emerge from complexity, thus inhibiting the predictability of any event occurring (Juarrero, 2000; Snowden and Boone, 2007).

In a system where everything is equiprobable, all events are random, i.e. each event is equally probable to occur as any other event in the system (Juarrero, 2015a, pt. 09:30). Such a system state could be visualised as an utterly smooth landscape devoid of any dispositions or propensities serving as attractors (Juarrero, 2000). In other words, the system has no constraints, contains no information or structure, and thus has no identity (Juarrero, 2000). In this state, nothing is enabling or restricting the system's behaviour, and for something meaningful to emerge from the behaviour of its components, the system must move far from equilibrium, where some events are much more likely to occur than others.

A very stable system tends to rapidly settle around a small number of strong attractors resulting in the system's behaviour becoming more predictable and fixed, thereby limiting the emergence of novelty. In contrast, the absence of strong attractors characterises precarious systems resulting in unpredictable, chaotic system behaviour (Cilliers, 1998). For example, data management frameworks aim to create structure and stability for organisations' data management practices by clearly defining roles, functions and processes (Ofner, Huener and Otto, 2009; Brous, Janssen and Vilminko-Heikkinen, 2016; DAMA International, 2017). A system in perfect equilibrium is uninteresting as the probability of all events is perfectly predictable and thus void of emerging novelty (Juarrero, 2015a, pt. 09:30). Therefore, this study takes an interest in CAS dynamics as they poise and transition between complexity and complicatedness in EDM contexts while producing, reproducing and integrating the emerging and evolving phenomena of agility.

In a CAS, adaptation creates a hierarchical organisation that allows combinations of building blocks at a lower level to evolve into building blocks at a higher level (Holland, 1992, 2002). However, the traditional notion of rigid, clearly defined, permanent hierarchies is incompatible with complex contexts where the system's survival depends on the transformability and adaptability of its structures (Cilliers, 2001).

Exaptation is repurposing, whereby an existing social or technical pattern that was evolved and embedded from previous iterations is repurposed to fit the changed context (Snowden and Rancati, 2021). Knowledge creation employs learning mechanisms, such as repeated

practice, to direct the evolution of dynamic capabilities over time (Eisenhardt and Martin, 2000). Thus, continuous adaptation iterations across levels in the system emerge non-repeatable agility, whereas iterations of adoption across levels in the system evolve repeatable agility (Eisenhardt and Martin, 2000; Juarrero, 2000; Snowden and Rancati, 2021). Even though there is constant change in a CAS, there is also structural repeatability as some patterns stabilise temporarily (Preiser, Cilliers and Human, 2013).

The CAS coevolves with its environment in a way that distinguishing between a specific configuration and system properties at the highest level becomes irrelevant because, as the system evolves, phenomena at the highest level become increasingly shaped by phenomena that are progressively closer to the emergent level (Juarrero, 2015b). As Juarrero (2015b) explains, the repeating dynamic iterations of constraint closure stabilise configurations in the system, enabling self-direction and autonomy of the system's conscious, sentient and self-aware agents. With each iteration, newly emergent phenomena at the lower levels issue control and behavioural patterns that are then embodied at the global level of the CAS (Juarrero, 2015b, p. 520).

5.2.3 Agile enterprise data management as a dynamic multi-level construct

In the qualitative case study of DSR Cycle 1, contextualised differences were found in the dynamic capabilities and agility features, depending on whether the context was complex or complicated. In addition, the analysis showed that, in some cases, agility faltered, presenting unintended consequences for agility resulting from DM agents' decisions and actions. As discussed in the previous section, agility is a phenomenon that emerges from complex contexts and evolves in complicated contexts.

In complex and complicated organisational contexts, decision-making occurs at Cynefin's "key decision points" at the liminal boundary between complex and complicated, thus transitioning the system's sense-respond state through the liminal area of Cynefin (Snowden, 2021c). Therefore, contextualised decision-making enables dynamics for effective transitions, resulting in improved outcomes, through key decision points at the boundary between these two domains (Snowden, 2021c; Snowden and Rancati, 2021).

Salthe (2012, p. 351) proposes that a three-level hierarchy is suitable for modelling stability because "a third level always anchors relations between the other two, and so the middle, focal level cannot be reduced either upward or downward by assimilation into a contiguous

level". The highest level, the complex and complicated system, is the main focus, with the sub-levels providing the macro-level with cumulative initial conditions through feedback loops (Salthe, 2012).

Crick and Chew's (2020) research on the microfoundations of agility in organisations applied Coleman's (1986) work on how individual action at the micro-level emerges phenomena at the macro-level of an organisation. Similarly, Eisenhardt, Furr and Bingham (2010) applied Coleman's concept of individual actions influencing macrosocial functioning, proposing that organisational processes with shared heuristics emerge from the group and individual actions to bring about improved firm performance.

By placing CAS as a lens on the agility problem in EDM, considering the role of dynamic capabilities in connecting and interrelating the sociotechnical strategies and actions in complex and complicated sociotechnical contexts, and adopting decision-making as a mechanism for transitions (as proposed by Cynefin), the proposed concept for the dynamic components of agility in complex and complicated sociotechnical contexts comprises three levels, which are synthesised and discussed in the following sections. The meso-level building blocks interrelate the macro- and micro-levels without assimilating the system into a contiguous level, providing practical units of analysis for the qualitative case study conducted in Chapter 6 (Part II of DSR Cycle 2).

5.2.4 Macro-level: complex and complicated sociotechnical contexts

DSR Cycle 1 concluded that achieving organisational agility is strategically important and requires IT and EDM to enable it. Therefore, strategic management at the meso-level of EDM should sense and respond to opportunities to achieve and improve agile EDM, supporting agility at the macro-level, thus, for the whole EDM organisation. EDM strategy exercises top-down constraints (whole-to-part) on the lower levels in the EDM organisation to "steer" the overall system towards favourable agility outcomes.

When organisational contexts are complex, organisational strategising, management routines, and planning can set a goal-based direction towards, but not control and guarantee, desired outcomes (Kurtz and Snowden, 2003). Thus, decisions cannot be made to "cause" predictable outcomes in complex contexts (Kurtz and Snowden, 2003; Park, El Sawy and Fiss, 2017). When contexts are less complex and more complicated, and enough knowledge exists, experts can know how to predict and achieve desired outcomes (Kurtz

and Snowden, 2003; Park, El Sawy and Fiss, 2017). Thus, decision-making in complex and complicated contexts can have intended outcomes or unintended consequences.

“Emergence” occurs when “the whole of the system's behaviour goes beyond the simple sum of the behaviours of its parts” (Holland, 2002, p. 25). A system is fractal when it has self-similarity across multiple levels. Self-similarity implies resemblance, as opposed to one-to-one equivalence, and similar but different variables operating at different levels can emerge and evolve changes bottom-up to higher levels in the system (Ramos-Villagrasa *et al.*, 2018). Thus, agility features as emergent phenomena would maintain resemblance across the system's micro-, meso- and macro-levels.

The system’s overall agility state continuously transitions between the complex and complicated domains and downwards through the levels of the CAS. Governing constraints at the overall level of a CAS constrain the system top-down, thereby maintaining and enhancing the system’s state as a whole (Juarrero, 1999). Therefore, the overall EDM sociotechnical contexts and strategic management at the macro-level exercise top-down constraints (whole-to-part) on the EDM organisation as a whole.

5.2.5 Meso-level: dynamic capabilities in complex and complicated sociotechnical contexts

Teece (2023, p. 125) defines dynamic capabilities as “a framework that recognizes complex interactions within a firm, with other firms, and with the business environment in a quest to understand long-run enterprise performance”. Dynamic capabilities assign the harnessing and managing of opportunities to management roles in the organisation (Teece, 2023). As discussed in DSR Cycle 1, achieving organisational agility is strategically important and requires IT and EDM to enable organisational agility. Therefore, management at the meso-level of EDM should sense and respond to opportunities to achieve and improve agility in EDM to enable agility for the enterprise.

Dynamic capabilities were identified from the literature and confirmed in the qualitative case study as structural components of agile EDM in DSR Cycle 1. The original dynamic capabilities theory was authored by Teece, Pisano and Shuen (1997) but was further explained for practical use in firm performance by Pavlou and El Sawy (2011). In an organisation, dynamic capabilities reside at the managerial level, where principles can be applied to trade-off agility for efficiency and represent higher-order capabilities that govern

activities (Teece, Peteraf and Leih, 2016). For example, coordination capabilities are required to perform project management activities (Zheng, Venters and Cornford, 2011), learning capabilities are needed to grow expertise and competence (Sambamurthy, Bharadwaj and Grover, 2003; Snowden and Rancati, 2021), a sensing capability is essential to make effective management decisions (Kurtz and Snowden, 2003; Teece, 2023), and integration capabilities are required to integrate deliverables into value-creating processes (Sambamurthy, Bharadwaj and Grover, 2003; Pavlou and El Sawy, 2011).

Entrepreneurial managers use dynamic capabilities to drive organisational change (Teece 2014). Nijssen and Paauwe (2012, p. 3316) define the focus of dynamic capabilities as "the process of transformation of organizations — as a result from changes in the environment — which leads to a break in routines and involves a shift in competencies and required knowledge". Eisenhardt, Furr and Bingham (2010, p. 1263) define the microfoundations of dynamic capabilities as: "the underlying individual-level and group-level actions that shape strategy, organization, and, more broadly, dynamic capabilities, and lead to the emergence of superior organization-level performance". Therefore, dynamic capabilities are understood in this study of agile EDM to exercise top-down and bottom-up constraints (whole to part and part to whole) in complex and complicated sociotechnical contexts. The meso-level represents the sensing and seizing of opportunities for, and threats to, improving agility in complex and complicated sociotechnical contexts, such as EDM.

Dynamic capabilities theory recognises the importance of adaptation through feedback loops and learning through collective sensing (scanning the environment and contextual diagnoses of problems to enable action), coordination and integration of knowledge (Pavlou and El Sawy, 2011; Teece, 2018). The terms "sensing", "learning", "coordinating", and "integrating" were adopted in this study from the research on dynamic capabilities done by Pavlou and El Sawy (2011).

Peppard (2018) points out that understanding how IS knowledge is coordinated and integrated across diverse teams and disciplines in organisations remains less developed in scientific literature. Organisational routines comprise social action and interaction (Leonardi, 2011), and the capacity to act implies agency (Giddens, 1984). Teece, Pisano and Shuen (1997, p. 520) define routines as "patterns of interactions that represent successful solutions to particular problems". In CAS, patterns are repeatable building blocks that were useful in the past, and can be successfully applied again in the future (Holland, 1992). Holland (1992,

p. 26) further explains that "[o]verall, these mechanisms allow a complex adaptive system to adapt, while using extant capabilities to respond, instant by instant, to its environment".

Steininger, Mikalef, Pateli and Ortiz-de-Guinea (2022) acknowledged the importance of dynamic capabilities theory in IS research in their extensive critical review of the use of dynamic capabilities in IS studies. They found that most IS research focused on the strategic role of IT in creating business value and competitive advantage for the firm. Steininger *et al.* (2022) identified three themes in existing IS research with problematic use of dynamic capabilities: (1) studies creating conceptualisations of dynamic capabilities and IT; (2) studies of the impacts of IT and dynamic capabilities; and (3) studies with a stagnant perspective of dynamic capabilities in IS, where the firm is the central unit of focus and dynamic capabilities are viewed as static. The first two concerns raised by Steininger *et al.* (2022) relate to research on dynamic capabilities as they apply to IT and technology. However, the third concern is relevant to this research of agile EDM as it calls for IS research to consider the "[i]ncorporation of temporal perspective in the study of DCs [dynamic capabilities] in IS research", to "[i]nvestigate how internally misaligned rhythms may cause temporally uncoordinated actions", to investigate the "evolutionary relationship between IT, DCs [dynamic capabilities], and performance outcomes", and how technology and dynamic capabilities produce transformations that span organisational boundaries (Steininger *et al.*, 2022, pp. 460–461).

Dynamic capabilities and agility in organisations

In considering the relationship between IT and organisational agility, IS research contributions have often applied dynamic capabilities as a theoretical lens (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Roberts and Grover, 2012; Richardson *et al.*, 2014; Park, El Sawy and Fiss, 2017; Queiroz *et al.*, 2018).

Teece, Pisano and Shuen (1997, p. 516) define dynamic capabilities as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments". Building any capabilities in an organisation includes the "patterning of activity" (Winter, 2003). Eisenhardt and Martin (2000, p. 1118) conceptualise dynamic capabilities as "tools that manipulate resource configurations" into "value-creating strategies". Dynamic capabilities govern activities within the organisation, stand apart from the organisation's strategy and intentions, and enable the organisation to produce desired

outcomes in continually changing business environments (Teece, 2014). However, obtaining desired outcomes is a temporary state as continuous change will eventually require an organisation to find new ways of reaching its goals (Preiser, Cilliers and Human, 2013).

The options open to an organisation's paths through time are a function of its current position, shaped by its historical course and the possible trajectories towards a future state (Teece, Pisano and Shuen, 1997; Snowden, 2002). Dynamic capabilities are grounded in high-performance routines or patterns enacted within the organisation, shaped by the firm's history, and embedded in its processes (Teece and Pisano, 1994). The structural patterns of dynamic capabilities in an organisation vary depending on the level of volatility in the organisational environment. High-velocity environments exhibit semi-structured routinisation, whereas robust, structured patterns manifest in moderately dynamic organisational environments (Eisenhardt and Martin, 2000). Eisenhardt and Martin (2000) propose that dynamic capabilities are identifiable and specific rather than unclear or tautological.

The structural components of dynamicity for moderately and highly dynamic environments are described in Table 5-2.

Table 5-2: Dynamic capabilities and types of dynamic environments (based on Eisenhardt and Martin (2000, p. 1115))

Determinant	**Moderately dynamic environment (complicated contexts)**	**Highly dynamic environment (complex contexts)**
Characteristics of the environment	Stable structure, linear and predictable change, clear boundaries and business models, identifiable actors	Unstable/ambiguous structure, nonlinear and unpredictable, blurred boundaries, fluid business models, shifting and ambiguous actors
Patterns/ routines	Analytic and detailed patterns relying mainly on existing knowledge	Simple routines that are experiential and rely on newly created situational-specific knowledge
Execution style	Linear	Iterative
Stability status	Stable	Unstable
Outcomes	Predictable	Unpredictable
Key to effective evolution	Frequent, close-proximity variation	Selection that is managed with prudence

Environmental factors such as dynamism, uncertainty and heterogeneity of the organisational capabilities influence the effectiveness of those capabilities (Drnevich and Kriauciunas, 2011; Teece, Peteraf and Leih, 2016). Research conducted by Drnevich and Kriauciunas (2011) examines how the positive and negative influences of capability heterogeneity and environmental dynamism on dynamic and ordinary capabilities impact organisational performance.

Winter (2003, p. 992) defines ordinary capabilities as routinised activity patterns that enable the firm to "earn a living by producing and selling the same product, on the same scale and the same customer population". In contrast, Winter (2003, p. 991) defines dynamic capabilities as "those that operate to extend, modify or create ordinary capabilities".

Pavlou and El Sawy (2011) adopt Winter's (2003) definition of ordinary capabilities, terming them "operational capabilities" that enable the firm to perform its routinised everyday activities. According to Pavlou and El Sawy (2011), dynamic capabilities enable the creation and evolution of operational capabilities, reconfiguring them in response to changes in the environment. Pavlou and El Sawy's (2011) research aimed to provide a concise understanding of dynamic capabilities and developed a framework comprising four measurable dynamic capabilities, which is presented in Figure 5-10.

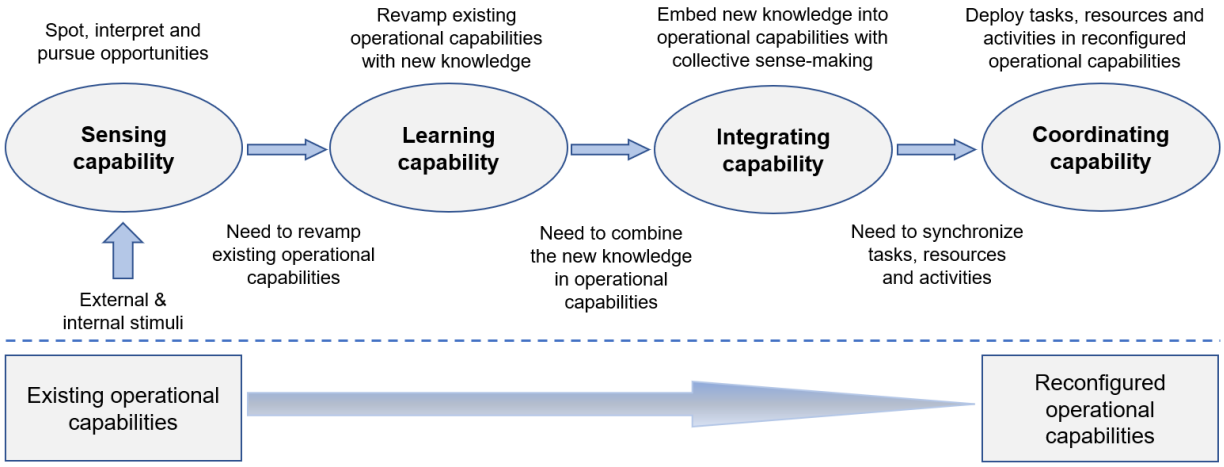


Figure 5-10: A framework for measurable dynamic capabilities (reproduced from Pavlou and El Sawy (2011, p. 243))

Operational capabilities concern the organisation's ability to perform ordinary or day-to-day activities. Operational capabilities are supra-individual in that they develop from collaborative activities and do not reside within any specific individual (Pavlou and El Sawy, 2011). Knowledge of operational (also called ordinary) and dynamic capabilities, as defined in the literature, is synthesised in Table 5-3.

Table 5-3: A synthesis of dynamic and operational capabilities

Capability	Type	Description of construct
Strategic planning and decision-making	Sensing (Dynamic)	Sensing capability is the ability to become aware of, make sense of, and act upon opportunities presented in the organisational environment (Pavlou and El Sawy, 2011). For improved strategic planning and decision-making capability, managers in volatile environments require a higher understanding of how to manage risk ("known probabilities") and uncertainty ("unknown unknowns") differently (Teece, Peteraf and Leih, 2016). Dynamic capabilities emerge when managers effectively combine their diverse functional, personal and business expertise to make strategically important decisions for the organisation (Eisenhardt and Martin, 2000).
Configuration and integration of resources	Integrating (Dynamic)	Integration capability enables the combination of new individual knowledge and patterns of interaction with operational capabilities into a unified system to emerge new compositions of operational capabilities (Pavlou and El Sawy, 2011). Dynamic capabilities emerge when managers effectively combine their diverse functional backgrounds and skills to configure and integrate resources (Eisenhardt and Martin, 2000).
Deliberation in action	Integrating (Dynamic)	Awareness of when to choose to deliberate in action over favouring reliance on established patterns contributes to the emergence of dynamic capabilities (Wollersheim and Heimeriks, 2016).
Knowledge creation	Learning (Dynamic)	Learning capability is the ability to revise and overhaul existing operational capabilities through the acquisition, assimilation, transformation and exploitation of knowledge (Pavlou and El Sawy, 2011). Knowledge creation employs learning mechanisms, such as repeated practice, to direct the evolution of dynamic capabilities over time (Eisenhardt and Martin, 2000).
Coordination and coevolution	Coordinating (Dynamic)	Coordinating capability involves the effective orchestration and deployment of tasks, activities and resources in the new configurations of organisational capabilities (Pavlou and El Sawy, 2011). Continuous transformation and renewal are central to dynamic capabilities (Teece, Peteraf and Leih, 2016). Shifting synergies within the firm evolve through the patterns managers apply to connect and reconnect collaborative networks between the various actors and teams of the organisation (Eisenhardt and Martin, 2000).

Capability	Type	Description of construct
Existing knowledge	Operational/ ordinary	Existing knowledge in the organisation supports the evolution of dynamic capabilities when actors can discern to what extent the existing knowledge can be applied successfully relative to the dynamicity of the environment (Eisenhardt and Martin, 2000).
Existing patterns/ routines	Operational/ ordinary	Existing patterns and routines in the organisation are vital to dynamic capabilities (Teece, Peteraf and Leih, 2016). Routines support the evolution of dynamic capabilities when actors can discern to what extent the existing pattern/routine can be applied successfully relative to the dynamicity of the environment (Eisenhardt and Martin, 2000).
Existing expertise	Operational/ ordinary	Existing expertise in the organisation supports the evolution of dynamic capabilities when actors can discern to what extent the existing expertise can be applied successfully relative to the dynamicity of the environment (Eisenhardt and Martin, 2000).

Sensing in complex and complicated contexts

In this study, the dynamic capability of "sensing" is enacted through sense-making. Turner, Snowden and Thurlow (2022, p. 1) define sense-making as the process of how "we make sense of the world so we can act in it, using (naturalizing) natural sciences as a constraint to determine not only what is possible, but what is impossible coupled with the idea of taking action, or executing tasks, to creating meaning". For example, data management agents use their cognition to sense and make value judgements, influenced by their feeling and emotions, about whether available data will address a business requirement (Kettinger and Marchand, 2011).

Like motivation and other human attributes, perception is not simply an aggregation of unconnected "perceptions" but is a flow embodied in human movement in space-time. Anticipatory schemata organise perception as the human agent anticipates new information as it is received and simultaneously integrates it with preexisting information (Giddens, 1984, p. 46). Beckage *et al.* (2013, p. 2) propose that "[h]uman social systems create their own 'adjacent possible' through the creativity of sentience, and accumulate and store this information culturally, as reflected in the emergence and evolution of, for example, technology".

Anticipatory awareness is a concept that is central to sense-making whereby complexity is approached by acknowledging that the future is unpredictable, thus considering what can be done in the present for a better future (Snowden, 2021b, pt. 03:19). It is crucial to understand the present well enough to manage its evolutionary potential, thus navigating towards a favourable future state. The message is to "do the next right thing", then scan the environment and repeat this process, thereby creating points to "stop and think" instead of formulating a plan upfront and expecting to execute it precisely from start to finish (Snowden, 2021b, pt. 03:19).

Learning in complex and complicated contexts

An organisation's capabilities are knowledge assets that must be gradually built up over time through organisational learning (Bleda, 2017). Feedback loops, adaptation, and evolution all pertain to a CAS's ability to learn (Turner and Baker, 2019). The ongoing activities of distributed and diverse individuals constitute knowing in practice (Orlikowski, 2002). Thus, "knowing" and practice have a mutual constitution (Orlikowski, 2002). Transitioning the CAS from complex to complicated is an iterative learning process requiring energy to embed increased expert knowledge into practice (Snowden and Rancati, 2021). Learning is a process requiring time and space to allow for the emergence of new meaning (Snowden, 2002).

Snowden (2002, p. 102) emphasises three changes required to the mindset for managing knowledge: (1) knowledge cannot be conscripted but only volunteered as it is impossible to tell whether someone is applying their knowledge, but their compliance to a process is assessable; (2) "we can always know more than we can tell, and we will always tell more than we can write down" — speaking on a topic requires less time than writing about it, and writing is a reflective process and cannot contain the exact and complete original thought or whole experience; and (3) "we only know what we know when we need to know it" — the context of someone's "knowing" must be recreated before one can ask meaningful questions about their knowledge or enable the use of their knowledge. Thus meaningful knowledge is contextual and requires interaction in its application in the real world (Juarrero, 2000).

Integrating in complex and complicated contexts

Giddens (1984, p. 28) defines integration in social systems as "involving reciprocity of practices (of autonomy and dependence) between actors or collectivities", thus

complementing the distinction between reflective self-regulation and stable causal loops driven by an overall motivation to integrate routine practices in a CAS over space and time (Giddens, 1984, pp. 28, 64). Integration by mutual agreement of individual agents' efforts enables the team's effort to transcend the individual (Bolman and Deal, 2017). As Bolman and Deal (2017, p. 44) analogically explain, "[a]ll rowers have to optimize their strokes for the benefit of the boat".

Complexity studies revealed notable theoretical dynamics of emergence whereby unconnected and local forms of interaction evolve into interconnected forms creating more institutionalised and integrated structures (Langley *et al.*, 2013). However, the more complex an organisation's role structures become, where many people perform a multitude of diverse activities, the harder it becomes to sustain a tightly integrated, focused organisation (Bolman and Deal, 2017).

Coordinating in complex and complicated contexts

Cooperation and coordination among diverse individuals are crucial for team performance because these enable synergy and synchronised motion, integrating individual efforts and transcending the individual (Bolman and Deal, 2017). Teams within a CAS are self-organising entities that adapt effectively by coordinating explicitly, such as sharing information and expertise within the team (Ramos-Villagrasa *et al.*, 2018).

The effectiveness of agents' coordination efforts across organisational boundaries depends on their skills and credibility in interacting with stakeholders (Bolman and Deal, 2017). By building informal networks that span across organisational silos, organisational teams' resilience when operating in complex contexts is enormously enhanced based on high levels of trust when working together (Snowden, 2002; Snowden and Rancati, 2021). Informal networks are context-specific entanglements that create very effective channels for information flow and coordination within the context of a specific need (Snowden, 2021b, pt. 34:50).

Contextual constraints in a CAS expand the heterogeneity of states accessible to the whole system by coordinating and correlating previously aggregated components into a more complex, systematic, differentiated whole (Juarrero, 2000, p. 36). For novelty to emerge in a CAS, there must be an ongoing foundation of interaction, collaboration and interdependence. Context-sensitive constraints create interactivity and interdependence in

a CAS, making things possible at a lower level, such as a task level (Juarrero, 2015a, pt. 15:40).

5.2.6 Micro-level: teams and individuals acting in complex and complicated sociotechnical contexts

The cognitive processes of rationalisation, motivation and reflection underlie all human action and relate directly to human intention (Giddens, 1984). However, technology affordances are not always predictable and controllable, making contexts where social and technological agents are entangled brittle and ephemeral, resulting in intended and unintended consequences of agents' actions (Orlikowski, 2007). Meyer, Gaba and Colwell (2005) explain that, in the entangled ecology of organisations, one agent's actions contribute to the construction of another agent's context, catalysing forces that form networks of social structures across different levels. Processes of structuration in organisations generate routines from agents' actions that construct progressively coherent patterns of interaction, shared governance, collective awareness and information sharing (Meyer, Gaba and Colwell, 2005). The routines and technologies in organisations are becoming increasingly flexible and continuously require changes in the human and material agents' actions and interactions (Leonardi, 2011).

Giddens (1984, p. 22) proposes that all social agents "are highly 'learned' in respect of knowledge which they possess, and apply, in the production and reproduction of day-to-day social encounters". The individuals in organisational contexts act with awareness, purpose, and reflexivity, routinely and continually monitoring the flow of their own and others' actions and their enactments' physical and social contexts (Orlikowski, 2002). Orlikowski (2002) views social agents, in addition to being reflexive, as knowledgeable and able to provide a rational account of their actions. As agents use opportunities and motivation to modify their practices by learning through reflection, improvisation and experimentation, their "knowing" changes in concert with their practices (Orlikowski, 2002). However, Giddens (1984) points out that most agents' knowledge is practical, not theoretical, and further distinguishes discursive knowledge as verbalisable from practical knowledge, which is tacit by nature. Therefore, the relationship between what agents know and how they apply what they know in their actions is not always discernible.

Figure 5-11 illustrates that action is not merely an aggregation of distinct acts, each driven by a cognate motive because motivation is processual in that reflective monitoring of action is seldom directly influenced by the unconscious, and the sustained relationships among agents in their routine practices mediate the connections that constitute motivation (Giddens, 1984).

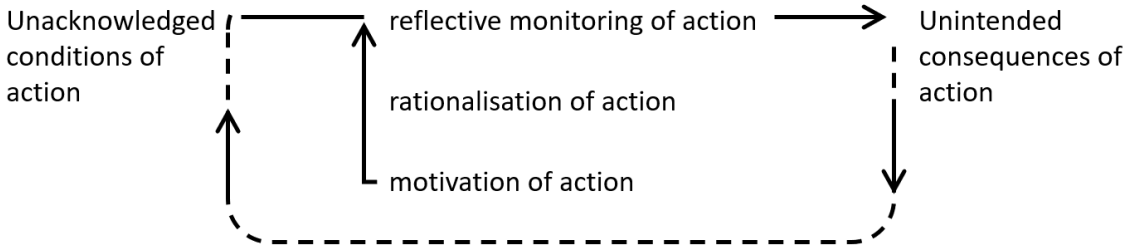


Figure 5-11: The stratification model of the agent (reproduced from Giddens (1984, p. 5))

As social agents act with knowledge and reflection in organisations, interaction patterns establish standardised practices, such as coordinating a meeting, managing a project or manufacturing a product (Orlikowski, 1992). The habitual use of these practices becomes institutionalised over time to constitute structural properties in the organisation that agents then utilise in their ongoing interactions, which, in turn, strengthens the institutionalised properties (Orlikowski, 1992).

Actions at the micro-level contribute to collective organisational change over time (Eisenhardt, Furr and Bingham, 2010) and emerge collective action at the macro-level (Meyer, Gaba and Colwell, 2005). Thus, actions and interactions at the micro-level exercise bottom-up constraints (part to whole). However, Giddens (1984) explains that, despite the significant influence of micro-level behavioural patterns on the overall system, it is not meaningful to understand the macro-processes of social organisations as aggregations of coexisting micro-situations or as aggregated products of interactions occurring at the micro-level.

Eisenhardt, Furr and Bingham (2010) add that collective constructs change over time, influenced by the outcomes and consequences of interactions at the micro-level. At the micro-level, agents' motivation, skills and interpretation of the organisational routines are enacted in their practices, yet routines are subject to the agents' interpretation and are,

therefore, subject to adaptation and workarounds as the agents sense and respond to constraints in the operative context (Crick and Chew, 2020).

As observed at the case study organisation, the EDM functions within an organisation consist of forums, project and operational teams, committees and other collaborative networks of diverse specialists, perpetually organising and reorganising while aligning with business requirements for data delivery. It is not easy to represent all facets of understanding, decision-making and action where collective identities and multiple dynamic individual identities operate simultaneously (Kurtz and Snowden, 2003).

EDM comprises many interdependent data management functions performed by individuals and teams of specialists who interact in a coordinated, integrated way in complex and complicated data management contexts to deliver valuable data to the business (DAMA International, 2017; Legner, Pentek and Otto, 2020). Complicated problems in organisations can be solved when the required expertise is available and utilised by applying rules and routines, and through command-and-control approaches that rely on embedded organisational processes and hierarchies (Nason, 2017). Specialists in the data management disciplines have the expertise and actionable know-how to analyse and guide data management solutions in complicated contexts (DAMA International, 2017; Legner, Pentek and Otto, 2020). However, when conditions are uncertain, it is more challenging to maintain control as expertise cannot provide concrete answers to problems in complex contexts (Kurtz and Snowden, 2003).

5.2.7 Decision-making in complex and complicated sociotechnical contexts

Decision-making occurs at key decision points at the boundary between complex and complicated contexts (Snowden, 2021c) at all three levels of the EDM organisation. The macro-level is where strategic EDM decisions are made, resulting in top-down dynamics that feed back into the managerial/oversight level (dynamic capabilities) and the work execution level. At the meso-level, data management policy, planning and oversight (managerial) decisions are made, exercising top-down and bottom-up dynamics, feeding back to the overall EDM organisation and work execution levels. Data management teams and specialist individuals make decisions at the micro-level, where bottom-up dynamics feed back into the managerial/oversight and overall EDM organisation levels.

Lapalme *et al.* (2016) suggest that coordinated decision-making and acting are essential to cope with complexity and uncertainty. By allowing decisions to be made at the organisational level where understanding of the ongoing context is highest, and instilling a sense in the actors that they are part of a larger context, individuals and teams are empowered and enabled to cope with complexity (Lapalme *et al.*, 2016). Nijssen and Paauwe (2012) emphasise that because dynamic environments are fast-paced, it is crucial that employees build a shared understanding of the objectives and goals of the organisation, and that they are involved in rapid decision-making processes to contribute to the quality of the decisions taken. Therefore, this study views effective decision-making as occurring at the macro-, meso-, and micro-level in complex and complicated organisational contexts.

Complexity is the domain of unknown unknowns without causality, whereas complicatedness is the domain of known unknowns exhibiting direct links between causes and effects (Kurtz and Snowden, 2003). Snowden and Boone (2007, p. 5) explain that "[i]n a complicated context, at least one right answer exists. In a complex context, however, right answers can't be ferreted out". However, as acknowledged early on in this chapter, there is no sharp, demarcated boundary between the complex and the complicated, and they can coexist (Tsoukas and Hatch, 2001; Kurtz and Snowden, 2003; Holland, 2014). Complex contexts require a complex systems thinking approach, as strategies and plans cannot be guaranteed to produce the desired outcomes. Thus, flexibility and adaptation are critical for positive results when navigating problems in complex contexts (Nason, 2017).

Challenges to decision-making for action in complexity

An organisation can be seen as complex when cascades of changes exceed the actors' capacity to recalibrate and adapt to the changes (Hannan, Polos and Carroll, 2002). When faced with real-world complexity, organisational processes unfold to find "good enough" answers in response to questions for which the best answers are unknowable because what people cannot do, they will not do even when highly motivated to do it (Simon, 1996).

Indecision and ineffective decision-making can negatively influence agility in a CAS at transition boundaries resulting in the system moving towards faltering agility. As Hannan and Freeman (1984, p. 151) point out, "even when actors strive to cope with their environments, action may be random with respect to adaptation as long as the environments are highly uncertain or the connections between means and ends are not well understood".

If agents acting in a system were perfectly rational and possessed complete knowledge to inform their choices at all times, they would be fully adaptable, fast and intelligent in taking the most beneficial action to achieve an optimal outcome for all situations (Waldrop, 1992). The development of management science is founded on the belief that systems are ordered and that competencies can be identified, mapped and replicated to maintain that order (Kurtz and Snowden, 2003). Kurtz and Snowden (2003) have challenged the assumption of "order" in organisational decision-making: that an ideal or right way to do things exists, that it is possible to construct prescriptive and predictive models and craft interventions that enable goal attainment, and that "best practices" can be inferred from causal links in past behaviour to guide future behaviour (Kurtz and Snowden, 2003).

Law (1994, p. 33) warned us of the relevance of uncertainty and our fallibility in attempting to control complexity: "Each one of us is an arrangement. That arrangement is more or less fragile. There are ordering processes which keep (or fail to keep) that arrangement on the road. And some of those processes, though precious few, are partially under our control some of the time". All conditions, scenarios and aspects in organisations constantly emerge, and stability is primarily temporary (Cecez-Kecmanovic *et al.*, 2014).

CASs present difficulties for decision-makers because the different levels of the CAS feed different types of information back through the system, producing nexuses of contingencies through multiple levels in the system, resulting in agents constraining each other mutually even when not interacting directly with one another (Salthe, 2012). Furthermore, there is no clear differentiation between what is complicated or complex (Holland, 2014), and often a context is both complex and complicated (Kurtz and Snowden, 2003).

Complex systems present "wicked problems" that, by their nature, have no "right" or "wrong" answer (Rittel and Webber, 1973). Rittel and Webber (1973) explain that human agents have become aware that the problem-solving actions of the agents in the complex and complicated system generate waves of repercussions through the CAS, increasing the probability that actions targeting one node in the network indirectly result in unintended consequences and can create more significant problems for other nodes elsewhere in the network. This realisation compels human agents to consider how external forces influence their contexts and interactions and how to expand the boundaries of the systems they act in (Rittel and Webber, 1973). At lower levels of the organisation, employees can be very

focused on their localised goals, thus creating a narrow perspective that obscures the broader context of their work in the organisation (Nonaka, 1994).

According to Snowden and Rancati (2021, p. 10), a limitation of human decision-making is that humans tend to "quickly carry out a partial data scan and then filter it through multiple fragmented memories for a 'first fit' (vs a 'best fit') pattern match". Humans tend to make decisions "based on past patterns of success and failure, rather than on logical, definable rules" (Snowden and Boone, 2007, p. 3). The Theory of Bounded Rationality (Simon, 1972) considers the psychology of the decision-maker. Bounded rationality is different from utility-maximising rationality, which assumes that results can be predicted without regard for the decision-making process used by the individual (Simon, 2000).

Simon (2000, p. 25) defines bounded rationality as "the idea that the choices people make are determined not only by some consistent overall goal and the properties of the external world, but also by the knowledge that decision makers do and don't have of the world, their ability or inability to evoke that knowledge when it is relevant, to work out the consequences of their actions, to conjure up possible courses of action, to cope with uncertainty (including uncertainty deriving from the possible responses of other actors), and to adjudicate among their many competing wants."

Intentionality

The reasons humans have for their actions are seldom the best rationale and are rarely consistent across the entire range of available choices (Simon, 2000). Human uncertainty about the present and future state of an environment, and their uncertainty about the behaviours of others involved in the context, must be considered if the dynamics of a given context are to be taken seriously (Simon, 2000).

Kurtz and Snowden (2003) challenge the assumptions of "rational choice" and "intentional capability". Rational choice assumes that human actors will make "rational" decisions based purely on maximising pleasure or minimising pain when faced with a choice of alternatives. The implication is that, through this tendency, collective and individual behaviour can be managed by manipulating the pain/pleasure outcomes and educating the actors on the consequences (Kurtz and Snowden, 2003). Intentional capability assumes that when a capability is acquired, there exists an intention to utilise it and that the actions of individuals

or groups result from intentional behaviour. As Kurtz and Snowden (2003, p. 463) put it: “We accept that we do things by accident, but assume that others do things deliberately.”

The cognitive processes of rationalisation, motivation and reflection underlie all human action and relate directly to human intention (Giddens, 1984). However, “wisdom varies as the occasion requires”, meaning that human behaviour is contextually and temporally embedded (Juarrero, 2000, p. 24). Human action is integral to knowing how to get things done in complex organisational contexts (Orlikowski, 2002). Orlikowski (2002) proposes that “knowing” is an ongoing achievement that is continuously constituted and reconstituted as social actors engage in real-world contexts while performing their practices. Sociotechnical organisational routines stem from the agents’ interaction patterns, and these emerging and evolving practices intend to, but often fail to, align with managerial objectives (Crick and Chew, 2020).

In complex contexts, agility is impossible to emerge through deliberate intentions and actions, but sensing and utilising opportunities to move the system out of complexity towards a complicated state can enable the organisation to become more agile and resilient (Snowden and Rancati, 2021). In complex contexts, multiple agents interact in nonlinear ways, and emergence occurs from the dynamics of these interactions (Snowden and Boone, 2007).

Heuristics and decision-making

Human beings have evolved to continuously assess and scan the environment for problems that must be solved to survive within dynamic contexts: “How are things going? Is there a threat or a major opportunity? Is everything normal? Should I approach or avoid?” (Kahneman, 2011, p. 76). Lissack (2019) explains that questioning and understanding ground the enactment of human agency, providing a foundation for taking action. Thus, when we act, we ascribe our will to act to a fleeting “certainty” in recognising and being prepared to act on an available, acceptable choice despite the complexities of the ongoing context (Lissack, 2019). Having learnt over time to ask whether our actions reflect our conviction of what the right thing to do is, we have come to consider the consequences and output of our actions and pose problem statements in frameworks that enable the evaluation of those outputs (Rittel and Webber, 1973).

Uncertainty is ever-present in complex situations and introduces a risk that, due to actor biases, the desired outcomes might not be generated (Tversky and Kahneman, 1974). Furthermore, unintended, undesirable outcomes can emerge from the complex intertwining of human organisation and the technical aspects of information systems (Cecez-Kecmanovic *et al.*, 2014). Bolman and Deal (2017, p. 22) advise that when dealing with uncertainty and fearing ambiguity and loss of control, "develop creativity, risk-taking, and playfulness in response to life's dilemmas and paradoxes, and focus as much on finding the right question as the right answer, on finding meaning and faith amid clutter and confusion". Merriam-Webster Incorporated (2022, n. p.) states that the word "heuristic" essentially means "using experience to learn and improve". The literal meaning of the word "heuristics" is "the art (or practice) of discovery", derived from the Greek word "heuriskein" that means "to find or discover" (Ulrich, 2005, p. 1).

Humans typically use heuristics when they must make decisions based on incomplete information in conditions of uncertainty to address unclear problems for which there are multiple solutions and the probabilities of the potential outcomes are unknown (Gigerenzer & Gaissmaier, 2011). Simon's (2000) concept of "satisficing" proposes that agents should strive to find "good enough" answers instead of aspiring to find optimal solutions to problems in uncertain environments.

Heuristics are intrinsic to professional practice that deals with qualitative, ill-defined issues, such as what changes would constitute an improvement for an identified problem to be solved for which there is no right or wrong solution (Ulrich, 2005). For example, "achieving agility" is an "improvement" but does not have a "right" or "wrong" solution. To be successful in its application, a heuristic must match the context within which it is applied (Artinger, Petersen, Gigerenzer and Weibler, 2015).

Artinger *et al.* (2015) emphasise the importance of heuristics because their influences traverse organisational hierarchies across the individual and organisational levels. Shared understanding and experience of environmental features spanning organisational levels imply that insights informing heuristics at the managerial level hold value at the individual level and vice versa (Artinger *et al.*, 2015). However, all agents are not perfectly adapted to the given context, thus, a heuristic is functional, having a particular contextualised purpose, but does not necessarily align perfectly with the real world (Gigerenzer and Gaissmaier, 2011). Nonetheless, heuristics can be highly effective in informing decision-making for

enhanced outcomes in complex organisational contexts (Artinger *et al.*, 2015; Schilke, Hu and Helfat, 2018).

5.2.8 Conclusion — A concept for the multi-level dynamic components of agility in complex and complicated sociotechnical contexts

In organisational and IS science, sensing and responding are the overarching concepts for achieving agility in organisations (Sambamurthy, Bharadwaj and Grover, 2003; Park, El Sawy and Fiss, 2017; Tallon *et al.*, 2019). The Cynefin framework explains how effective decision-making in complex and complicated contexts can transition the CAS towards improved outcomes from the sensing and responding capabilities and actions of the organisation's agents (Snowden and Boone, 2007).

This study of agile EDM defines thriving agility as the sustained functional emergence and evolution of constraints that iteratively create and enhance agility features. In contrast, faltering agility is defined here as the emergence and evolution of constraints that iteratively disintegrate agility features with consequential loss of the system's overall agility coherence. Both thriving and faltering agility can emerge and evolve intentionally or unintentionally.

A multi-level perspective is required to understand and explain complexity and complicatedness due to the fractal nature of complexity (Cilliers, 2001; Salthe, 2012; Juarrero, 2015b; Ramos-Villagrasa *et al.*, 2018; Snowden and Rancati, 2021). CASs have multiple levels of organisation, and are characterised by flows, cascades, iterations, feedback loops and transitions (Abraham, 1984; Juarrero, 2000; Snowden and Rancati, 2021). A CAS view of real-world contexts provides scientific foundations to explain bidirectional inter-level causal relationships and differences between stability and resilience in complex networks (Juarrero, 2000).

Based on the structural components of agile EDM developed in DSR Cycle 1, and applying CAS as the underlying theory to explain the dynamics of agile EDM across three levels, this section developed a concept for the multi-level dynamic components of agility in complex and complicated sociotechnical contexts, which is presented in Figure 5-12.

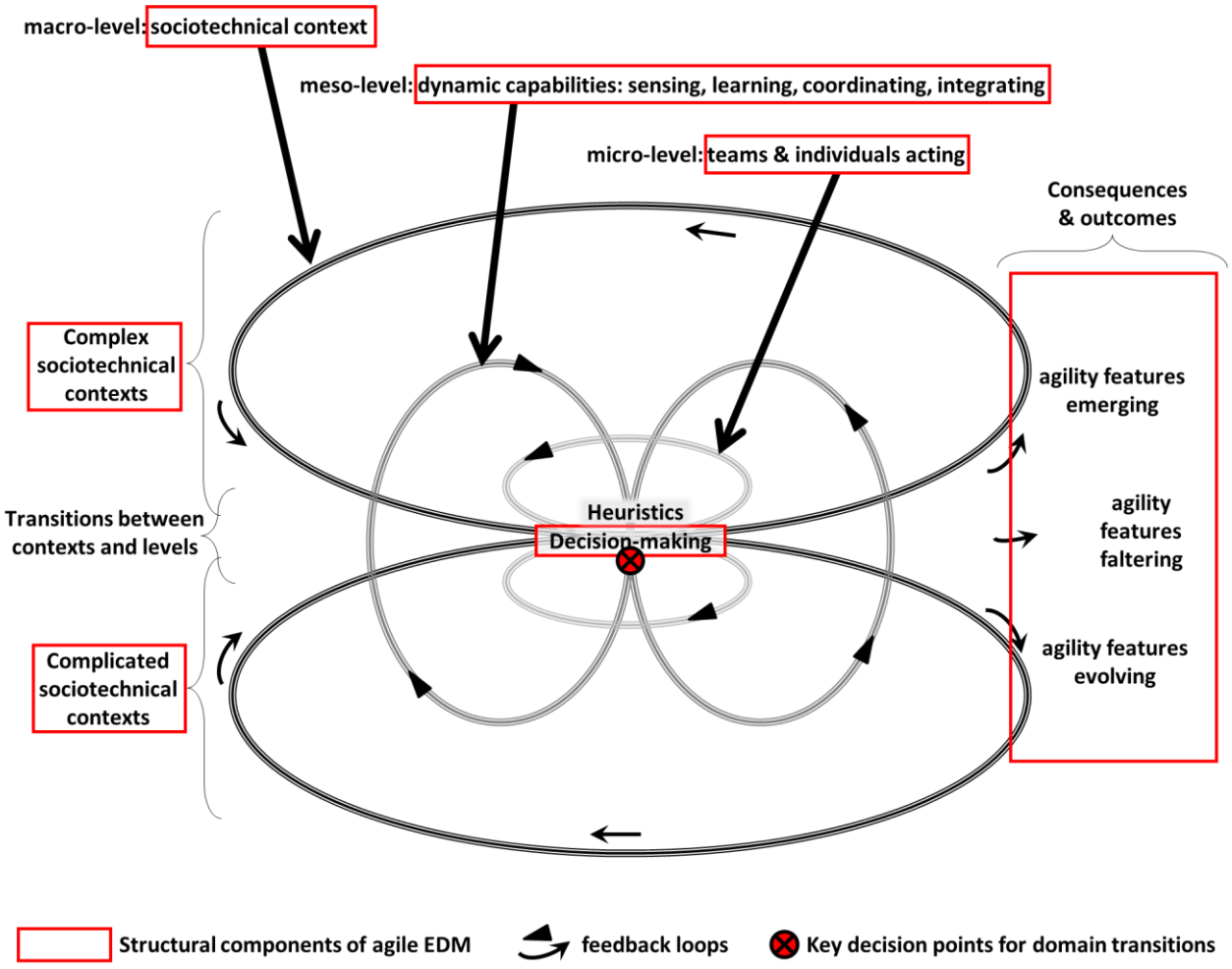


Figure 5-12: A concept for the multi-level dynamic components of agility in complex and complicated sociotechnical contexts (based on Holland (1992); Juarrero (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

As adopted from the Cynefin framework, a CAS transitions between complexity and complicatedness through key decision points (Snowden, 2021c). Thus, the dynamic processes of agility in complex and complicated sociotechnical contexts transition through decision-making at the proposed concept's macro-, meso- and micro-levels. However, challenges to decision-making and agents' intentionality in complex and complicated organisational contexts raised the importance of considering the role of heuristics in decision-making under conditions of uncertainty.

The structural components of agile EDM defined the overall context of EDM as sociotechnical, complex and complicated, providing a perspective of the macro-level dynamics of agile EDM. At the meso-level, dynamic capabilities, as adopted from Pavlou and El Sawy (2011), govern activities and continuously align and realign the organisation's

idiosyncratic resources with its strategy (Teece, 2014). The actions and interactions of teams and individuals represent the micro-level of the proposed multi-level dynamic components of agility in complex and complicated sociotechnical contexts.

Sociotechnical contexts in organisations are complex and complicated and require effective and coordinated decision-making to achieve agility. However, despite decision-making processes, agents in such contexts rely on heuristics to enable quick responses to opportunities and threats (Artinger *et al.*, 2015; Schilke, Hu and Helfat, 2018). Complete knowledge and control for decision-making are not attainable in complex contexts (Simon, 2000; Gigerenzer and Gaissmaier, 2011; Artinger *et al.*, 2015). Therefore, an explanation for the relationship between heuristics, dynamic capabilities and decision-making in complex and complicated organisational contexts is a crucial requirement for developing the dynamic components of agile EDM. The following section raises the third sub-question to address this requirement.

5.3 SQ2.3: HEURISTICS INFLUENCING DYNAMIC CAPABILITIES IN ORGANISATIONAL CONTEXTS

Complex things cannot be wholly known, thus, the behaviour of a complex system, including a CAS, cannot be predetermined (Preiser, Cilliers and Human, 2013). Rational models of managerial decision-making assume that decision-makers have complete knowledge of all possible options and their probabilities and consequences (Simon, 2000). However, managerial decision-making is characterised by uncertainty because organisational contexts are inherently complex (Snowden, 2002; Artinger *et al.*, 2015). Critical managerial decisions in organisations often do not rely on decision rules and technical analysis but instead depend on intuition and creative insight (Teece, 2023). Heuristics are schemata, simple “rules of thumb” that are quick and easy for an organisation’s social agents to use, efficiently guide actions, and allow for the flexible adjustment of other actions in real-time (Eisenhardt, Furr and Bingham, 2010).

As highlighted in the research process in Figure 5-13, a systematic literature search, review and synthesis of how heuristics influence dynamic capabilities in organisational contexts answered the third sub-question of DSR Cycle 2:

SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?

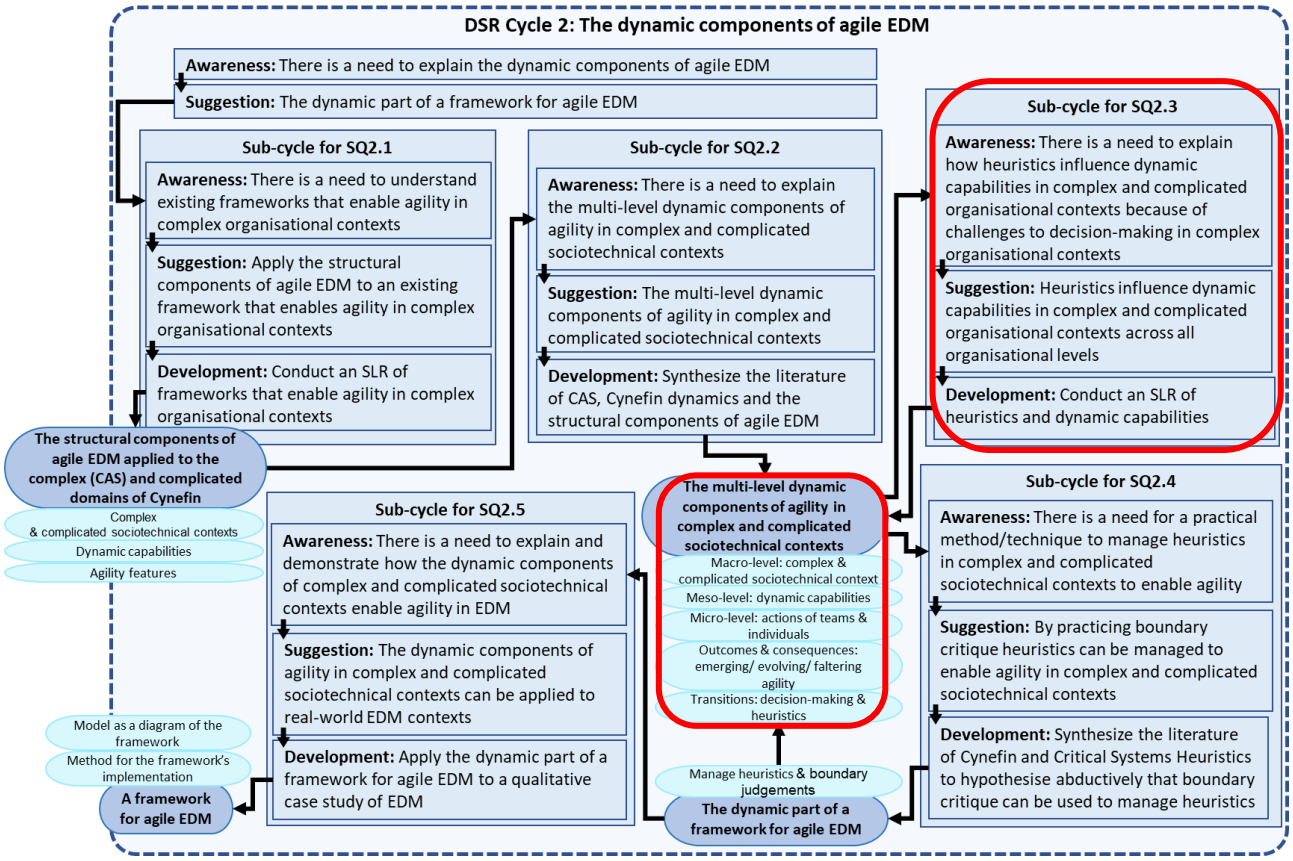


Figure 5-13: Research design — sub-cycle for SQ2.3

5.3.1 Method: a systematic literature review

The systematic literature search and review of how heuristics influence dynamic capabilities was directly shaped by the keywords contained in SQ2.3: “heuristics” (identified in the previous section as an essential consideration for decision-making in complex and complicated organisational contexts), and “dynamic capabilities” (defined as the meso-level constructs of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts). The SLR process adopted the guidelines proposed by Okoli (2015), as presented in Figure 5-14.

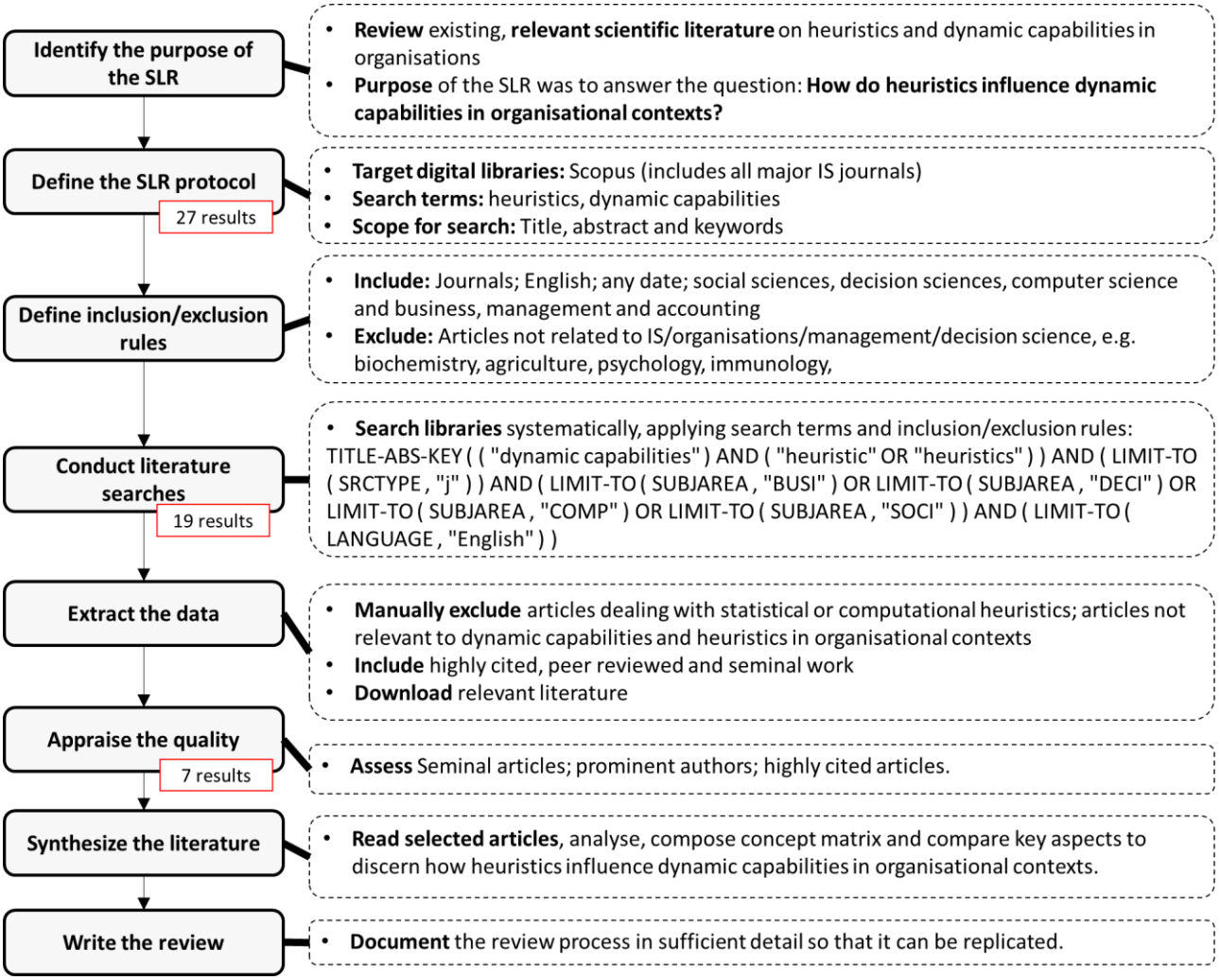


Figure 5-14: Systematic literature review process to find existing knowledge of how heuristics influence dynamic capabilities in organisations (based on Okoli, 2015 (pp. 883–884))

5.3.2 Analysis and findings

The articles found were reviewed, summarised and synthesised based on the concepts relevant to how heuristics influence dynamic capabilities in organisational contexts. Adopting the approach proposed by Webster and Watson (2002), concepts were identified to create a conceptual structure to analyse the articles' relevance to the research question's topic: (1) the purpose, effects and value of heuristics, (2) the implications of using heuristics in decision-making, (3) dynamic capabilities influenced by heuristics, and (4) the organisational level where heuristics were applied in the article. A summary of the findings is presented as a concept matrix in Table 5-4.

Table 5-4: The influence of heuristics on dynamic capabilities in organisational contexts

Articles	Purpose, effects, and value of heuristics	Implications of using heuristics in decision-making	Dynamic capabilities influenced by heuristics	Strategic level	Managerial/ oversight level	Individual/ Team level
Pandza, Horsburgh, Gorton and Polajnar (2003)	Apply heuristics to develop knowledge and capabilities in the organisation that can be exploited in the future.	Valuable capabilities are not the result of rational decision-making driven by pre-determined goals to develop or adopt best practices or improved capabilities. Instead, decisions made using available options are subject to uncertainty due to the incomplete knowledge of decision-makers and the inherent complexity of organisational contexts.	The structures of dynamic capabilities are complex, interrelated and have collective value. Capabilities provide flexibility under conditions of uncertainty.	**X**	**X**	
Eisenhardt, Furr and Bingham (2010)	Heuristics are "uniquely suited to high-performing strategic processes in dynamic environments" (p. 1266). Heuristics allow for flexible real-time adjustments to actions in response to events. Heuristics mitigate organisations' tendency to favour efficiency over flexibility.	Heuristics enable strategists to effectively balance efficiency and flexibility by applying simple rule strategies in key strategic processes. Managerial reflection, understanding, learning, and attention are required for taking actions that balance efficiency and flexibility.	Sensing and responding.	**X**	**X**	**X**

Articles	Purpose, effects, and value of heuristics	Implications of using heuristics in decision-making	Dynamic capabilities influenced by heuristics	Strategic level	Managerial/ oversight level	Individual/ Team level
Bingham and Eisenhardt (2011)	Heuristics are essential to strategy because "(1) heuristics are 'rational', especially in unpredictable markets; (2) capability creation involves the transition of novice to expert heuristics; and (3) simplification cycling of heuristics portfolios is a key dynamic capability, enabling firms to poise at the 'edge of chaos.'" (p. 1459-1460) Opportunity-capture heuristics are 'simple rules' of strategic value.	Heuristics are suitable for most strategic decisions as they involve highly unpredictable situations, entail high levels of heterogeneity, and the actors have limited relevant experience.	Heuristics applied as 'simple rules' are key to enabling and developing dynamic capabilities. Sensing and responding (opportunity capture), and learning (leaders' ability to learn and develop effective heuristics).	**x**		
Bingham and Haleblian (2012)	Firm-level learning of heuristics from negative outcomes across hierarchical and functional levels in the organisation improves heuristics and decision-making.	Informal communication enables decision-making through quick discussion and assessment of available options and promotes learning of heuristics across groups and hierarchies.	Learning across levels and functions from negative outcomes. Coordinating at the collective level using informal communication and tacit knowledge.	**x**	**x**	**x**

Articles	Purpose, effects, and value of heuristics	Implications of using heuristics in decision-making	Dynamic capabilities influenced by heuristics	Strategic level	Managerial/ oversight level	Individual/ Team level
Nijssen and Paauwe (2012)	Heuristics can be effectively applied to identify organisational practices as determinants of organisational agility and evaluate their ongoing effectiveness in supporting organisational agility. Heuristics should support a scalable workforce, fast organisational learning, and highly adaptable organisational structures.	Heuristics influence the speed of, quality of, buy-in for, employee contribution to, and effect of coercive and normative mechanisms on decision-making. Heuristics impact the speed of decision-making in strategic processes. Decisions are often based on incomplete or incorrect information, thus necessitating heuristics. Managers are the dominant decision-makers in organisations.	Organisational agility, sensing, learning, coordinating, and integrating.	**X**	**X**	**X**
Espejo (2015)	Heuristics allow for autonomy, adaptation, and cohesion, enabling self-regulation and self-organisation in organisational systems that must achieve more with fewer resources.	Heuristics allow for autonomy in decision-making.	Reflexive learning understands how actors' actions affect each other, system boundaries and the environment. Dynamic capabilities are viewed as unfolding outcomes of processes enabling ongoing improvement of organisational processes.	**X**	**X**	**X**

Articles	Purpose, effects, and value of heuristics	Implications of using heuristics in decision-making	Dynamic capabilities influenced by heuristics	Strategic level	Managerial/ oversight level	Individual/ Team level
Ajgaonkar, Neelam and Wiemann (2022)	Heuristics consider the drivers of workforce agility: external resources available for hire, internal resources available, and pressure to achieve workforce agility.	Use heuristics based on the drivers of workforce agility to inform strategic decisions for organisational competitiveness, growth, and economic drivers. Workforce transformation decisions are based on sensing and seizing opportunities to retain, reuse and grow workforce capabilities based on the viability of products. IT managers play a crucial role in creating organisational culture and processes to achieve workforce agility.	Sensing, seizing, and continual renewal to achieve workforce agility.	**X**	**X**	**X**

Five of the seven articles perceived heuristics as functioning across the strategic, managerial and team/individual levels in organisations. Only one of the seven articles considered heuristics at the strategic level and not at the lower levels in the organisation.

The purpose, effects, and value of heuristics

Heuristics enable fast organisational learning (Nijssen and Paauwe, 2012) and can be practised to develop organisational knowledge and capabilities that can be exploited in the future (Pandza *et al.*, 2003). Bingham and Haleblian (2012) explain that valuable heuristics can be learnt at the overall organisational level from negative outcomes spanning hierarchical and functional levels in the organisation. As experts reflect on and share lessons learned, a collective understanding of organisation-specific heuristics is created instead of depending on individuals' experiential knowledge of heuristics (Bingham and Eisenhardt, 2011).

Heuristics are strategically important in dynamic environments as they enable high-performance strategic processes (Eisenhardt, Furr and Bingham, 2010). Eisenhardt, Furr and Bingham (2010) further explain that heuristics allow for flexible real-time adjustments to actions in response to events, mitigating organisations' tendency to favour efficiency over flexibility. Heuristics are essential to strategy because heuristics are 'rational' in unpredictable contexts (Bingham and Eisenhardt, 2011). Bingham and Eisenhardt (2011) propose that (1) organisations learn heuristics explicitly; (2) learned heuristics have a typical structure across organisations because each type of heuristic addresses a specific aspect of opportunity capture; (3) heuristics specific to capturing opportunities are learned in a particular developmental order by first capturing single opportunities one at a time and progressing to capturing multiple opportunities simultaneously, thus, increasing in cognitive difficulty thereby developing expertise through experience; and (4) organisations practice simplification cycling whereby heuristics are pruned and added in a continual fine-tuning process. Opportunity-capture heuristics are 'simple rules' of strategic value (Bingham and Eisenhardt, 2011).

Nijssen and Paauwe (2012) propose that heuristics support organisational agility when effectively applied to identify organisational practices as determinants of organisational agility and evaluate their ongoing effectiveness in supporting organisational agility. Heuristics should support a scalable workforce, fast organisational learning, and highly

adaptable organisational structures (Nijssen and Paauwe, 2012). Heuristics further support organisational agility by allowing for autonomy, adaptation, and cohesion, enabling self-regulation and self-organisation in organisational systems that must achieve more with fewer resources (Espejo, 2015). Ajgaonkar, Neelam and Wiemann (2022) emphasise the importance of heuristics that consider the drivers of workforce agility: external resources available for hire, internal resources available, and pressure to achieve workforce agility.

Implications of using heuristics in decision-making

Heuristics are suitable for most strategic decisions as they involve highly unpredictable situations, entail high levels of heterogeneity, and actors who have limited relevant experience (Bingham and Eisenhardt, 2011). Managers are the dominant decision-makers in organisations but often base their decisions on incomplete or incorrect information, thus necessitating heuristics (Nijssen and Paauwe, 2012).

Efficiency (exploiting routines and well-known methods) and flexibility (exploring opportunities presenting novelty) can be balanced through cognitive processing mechanisms practised by groups and individuals (Eisenhardt, Furr and Bingham, 2010). Agility comes at the cost of efficiency, and organisations need to develop robust sensing, seizing and transforming capabilities in their management functions so that they may know when and how to manage deep uncertainty (Teece, Peteraf and Leih, 2016). Eisenhardt, Furr and Bingham (2010, p. 1271) explain that “[e]fficiency will always be about the quick, economical, mistake-free execution of specific opportunities, whereas flexibility will always be about the fluid, extemporaneous execution of varied opportunities”. This view reflects Snowden and Boone's (2007) suggestion that different approaches are required for decision-making in complex and complicated situations, respectively.

Heuristics enable strategists to effectively balance efficiency and flexibility by applying simple rule strategies in key strategic processes. Managerial reflection, understanding, learning, and attention are required for making decisions and taking actions that balance efficiency and flexibility (Eisenhardt, Furr and Bingham, 2010). Ajgaonkar, Neelam and Wiemann (2022) suggest using heuristics based on the drivers of workforce agility to inform strategic decisions for organisational competitiveness, growth, and economic drivers, as well as workforce transformation decisions based on sensing and seizing opportunities to retain, reuse and grow workforce capabilities, based on the viability of products.

Pandza *et al.* (2003) propose that valuable capabilities are not the result of rational decision-making driven by pre-determined goals to develop or adopt best practices or improved capabilities. Instead, decisions made using available options are subject to uncertainty due to the incomplete knowledge of decision-makers and the inherent complexity of organisational contexts.

Heuristics allow for autonomy in decision-making (Espejo, 2015) and impact the speed of decision-making in strategic processes (Nijssen and Paauwe, 2012). However, heuristics influence the speed of, quality of, buy-in for, employee contribution to, and effect of coercive and normative mechanisms on decision-making (Nijssen and Paauwe, 2012). Informal communication enables decision-making through quick discussion and assessment of available options and promotes learning and adoption of heuristics across groups and hierarchies (Bingham and Haleblian, 2012).

Dynamic capabilities influenced by heuristics

The structures of dynamic capabilities are complex, interrelated and have collective value (Espejo, 2015). Heuristics are essential to effective sensing and responding capabilities in uncertain organisational contexts (Eisenhardt, Furr and Bingham, 2010). Dynamic capabilities provide flexibility under conditions of uncertainty (Pandza *et al.*, 2003). Heuristics applied as ‘simple rules’ are crucial to enabling and developing dynamic capabilities: sensing and responding (opportunity capture) and learning (leaders' ability to learn and develop effective heuristics) (Bingham and Eisenhardt, 2011).

Heuristics promote learning from adverse outcomes across organisational levels and functions and enable coordination at the collective level using informal communication and tacit knowledge (Bingham and Haleblian, 2012). The experiences of individuals and groups emerge shared heuristics in organisational processes whereby groups and individuals develop distinctive heuristics that exploit their heterogeneous knowledge (Eisenhardt, Furr and Bingham, 2010).

Espejo (2015) describes dynamic capabilities as the unfolding outcomes of processes, enabling ongoing improvement of organisational processes. Heuristics enable organisational agility by informing and developing the organisation’s sensing, learning, coordinating, and integrating capabilities (Nijssen and Paauwe, 2012). The heuristic

framework proposed by Ajgaonkar, Neelam and Wiemann (2022) promotes sensing, seizing, and continual renewal of capabilities to achieve workforce agility.

5.3.3 Conclusion — Initial version of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts

It was evident from the SLR conducted in this section that heuristics hold purpose and value for their use in decision-making and influencing dynamic capabilities in organisational contexts. Therefore, the influence of heuristics on dynamic capabilities is considered relevant to agility outcomes in complex and complicated sociotechnical contexts because there is no clear demarcation between what is complex and what is complicated. Heuristics are applied by agents when making decisions under conditions of uncertainty.

Based on the concept developed in the previous section, Figure 5-15 presents an initial version of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts that include heuristics, the dissipative and discontinuous nature of complexity (as dashed, dispersing lines in the complex domain), and iterative processes (as multiple lines in the complex and complicated domains):

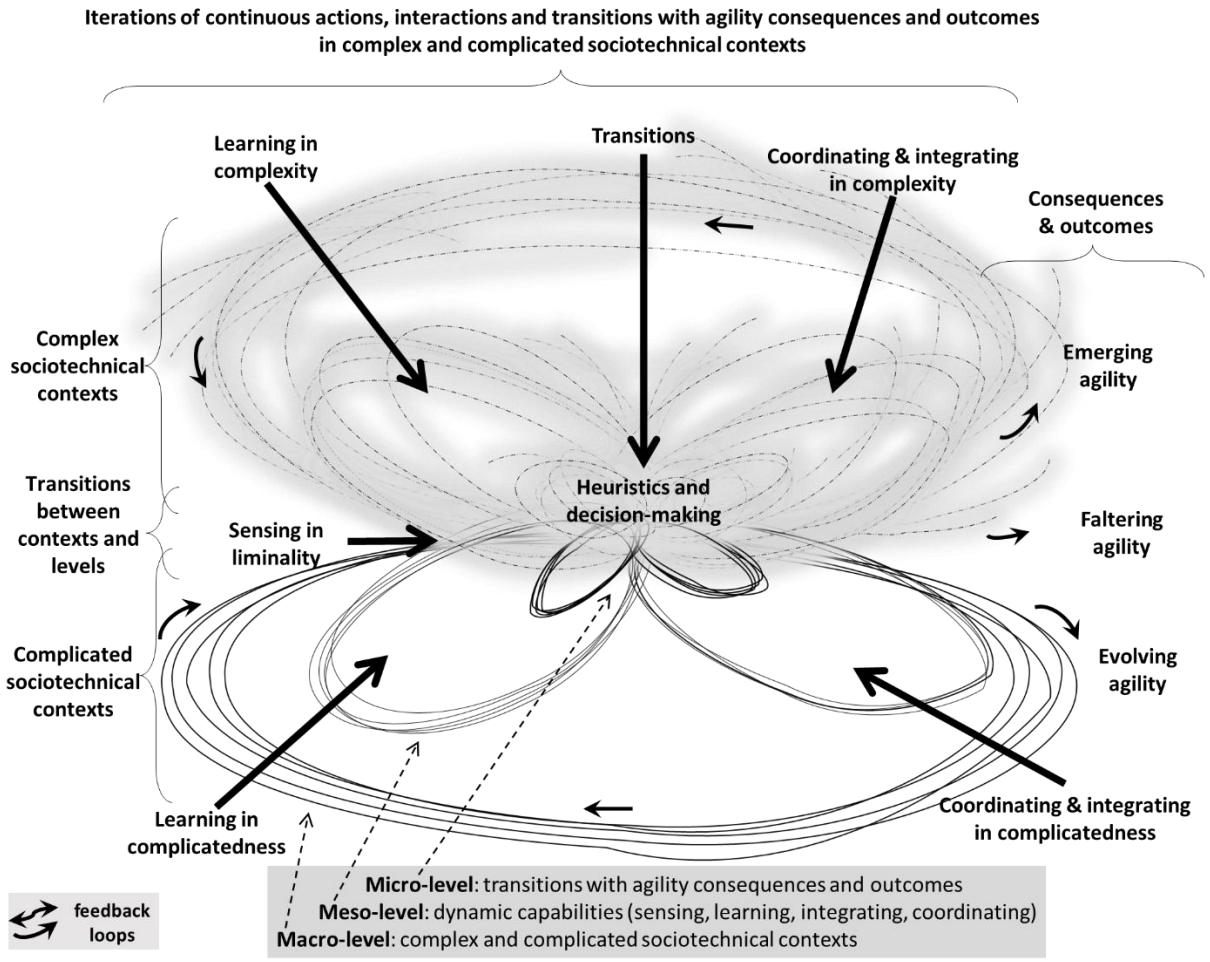


Figure 5-15: Initial version of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts (based on Holland (1992); Juarrero (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

From the SLR findings, heuristics are understood to be simple "rules of thumb" that enable efficient decision-making under conditions of uncertainty across the strategic, managerial and operative levels in an organisation. In addition, heuristics were found to influence organisations' dynamic capabilities and decision-making to the benefit or detriment of organisational performance. It is, therefore, proposed here that a practical technique for the effective management of heuristics in real-world organisational contexts is an integral aspect of a framework for agile EDM that is relevant and implementable in the real world. This requirement raised the next sub-question, addressed in the following section of this second DSR cycle, to find a suitable method or technique whereby heuristics can be managed to enable agility in complex and complicated sociotechnical contexts.

5.4 SQ2.4: MANAGING HEURISTICS TO ENABLE AGILITY

The preceding discussions of decision-making, heuristics and action concluded from the literature that heuristics are highly contextualised simple rules that are continuously refined and practised by individuals and teams, influencing their decision-making and dynamic capabilities while navigating complex and complicated organisational environments for improved outcomes. The framework for agile EDM aims to offer a viable solution for organisations to achieve agile EDM. Therefore, as highlighted in Figure 5-16, this section searched for a practical method or technique in scientific literature whereby heuristics can be managed in real-world contexts to steer the complex and complicated sociotechnical CAS of EDM towards favourable agility outcomes. Building on the knowledge of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts, abductive reasoning was applied to answer the fourth sub-question of DSR Cycle 2:

SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?

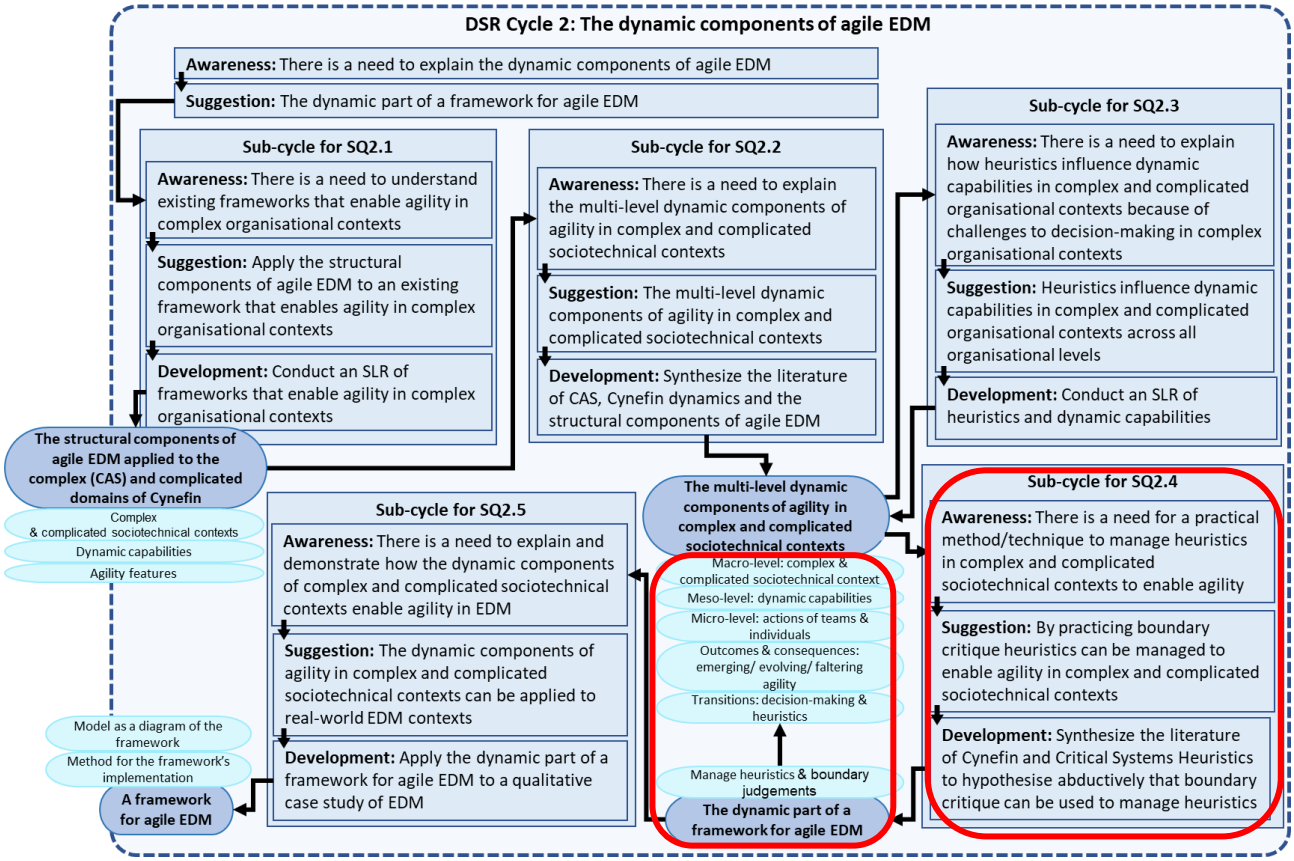


Figure 5-16: Research design — sub-cycle for SQ2.4

Framing the process of navigating complexity as engaging through different levels (fractal engagement) and understanding the direction, speed and intensity of effort required to move towards desired outcomes, makes it necessary to ask the following pragmatic and inclusive question of any stakeholder of the system: "What can we do tomorrow to create more stories like these and fewer like those?" (Snowden and Rancati, 2021, p. 29). This approach provides direction and empathy, allowing space to break habits and surrender existing entanglements in uncertain situations, thereby utilising "a real chance to sense, see and actuate new forms of simplicity to increase the overall agility and resilience of the organisation" (Snowden and Rancati, 2021, p. 11).

Approaches based on theories of change aim to predict targeted outcomes through planned interventions, thereby attempting to create a specific desired future state for the system (Waddock *et al.*, 2015; Preiser, Biggs, de Vos and Folke, 2018). However, such approaches ignore the difficulties of accelerating change and evolution in a CAS, especially when pre-determining explicit outcomes upfront (Jenal and Cunningham, 2015). Decision makers can seldom predict all consequences of changes, even when they might seem highly desirable, to organisational structures or processes (Hannan, Polos and Carroll, 2002), as unintended consequences will result from any intervention in a CAS (Preiser *et al.*, 2018).

Opacity adds to this limitation of foresight, where the information structures of teams are challenging to penetrate (Hannan, Polos and Carroll, 2002), for example, in the case of highly specialised teams. Complexity increases when cascades of changes overwhelm agents' capacity to analyse all possible consequences (Hannan, Polos and Carroll, 2002). Hannan, Polos and Carroll (2002, p. 1) warn that "complexity and opacity lead actors to underestimate the lengths of periods of reorganization and the associated costs of change, thereby prompting them to undertake changes with adverse consequences".

Because individuals are unable to recognise their own cognitive biases (Kahneman, Lovallo and Sibony, 2011), cognitive bias presents challenges to sense- and decision-making at an individual level in a CAS. However, when decision-making moves from the individual to the collective level, this lack of awareness can be somewhat neutralised as individuals can identify biases in each other's thinking (Kahneman, Lovallo and Sibony, 2011). Despite the risk of biases, heuristics can set enabling constraints in complexity by acting as simple principles, creating common ground and reducing noise, thus providing "pre-conditions for

consensus" and speeding up decision-making processes (Snowden and Rancati, 2021, p. 12).

Evaluations contain wisdom and generate a willingness to sacrifice short-term gains for longer-term benefits (Ackoff, 2010). Practising reflection is a process of rationalisation that inherently involves the competence of agents and, over time, structures and re-structures social practices in an organisation (Giddens, 1984, p. 3). However, the principle of rational choice assumes that an agent will consistently espouse the option that maximises its utility, presented as an objective measure of the value that it brings, for example, "happiness" (Heylighen, Cilliers and Gershenson, 2007) or, in this case, "agility". However, "when we deal with complexity — and in the social and human domain we always do — we cannot escape the moment of choice, and thus we are never free of normative considerations" (Heylighen, Cilliers and Gershenson, 2007, p. 130).

5.4.1 Systems thinking in complexity

Humans have come to realise that social processes are the connections that tie open systems into large interconnected networks of systems where the outputs from one system become the inputs for other systems, making it difficult to know the precise location of problems and where and how to intervene despite knowing what outcome we seek (Rittel and Webber, 1973). Our approaches to analysing the world are always subject to unpredictable forces in the environment. Therefore, we must acknowledge the complexity of an ongoing context and practice self-critique, choosing to be open to alternative options (Human and Cilliers, 2013).

Organisational reconfigurations require people to be flexible and willing to partake in transformational sensemaking to bring about effective organisational changes (Orlikowski and Scott, 2021). An organisation should leverage its existing successful competencies but be open to change and probing new opportunities (Brown and Eisenhardt, 1997). Diversity of knowledge, experience and perspectives supports a team's competence in managing complexity (Snowden and Rancati, 2021). An adaptive organisation that can move with changes in the environment enables adaptive processes by absorbing contradictions and creating space for new ideas to develop (Uhl-Bien and Arena, 2018).

Critical systems thinking questions the paradigm and metaphors we apply in our worldview when confronted with a problem in a real-world context (Jackson, 2006). Jackson (2006)

argues that managers today act in increasingly complex contexts and that their approaches to achieve desired outcomes are inadequate to cope with continuous change and uncertainty in the organisational environment. Practical critical systems thinking approaches to the agility problem in EDM could arguably enable managers to sense, decide and act in ongoing complex and complicated sociotechnical contexts to, for example, improve agility outcomes for EDM.

What Preiser, Cilliers and Human (2013) define as "critical complexity thinking" takes a normative approach that emerges from the viewpoint of ethics while being situated in a transitional space (at a boundary) where the moral agent must embrace the ambiguity of the situation instead of merely choosing between an idealistic or pragmatic option. Embracing ambiguity requires the critique process to simultaneously cut apart and weave together, thus enabling divergent ways of being in the world (Preiser, Cilliers and Human, 2013). As Preiser, Cilliers and Human (2013, p. 272) explain, "the ethics of complexity attempts to guide us in acting in meaningful ways whilst taking into consideration that these actions are meaningful precisely because they close down other possibilities".

In today's fast-paced world, "agility" is generally associated with speed. However, in being too quick, we neglect essential aspects of our choices and actions, such as reliability and integrity, which require our reflection (Cilliers, 2006). As Cilliers (2006, p. 107) warns, reflection is at odds with our striving for speed because "reflection involves delay, and in a cult of speed, delay is unacceptable" nonetheless, thorough reflection can bring benefits that are not instantly evident. Preiser, Cilliers and Human (2013) emphasise the value of practising critique when dealing with real-world complexity, whereby the critique acknowledges itself as being in a state of transformation, also that it holds an imperfect understanding of itself and that which is transforming (the ongoing complexity).

5.4.2 Complexity and critical systems heuristics

Critical systems heuristics (CSH) is a framework developed by Ulrich (2000) that enables reflective practice in organisations. CSH is founded in systems thinking and practical philosophy, where the agents in the system apply self-reflective, dialogical and controversial boundary questioning from all stakeholder perspectives to a system of interest, assessing its ideal and actual state with the collective goal of improving the system (Ulrich, 2000).

Heuristics are intrinsic to professional practice that deals with qualitative, ambiguous issues, such as what changes would constitute an improvement for an identified problem to be solved for which there is no right or wrong solution (Ulrich, 2005).

What human agents first observe in a situation tends to be what they expect or remember from previous experience (Snowden and Rancati, 2021). Humans risk seeing patterns that might not exist due to their limited understanding causing them to jump to premature conclusions in the discovery process of evaluating possible actions and outcomes (Kahneman, 2011). Thus, a critical approach is required that incorporates the stakeholders' personal views and value assumptions and allows for debate and reflection on available alternatives for solving the problem at hand (Ulrich, 2005). Once patterns start emerging and options for moving forward are identified, the CAS can start its transition path away from the complex domain, through the liminal space and, ultimately, into the complicated domain where patterns producing favourable consequences can be adopted (Turner, Snowden and Thurlow, 2022).

CSH is “a framework for reflective professional practice” (Ulrich and Reynolds, 2020, p. 255), providing practitioners with a conceptual tool for “practicing practical reason”, allowing for the systematic discourse of the value implications of problem definitions and solution plans or programmes (Ulrich, 1983). Boundary critique is a participatory process central to CSH that reveals the boundary judgements made by participating agents to understand a given situation and design ways to improve the systems involved (Ulrich and Reynolds, 2020).

Boundary critique is “a systematic effort of handling boundary judgements critically”, enacted as reflective practice when being self-critical or emancipatory practice when countering those who are being less self-critical (Ulrich, 2005, p. 3). Boundary judgements, intentional or unintentional, eminently shape the agents’ perception of a situation and where boundary judgements differ significantly, communication amongst stakeholders becomes more challenging (Ulrich, 2000, 2005).

An assessment of the benefits and defects of a proposed improvement depends on the reference **system** (the ongoing context), the **facts** pertaining to possible consequences of the proposition, and the **values** regarding the beneficiaries and purposes of the proposition (Ulrich, 2000). As agents change their boundary judgments regarding what is included in and excluded from the system’s boundaries, the facts and values change simultaneously,

expanding or shrinking accordingly in their scope (Ulrich, 2000). More crucial issues arise when agents do not have the same understanding of the reference system represented by the ongoing context, resulting in a mutual inability to see the same facts and values (Ulrich, 2000). This "eternal triangle" of sustained interdependency between the system, facts and values, as adopted by this study of agility in a sociotechnical CAS, is illustrated in Figure 5-17.

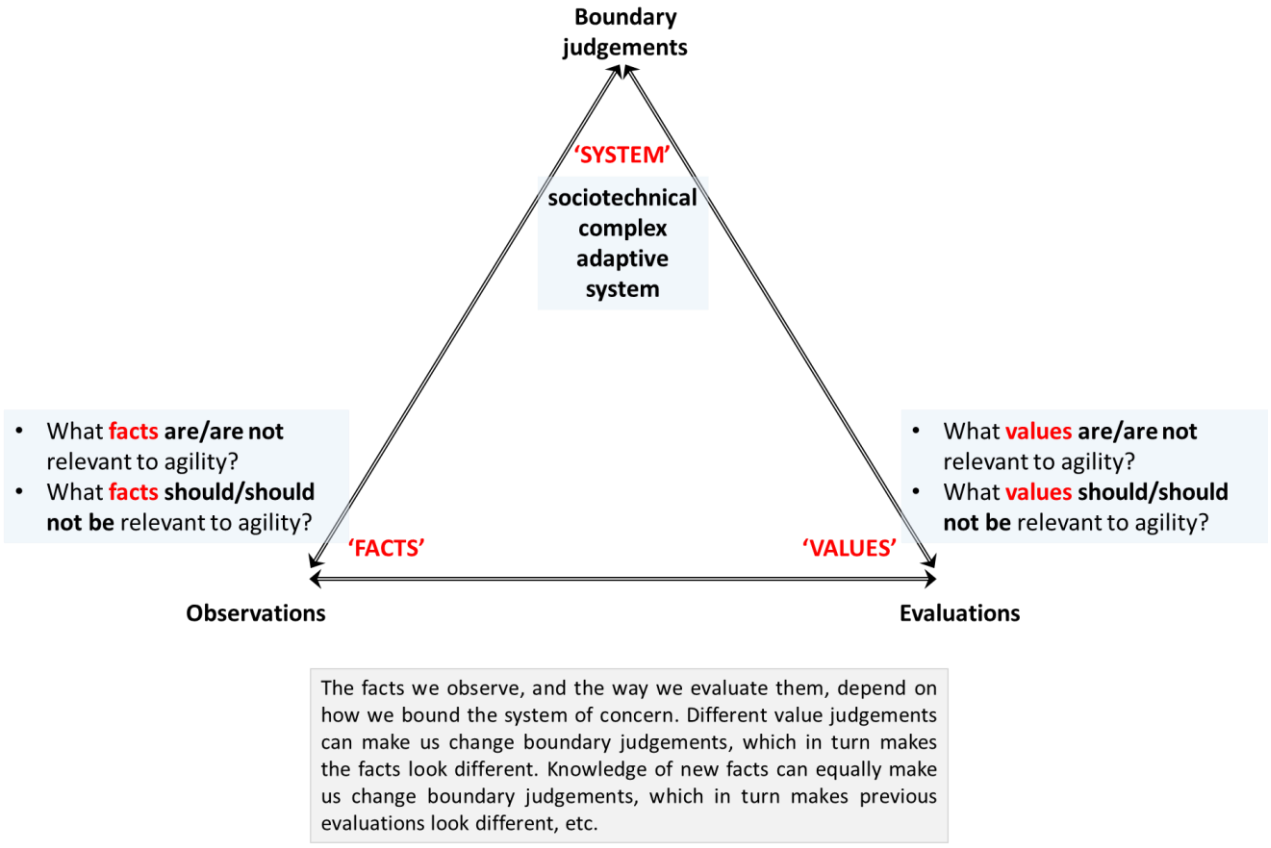


Figure 5-17: The interdependence of boundary judgements, observations, and evaluations of a sociotechnical CAS (based on Ulrich (2000, p. 252; 2005, p. 8))

Judging the relevant values and facts is only possible when agents delimit the ongoing context of interest, taking into account space, time, and intentions (Ulrich, 2000). Empirical selectivity of boundary judgements considers the "facts" and "values" that **are at work** in the system, providing a perspective on actuality. On the other hand, normative selectivity of boundary judgements considers what "facts" and "values" **ought to be at work** in the system, thus providing a perspective of the ideal (Ulrich, 2005).

Ulrich and Reynolds (2020) propose that the realities and the ideals of the "facts" and "values" of specific concerns and key problems must be considered for their impact on the

overall system from the perspective of four stakeholder groups: the beneficiaries, the decision-makers, the experts and the witnesses (those who are not involved but could be negatively affected). This approach is designed to unfold multiple perspectives and promote mutual understanding by asking boundary questions revealing differences in people's underlying boundary judgements in terms of how they frame the given situation and their understanding of what aspects should and should not form part of the system of interest and its improvement (Ulrich and Reynolds, 2020).

To enable the observation and evaluation of how a system of interest (for example, agile EDM) "is" and how it "ought to be", Ulrich (2000) proposes a framework, presented in Figure 5-18. This framework comprises 4 groups of boundary issues and 12 foundational boundary categories that are considered by questioning **how things are** (descriptive or actual mode) and **how they ought to be** (normative or ideal mode) to guide reflective practice.

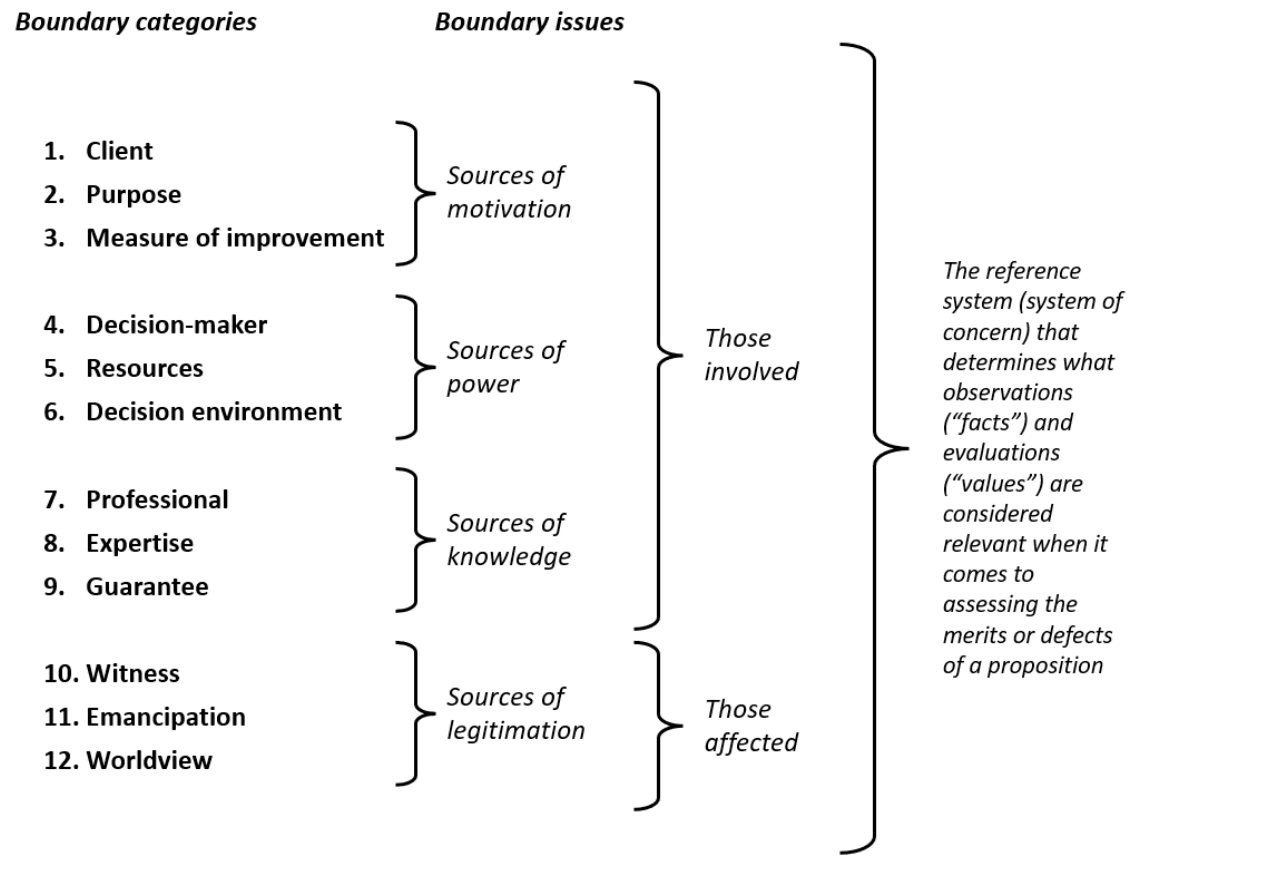


Figure 5-18: Twelve critically-heuristic boundary categories (reproduced from Ulrich (2000, p. 256))

The practice of systematic boundary critique requires three types of boundary questioning: (1) self-reflective boundary questioning identifies and reveals our boundary judgements; (2) dialogical boundary questioning seeks agreement and accord on the identified boundary judgements; and (3) controversial boundary questioning where agents challenge each other's boundary judgements (Ulrich, 2000).

Through the systematic process of boundary critique, the following stands to be gained: (1) understanding the sources of selectivity that shape agents' claims by revealing foundational boundary judgements; (2) understanding the practical and ethical implications of the foundational boundary judgements and how these implications frame agents' views of the ongoing context; (3) finding alternative perceptions of the reference system because

different answers to boundary questions can reveal differences in agents' understanding of what the selected reference system is; (4) create a shared understanding to select and agree what the reference system is for all stakeholders thus supporting rational communication, limiting misunderstandings and increasing tolerance between agents; (5) utilise opportunities to challenge agents who are not being self-reflective thereby practising emancipatory boundary critique (Ulrich, 2005, p. 4).

The process of boundary questioning takes an analytical approach to understand situations by enabling reflective practice that aims to make the operating boundary judgements and associated implications transparent and comprehensible to all stakeholders of the ongoing context. This approach of questioning and dialogue subsequently allows actors of aligned and divergent perspectives to engage and concentrate on ways to improve the system (Ulrich and Reynolds, 2020).

Rather than being a process of boundary setting by experts, boundary critique is a process of questioning and unfolding boundary judgements (Ulrich and Reynolds, 2020). The boundary categories and questions proposed by CSH are presented in Table 5-5.

Table 5-5: The boundary categories and questions of CSH (based on Ulrich and Reynolds (2020, p. 256))

	Boundary judgements informing "the system of interest" (S)			
Sources of influence	**Social roles (Stakeholders)**	**Specific concerns (Stakes)**	**Key problems (Stakeholding issues)**	
Sources of motivation	*Beneficiary* — Who ought to be/is the intended beneficiary of S?	*Purpose* — What ought to be/is the purpose of S?	*Measure of improvement* — What ought to be/is S's measure of success?	**The involved**
Sources of control	*Decision maker* — Who ought to be/is in control of the conditions of success for S?	*Resources* — What conditions of success ought to be/are under the control of S?	*Decision environment* — What conditions of success ought to be/are outside the control of the decision maker?	
Sources of knowledge	*Expert* — Who ought to be/is providing relevant knowledge and skills for S?	*Expertise* — What ought to be/are relevant knowledge and skills for S?	*Guarantor* – What ought to be/is regarded as assurances of successful implementation?	
Sources of legitimacy	*Witness* — Who ought to be/is representing the interests of those negatively affected by, but not involved with, S?	*Emancipation* — What ought to be/are the opportunities for the interests of those negatively affected to have expression and freedom from the worldview of S?	*Worldview* — What space ought to be/is available for reconciling differing worldviews regarding S among those involved and affected?	**The affected**

For this study of agile EDM, the system of interest was a sociotechnical CAS, for which the stakeholders involved had to empirically and normatively consider the facts and values for how agility in the system of interest is and how it ought to be, thereby informing decisions on how to proceed in ways that would transition the system towards favourable agility outcomes and consequences. In other words, if the agents of the sociotechnical CAS sense that the system's current context does not exhibit or amplify the desired agility features, the underlying boundary judgements can be understood, and agents can review the facts and values to inform heuristics and decision-making for improved agility in EDM.

By practising boundary critique, the agents involved must then use the opportunity to consider what can and should change in the subsequent work iterations to amplify the desired agility features in EDM, locally and collectively. Adopting Figure 5-18 on page 212 and Table 5-5 on page 214 for this study, the boundary categories and critique questions defined for this study of agile EDM are summarised in Figure 5-19.

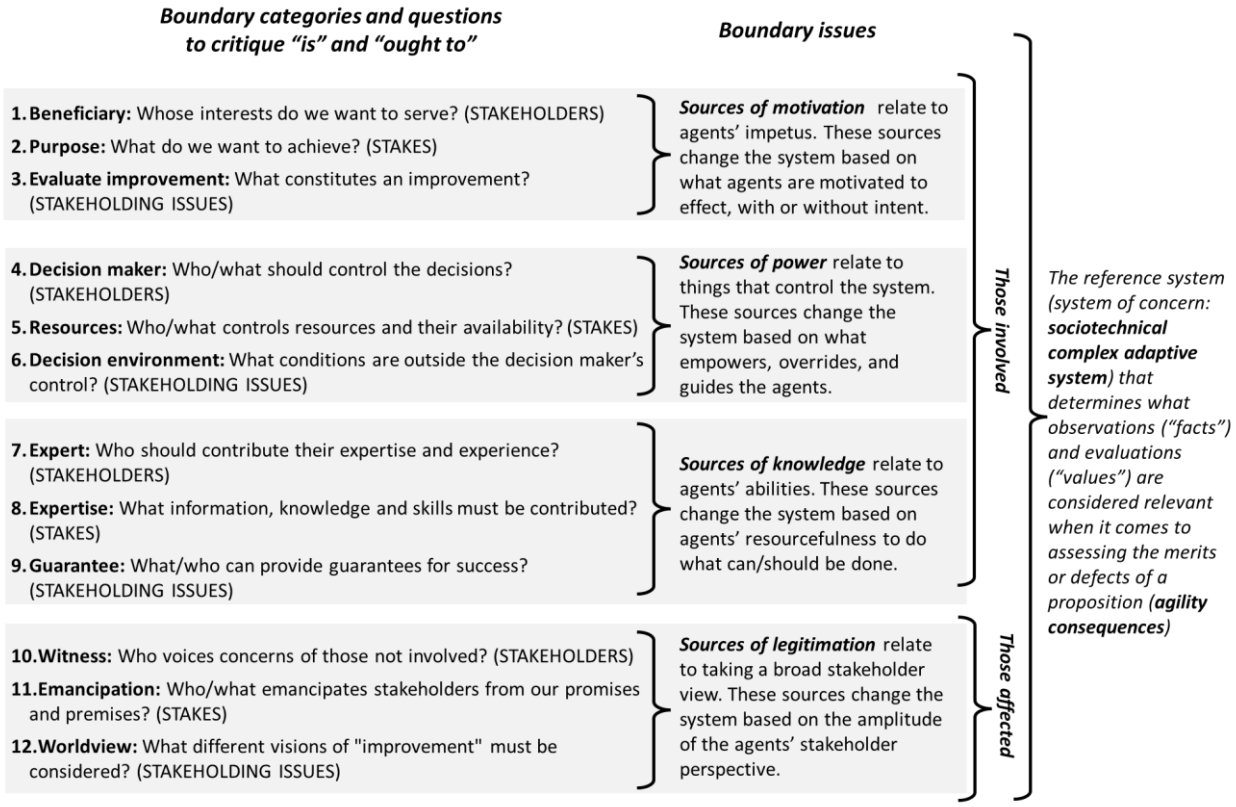


Figure 5-19: Boundary categories and questions for practising CSH boundary critique in a sociotechnical CAS (based on Ulrich (2000, p. 252); Ulrich and Reynolds (2020, pp. 256, 290))

Boundary judgements, as adopted in this study for their influence on agile EDM, comprise four categories: (1) sources of motivation relate to the agents' impetus based on what they are motivated to effect, with or without intent; (2) sources of power relate to control based on what empowers, overrides and guides the agents; (3) sources of knowledge refer to agents' abilities and resourcefulness to do what can or should be done; and (4) sources of legitimation relate to the amplitude of agents' stakeholder perspective.

Boundary judgements underly agents' heuristics and, therefore, influence their actions in a system of interest. Boundary judgements can be revealed by collaboratively asking and critiquing the answers to the 12 questions in the "is" (descriptive) and "ought" (normative) modes, as shown here in Figure 5-19 and Table 5-5 on page 214. However, these questions

can only be meaningfully asked and answered in a real-world context and represent context-sensitive and context-free constraints because they hold the potential to influence the system towards thriving agility consequences and outcomes (Juarrero, 2000; Ulrich, 2000). Additionally, there is no theoretical limit to the size of the sets of possible answers for each of the 12 boundary questions. It is, therefore, prudent to test the use of boundary critique as defined by CSH theory in a real-world EDM context to further develop and refine the framework for agile EDM.

Practising boundary critique presents opportunities to discover “unknown unknowns” (in complexity) and to question and debate “known knowns” (in clarity) and ”known unknowns” (in complicatedness) (Snowden and Boone, 2007), thereby taking a broader view of what can or should be coordinated and integrated to influence improved agility consequences and outcomes. For example, possibilities for reuse, scaling or repurposing might be overlooked when imposing a deterministic linear process on the system because opportunities for discussions are closed down *a priori*. For example, the organisation must first understand its existing data and data technologies before turning to external data sources or investing in new technologies (Peppard, 2016).

The practice of boundary critique can be applied to become aware of and understand the influence of enabling and governing constraints on agility in a sociotechnical CAS. Practising critical thinking in complex systems brings dynamics that keep the system moving yet held in the tension of paradoxical strictures in an unrelenting “undercurrent of interruption that never rests” (Preiser, Cilliers and Human, 2013, p. 269).

5.4.3 Conclusion — Refined version of the multi-level dynamic components of agility in complex and complicated sociotechnical contexts

Heuristics were identified in the preceding section as imperative for their influence on dynamic capabilities and decision-making in complex and complicated organisational contexts. Therefore, developing the dynamic components of agile EDM required a practical, scientifically-grounded construct to explain how to manage heuristics for knowing, deciding and acting at the boundaries between complex and complicated sociotechnical contexts of EDM for an improved state of agility. The continuous quest for agility in EDM can be seen as a “wicked problem” because there is no straightforward right or wrong way to generate agility, as it is subject to variances in stakeholder understanding and intentions of how agility

can and should be generated in the ongoing sociotechnical context. The liminal space in the Cynefin framework presents a boundary where the iterative processes of adaption and adoption continuously shift the system to a new state (Snowden and Rancati, 2021).

CSH is a scientific theory that has its roots in CST and practical philosophy and includes not only decision-makers but all stakeholders in the process of "critical reflection" on a situation (Ulrich, 2005). CSH is a theory offering a viable approach to "reflective practice" (practising boundary critique) that asks how a "system of interest" (such as the sociotechnical CAS that is agile EDM) "ought to be" and how it "actually is" (Ulrich, 2000). The practice of boundary critique identifies the sources of influence and related boundary judgements that underlie agents' heuristics that can move a system towards an improved state. This approach allows the stakeholders of the "system of interest" to negotiate how the system can be moved towards an improved state, for example, improved agility in EDM. The concept in CSH of "moving the system to an improved state" (Ulrich, 2000) aligns with the Cynefin framework's concept of "moving to a more favourable adjacent possible state" at the boundaries where key decision points can transition the system between the complex and complicated domains (Snowden and Rancati, 2021).

The practice of boundary critique potentially provides a suitable technique to this study of agile EDM for understanding and improving agents' sense-making processes, and their responses to governing (context-free) constraints (in complicatedness) and enabling (context-sensitive) constraints (in complexity) because practising boundary critique brings to light the boundary judgements that agents are using in their heuristics. Through this approach, the practice of boundary critique can change the quality of the system's interactions iteratively by influencing how agents sense, learn, coordinate and integrate, thereby continuously providing opportunities to move the system at the micro-, meso- and macro-levels towards a more favourable agility state. Therefore, this study proposes the practice of boundary critique from CSH as a practical technique to identify the underlying boundary judgements to manage the heuristics that influence actions (governed by dynamic capabilities) with agility outcomes and consequences.

Heuristics are often embedded in an organisation's governance principles and can eliminate noise while guiding the execution level, thus enabling distributed decision-making (Snowden and Rancati, 2021). At the boundary between the complicated and complex domains, human actors intentionally (or unintentionally) influence the direction in which the system

moves to next (Snowden and Boone, 2007). In other words, agents have opportunities to reflect on the system's current state and decide what can be done to move the complex and complicated system of EDM in a favourable general direction of improved agility. Practising boundary critique at the liminal boundary between complexity and complicatedness provides a mechanism to evaluate the next thing to do for amplifying the emergence and evolution of agility features in EDM.

The constraints form and shape the behaviour of the CAS (Holland, 2002) and are those things that govern, enable or cause tension in the coordination and integration (Teece, Pisano and Shuen, 1997) of agents' activities. CSH provides a theoretical keystone that enables an empirical investigation of how heuristics can influence interactions to change the system's agility state during phase-shifting between complicated and complex contexts in such a way as to continuously emerge and evolve favourable agility features in a sociotechnical CAS. Figure 5-20 presents the multi-level dynamic components of agility in complex and complicated sociotechnical contexts.

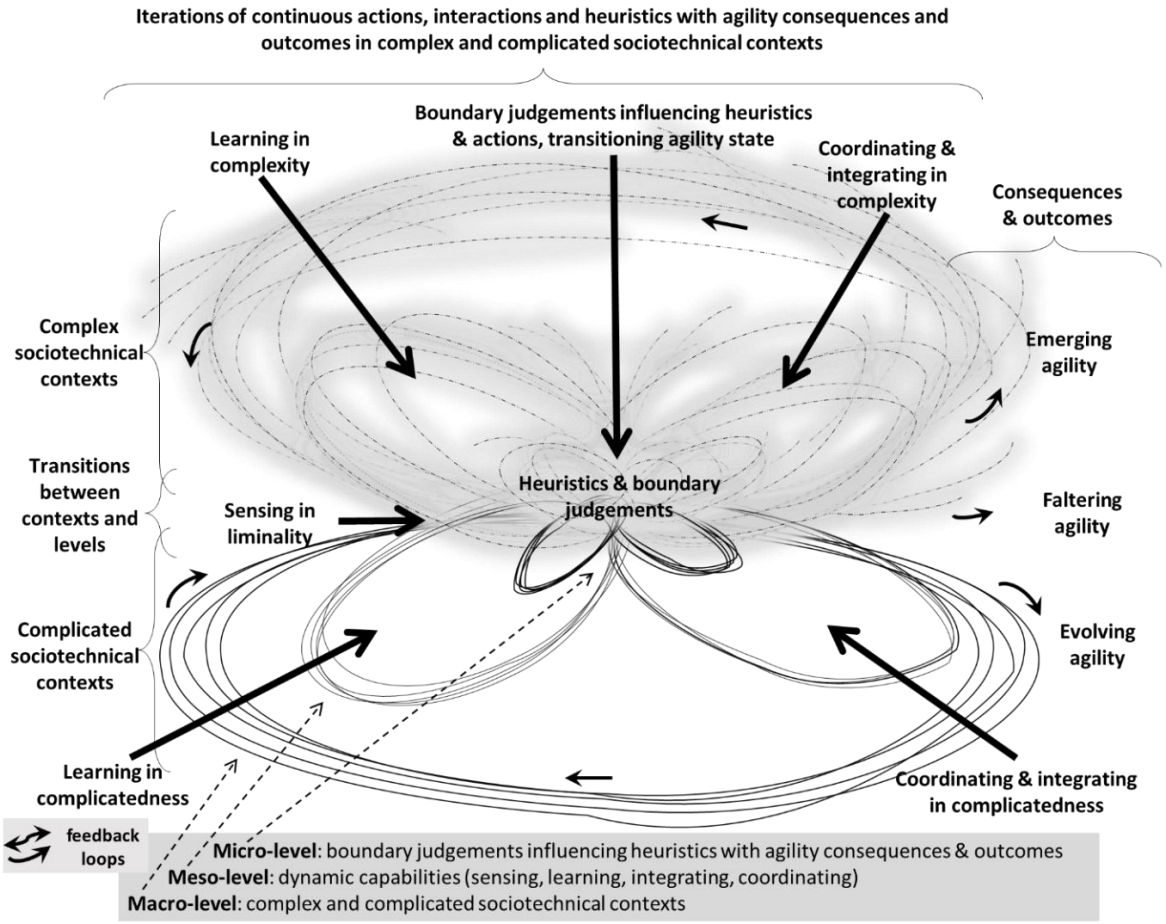


Figure 5-20: The multi-level dynamic components of agility in complex and complicated sociotechnical contexts (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

This section identified CSH as a theory that involves the practice of boundary critique for illuminating the boundary judgements underlying agents' heuristics, thus providing a practical technique for managing heuristics in complex and complicated sociotechnical contexts. CSH contributes to the design of the dynamic components of agile EDM by explaining how a CAS, such as EDM, can transition between complex and complicated contexts, thereby emerging and evolving thriving and faltering agility.

5.5 CONCLUSION — THE DYNAMIC PART OF A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

In this second DSR cycle, the dynamic components of agile EDM were developed by systematically reviewing and synthesising the literature on the dynamics of achieving agility in organisational and sociotechnical contexts, answering the first four underlying questions of the second sub-question of this research:

Sub-RQ2:	What are the dynamic components of agile enterprise data management?
SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?
SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?
SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?
SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?

Targeted outcomes cannot be “caused” in complex contexts (Waddock *et al.*, 2015; Preiser *et al.*, 2018) and can only, at best, be retrospectively understood (Cilliers, 2000b). This chapter proposed that complex and complicated sociotechnical contexts, such as EDM, can be influenced to transition iteratively towards emerging and evolving agility outcomes by practising boundary critique to continuously identify opportunities and so perpetually transitioning the system towards an improved state of agility.

In DSR Cycle 1, the sociotechnical context of agile EDM was found to be complex and complicated. Additionally, dynamic capabilities (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011) were identified as a theory-based explanation of the activities and interactions associated with agility in complex and complicated contexts. In this second DSR cycle, the Cynefin framework, underpinned by CAS theory (Holland, 1992), was identified to explain the nature of agility as emergent and evolutionary in complex and complicated sociotechnical contexts. Lastly, critical systems heuristics theory (Ulrich, 2000) was identified as the theory to explain how boundary judgements can influence actions shifting the system’s agility state towards more favourable agility consequences and outcomes.

In the decades since their initial development, these theories have matured further through scientific research and have been made more practical. Systems theory has evolved through various streams of research across diverse scientific disciplines, including organisational science (Teece, 2018). Pavlou and El Sawy (2011) expanded our understanding of dynamic capabilities, and Teece, Peteraf and Leih (2016) implicated dynamic capabilities in organisational agility. Snowden's (2002) Cynefin framework and Juarrero (2000) explained the foundational role of complex adaptive systems science when acting in complex and complicated organisational contexts. Ulrich and Reynolds (2020) further explained practical

CSH techniques for working constructively with tensions arising between conflicting perspectives when intervening to improve organisational situations at transitional boundaries. These scientific theories served as the theories that bound the theoretical constructs at the three levels of a sociotechnical CAS with agility consequences and outcomes, thereby providing this study with a synthesised, multi-level conceptual framework for developing a framework for agile EDM.

In CAS, phenomena such as innovation, agility and strategy emerge from the interactions of the agents in the CAS (Onik, Fielt and Gable, 2017; Werder and Maedche, 2018; Turner and Baker, 2019). An organisation's data infrastructures involve people, processes, technology and data (DAMA International, 2017) that constitute diverse adaptive elements exhibiting nonlinear interactions (Brous *et al.*, 2014; Lillie and Eybers, 2019). EDM comprises multiple interdependent sociotechnical parts that continuously interact while performing diverse data management functions (see Figure 2-6 on page 28) that collectively manage the organisation's data assets and deliver data-related solutions to the business (DAMA International, 2017).

CASs consist of multiple agents that learn and adapt as they interact in nonlinear ways (Holland, 2002; 2006). Emergent phenomena arise from the nonlinear interactions of agents in CASs as the agents accumulate experience and modify patterns to move the system to an improved state (Holland, 2002; Levin, 2003). Nonetheless, fluctuations should be managed with a deep appreciation for stability, as change is meaningless and costly if stabilised patterns currently provide the desired outcomes (Nguyen Huy and Mintzberg, 2003).

In the complex and complicated domains of the Cynefin framework, learning, knowing and sensing are precursors to responding, as shown in Figure 5-4 on page 147 and Figure 5-6 on page 151 (Kurtz and Snowden, 2003; Snowden and Rancati, 2021). The same concept of knowing before acting applies to dynamic capabilities, as presented in Figure 5-10 on page 177, where sensing and learning precede integrating and coordinating (Pavlou and El Sawy, 2011).

Transition points in the system and the stability stemming from previously adopted and embedded patterns of practice enable the system to pivot when it needs to change direction and adapt to new conditions (Teece, 2014). In dynamic capabilities theory, the sensing

activity includes scanning the environment and importing unorganised information and raw data from the external environment into the organisational context to inform a response to the existing situation (Teece, 2018). Anticipatory awareness, pausing to think and question before deciding on how to proceed (Snowden, 2021b, pt. 03:19), presents junctures for transitioning the prevailing system state towards improved agility while navigating complex and complicated sociotechnical contexts of EDM.

The multi-level dynamic components of agility in complex sociotechnical contexts were developed from the scientific knowledge of CAS, dynamic capabilities and CSH:

- The **macro-level** represents complex and complicated sociotechnical contexts and is based on the Cynefin framework, underpinned by CAS theory, with transitions through key decision points at the complex and complicated domain boundaries.
- The **meso-level** represents the oversight/managerial level (managing and governing activities), comprising the dynamic capabilities of sensing, learning, coordinating and integrating in complex and complicated sociotechnical contexts.
- The **micro-level** is where heuristics influence how activities are being/should be done for improved agility. The practice of boundary critique, adopted from CSH, explains how sources of influence, revealed in agents' boundary judgements, influence agility outcomes and consequences in complex and complicated sociotechnical contexts.

The products of the process that emerges and evolves agility in complex and complicated systems, which are agility features, are required for the agility-generating process itself (based on Juarrero (2000)). Thus, agility brings about agility. Agility features are amplified and diminished during interactions in the CAS and continuously feed back into the CAS, thereby iteratively reconstructing its agility state. In order to effect transitions in the system's agility state, opportunities must be identified, understood and utilised as far as possible to shift the system in the general direction of thriving agility. However, complex and complicated systems are not entirely under the control of their agents. Context-sensitive constraints continuously regulate the CAS's self-organised coherency, enabling the system to survive complexity where it operates far from equilibrium (Juarrero, 2015b). Thus, agility will falter under certain internal and external conditions of the complex and complicated system.

Part I of DSR Cycle 2 developed the dynamic part of a framework for agile EDM based on the structural components of agile EDM, Cynefin and the theories of CAS and CSH, and is presented in Figure 5-21.

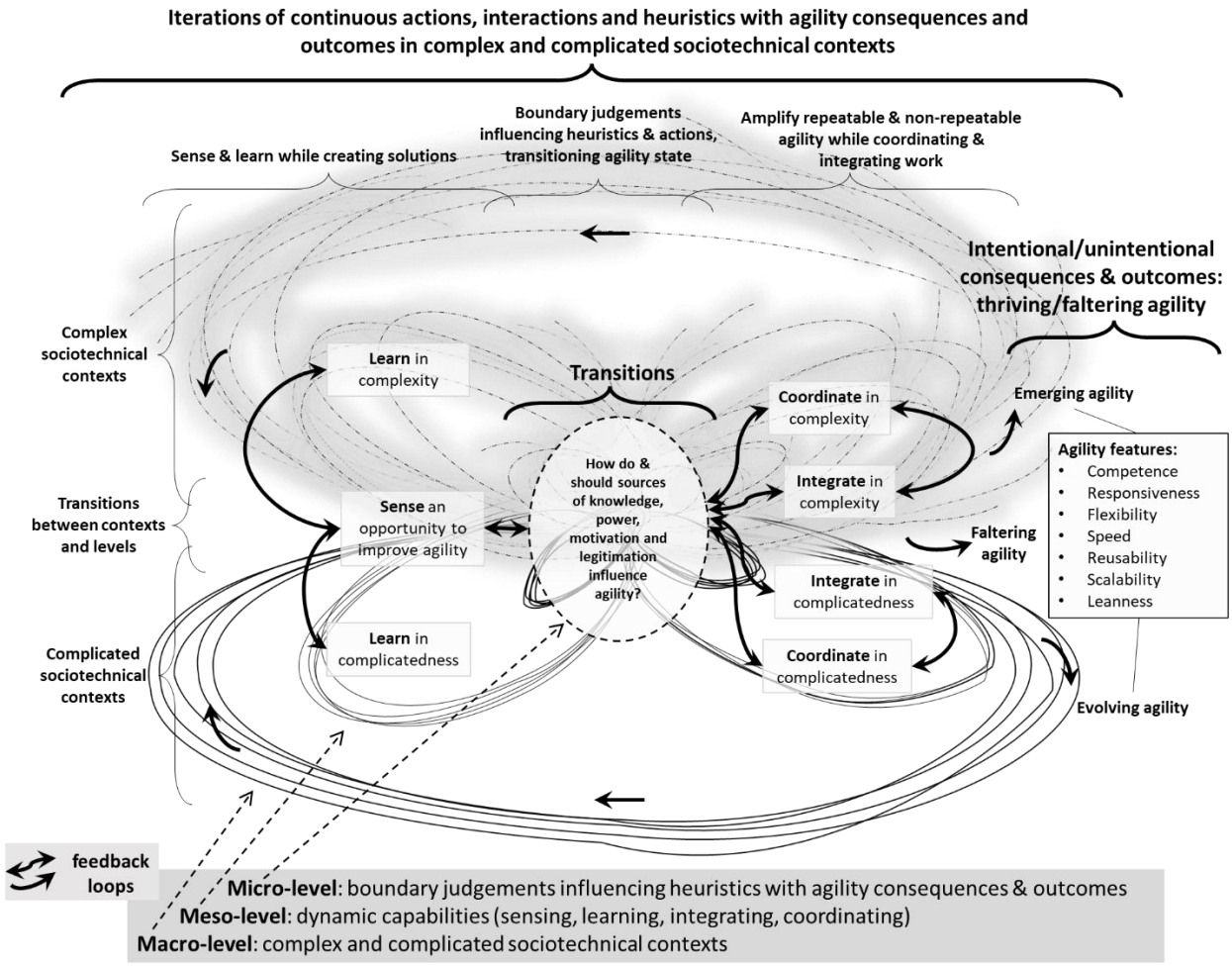


Figure 5-21: The dynamic part of a framework for agile EDM (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

Table 5-6 presents a summary of the definitions of the terms and constructs of the dynamic part of a framework for agile EDM.

Table 5-6: Definitions of terms and constructs for the dynamic part of a framework for agile EDM

Term/construct	Definition
Macro-level	At the macro-level, the context of EDM is defined as **sociotechnical, complex and complicated,** for which an improved agility state is desired in a complex and complicated sociotechnical context.
Meso-level	At the meso-level, EDM activities and interactions are defined as **dynamic capabilities** (learning, sensing, coordinating and integrating), and how they are performed can be influenced to have intended and unintended agility consequences and outcomes for a complex and complicated sociotechnical context (Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016).

Term/construct	Definition
Micro-level	At the micro-level, influences of agility in EDM contexts are defined as CSH **sources of influence** (motivation, power, knowledge and legitimation) which are underlying boundary judgements influencing the enactment of EDM activities, thereby having intended and unintended agility consequences and outcomes for a complex and complicated sociotechnical context (Ulrich, 2000).
Complicated sociotechnical contexts	Complicated contexts are **ordered situations with high levels of certainty**. Cause and effect exist, but only **experts** can analyse and understand the causality, events can be predicted, and rules can be used to govern activities and outcomes. Complicatedness is the domain of "good practice" enabled by **expertise and know-how** (Snowden and Rancati, 2021).
Complex sociotechnical contexts	Complex contexts are **unordered situations with high levels of uncertainty**. There is no cause and effect, relationships between events and their consequences are non-linear, and constraints must be managed to enable adaptation to the ongoing changes (Snowden and Rancati, 2021).
Liminal sociotechnical contexts	The liminal area between complicated and complex practice has a **transitionary and iterative nature**, where good practice can establish in the complicated domain through a transitionary process requiring energy to shift and adopt new emergent practices from the complex domain (Snowden and Rancati, 2021).
Dynamic capabilities	The concepts of dynamic capabilities used in this study that describe the general actions and interactions with agility consequences within sociotechnical contexts are: **Learning:** Building knowledge and skills while being productive and creating solutions. Thus, building knowledge and skills by continuously combining existing and new knowledge. **Sensing:** Scanning for and making sense of opportunities to improve agility (sense-making). Thus, becoming aware of the need to change and knowing "what to do next". **Coordinating:** Collaborating and working collectively towards a shared purpose. Bringing new and existing elements into an efficient, harmonious relationship. **Integrating:** Combining work effort and outcomes for collective benefit. Combining existing and new parts into a more valuable whole. The definition of dynamic capabilities for this study was primarily based on the research done by Pavlou and El Sawy (2011), and the definition of sense-making was adopted from Turner et al. (2022).

Term/construct	Definition
Categories of boundary judgements	Boundary judgements **inform heuristics** when agents consider and decide **how agility is** and **how agility should be** within the given context: **Sources of knowledge** relate to agents' abilities. These sources change the system based on agents' resourcefulness to do what can/should be done. **Sources of legitimation** relate to taking a broad stakeholder view. These sources change the system based on the amplitude of the agents' stakeholder perspective. **Sources of motivation** relate to agents' impetus. These sources change the system based on what agents are motivated to effect, with or without intent. **Sources of power** relate to things that control the system. These sources change the system based on what empowers, overrides, and guides the agents. (These definitions of boundary judgements are based on Ulrich and Reynolds (2020).)
Evolving agility	Evolving agility features are relevant to complicated contexts. Evolving agility features are adopted and embedded, thereby evolving as part of good practice.
Emerging agility	Emerging agility features are relevant to complex contexts. These features enable adaptation under uncertainty and emerge to support the evolution of new patterns for evolving agility.
Thriving and faltering agility	**Thriving agility** is the sustained functional emergence and evolution of constraints that iteratively create and enhance agility features. In contrast, **faltering agility** is the emergence and evolution of constraints that iteratively disintegrate agility features with consequential loss of the system's overall agility coherence. Both thriving and faltering agility can emerge and evolve intentionally or unintentionally.

Using abductive reasoning, CSH was considered a suitable scientific theory to explain how heuristics influence dynamic capabilities in complex and complicated sociotechnical contexts, as it explicitly provides "sources of influence" (knowledge, power, motivation and legitimation) as theoretical constructs. The practice of boundary critique prescribed by CSH is hypothesised to be a technique for managing heuristics in EDM's complex and complicated sociotechnical contexts. This hypothesis was tested in a qualitative case study, including the in-depth analysis of rich interview data and DM policy and standards documents collected at the case study organisation, as presented in the next chapter of this thesis (Part II of DSR Cycle 2).

By considering the nature of EDM as sociotechnical complexity and complicatedness, and the nature of agility as emergent and evolutionary, with intentional and unintentional consequences and outcomes, and considering how boundary judgements influence decision-making, actions and interactions in liminality to change the state of agility in EDM, the multi-level dynamic components of agility in complex and complicated sociotechnical contexts served as a conceptual framework, including its components as units of analysis, to conduct an in-depth qualitative case study of agility in EDM at BankGroup.

Design knowledge, such as DSR artefacts, is naturally ephemeral and requires continuous updating (vom Brocke *et al.*, 2020). Theoretical contributions from prior DSR research provide opportunities for subsequent DSR research to test existing design knowledge in practice. In turn, this provides an opportunity to revise the existing theoretical artefacts for their relevance and produce new practical artefacts for application in current real-world contexts (vom Brocke *et al.*, 2020). The design artefact developed in Part I of this second DSR cycle potentially offers a theoretical contribution to the body of knowledge as an approach to develop solutions for emerging and evolving phenomena of interest, such as agility, in a complex and complicated sociotechnical context of interest, such as EDM.

6 DSR CYCLE 2 – PART II: SQ2.5: A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

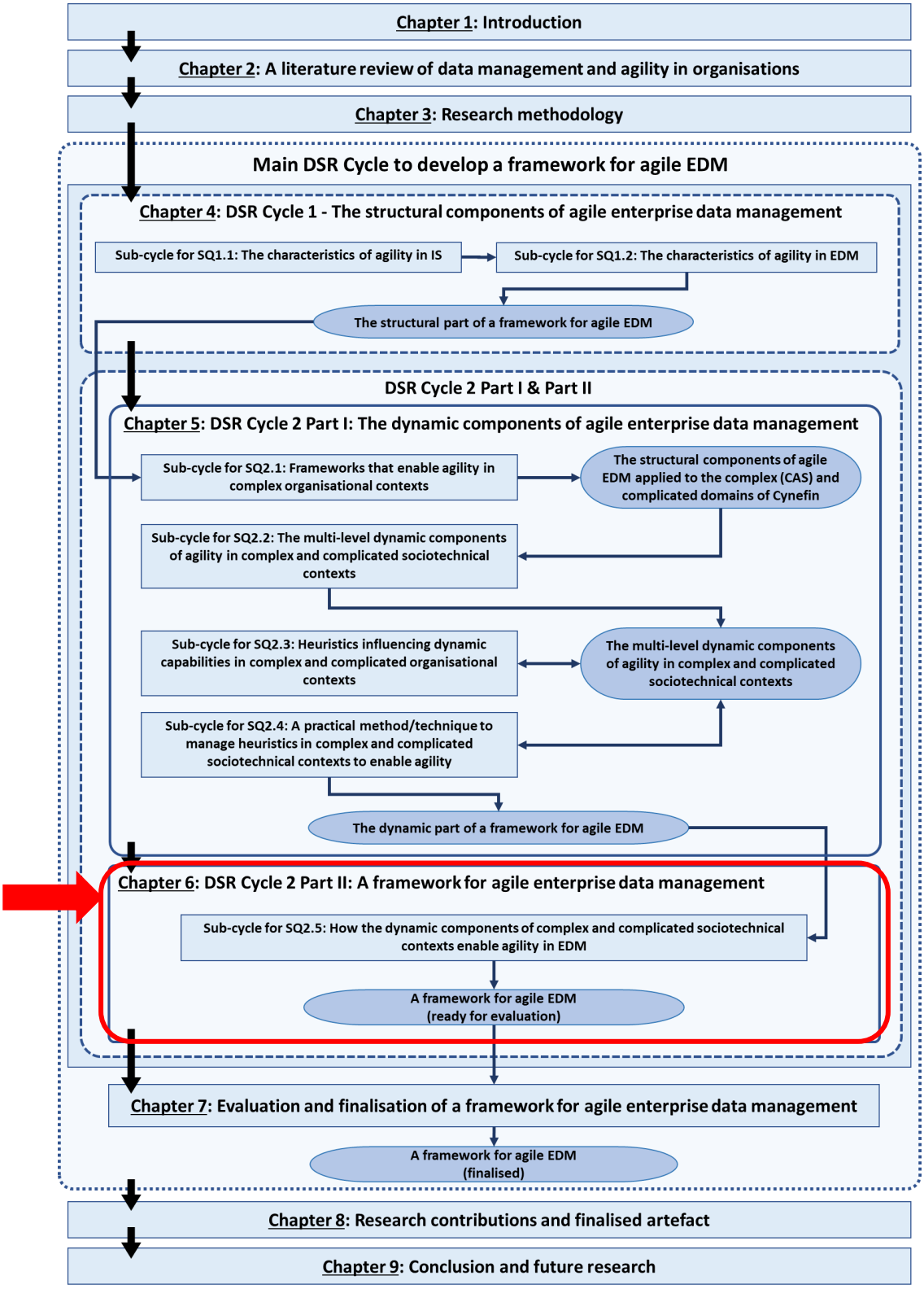


Figure 6-1: Chapter map — Chapter 6

To formalise the DSR artefact, DSR Cycle 2 Part II applied the dynamic part of a framework for agile EDM developed in DSR Cycle 2 Part I to a qualitative case study at BankGroup. The qualitative case study in DSR Cycle 1 confirmed the relevance of the structural part of a framework for agile EDM for achieving agility in real-world contexts. The qualitative data was analysed in more detail in this chapter using the constructs of the dynamic part of a framework for agile EDM, developed in DSR Cycle 2 Part I, as the units of analysis. Additional data collected in this second DSR cycle included the case study organisation's data management policy and standards documents. The objective of this chapter was to answer the fifth and final sub-question of DSR Cycle 2, as indicated on the research design map in Figure 6-2.

Sub-RQ2:	What are the dynamic components of agile enterprise data management?
SQ2.5:	How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?

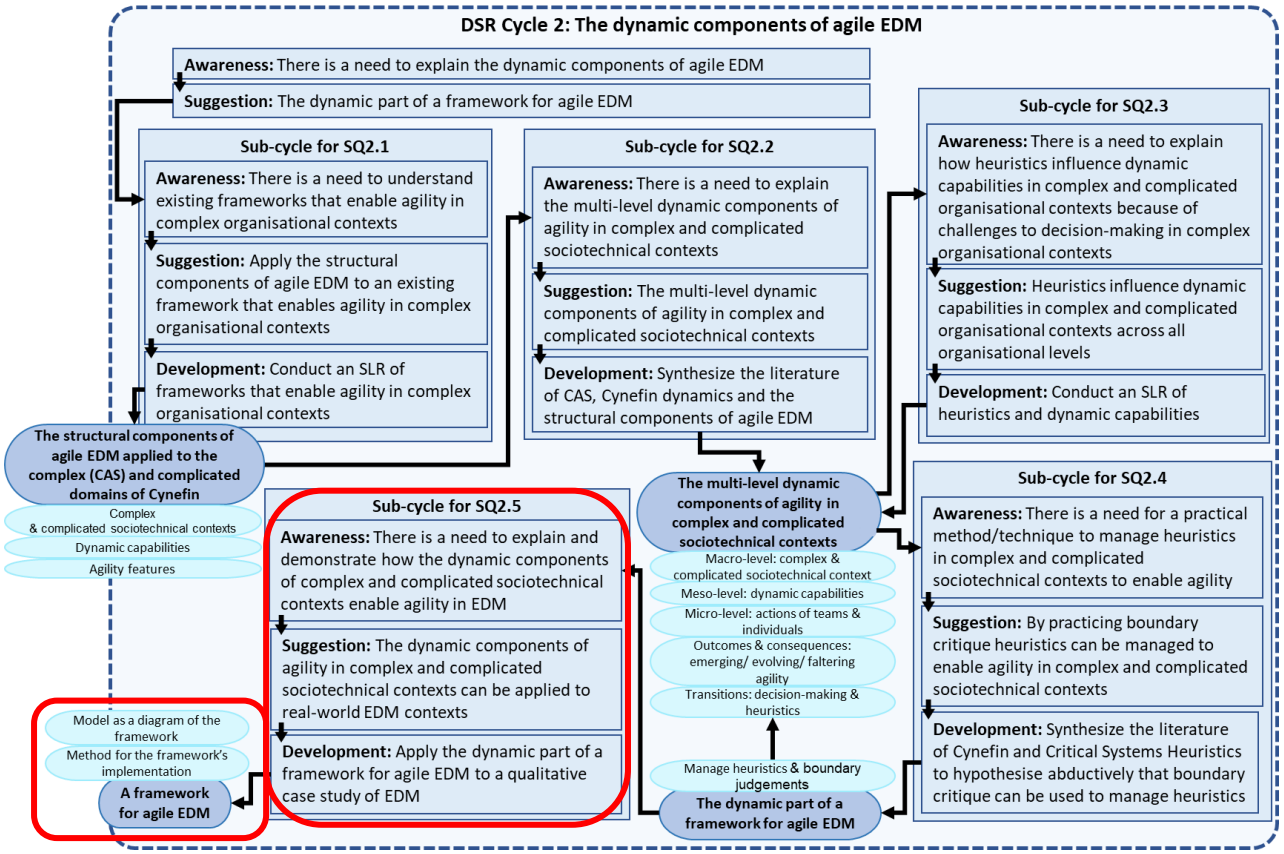


Figure 6-2: Research design — sub-cycle for SQ2.5

6.1 METHOD: A QUALITATIVE CASE STUDY

Chapter 3, section 3.8 on page 69, documents the details of the qualitative case study conducted to confirm the relevance of the structural and dynamic components of agile EDM. DSR Cycle 2 Part I concluded that influences on agility operating at the micro-level in EDM cannot be theorised because agility emerges and evolves from the actions and interactions of agents in complex and complicated contexts and, thus, needs to be empirically studied. The artefact's underlying constructs, models, and methods can only be formalised by studying and applying them to a real-world setting (March and Smith, 1995).

The dynamic part of a framework for agile EDM (see Figure 5-21 on page 223), including the structural and dynamic constructs for the units of analysis, provided a conceptual framework for the qualitative case study of agility in a real-world EDM context. This was used to refine and further develop the DSR artefact to produce a framework for agile EDM. The in-depth analysis of the qualitative data collected at the case study organisation served as an instantiation that preceded the final articulation of the artefact's underlying constructs (March and Smith, 1995) by applying real-world data to a conceptual framework for agile EDM. The conceptual framework for a qualitative case study of agile EDM, which is based on the structural and dynamic parts of a framework for agile EDM developed in DSR Cycle 1 and the preceding sub-cycles of DSR Cycle 2, is presented in Figure 6-3.

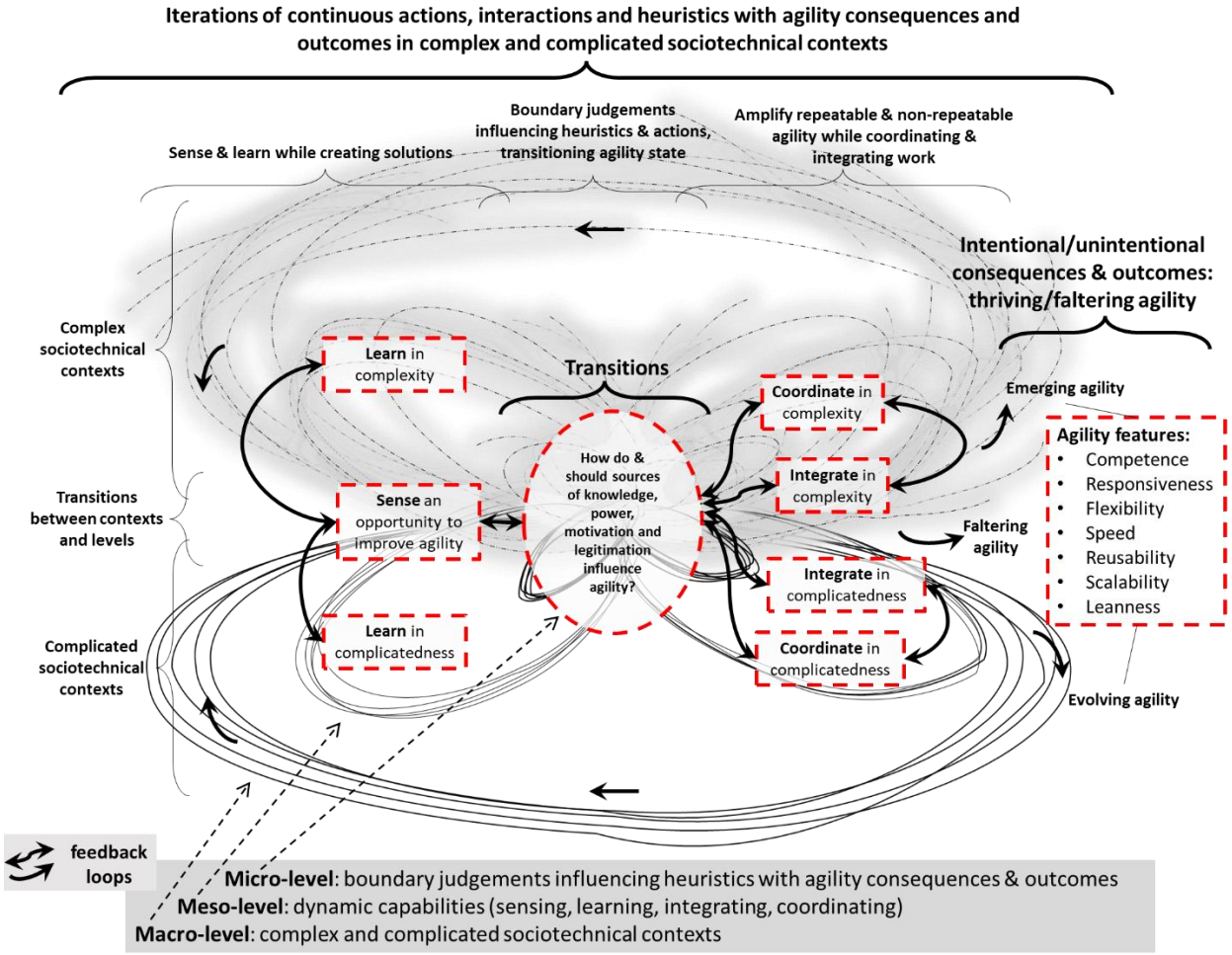


Figure 6-3: A conceptual framework for a qualitative case study of agile EDM (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

When mining an organisation's narratives, valuable insights can be gained to investigate how heuristics evolve related to experience and expertise (Snowden and Rancati, 2021). In the thematic analysis, the data was examined to understand how heuristics (boundary judgements) were enacted in dynamic capabilities to transition the state of agile EDM between complexity (emerging non-repeatable agility features) and complicatedness (evolving repeatable agility features), thereby influencing agility outcomes and consequences.

As proposed by critical systems heuristics (CSH) theory, the practice of boundary critique provides a mechanism whereby the agents interacting at a boundary in a CAS can influence the system to shift to an improved state (Ulrich and Reynolds, 2020). The richly descriptive narratives from the qualitative interviews and the policy and standards documents found at the case study organisation presented an interesting data set containing descriptive

perspectives and normative instructions for how agility in EDM **is** (current facts and values) and how it **ought to be** (desired facts and values).

6.2 QUALITATIVE THEMATIC CODING AND FINDINGS

The qualitative thematic analysis used the constructs of the structural and dynamic components of agile EDM to investigate the context-based differentiation of the framework's components, the relationships between the components, and how the dynamic mechanisms function to influence the emergence and evolution of agility in the complex and complicated sociotechnical contexts of EDM. The thematic analysis aimed to inductively discover and explain, from real-world situations, the transition dynamics of complex and complicated EDM contexts, and how these transitions resulted in agility consequences and outcomes.

Process studies investigate how organisational and managerial phenomena change, emerge and unfold over time (Langley *et al.*, 2013). Langley (1999, p. 692) identified four challenges faced by researchers regarding process data collected from real-world organisational contexts: (1) such data pertains primarily to sequences of "events" provided as narratives of chronologically ordered choices, activities and events; (2) process data usually span multiple levels and units of analysis that present ambiguous boundaries, making it difficult to isolate phenomena due to their fluid nature across space, time and in different contexts; (3) the process data's time-dependent embeddedness varies in its duration, exactness and relevance due to the influences of modulating background processes moving at a different pace or level, and non-disclosure of relevant information at a crucial point in time; and (4) despite process data collection pursuing knowledge of events, the data tends to be eclectic and attracts the inclusion of phenomena such as feelings, thoughts, changing relationships and interpretations.

Using the qualitative interview data collected at the case study organisation, the thematic analysis process first inductively differentiated the framework's constructs for complex and complicated contexts to refine and interrelate the codes for dynamic capabilities and agility features that were developed in DSR Cycle 1. Then, boundary judgements underlying heuristics and influencing agility in EDM were inductively identified, coded and interrelated based on the qualitative interview data, to explain the influences on agility at the micro-level of complex and complicated EDM contexts at the case study organisation. Subsequently, the coding process was extended to include the policy and standards documents collected

at the case study organisation. Through this process, a coding scheme comprising codes, relationships and code groups evolved until no new codes or relationships could be identified in the data.

6.2.1 Dynamic capabilities and agility features in complex and complicated EDM contexts

As the analysis and review of the initial codes applied to the data in the first DSR cycle progressed, it became apparent that there were differences in dynamic capabilities and agility features depending on whether the EDM context was complicated or complex. Participants provided differing descriptions of competence, expertise, speed, reuse and leanness depending on whether the context was complex or complicated. Flexibility and responsiveness were mainly associated with complex contexts involving uncertainty.

In complex EDM contexts, dynamic capabilities and agility features are emerging and non-repeatable because they are subject to enabling (context-sensitive) constraints and must deal with unknown unknowns by progressing in short iterations of probing, sensing and responding (Kurtz and Snowden, 2003). Under uncertain conditions, nonlinear, dynamic interactions result in complexity (Cilliers, 2000a).

In complicated EDM contexts, dynamic capabilities and agility features are evolving and repeatable because they are subject to governing (context-free) constraints and deal with known unknowns, solvable by experts, with direct links between causes and effects (Kurtz and Snowden, 2003).

The following examples include interview participants' input, and show how agents enact dynamic capabilities differently in complex and complicated contexts and how the resulting agility features take on distinct characteristics depending on the complex or complicated nature of the described EDM context. ("P#" is the interview/participant number; "(x:y)" provides x as the interview/participant number and y as the unit of meaning number within the transcribed text; "T" is the researcher's initial).

In the first example, the agents in the EDM context were dealing mainly with **complexity**, with consequences of **emerging** non-repeatable agility features:

Unit of meaning (6:14): learning through creating solutions and also experimenting with new solutions as requirements come up; building competence/fluency	**Codes created, refined and applied**
"P6: I think they always say, 'don't waste a good crisis'. Probably the best learning capability we've got is we set a challenge or a challenge set for us, and we react to it and try and do it. In doing that, we coming across new ways to do things better, ways of doing things. So the learning is in the doing, without a doubt. We're not scared to sort of try new things and fail. Quite often, we do things wrong the first time. We learn from it, and the other thing [is] that we got an approach or a methodology again is working through iterations, so if we want to do something, we say, okay, what is the base thing that we want to do or [i.e.] iteration one of this. Then we go through iteration one, and then we'll say, let's productionise iteration one of this. Then go into iteration two of the same thing and then iteration three, and then, hopefully, after iteration three we've got our deliverable up [and running]. So it's like we've got hands-on learning or iterative learning, so you learn from what you've done and then take it to the next level, the next iteration and the next iteration. *T: so innovation and experimentation are encouraged?* *P6: Yes, and failure."*	**Dynamic capabilities:** • SENSE opportunity to evolve/emerge agility • LEARN while applying/embedding existing knowledge • LEARN while producing newness • COORDINATE response to constraints • INTEGRATE novelty/fluctuation **Agility features:** • competence/aptitude • speed enabled by competence and resilience • responsiveness • leanness (limit work-in-progress)

In the second example, the agents in the EDM context were dealing mainly with **complicatedness**, with consequences of **evolving** repeatable agility features:

Unit of meaning (7:38): keyman dependency including very synergetic relationship with P6	**Codes created, refined and applied**
"P7: So I'll tell you where maybe the problem should be. so because I have such a good working relationship with P6 we have a very close working relationship. He knows where I am and what I'm up to at the moment, but it's more. I mean, so as an example, P6 needs to make sure [the] metadata hub is up and running and the data quality component Express>It is up and running. He must make sure those things are up and running. He's not looking at, I mean he's got an awareness of how this integration is happening, but he's not looking at it from an information management perspective, to say, how do we start to leverage these different components to drive other things going forward. He's also not. Although he obviously knows how the Semantic Discovery component works, he's not going to be the one who [will ask] from an information management perspective how do we want to drive it. He's going to say, hey, we've given you Semantic Discovery. His response is, get it implemented, make	**Dynamic capabilities:** • SENSE opportunity to evolve/emerge agility • LEARN while applying/embedding existing knowledge • COORDINATE what is knowable • INTEGRATE expert knowledge/know-how/capability **Agility features:** • speed enabled by specialisation and equilibrium • expertise/specialised capability

Unit of meaning (7:38): keyman dependency including very synergetic relationship with P6	**Codes created, refined and applied**
sure it works properly make sure it's up and running. But the leveraging it into the organisation is not his role. That for me, is probably where the big gap would happen if I was no longer in this particular team."	

There were instances, as illustrated by the following example, where the agents of EDM were interacting in a **complicated context and transitioning to a complex** context, due to uncertainty and incomplete knowledge, with consequences of **faltering** agility:

Unit of meaning (10:51): people make decisions because they have autonomy but don't have the shared understanding of impact on information architecture (IA); things change along the way without continuous feedback which could impact information architecture	**Codes created, refined and applied**
"P10: Yes, that's exactly, but that's what I'm saying is like, you know, because what you find is like what I've seen happen is people would make decisions because you do have autonomous teams when you're working in an agile manner, and they can make certain decisions. So they've made a decision either not understanding the impact on the architecture, so they'll think it's like a really small thing, but it [then] actually ends up becoming a problem. Because that discussion doesn't happen right there and then and get debated and way forward worked out, you then end up with not implementing what was in mind because people have kind of changed things along the way instead of feeding back up saying, we're having these issues and working out the best way to accommodate for those things. So I've also seen that happening."	**Dynamic capabilities:** • SENSE opportunity to evolve/emerge agility • LEARN while producing newness • LEARN while applying/embedding existing knowledge • COORDINATE response to constraints • COORDINATE what is knowable • INTEGRATE novelty/fluctuation • INTEGRATE expert knowledge/know-how/capability **Faltering agility:** • precarious agility • disintegrating agility **Agility features lost:** • competence/aptitude • speed enabled by competence and resilience • flexibility • speed enabled by specialisation and equilibrium • expertise/specialised capability

In the following example, **faltering** agility was consequential in a **complicated** EDM context:

Unit of meaning (7:40): keyman dependency would cause multiple projects to stop completely if something were to happen	**Codes created, refined and applied**
"P7: …also projects, how the project is happening and a lot of it is about leveraging existing capability. P6's job is to make sure that the capability is there. So he's not going to be on a project. He's going to say, well, but you got this capability, you guys must work out how to use the capability to solve your project requirements or your new requirement. That's also probably where, if I wasn't in the team, that there will be a big gap from a project perspective and given how much stuff is being brought onto the [data] platform. I would think that's probably the other big gap that would happen in the organisation. A lot of projects would probably come to pretty much a screeching halt before things got [back] up to speed."	**Dynamic capabilities:** • COORDINATE what is knowable • INTEGRATE expert knowledge/know-how/capability • SENSE opportunity to evolve/emerge agility • LEARN while applying/embedding existing knowledge **Faltering agility:** • unprioritised/ unvalued/ unrealisable agility **Agility features lost:** • expertise/specialised capability • speed enabled by specialisation and equilibrium

The codes for dynamic capabilities, and agility features were continually refined as the coding and analysis of the interview transcriptions progressed. Table 6-1 presents the refined codes for dynamic capabilities and agility features relevant to **complex** EDM contexts resulting from the thematic analysis process.

Table 6-1: Refined codes for dynamic capabilities and agility features in complex EDM contexts

Code	**Meaning**	**Initial code from the first DSR Cycle**
LEARN while producing newness	building knowledge and skills by continuously combining new and existing knowledge in a complex context	DC: learning
SENSE opportunity to evolve/emerge agility	becoming aware of the need and opportunity to change the state of agility	DC: sensing
COORDINATE response to constraints	organising and harmonising new and existing elements in a complex context	DC: coordinating
INTEGRATE novelty/fluctuation	combining existing and new parts into a more valuable whole in a complex context	DC: integrating
competence/aptitude	having experience, discernment, aptness and generalist skills	AGILITY: competence

Code	Meaning	Initial code from the first DSR Cycle
flexibility	being adaptable and open to alternative solutions and approaches	AGILITY: flexibility
leanness (limit work-in-progress)	being able to limit work-in-progress to prioritised, essential value delivery	AGILITY: leanness
repurpose-ability/extensibility	being able to extend or use an existing capability for something other than its original purpose	AGILITY: reusability
responsiveness	being able and motivated to comprehend and to act on what is required	AGILITY: responsiveness
speed enabled by competence and resilience	being able to deliver value quickly due to being competent and resilient	AGILITY: speed
disintegrating agility	unable to understand and respond to the current state to move towards an improved state of agility	No code defined
precarious agility	unable to fully understand and respond to the current state to move towards an improved state of agility	No code defined

From the data, it became apparent that agility features in complex EDM contexts enabled resilience. Resilience is the tolerance that a system possesses to experience disturbance or magnitude of change without shifting to an adjacent state that has different functional and structural properties (Gunderson *et al.*, 2010). According to Juarrero (1999), a resilient system can change its distinctive structure, thereby ensuring the adaptability and survival of its overall organisation. Juarrero (1999, p. 111) further explains, “Complex systems are usually more resilient than simple ones, with complex open systems that interact with their environment exhibiting the highest degree of resilience. As anyone who has tried to rid his house of cockroaches can confirm, evolution generally favors resilience, not stability”. If decisions in a situation are clear when retrospectively assessed, despite the response not being knowable in advance, the system is resilient and embodies sufficient redundancy to deal with perturbations (Snowden and Rancati, 2021, p. 10).

Table 6-2 presents the refined codes for dynamic capabilities and agility features relevant to **complex** EDM contexts resulting from the thematic analysis process.

Table 6-2: Refined codes for dynamic capabilities and agility features in complicated EDM contexts

Code	Meaning	Initial code from the first DSR Cycle
LEARN while applying/embedding existing knowledge	building knowledge and skills by continuously combining existing and new knowledge in a complicated context	DC: learning
SENSE opportunity to evolve/emerge agility	becoming aware of the need and opportunity to change the state of agility	DC: sensing
COORDINATE what is knowable	organising and harmonising new and existing elements in a complicated context	DC: coordinating
INTEGRATE expert knowledge/know-how/capability	combining existing and new parts into a more valuable whole in a complicated context	DC: integrating
expertise/specialised capability	having expert or specialised knowledge, skills and capability	AGILITY: competence
leanness (eliminate/avoid redundancy)	being able to avoid or eliminate wastage of resources	AGILITY: leanness
reusability	being able to repeat the use of an existing capability in a new or similar context	AGILITY: reusability
scalability	being applicable to a wider scope, vertical/horizontal, by repeating and/or recombining existing capabilities	AGILITY: scalability
speed enabled by specialisation and equilibrium	being able to deliver value quickly due to expert capability and stability in the environment	AGILITY: speed
Unprioritised/ unvalued/ unrealisable agility	understanding the current state but deciding that no value can be added by amplifying agility features	No code defined

Coding of the data reached saturation when no new codes or updates to existing codes were needed, and existing codes could be “dragged and dropped” onto units of meaning to complete the thematic analysis phase (Friese, 2019). The refined conceptual framework for a qualitative case study of influences on agility in EDM is presented in Figure 6-4, including the refined codes for agility features and dynamic capabilities in complex and complicated EDM contexts.

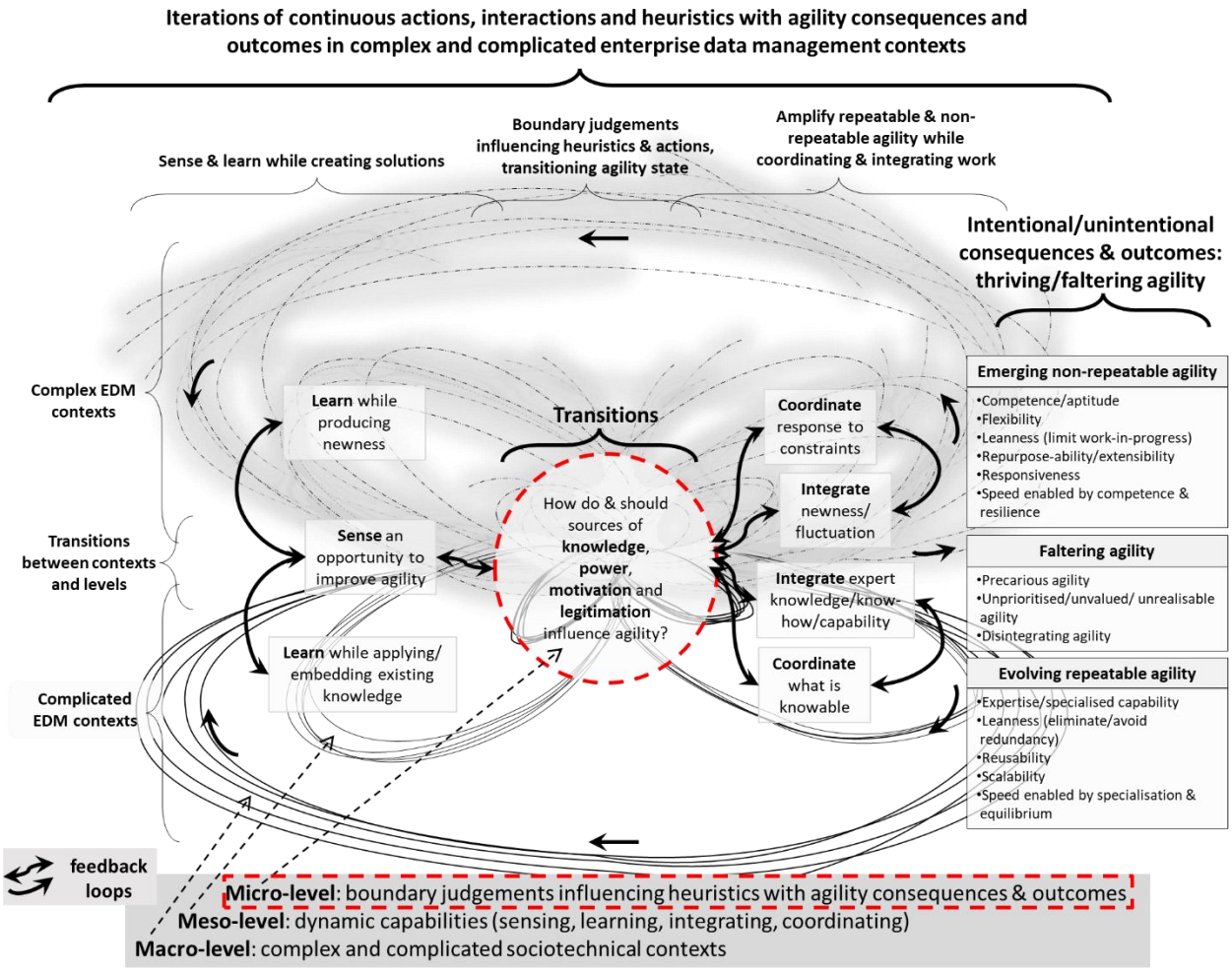


Figure 6-4: Refined conceptual framework for a qualitative case study of influences on agility in EDM (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

6.2.2 Boundary judgements and agility outcomes and consequences

The same qualitative interview data collected in DSR Cycle 1 was used to investigate how boundary judgements in heuristics influence thriving and faltering agility in EDM contexts. This approach enabled inductive reasoning on how the transitions between complicated and complex transpired without constructing participant responses through directed lines of questioning during the interviews about how the participant believed agility emerged and evolved in EDM. Instead, the participants' answers to how they saw and experienced the transitions of EDM contexts through liminality with agility consequences and outcomes were interwoven with their narratives.

Practising boundary critique presents opportunities to discover the underlying judgements that influence how stakeholders understand a situation and how it could be improved (Ulrich and Reynolds, 2020). Examples include taking a broader view of what can or should be coordinated and integrated to influence an improved agility outcome or examining possibilities for reuse or repurposing, which might be overlooked if a deterministic linear process is enforced. The organisation must first understand its existing available data technologies and data before investing in new technologies or sourcing data externally (Peppard, 2016). The following narrative from the case study organisation illustrates such an example:

> *[P9:10] "We've been on a journey because we were told not to do Big Bang. And maybe that's the fourth thing. So remember I said, BankGroup have this vision: BankGroup wants to be a data-driven organisation. So, for instance, LE's team, that's the enterprise data governance team in BankGroup, was also running with something on their side. They have this data 2020 strategy, and they brought in [the data warehouse Chief Technology Officer] to kind of do some sort of consultation on data strategy with us. So um, from a customer point of view, these guys couldn't create this customer-centric view of the world if we couldn't get a single view of the customer and all of these different customer data sets, you know, lying all over the organisation, meant we couldn't get consistent insights. So they needed that kind of single view of the customer. We were trying to build it on our side to get rid of complexities and costs, and then when the guys went out to look at what the business case for big data was, I think NC at the time took a step back and said, just hold on. The bank has so much data that we can consider the bank's data, big data, and if we look at, before we go out and purchase data from Google and Twitter and everything if we look at the data that the bank has, we're not even using 20% of that data. So we decided to all come together, and we created what we call the Data 2025 Strategy. And what that Data 2025 Strategy looked at doing was it looked at consolidating this data capability."*

The boundary categories and issues from CSH theory served as overarching themes for the detailed boundary critique questions that emerged from the data management specialists'

narratives, revealing the heuristics applied in the case study organisation's EDM contexts (Ulrich and Reynolds, 2020). Furthermore, this approach tested the coherence of the hypothesised split of agility into repeatable (evolving) features and non-repeatable (emerging) features as influenced by heuristic outcomes emanating from the liminal boundary between complex and complicated EDM contexts. The thematic analysis categorised the four sources of influence (knowledge, legitimation, motivation and power) as defined by CSH theory (Ulrich, 2000) for boundary judgements discovered in the qualitative data using an inductive approach.

6.2.3 Data coding scheme

The thematic analysis presented in this section applied the constructs and relationships of the conceptual framework for agile EDM, as shown in Figure 6-4 on page 238, to refine and extend the codes and code groups developed during the thematic coding and analysis process in the first DSR cycle. Throughout the data coding process, the thematic analysis was bound to the structural and dynamic components of agile EDM, which included the following hypotheses based on the artefact's development thus far:

- There is an identified requirement for improving a particular phenomenon in EDM. The phenomenon being investigated is agility, and the requirement for agility in EDM was confirmed in the literature review in Chapter 2 and the thematic analysis in the first DSR cycle.
- At the macro-level, EDM contexts are sociotechnical, complex and complicated. The agents acting in EDM contexts interact with each other and can be social (individuals and teams) or technical (such as platforms, technologies, applications and databases) by nature. Therefore, this study adopts a sociotechnical CAS perspective of agile EDM.
- Dynamic capabilities govern the actions and interactions within the system at the meso-level: learn (while being productive/creating solutions), sense (opportunities for improvement), coordinate (collaborate and work collectively towards a shared purpose) and integrate (combining work effort and outcomes for collective benefit). Differences in the dynamic capabilities were found in the data depending on whether the EDM context was complex or complicated.
- Repeatable agility features were interpreted as evolving features. Non-repeatable agility features were interpreted as emerging features. An agility feature cannot belong to both categories due to their context sensitivity, and the codes were refined to the required level of granularity to achieve this exclusivity. Differences in the agility features were found depending on the EDM context being complex or complicated.

- At the micro-level, heuristics practised by individuals and teams involve boundary judgements (sources of motivation, power, knowledge and legitimation) that influence actions and decision-making, ultimately influencing the agility outcomes and consequences for the CAS of agile EDM.

In the following sections, the thematic analysis investigated boundary judgements as sources of influence (Ulrich, 2000) that shift the complex and complicated system of EDM between complex and complicated realities with thriving and faltering agility consequences and outcomes. A thematic map was developed for the constructs of the refined conceptual framework (see Figure 6-4 on page 238) and the meanings found in the data during the thematic analysis (Braun and Clarke, 2006). Based on the thematic map, Figure 6-5 presents the annotated network diagram created in Altas.ti that served as the data coding scheme for the thematic analysis.

Throughout the coding and analysis process the notation B-M-, B-P-, B-K-, and B-L- was used for coding the boundary judgements identified in the data (“M” = source of motivation; “P” = source of power; “K” = source of knowledge; and “L” = source of legitimation).

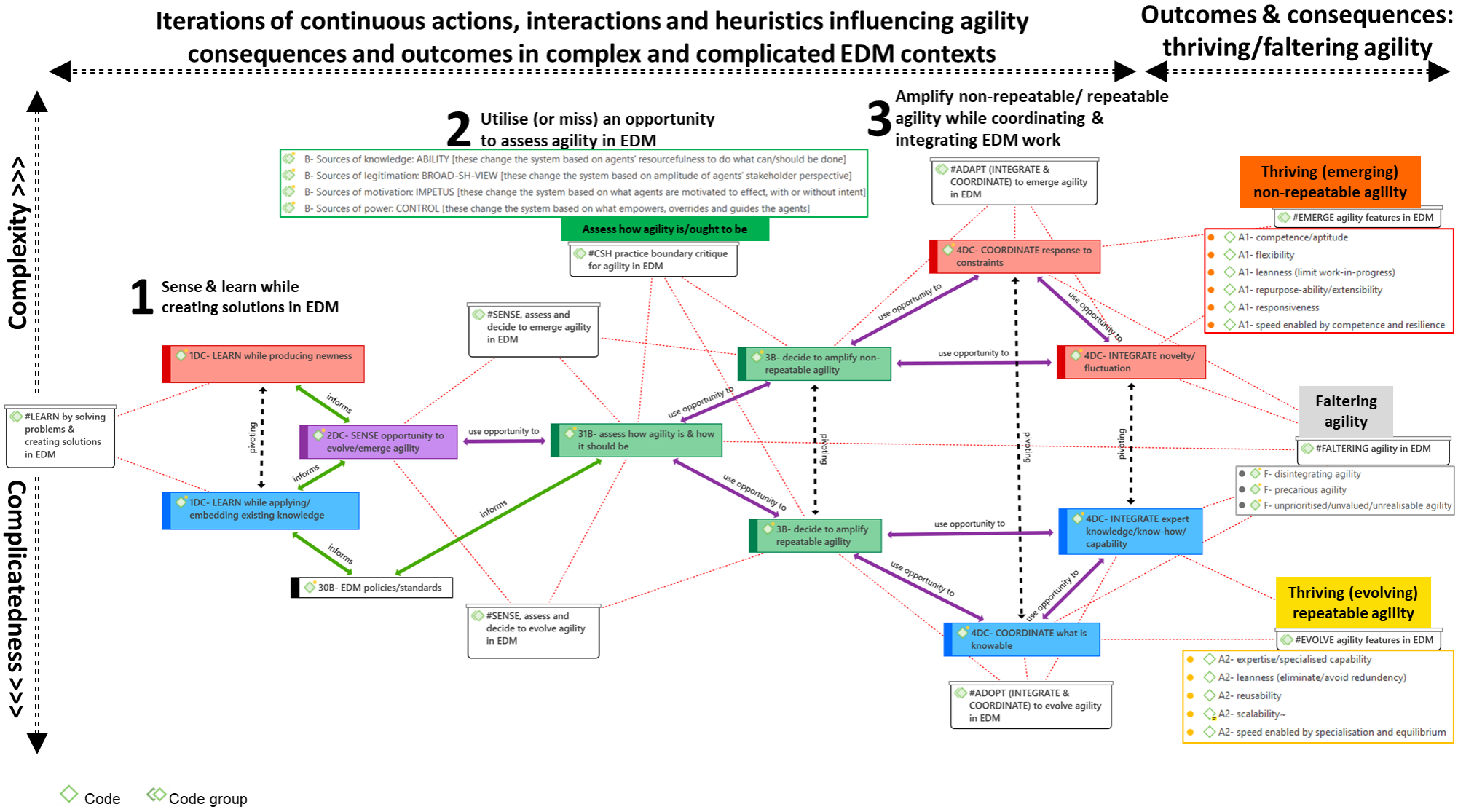


Figure 6-5: Data coding scheme for a framework for agile enterprise data management created using Atlas.ti

Using the data coding scheme presented in Figure 6-5, each quotation was coded by linking an aspect from each code group to each unit of meaning, resulting in very dense coding with **12 114** codes applied to **676** units of meaning identified in the **14** interview transcriptions and **8** policy and standards documents collected at the case study organisation.

Boundary critique is a participatory process central to CSH that reveals the boundary judgements made by participating agents to understand a given situation and design ways to improve the systems involved (Ulrich and Reynolds, 2020). As defined by Ulrich and Reynolds (2020), boundary judgements are used in the practice of boundary critique and comprise four categories: (1) sources of **knowledge** relate to agents' abilities and resourcefulness to do what can or should be done; (2) sources of **legitimation** relate to the amplitude of agents' stakeholder perspective; (3) sources of **motivation** relate to the agents' impetus based on what they are motivated to effect, with or without intent; and (4) sources of **power** relate to control based on what empowers, overrides and guides the agents of the system of interest. This study of agile EDM adopted these four boundary categories proposed by Ulrich and Reynolds (2020), for identifying sources of knowledge, power, motivation and legitimation that influence agility at the micro-level of the CAS of agile EDM.

The coding process considered aspects of the data that were relevant to each of the four boundary judgement code groups for sources of knowledge, motivation, power and legitimation (Ulrich and Reynolds, 2020). During this process, inductive reasoning guided the addition of new codes to each of the four boundary judgement code groups, refining existing code names, and merging duplicate codes for sources of influence with agility consequences and outcomes.

Figure 5-19 on page 215 proposed 12 main boundary questions to critique how agility is and how it ought to be in the ongoing contexts of the CAS of agile EDM. Using these main questions as a guideline, themes were sought in the data for how the agents of EDM enact boundary judgements in their heuristics, thereby influencing agility outcomes and consequences in EDM. The sources of influence identified for the boundary judgements in the framework for agile EDM influence actions and interactions in EDM, thereby influencing agility consequences while coordinating and integrating EDM work.

An example of interpretive reasoning while applying codes to a unit of meaning with thriving agility consequences is illustrated in Figure 6-6.

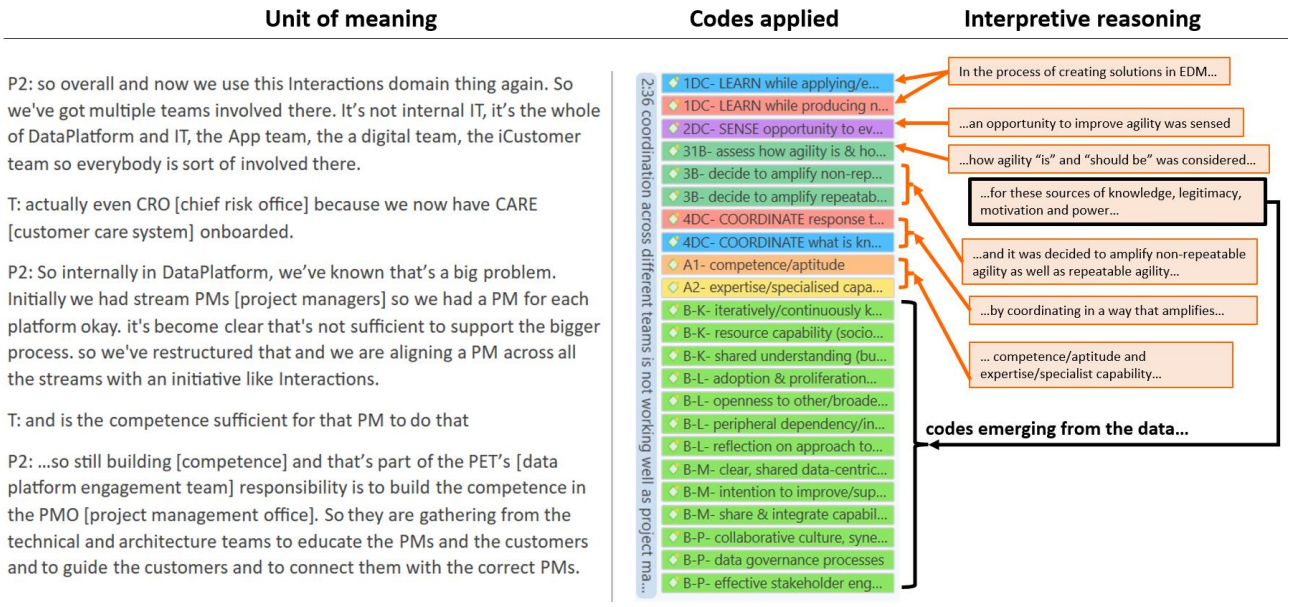


Figure 6-6: An example of the coding process for thriving agility

Figure 6-7 presents an example of the interpretive reasoning that was applied in the coding process for a case where agility faltered.

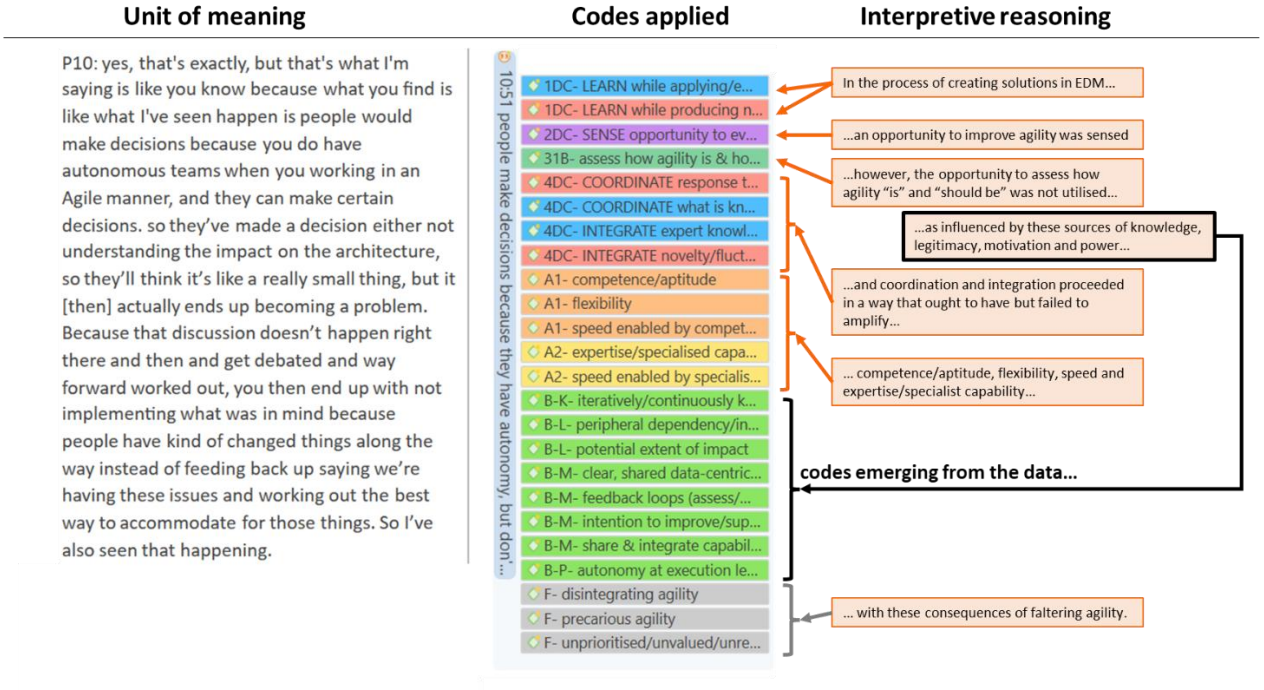


Figure 6-7: An example of the coding process for faltering agility

Once coding of a quotation was completed, a network diagram was generated to verify whether they made sense and reflected the narrative of the coded quotation. Relationships between the boundary critique codes were created and refined to further enrich the

understanding and documentation of the interpretation and analysis of the units of meaning. This approach was essential to the coding and analysis process because the coding became increasingly saturated until no new codes needed to be created or modified, and the relationships between the codes supported new units of meaning being analysed (Fusch and Ness, 2015).

Boundary judgement codes were applied to each unit of meaning to emerge the "story" of the sources of influence on agility features at play in the narrative. This process revealed how the agent(s) assessed an arising opportunity at a transitional boundary to improve agility and how the agents practised critically-heuristic thinking to inform their decision-making and actions, thus influencing the system to shift towards intentional or unintentional agility consequences. Such an example, showing only the codes applied for sources of knowledge, legitimation, motivation and power, is presented in Figure 6-8.

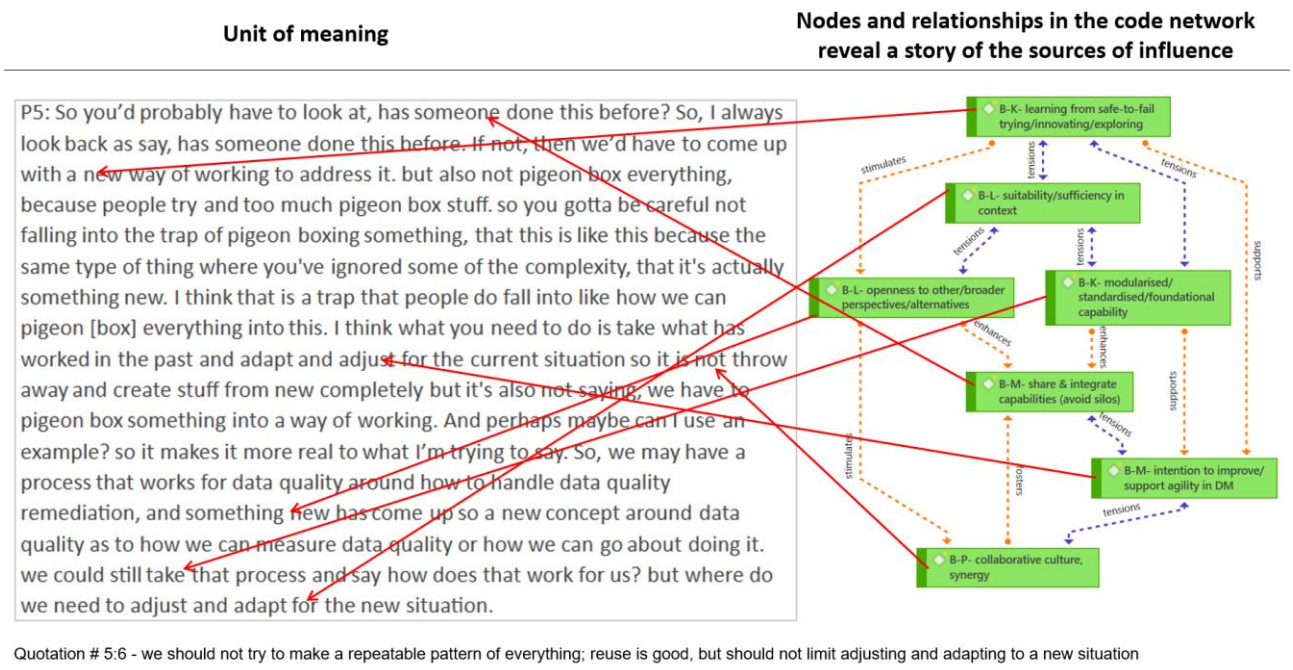


Figure 6-8: Example of sources of influence codes applied to a quotation

The network diagram showing the relationships between codes applied to a unit of meaning provides a picture of the interpretation of the participant's narrative (Friese, 2019). Applying the boundary judgement codes (names starting with B-M-, B-P-, B-K-, and B-L- for sources of motivation, power, knowledge and legitimation, respectively) and generating a network diagram revealed the interpretation of the nature of the agents' interactions in the EDM context. This approach enabled reflection on whether the story rendered by the nodes and

relationships in the network diagram closely represented the narrated EDM situation. As shown in the example in Figure 6-8, the relationships between the codes for sources of influence show the "thought patterns", revealing boundary judgements underlying the heuristics used in the given context as experienced and seen by the narrator. The patterns that emerged from the narratives indicated a process of balancing and pivoting what the facts and values are and what they ought to be to result in a perceived (imagined or observed) consequence of an improved state (Ulrich and Reynolds, 2020) for the CAS of agile EDM.

Network diagrams in ATLAS.ti revealed the storylines in the analysed narratives (Friese, 2019). The co-occurrence of codes in the same unit of meaning implied that these codes are related to each other, either directly or indirectly. Throughout the coding process, care was taken to ensure that there were no orphan codes (codes unrelated to any other codes) on the network diagram containing all the codes applied to a quotation under analysis. Table 6-3 documents the relationships defined and refined to reflect meaningful connections between the codes applied to the data set. The relationships involving the sources of influence codes applied to the data represent the nature and direction of influence that boundary judgements exert on EDM agents' practice of heuristics in their data management activities, resulting in agility consequences and outcomes.

Table 6-3: Relationships used for relating codes in network diagrams

Line style	Relationship name	Description of relationship
	amplifies	strengthens, consolidates, promotes
	considers	gives careful thought to
	emerges	twists together; intertwines
	enables	makes possible
	enhances	adds value to
	evolves	develops and advances iteratively
	fosters	nurtures and cultivates
	guides	gives direction to
	impedes	slows the progress of, reduces
	implements	materialises
	informs	contributes knowledge and understanding to
	matures	supports the development of
	moderates	limits extremes
	opportunity disregarded/not prioritised	does not see value in the opportunity presented
	opportunity missed	does not have an awareness of the opportunity or its value

Line style	Relationship name	Description of relationship
	opportunity not fully/appropriately utilised	only partially succeeds at utilising the opportunity presented
	pivoting	switching between
	stimulates	invigorates, sparks or gives spirit to
	supports	confirms, provides a foundation for
	tensions	tension presents an opportunity to leverage for change
	use opportunity to	make use of the opportunity presented to

The coding process developed into a pattern that flowed from the researcher's interpretive style, and saturation was reached where no meaningful new codes or relationships between codes were identifiable in the data (Friese, 2019).

Table 6-4 and Figure 6-9 present an example of thriving agility:

Table 6-4: Example-1 Thriving agility

Unit of meaning (5:6): we should not try to make a repeatable pattern of everything; reuse is good, but should not limit adjusting and adapting to a new situation.
"P5: So you'd probably have to look at, has someone done this before? So, I always look back and say, has someone done this before? If not, then we'd have to come up with a new way of working to address it, but also not pigeon box everything, because people try and too much pigeon box stuff. So you gotta be careful not falling into the trap of pigeon boxing something, that this is like this because the same type of thing where you've ignored some of the complexity, that it's actually something new. I think that is a trap that people do fall into, like how we can pigeon [box] everything into this. I think what you need to do is take what has worked in the past and adapt and adjust for the current situation, so it is not throw away and create stuff from new completely, but it's also not saying we have to pigeon box something into a way of working. And perhaps maybe…can I use an example? So it makes it more real to what I'm trying to say. So, we may have a process that works for data quality around how to handle data quality remediation, and something new has come up, so a new concept around data quality as to how we can measure data quality or how we can go about doing it. We could still take that process and say how does that work for us? But where do we need to adjust and adapt for the new situation."

Codes applied for dynamic capabilities (meso-level)	**Codes applied for critical systems heuristics (micro-level)**	**Codes applied for agility consequences**
1DC- LEARN while applying/embedding existing knowledge 1DC- LEARN while producing newness 2DC- SENSE opportunity to evolve/emerge agility	31B- assess how agility is & how it should be • B-K- learning from safe-to-fail, trying/innovating/exploring • B-K- modularised/standardised/ foundational capability • B-L- openness to other/broader perspectives/alternatives	**Emerging agility:** A1- repurpose-ability/ extensibility **Evolving agility:** A2- reusability

Codes applied for dynamic capabilities (meso-level)	**Codes applied for critical systems heuristics (micro-level)**	**Codes applied for agility consequences**
4DC- INTEGRATE expert knowledge/know-how/capability 4DC- INTEGRATE novelty/fluctuation	• B-L- suitability/sufficiency in context • B-M- intention to improve/support agility in data management • B-M- share & integrate capabilities (avoid silos) • B-P- collaborative culture, synergy **Opportunity used to:** 3B- decide to amplify non-repeatable agility 3B- decide to amplify repeatable agility	

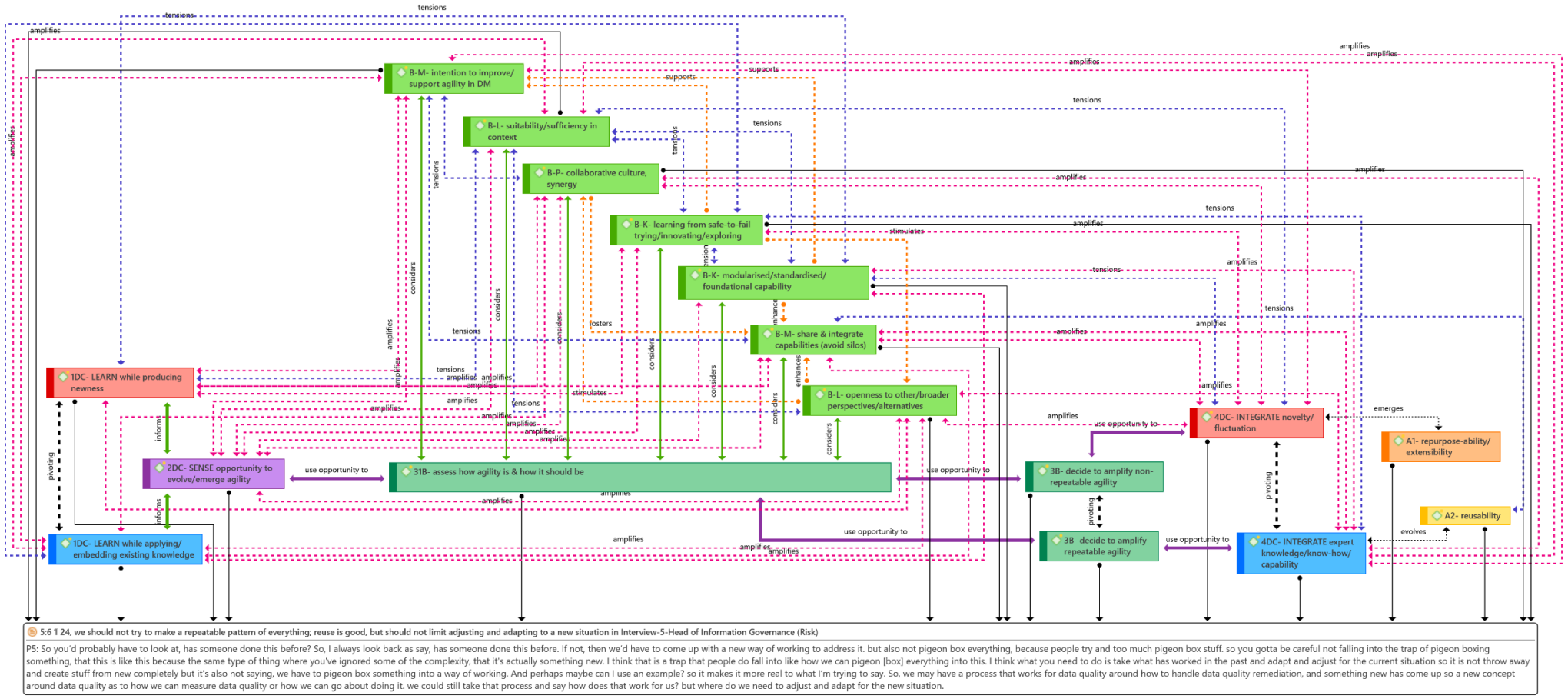


Figure 6-9: Example-1 of a complete network diagram illustrating thriving agility

Table 6-5 and Figure 6-10 present an example of faltering agility:

Table 6-5: Example-2 Faltering agility

7:61 ¶ 96 – 100, if coordination addresses priorities and dependencies/ interdependencies, agility can be enhanced. Interview-7-Head of Metadata

"P7: Yes, then it can be done. But otherwise, everything moves forward but at a slower rate. And then people are depending on me to do something before they can do something. It just has that big knock-on effect. So this is part of the real challenge that I have, is organisational priority of things. It's not for me to sit and do that. Hey, if you leave me to prioritise things, I'm going to prioritise Semantic Discovery because it's fun learning stuff that interests me.

T: Yes, exactly! I'm the same, I'll do the data architecture bits that interest me the most and have lots of meetings with P2 and draw target pictures, and the projects will be like, what? Yeah, that is a problem.

P7: Yes, it's actually a big frustration for me that I don't get that prioritisation. Because then it's almost, oh well, who shouts the loudest or which projects don't I want to work on. There are definitely a couple of those I don't want to work on, and I'll put those on hold.

T: So would you say that the coordination processes are, actually, from the coordination side, they are reactive rather than responsive?

P7: I would say definitely, they are reactive. Maybe the issue is, you know, knowing what to coordinate. If you've got priority, that coordination can follow the priority. But without the priority, there's nothing to coordinate to, and maybe that's the big issue."

Codes applied for dynamic capabilities (meso-level)	**Codes applied for critical systems heuristics (micro-level)**	**Codes applied for agility consequences**
1DC- LEARN while applying/embedding existing knowledge 1DC- LEARN while producing newness 2DC- SENSE opportunity to evolve/emerge agility 4DC- COORDINATE response to constraints 4DC- COORDINATE what is knowable	31B- assess how agility is & how it should be • B-K- defined, prioritised DM/data capability requirement • B-L- peripheral dependency/interdependency/ knock-on • B-L- reflection on approach to data initiatives • B-M- intention to be responsive • B-P- business area strategy/priority • B-P- effective stakeholder engagement • B-P- unilateral/BU decision-making **Opportunity to amplify agility disregarded or missed.**	**Faltering agility:** F- disintegrating agility F- unprioritised/ unvalued/ unrealisable agility **Diminished/lost emerging agility:** A1- responsiveness A1- speed enabled by competence and resilience **Diminished/lost evolving agility:** A2- speed enabled by specialisation and equilibrium

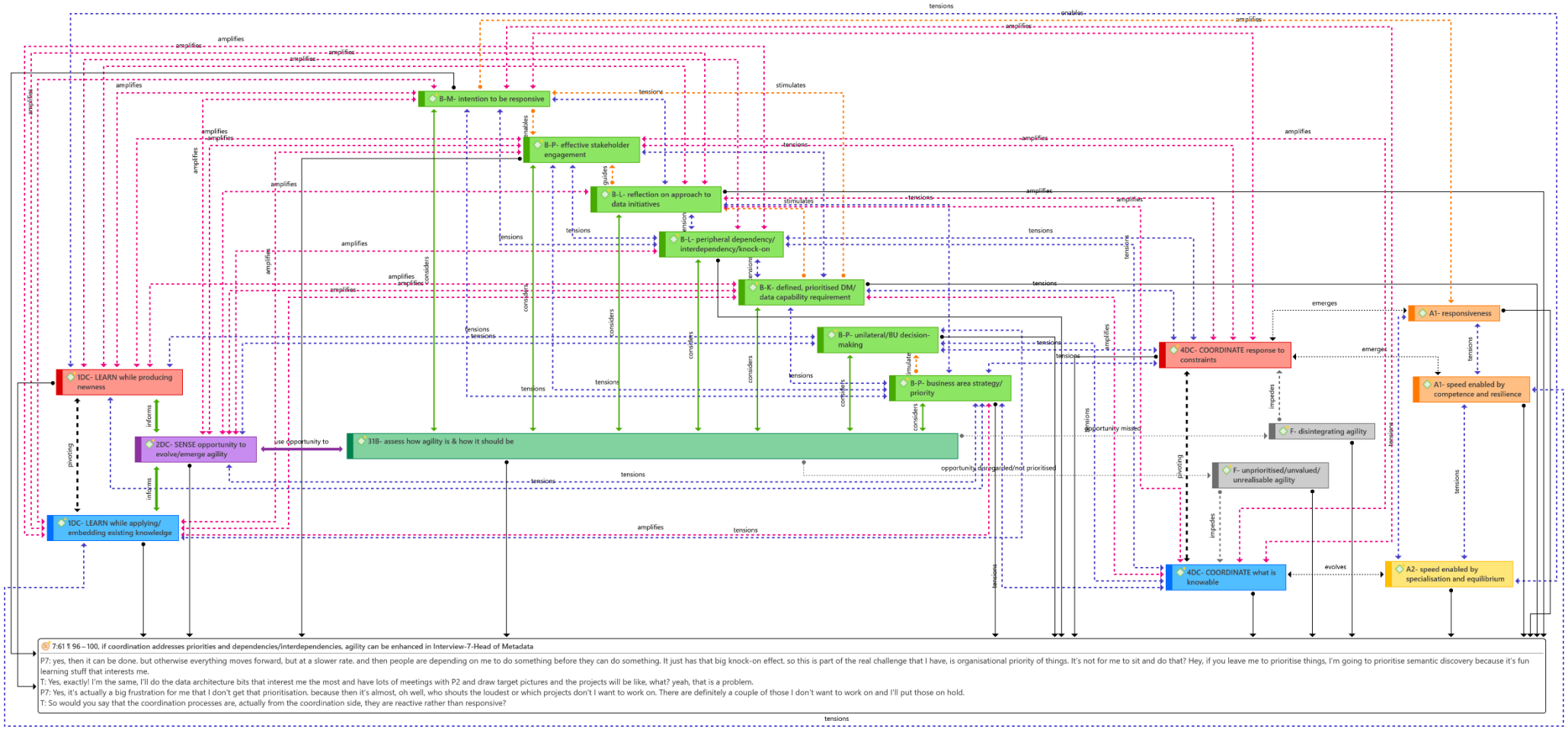


Figure 6-10: Example-2 of a complete network diagram illustrating faltering agility

Table 6-6 and Figure 6-11 present an example of thriving and faltering agility:

Table 6-6: Example-3 Thriving and faltering agility

13:18 ¶ 35, logging data quality issues needs to be integrated with the business process; system issues and data issues must be coupled in the business process. Interview-13-CDAO

"P13: When we started the data quality logging platform, we created a SharePoint site and were telling people you must log any data quality issues. We had that running for about three months. No data quality issues [were] logged. Then we went back, and we said guys, why are you not [logging DQ issues]? You are breaching this [as it] is now a policy that you must log your data issues. No data issues are being logged. Then we assessed, and we said, why are the issues not being logged? Because when I'm running a business and the system is down, or a file has not arrived with my data, I would rather actually log that on a CA Service Desk platform than actually go now to another SharePoint and log the same issue and it's [then] just to the central team [who are] supposed to solve that. So what highlighted it was if the capability to log issues is not part of the operations process, you're not going to get adoption because they're not feeling that you are an extension of their business or you are there to solve their business issues. And the decoupling between system issue and data issue at that time, even the understanding, had not [gotten through]. To them, it was the same thing. Then we moved it. That's the feedback loop, right? So we've defined a policy. DAMA says log an issue but doesn't necessarily say log an issue with the operational process. So you then take that, and then that's the feedback, and then you tweak it. So reiterative learning of the central team of saying what works for the business and how do we make sure that we get the right adoption because, at the end of the day we need to provide business value. So if that's the outcome [required], we need to bring it closer to their day-to-day processes. So we changed that, and we put the logging of issues in CA Service Desk, and the take up was literally 70% in the first month."

Codes applied for dynamic capabilities (meso-level)	**Codes applied for critical systems heuristics (micro-level)**	**Codes applied for agility consequences**
1DC- LEARN while applying/embedding existing knowledge 1DC- LEARN while producing newness 2DC- SENSE opportunity to evolve/emerge agility 4DC- COORDINATE response to constraints 4DC- COORDINATE what is knowable 4DC- INTEGRATE expert knowledge/know-how/capability 4DC- INTEGRATE novelty/fluctuation	31B- assess how agility is & how it should be • B-K- defined, prioritised DM/data capability requirement • B-L- potential extent of impact • B-L- suitability/sufficiency in context • B-M- business value/impact of DM initiative • B-M- feedback loops (assess/monitor/test) • B-P- business area strategy/priority • B-P- data management policies • B-P- effective stakeholder engagement	**Faltering agility:** F- unprioritised/ unvalued/ unrealisable agility **Emerging agility:** A1- competence/aptitude A1- flexibility A1- leanness (limit work-in-progress) A1- repurpose-ability/extensibility A1- responsiveness A1- speed enabled by competence and resilience **Diminished/lost evolving agility:** A2- expertise/specialised capability

Codes applied for dynamic capabilities (meso-level)	**Codes applied for critical systems heuristics (micro-level)**	**Codes applied for agility consequences**
	• B-P- formalised delivery processes **Opportunity used to:** 3B- decide to amplify non-repeatable agility **…but the opportunity to amplify repeatable agility was disregarded or missed**	A2- reusability

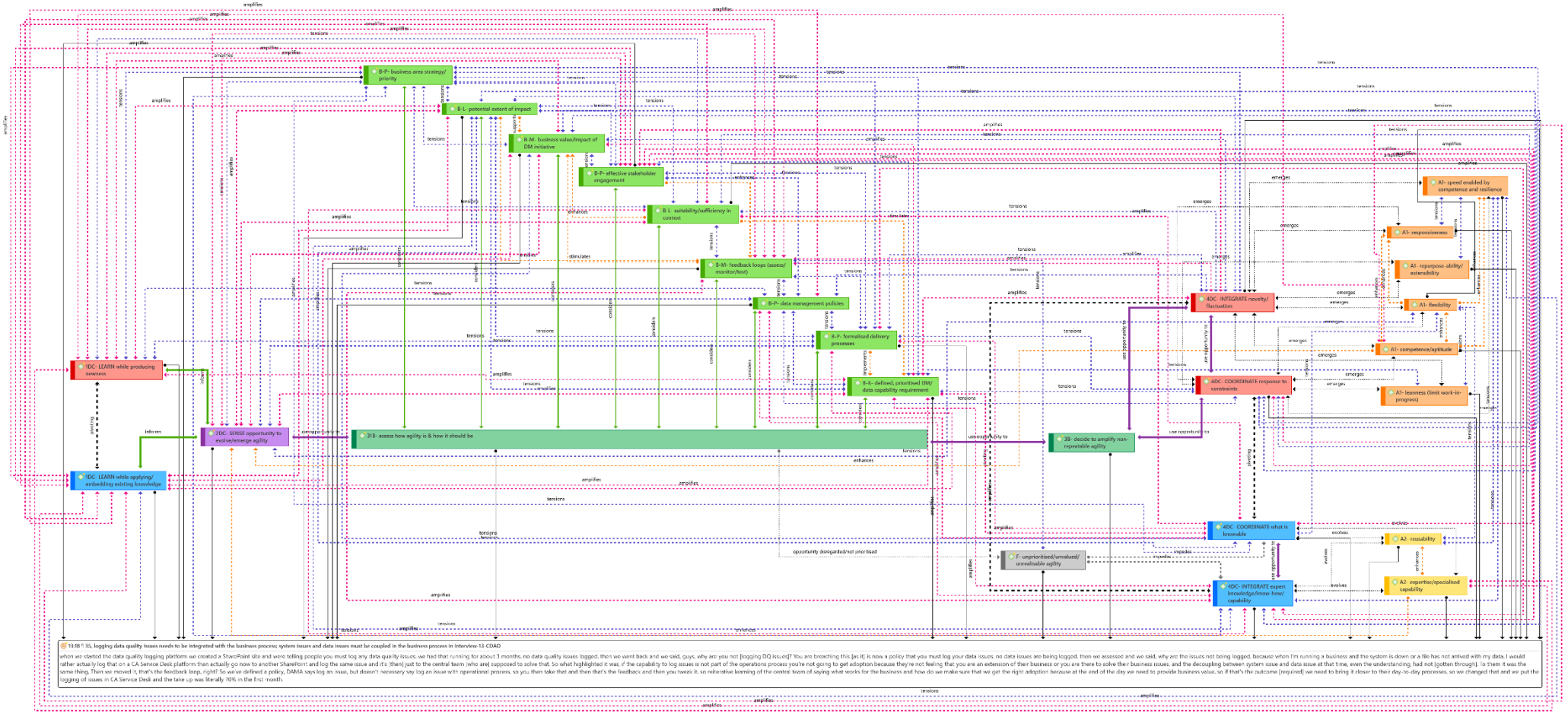


Figure 6-11: Example-3 of a complete network diagram illustrating thriving and faltering agility

The coding process set out to investigate agility influences at the micro-level of the CAS of agile EDM. Therefore, boundary judgements were coded as sources of influence that underlay agents' heuristics in their actions, resulting in outcomes (that were deliberate) and consequences (that were unintended or unexpected) for emerging and evolving agility features in the CAS of agile EDM. Code groups and smart codes were created in Atlas.ti for the 12 boundary critique questions, thus providing a higher level of analysis for investigating how the underlying boundary judgements influence thriving and faltering agility in EDM at the case study organisation. As explained by Ulrich and Reynolds (2020, p. 256), "In its most simple formulation, CSH uses a set of 12 questions to make explicit the everyday judgements on which we rely (consciously or not) to understand situations and to design systems for improving them". As shown in Figure 5-19 on page 215, the 12 boundary questions comprise three boundary categories representing the stakeholders, stakes and stakeholding issues for critically reflecting on the boundary judgements for sources of motivation, power, knowledge and legitimation.

Based on the qualitative data collected at the case study organisation, the following four sections present the boundary judgements found to influence thriving and faltering agility in EDM.

6.2.4 Sources of motivation influencing agility in enterprise data management

Sources of motivation relate to agents' impetus and change the system based on what agents are motivated to effect, with or without intent. Even though competent agents can often provide a discursive report of the reasons for and intentions of their actions, "unconscious motivation is a significant feature of human conduct" (Giddens, 1984, p. 6). The sources of motivation for boundary judgements influencing agility in EDM were identified and coded during the thematic analysis of the interview transcriptions and organisational documents collected from the case study organisation. The codes for sources of motivation were also mapped to the main boundary questions and are presented in Table 6-7.

Table 6-7:Sources of motivation influencing agility in enterprise data management

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of motivation codes**	**Related boundary question**	**Suggested response**
02. Purpose: What do we want to achieve? (STAKES) 03. Evaluate improvement: What constitutes an improvement? (STAKEHOLDING ISSUES)	B-M- avoid technical debt/rework/redundancy	Is there a will to avoid technical debt, rework or maintain redundant capabilities?	Cultivate and nurture a will to avoid technical debt, rework or maintain redundant capabilities.
01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS) 02. Purpose: What do we want to achieve? (STAKES) 03. Evaluate improvement: What constitutes an improvement? (STAKEHOLDING ISSUES)	B-M- business value/impact of DM initiative	Is there a will to deliver business value through the data initiative?	Cultivate and nurture a will to deliver business value through the data initiative.
01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS) 02. Purpose: What do we want to achieve? (STAKES)	B-M- buy-in/commitment from stakeholders of data priority	Is there a will to obtain stakeholder buy-in and commitment for the prioritised data requirement?	Cultivate and nurture a will to obtain stakeholder buy-in and commitment for the prioritised data requirement.
01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS) 02. Purpose: What do we want to achieve? (STAKES)	B-M- clear, shared data-centric purpose	Is there a will to contribute to a clear, shared data-centric purpose?	Cultivate and nurture a will to contribute to a clear, shared data-centric purpose.
01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS)	B-M- data role/function clarity	Is there a will to create clarity about role responsibility and accountability?	Cultivate and nurture a will to create clarity about role responsibility and accountability.

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of motivation codes**	**Related boundary question**	**Suggested response**
03. Evaluate improvement: What constitutes an improvement? (STAKEHOLDING ISSUES)	B-M- feedback loops (assess/monitor/test)	Is there a will to reflect on and learn from feedback and results from assessments, monitoring and/or testing?	Cultivate and nurture a will to reflect on and learn from feedback and results from assessments, monitoring and/or testing.
02. Purpose: What do we want to achieve? (STAKES)	B-M- intention to be proactive	Is there a will to be proactive?	Cultivate and nurture a will to be proactive.
02. Purpose: What do we want to achieve? (STAKES)	B-M- intention to be responsive	Is there a will to be responsive?	Cultivate and nurture a will to be responsive.
02. Purpose: What do we want to achieve? (STAKES)	B-M- intention to improve/support agility in DM	Is there a will to improve and support agility in data management?	Cultivate and nurture a will to improve and support agility in data management.
01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS) 02. Purpose: What do we want to achieve? (STAKES) 03. Evaluate improvement: What constitutes an improvement? (STAKEHOLDING ISSUES)	B-M- share & integrate capabilities (avoid silos)	Is there a will to share and integrate capabilities and to avoid working in silos?	Cultivate and nurture a will to share and integrate capabilities and to avoid working in silos.

Figure 6-12, Figure 6-13, Figure 6-14 and Figure 6-15 present the network diagrams for boundary judgements and relationships found in the data, explaining how sources of motivation influenced the coordination and integration of work in complex and complicated EDM contexts at the case study organisation. The nodes are the sources of motivation, as documented in Table 6-7 on page 256, and the relationships represent the type of influence as having either an amplifying or tensioning effect on the dynamic capability.

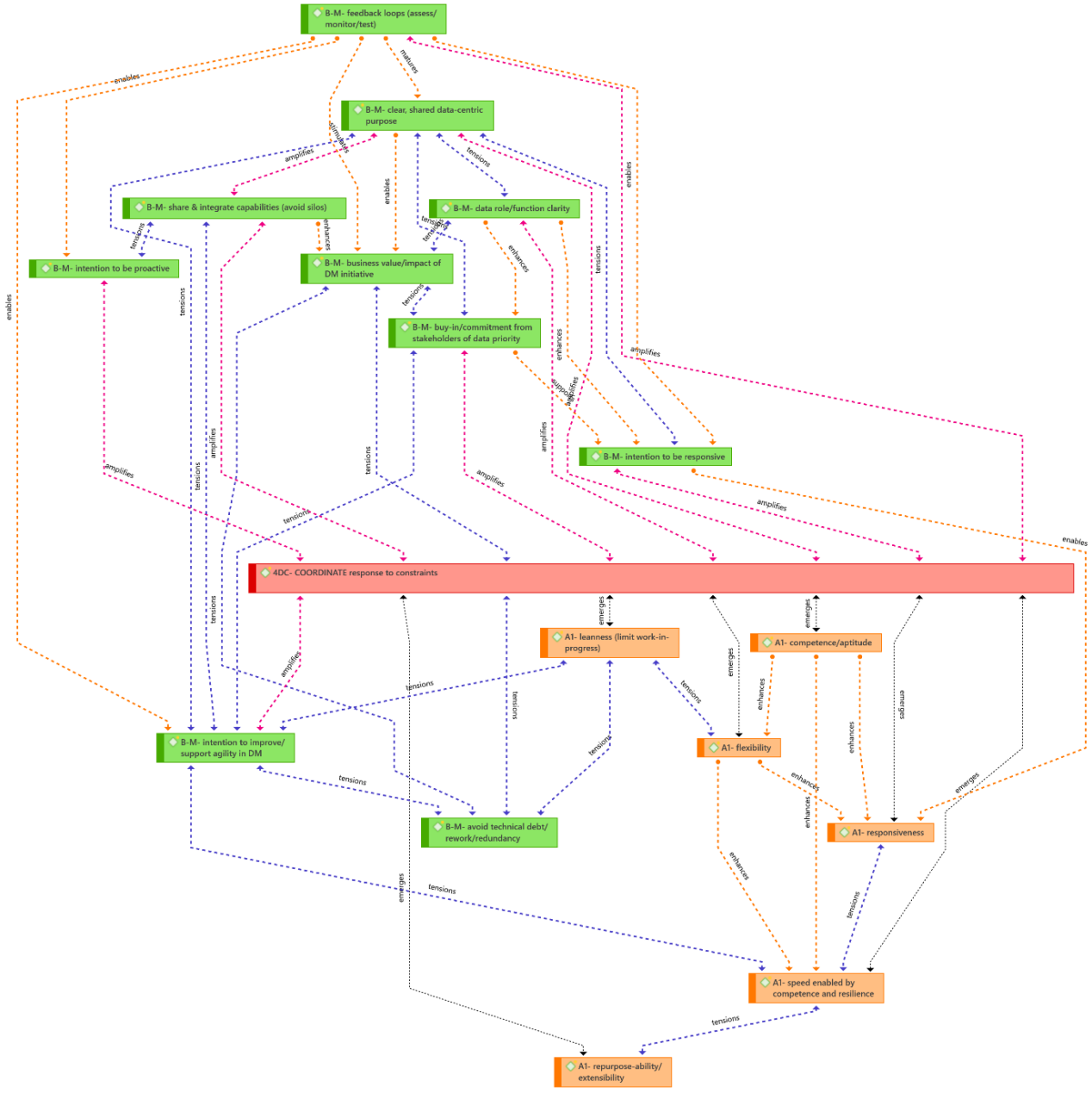


Figure 6-12: Sources of motivation influencing coordination in complexity with emerging agility consequences

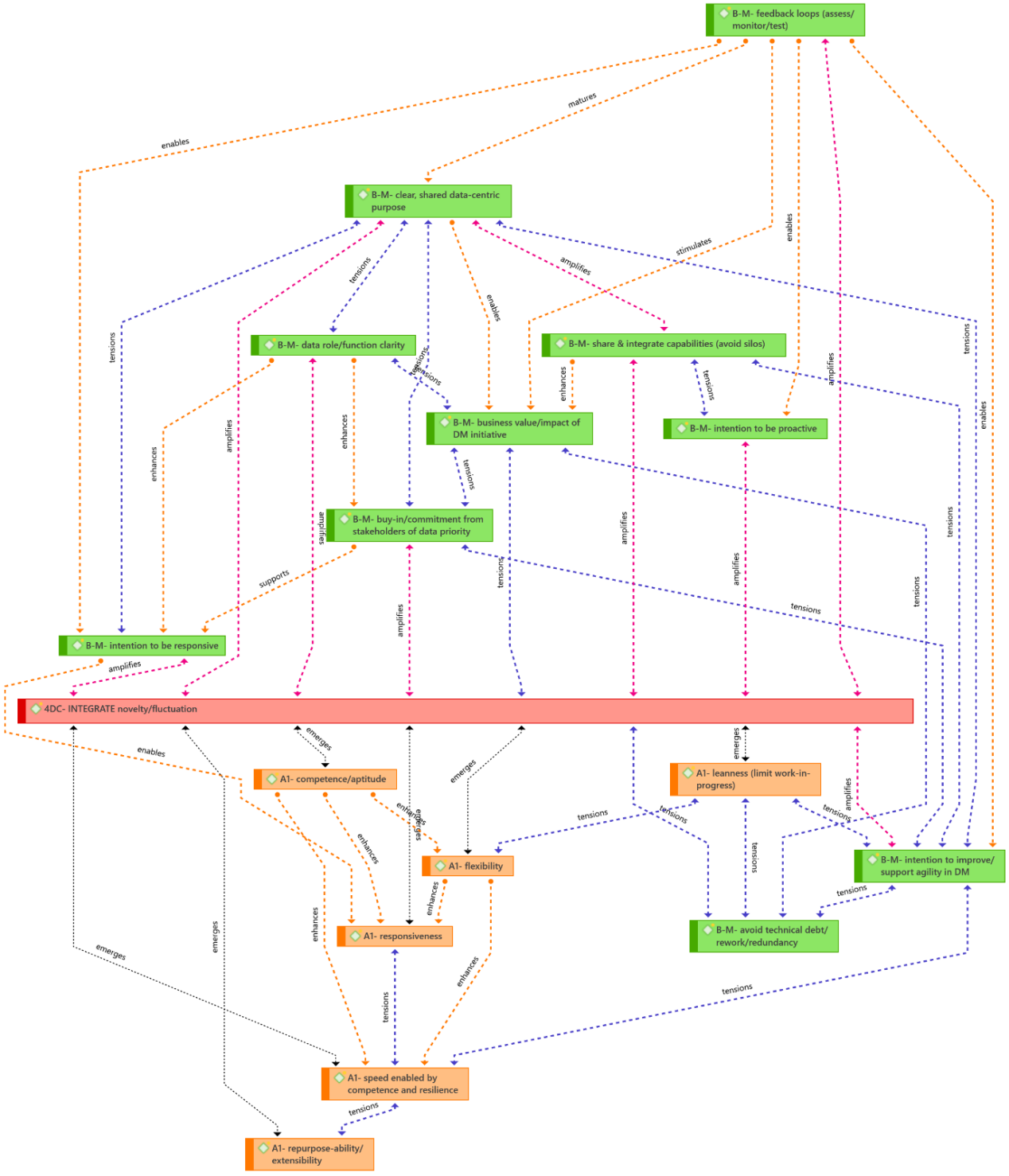


Figure 6-13: Sources of motivation influencing integration in complexity with emerging agility consequences

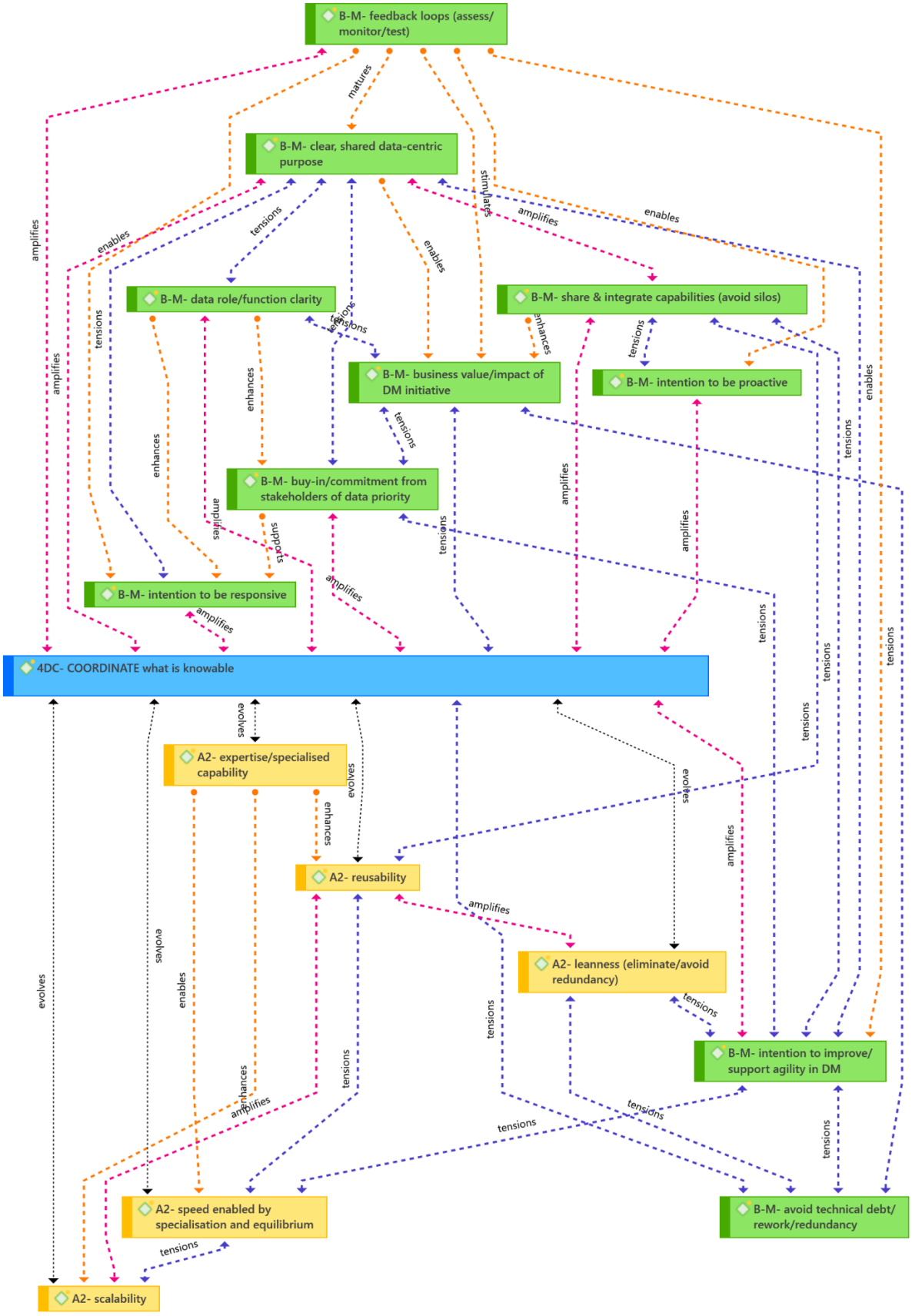


Figure 6-14: Sources of motivation influencing coordination in complicatedness with evolving agility consequences

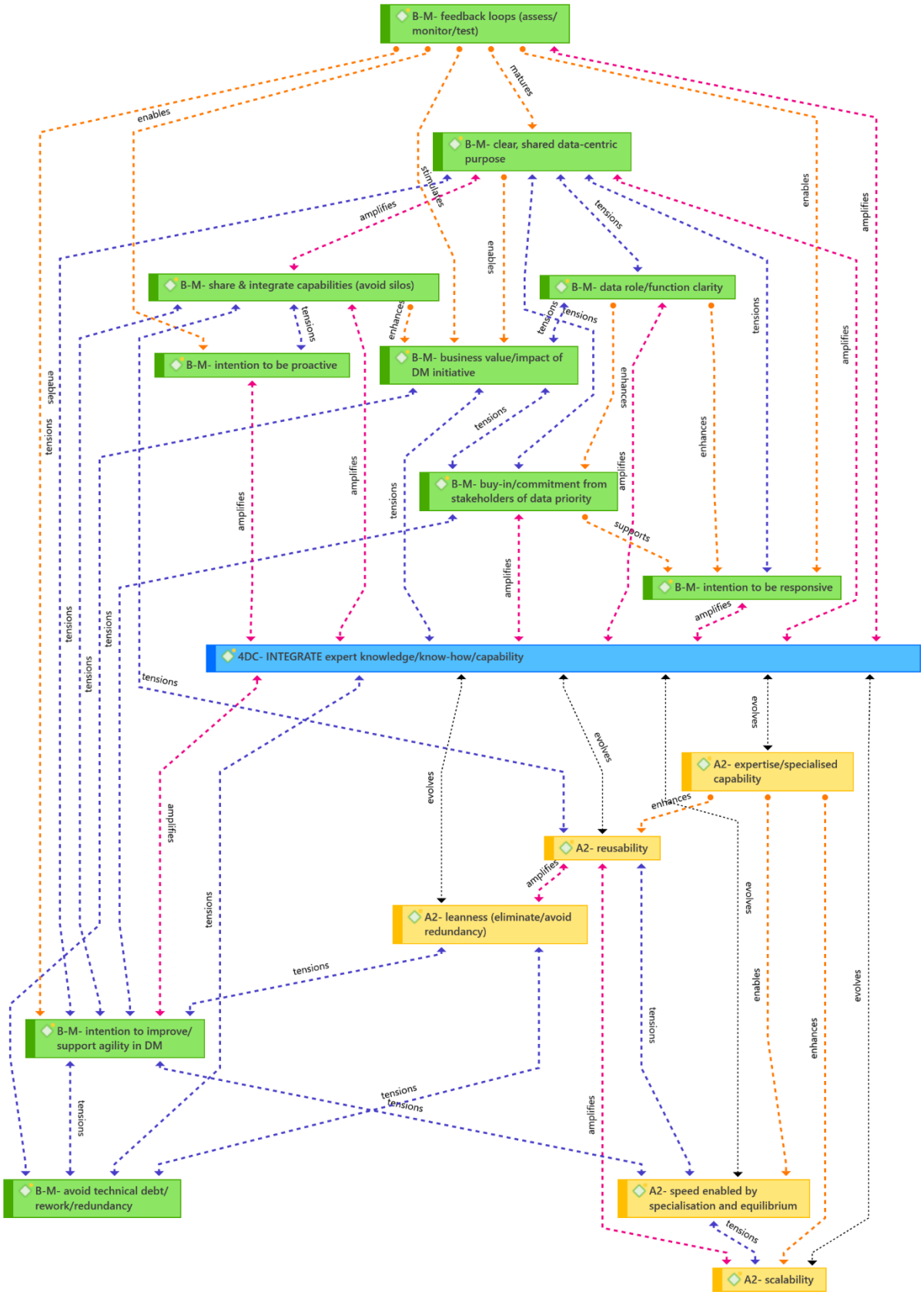


Figure 6-15: Sources of motivation influencing integration in complicatedness with evolving agility consequences

6.2.5 Sources of power influencing agility in enterprise data management

Sources of power relate to things that control and change the system based on what empowers, overrides, and guides the agents. When a team has shared clear goals, its ability to self-organise improves, enhancing its autonomy and agility (Werder and Maedche, 2018). The sources of power for boundary judgements influencing agility in EDM were identified and coded during the thematic analysis of the interview transcriptions and organisational documents collected from the case study organisation. The codes for sources of power were also mapped to the main boundary questions and are presented in Table 6-8.

Table 6-8: Sources of power influencing agility in enterprise data management

Main boundary critique questions based on Ulrich and Reynolds (2020)	Source of power codes	Related boundary question	Suggested response
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS)	B-P- autonomy at execution level	Is decision-making power granted at the execution level?	Assess and grant decision-making power at the lowest possible execution level for data management work.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 05. Resources: Who/what controls resources and their availability? (STAKES) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- business area strategy/priority	Is data management work guided by business area strategy and prioritisation?	Guide data management work by business area strategy and prioritisation.
05. Resources: Who/what controls resources and their availability? (STAKES) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- collaborative culture, synergy	Are data management resources empowered by a collaborative culture and synergy?	Cultivate and nurture collaboration and synergy in and across data management roles and functions and business stakeholders.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS)	B-P- data governance processes	Is data management work controlled by data governance processes?	Establish and enforce data governance processes.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 05. Resources: Who/what controls resources and their availability? (STAKES)	B-P- data leadership mandate/direction/support	Is data management work directed and mandated by data leadership?	Establish and empower data leadership to direct and mandate data management work.

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of power codes**	**Related boundary question**	**Suggested response**
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- data management policies	Is data management work controlled by data management policies?	Establish and enforce data management policies.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- data management principles	Is data management work guided by data management principles?	Establish and create a shared, practical understanding of data management principles.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- data management strategy	Is data management work directed by data management strategy?	Establish a clear, shared data management strategy to direct all data management work.
05. Resources: Who/what controls resources and their availability? (STAKES)	B-P- data ownership, stewardship, custodianship	Are data management roles and functions mandated with and held accountable for data ownership, stewardship or custodianship?	Establish clear data management roles and functions that are mandated with and held accountable for data ownership, stewardship or custodianship.
05. Resources: Who/what controls resources and their availability? (STAKES)	B-P- effective stakeholder engagement	Are data management roles and functions empowered through effective stakeholder engagement?	Engage stakeholders effectively to empower data management roles and functions in their work.

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of power codes**	**Related boundary question**	**Suggested response**
06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)			
05. Resources: Who/what controls resources and their availability? (STAKES)	B-P- formalised delivery processes	Is data management work controlled by a formalised delivery process?	Establish and enforce formalised delivery processes for data management work.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- legal/regulatory/audit compliance requirements	Are business and data management roles and functions controlled and held accountable by legal, regulatory and audit compliance requirements?	Empower, support, and enable business and data management roles to take accountability for meeting legal, regulatory and audit compliance requirements.
05. Resources: Who/what controls resources and their availability? (STAKES) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- resource capacity for DM (socio/tech)	Is socio-technical resource capacity enabling data management?	Establish and maintain sufficient human and technical resources to enable data management.
06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- team/role/organisation maturity	Is data management empowered by team, role and organisational maturity?	Cultivate and nurture data management team, role and organisational maturity.
06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- trust/trustworthiness	Is data management empowered by trust or trustworthiness?	Cultivate and nurture trust and trustworthiness amongst all data management stakeholders.

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of power codes**	**Related boundary question**	**Suggested response**
06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- uncertainty in external environment	Is data management subject to uncertainty in the external environment?	Manage constraints related to uncertainty in the external environment of data management.
06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- uncertainty in internal environment	Is data management subject to uncertainty in the internal environment?	Manage constraints related to uncertainty in the internal environment of data management.
04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS) 05. Resources: Who/what controls resources and their availability? (STAKES) 06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	B-P- unilateral/BU decision-making	Are data management decisions overruled by unilateral decisions or decision-making at a business unit level?	Manage prioritisation of data management work and communicate and agree on a clear shared purpose with all business stakeholders of data management.

Figure 6-16, Figure 6-17, Figure 6-18 and Figure 6-19 present the network diagrams for boundary judgements and relationships found in the data, explaining how sources of power influenced the coordination and integration of work in complex and complicated EDM contexts at the case study organisation. The nodes are the sources of power, as documented in Table 6-8 on page 263, and the relationships represent the type of influence as having either an amplifying or tensioning effect on the dynamic capability.

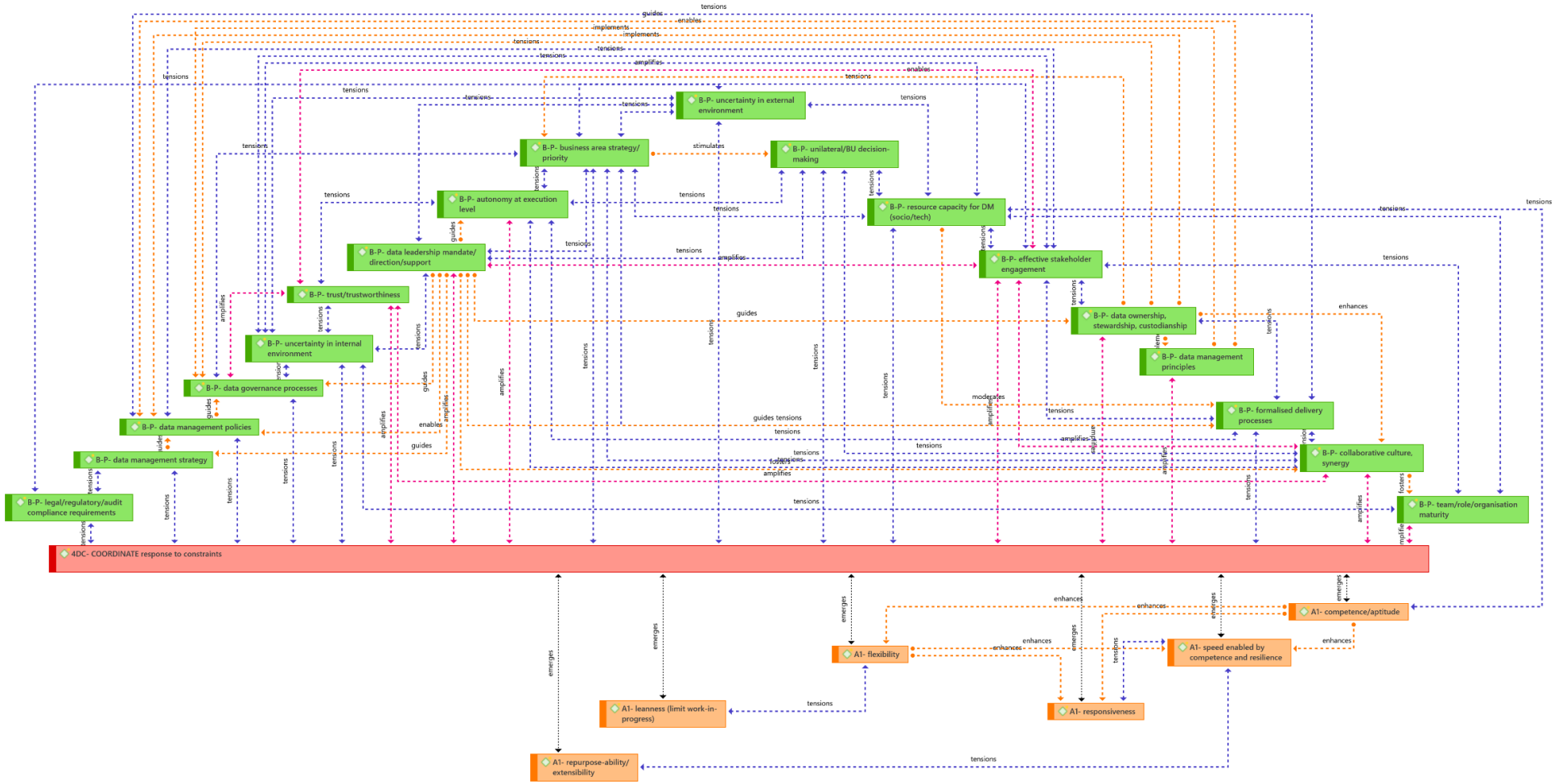


Figure 6-16: Sources of power influencing coordination in complexity with emerging agility consequences

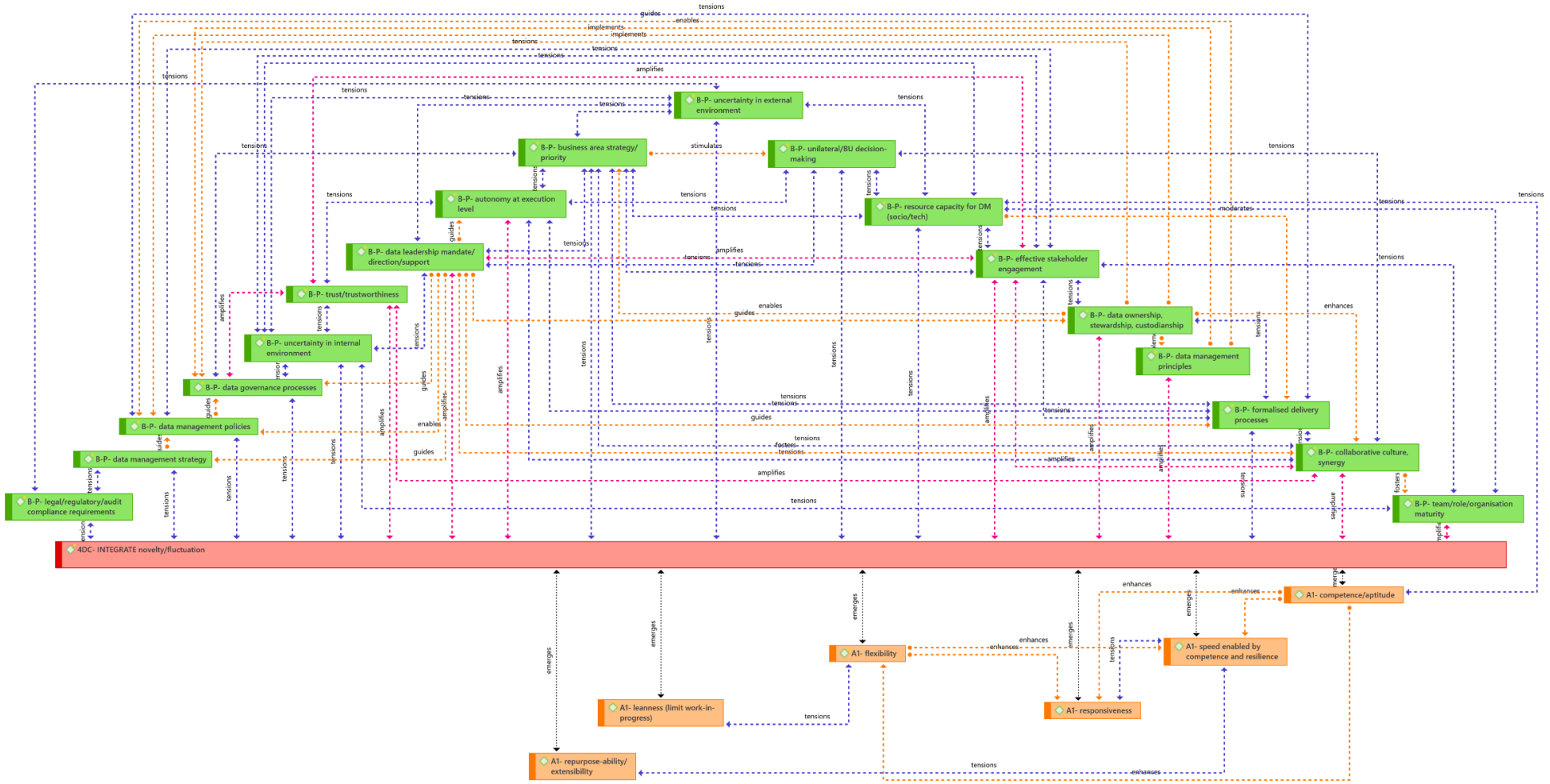


Figure 6-17: Sources of power influencing integration in complexity with emerging agility consequences

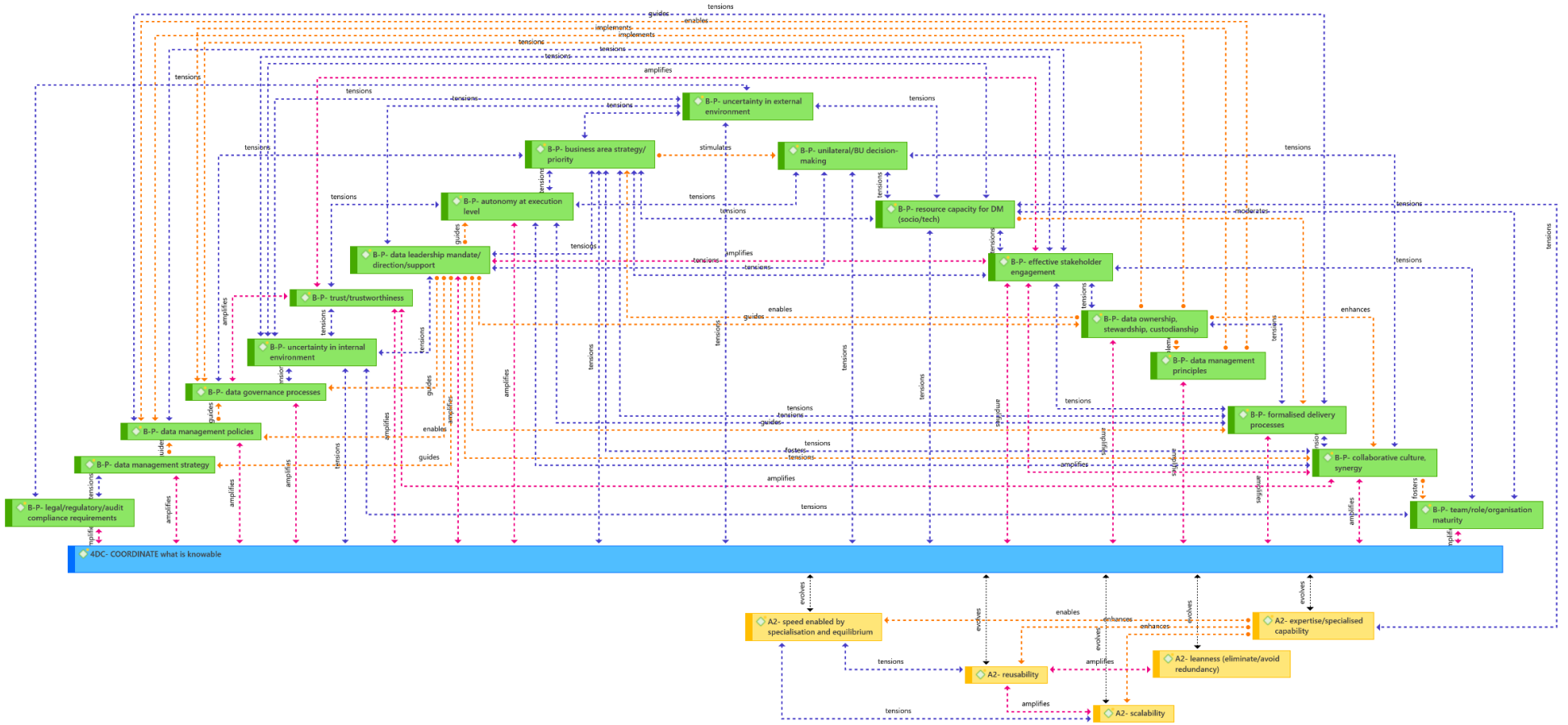


Figure 6-18: Sources of power influencing coordination in complicatedness with evolving agility consequences

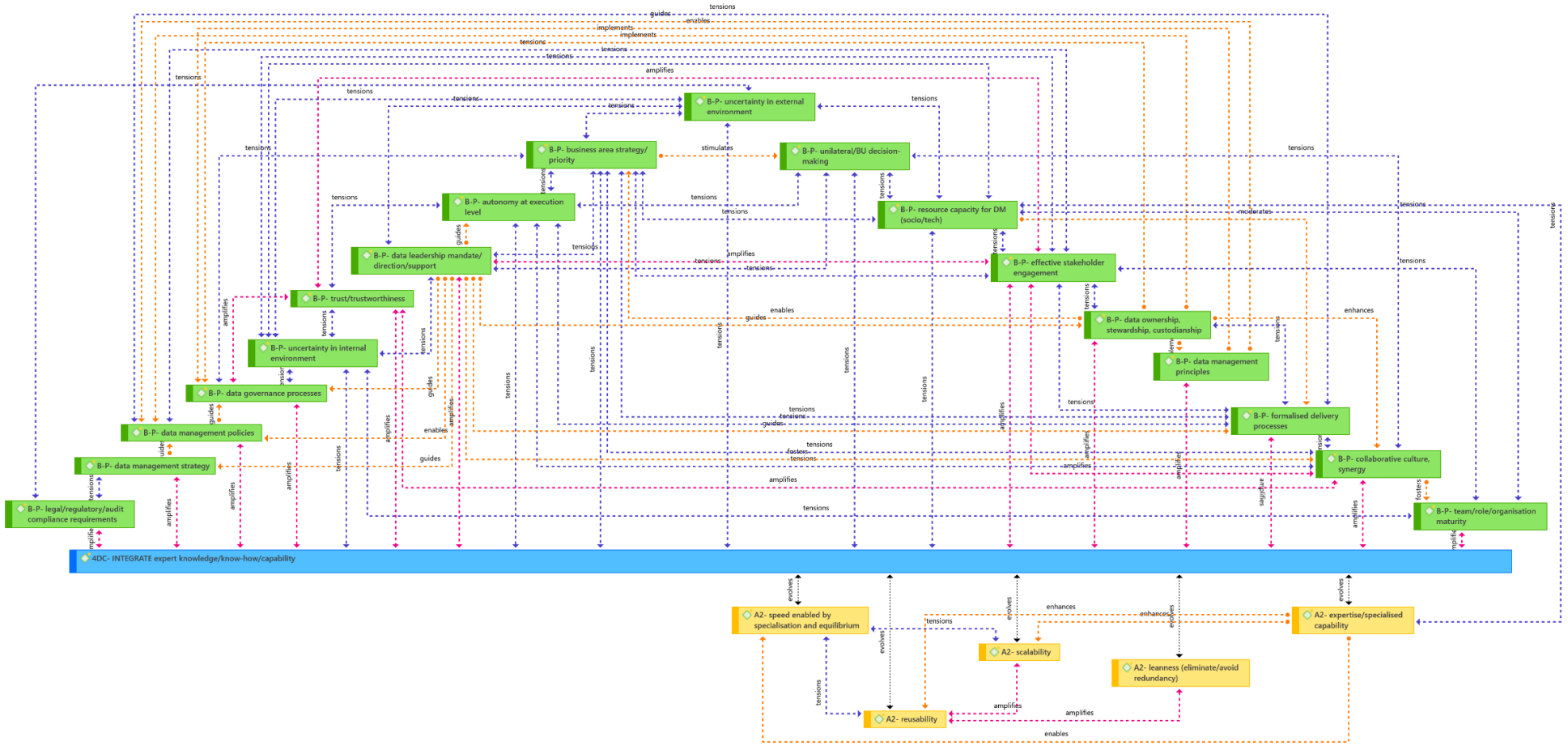


Figure 6-19: Sources of power influencing integration in complicatedness with evolving agility consequences

6.2.6 Sources of knowledge influencing agility in enterprise data management

Sources of knowledge relate to agents' abilities and change the system based on agents' resourcefulness to do what can and should be done. The sources of knowledge for boundary judgements influencing agility in EDM were identified and coded during the thematic analysis of the interview transcriptions and organisational documents collected from the case study organisation. The codes for sources of knowledge were also mapped to the main boundary questions and are presented in Table 6-9.

Table 6-9: Sources of knowledge influencing agility in enterprise data management

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Sources of knowledge codes**	**Related boundary question**	**Suggested response**
07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS) 08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- defined, prioritised DM/data capability requirement	Is there a defined, prioritised data management or data capability requirement?	Clearly define, prioritise and communicate the EDM requirement.
07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS) 08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- experience and ability/competence	Is there the necessary experience, ability and competence to create the required solutions?	Continuously acquire and build EDM experience and competence.
08. Expertise: What information, knowledge and skills must be contributed? (STAKES)	B-K- iteratively/continuously keep up & improve capability	Is there a culture/patterns to continuously update individual and collective knowledge and improve the data-related capability?	Create and nurture a culture of learning and knowledge sharing.
08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- learning from safe-to-fail trying/ innovating/ exploring	Is there a culture that allows for learning from trying/innovating/exploring without a guarantee of the outcome?	Create a safe-to-fail, as opposed to a fail-safe, environment for EDM work.

08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- modularised/standardised/ foundational capability	Are there shared reusable, stable rails that enable foundational, standardised data capabilities?	Create and maintain shared reusable, stable rails that enable foundational, standardised data capabilities.
08. Expertise: What information, knowledge and skills must be contributed? (STAKES)	B-K- process automation capability	Is there a reusable, repeatable capability that is automated?	Create and automate the required reusable, repeatable capability.
07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS) 08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- resource capability (socio/tech/data)	Is there the required social, technical and/or data management capability?	Continuously acquire and build socio-technical data resource capabilities.
07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS) 08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- shared understanding (business & data)	Is there a shared understanding of the business and data requirements?	Define and communicate the business and data requirements to create a shared understanding of what needs to be achieved.
07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS) 08. Expertise: What information, knowledge and skills must be contributed? (STAKES) 09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	B-K- specialist knowledge/skills/expertise/ understanding	Is there the required specialist knowledge, skills, understanding and expertise?	Continuously acquire and build the required specialist knowledge, skills, understanding and expertise.

Figure 6-20, Figure 6-21, Figure 6-22 and Figure 6-23 present the network diagrams for boundary judgements and relationships found in the data, explaining how sources of knowledge influenced the coordination and integration of work in complex and complicated EDM contexts at the case study organisation. The nodes are the sources of knowledge, as documented in Table 6-9 on page 272, and the relationships represent the type of influence as having either an amplifying or tensioning effect on the dynamic capability.

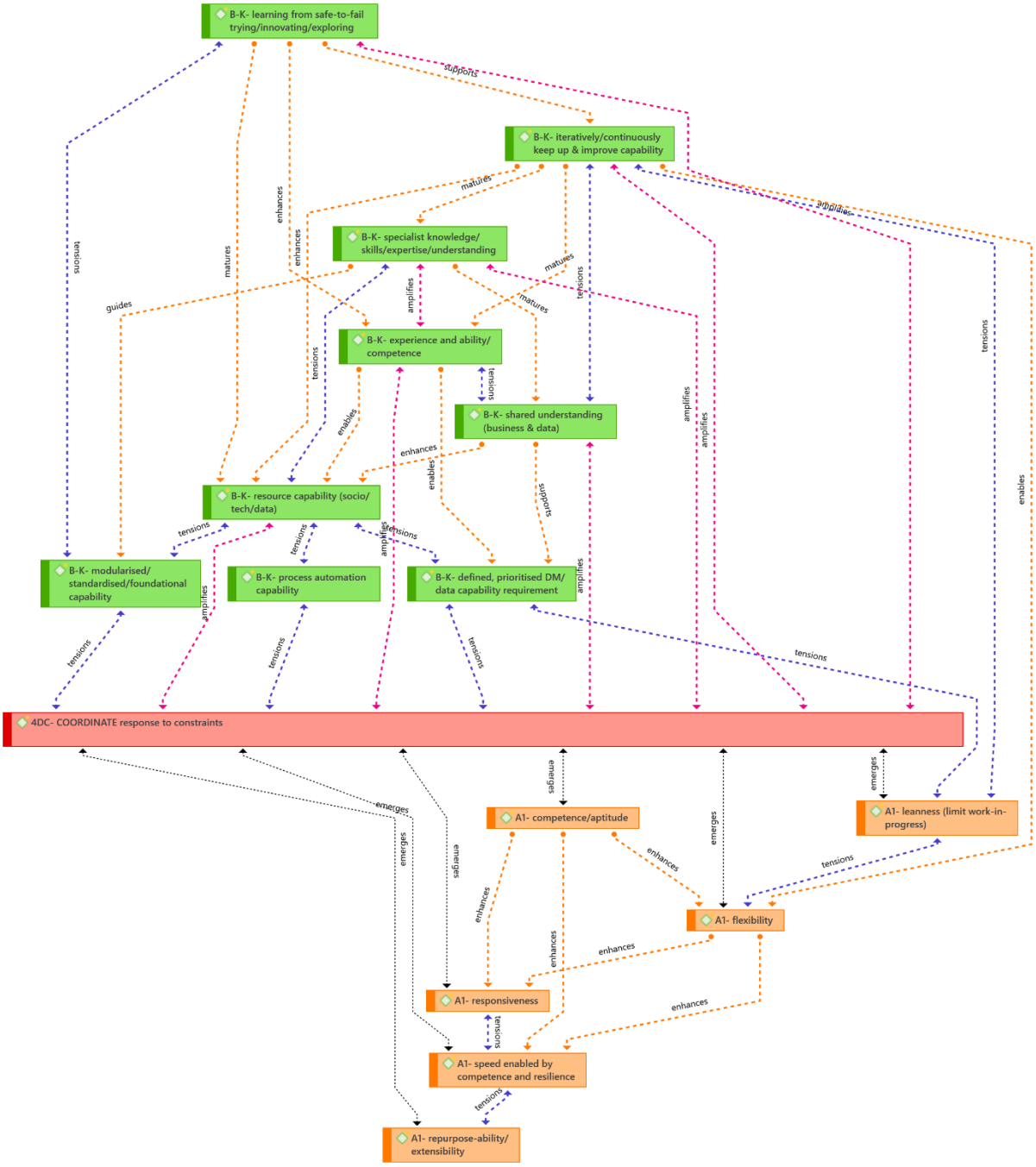


Figure 6-20: Sources of knowledge influencing coordination in complexity with emerging agility consequences

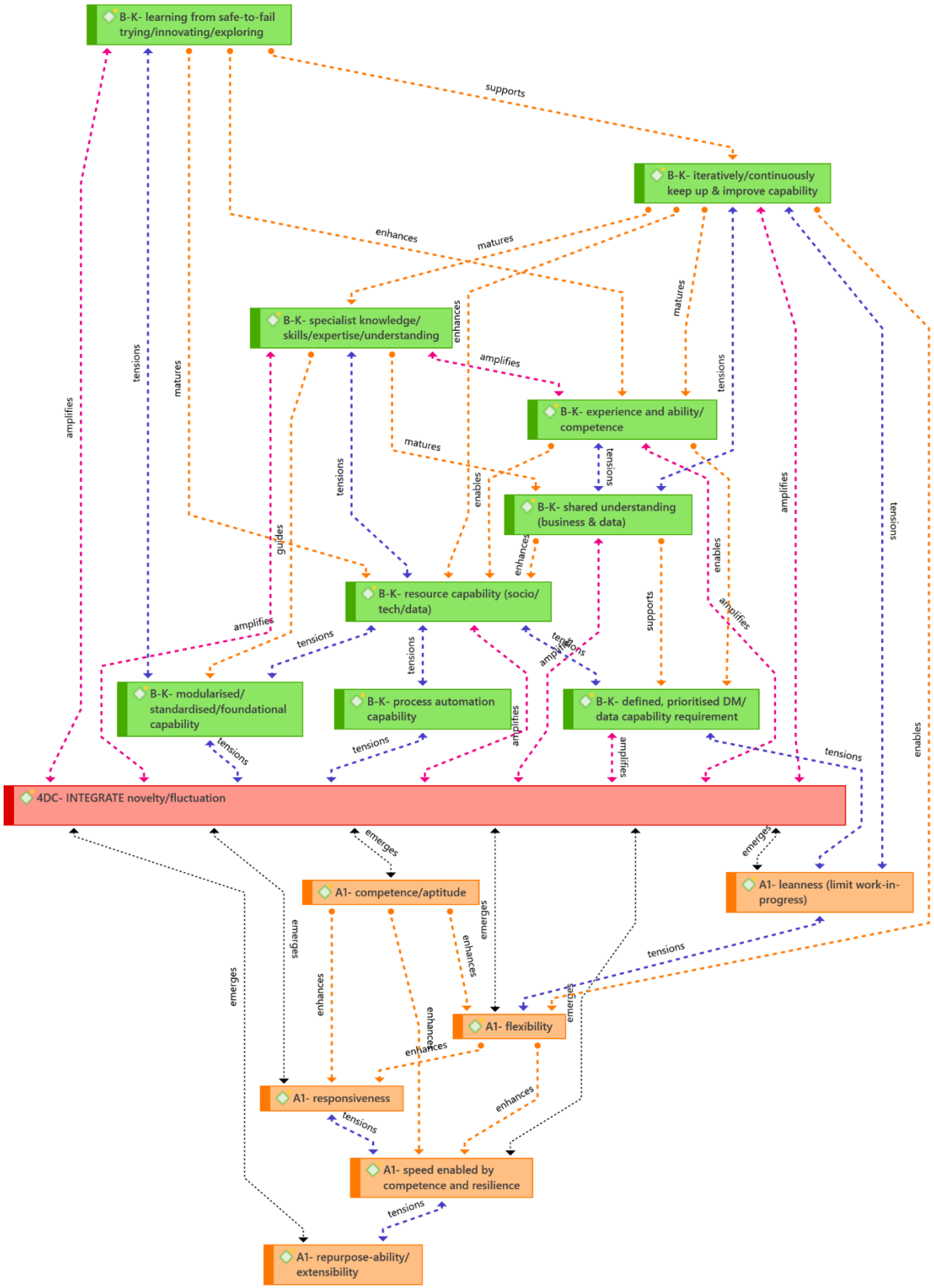


Figure 6-21: Sources of knowledge influencing integration in complexity with emerging agility consequences

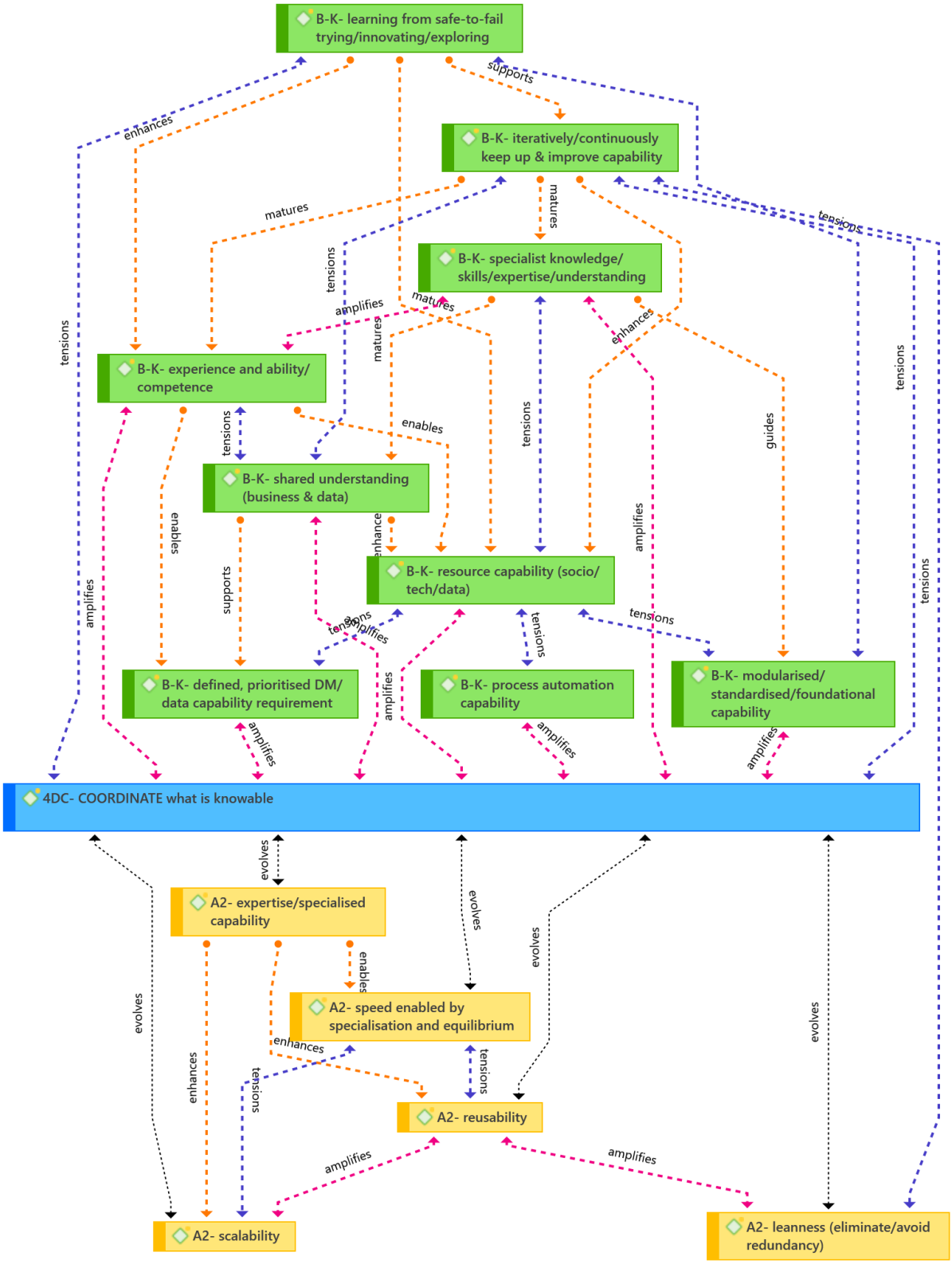


Figure 6-22: Sources of knowledge influencing coordination in complicatedness with evolving agility consequences

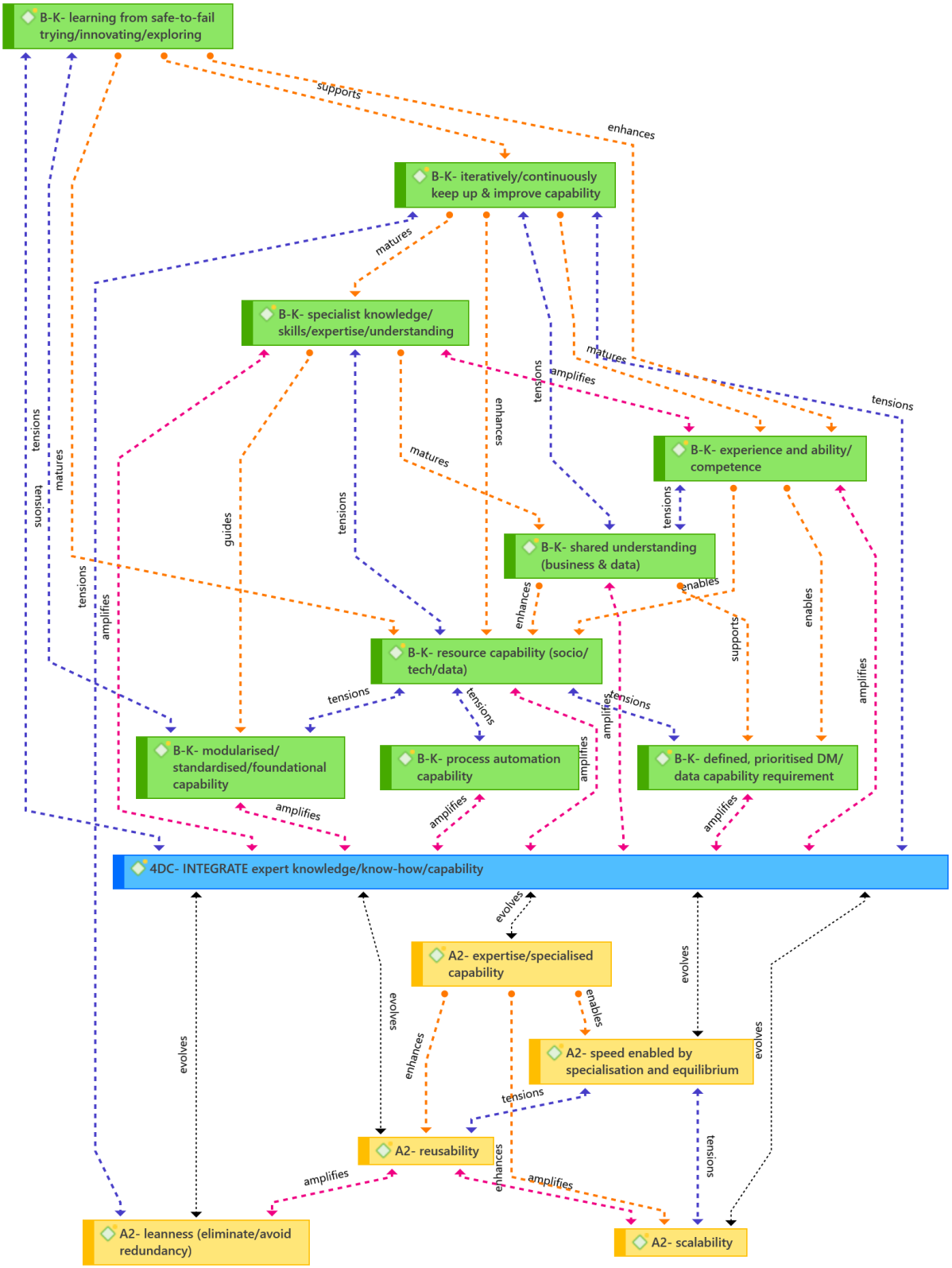


Figure 6-23: Sources of knowledge influencing integration in complicatedness with evolving agility consequences

6.2.7 Sources of legitimation influencing agility in enterprise data management

Sources of legitimation involve taking a broad stakeholder view and changing the system based on the amplitude of the agents' stakeholder perspective. The sources of legitimation for boundary judgements influencing agility in EDM were identified and coded during the thematic analysis of the interview transcriptions and organisational documents collected from the case study organisation. The codes for sources of legitimation were also mapped to the main boundary questions and are presented in Table 6-10.

Table 6-10: Sources of legitimation influencing agility in enterprise data management

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of legitimation codes**	**Related boundary question**	**Suggested response**
11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- adoption & proliferation DM capabilities	Is a broader stakeholder view considered for adopting and proliferating data management capabilities?	Assess the scope and potential value for adopting and proliferating data management capabilities.
10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS) 11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- openness to other/broader perspectives/alternatives	Is a broader stakeholder view considered for alternative options and perspectives?	Assess the scope and potential value of alternative options and perspectives.
11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- openness to/embracing/incorporating change	Is a broader stakeholder view considered for embracing and incorporating change?	Assess the scope and potential value of embracing and incorporating change.
10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS) 11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- peripheral dependency/interdependency/ knock-on	Is a broader stakeholder view considered for the possible impact on areas outside of the given context?	Assess the scope and potential value of the possible impact on areas outside the given context.

Main boundary critique questions based on Ulrich and Reynolds (2020)	**Source of legitimation codes**	**Related boundary question**	**Suggested response**
10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- potential extent of impact	Is a broader stakeholder view considered for the extent of the impact on areas outside the given context?	Assess the scope and potential value of the extent of the impact on areas outside the given context.
10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS) 11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- reflection on approach to data initiatives	Is a broader stakeholder view considered for how to approach the data initiative?	Assess the scope and potential value of how to approach the data initiative.
12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L- suitability/sufficiency in context	Is a broader stakeholder view considered for the suitability and sufficiency of the data capability?	Assess the scope and potential value of the suitability and sufficiency of the data capability.
10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS) 12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	B-L-tenability/durability/ sustainability	Is a broader stakeholder view considered for the long-term outlook of the data capability?	Assess the scope and potential value of the long-term outlook of the data capability.

Figure 6-24, Figure 6-25, Figure 6-26 and Figure 6-27 present the network diagrams for boundary judgements and relationships found in the data, explaining how sources of legitimation influenced the coordination and integration of work in complex and complicated EDM contexts at the case study organisation. The nodes are the sources of legitimation, as documented in Table 6-10 on page 279, and the relationships represent the type of influence as having either an amplifying or tensioning effect on the dynamic capability.

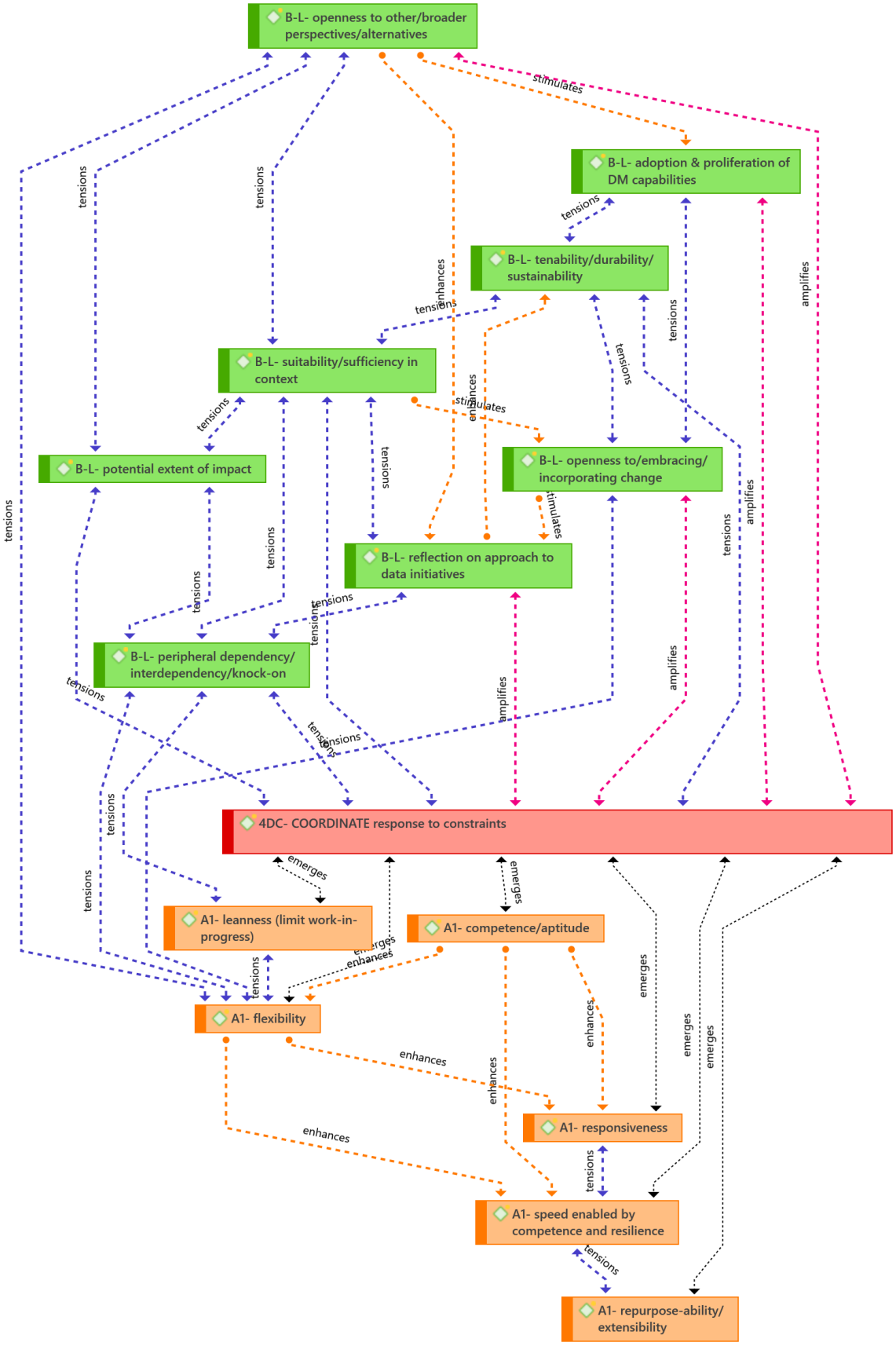


Figure 6-24: Sources of legitimation influencing coordination in complexity with emerging agility consequences

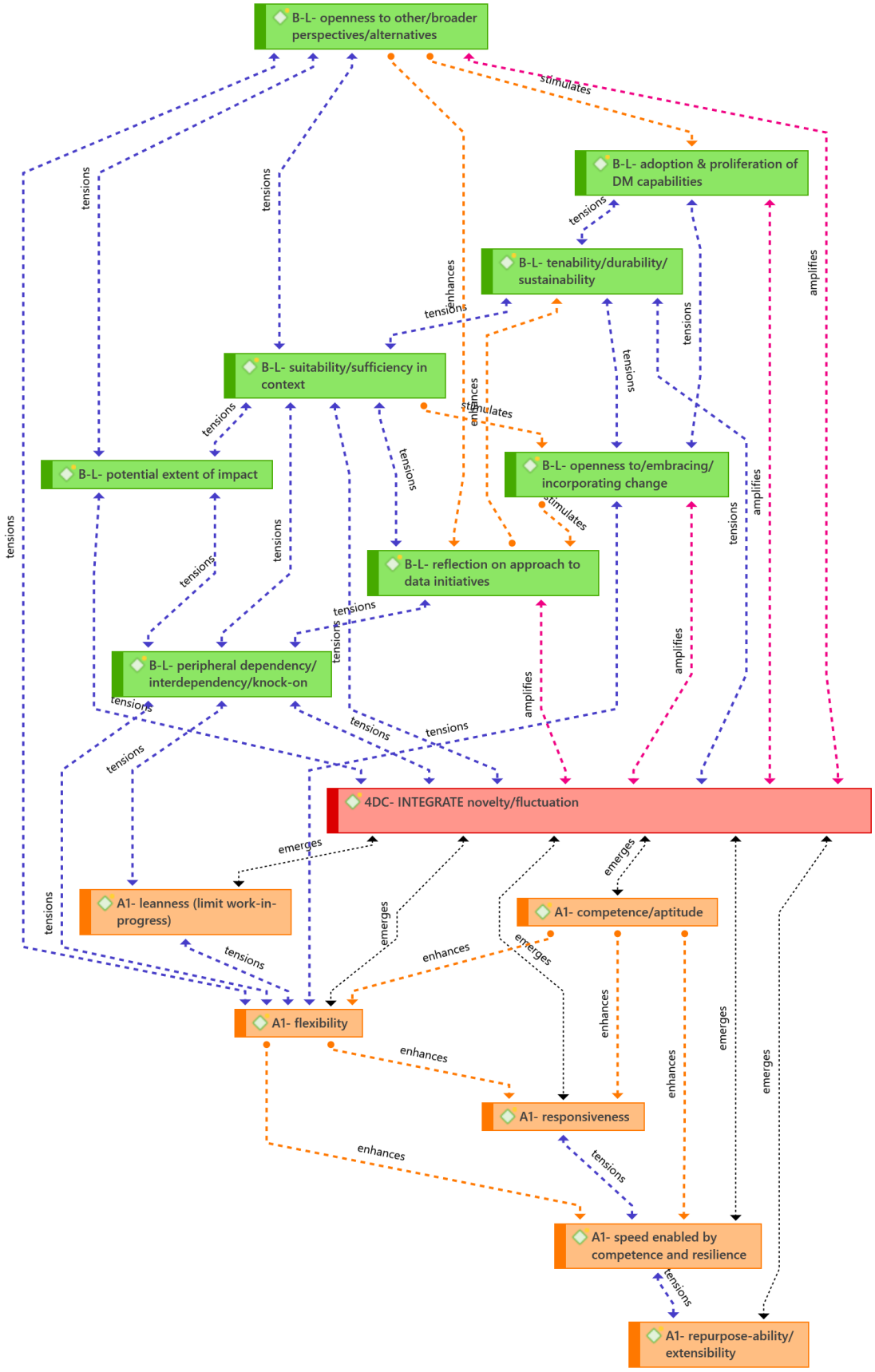


Figure 6-25: Sources of legitimation influencing integration in complexity with emerging agility consequences

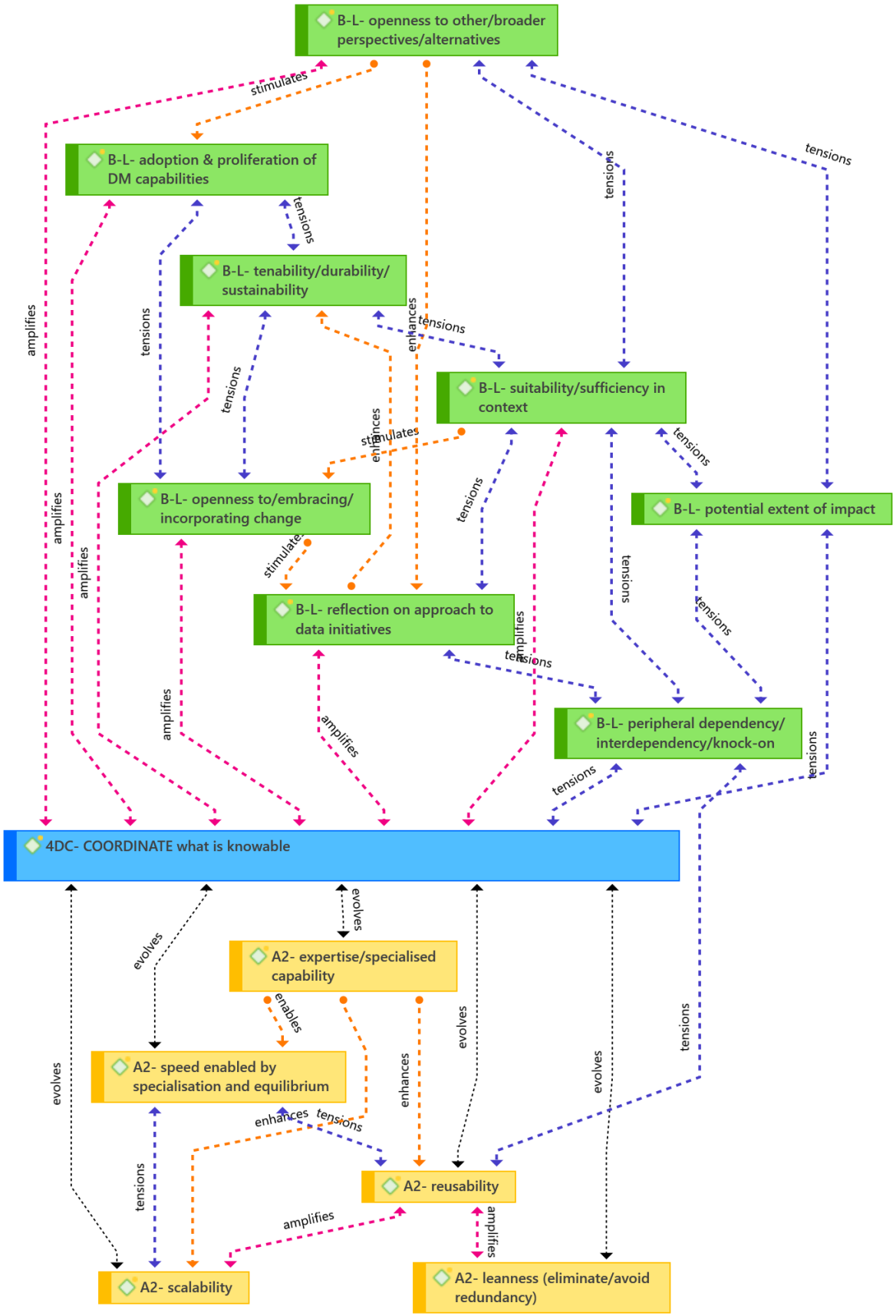


Figure 6-26: Sources of legitimation influencing coordination in complicatedness with evolving agility consequences

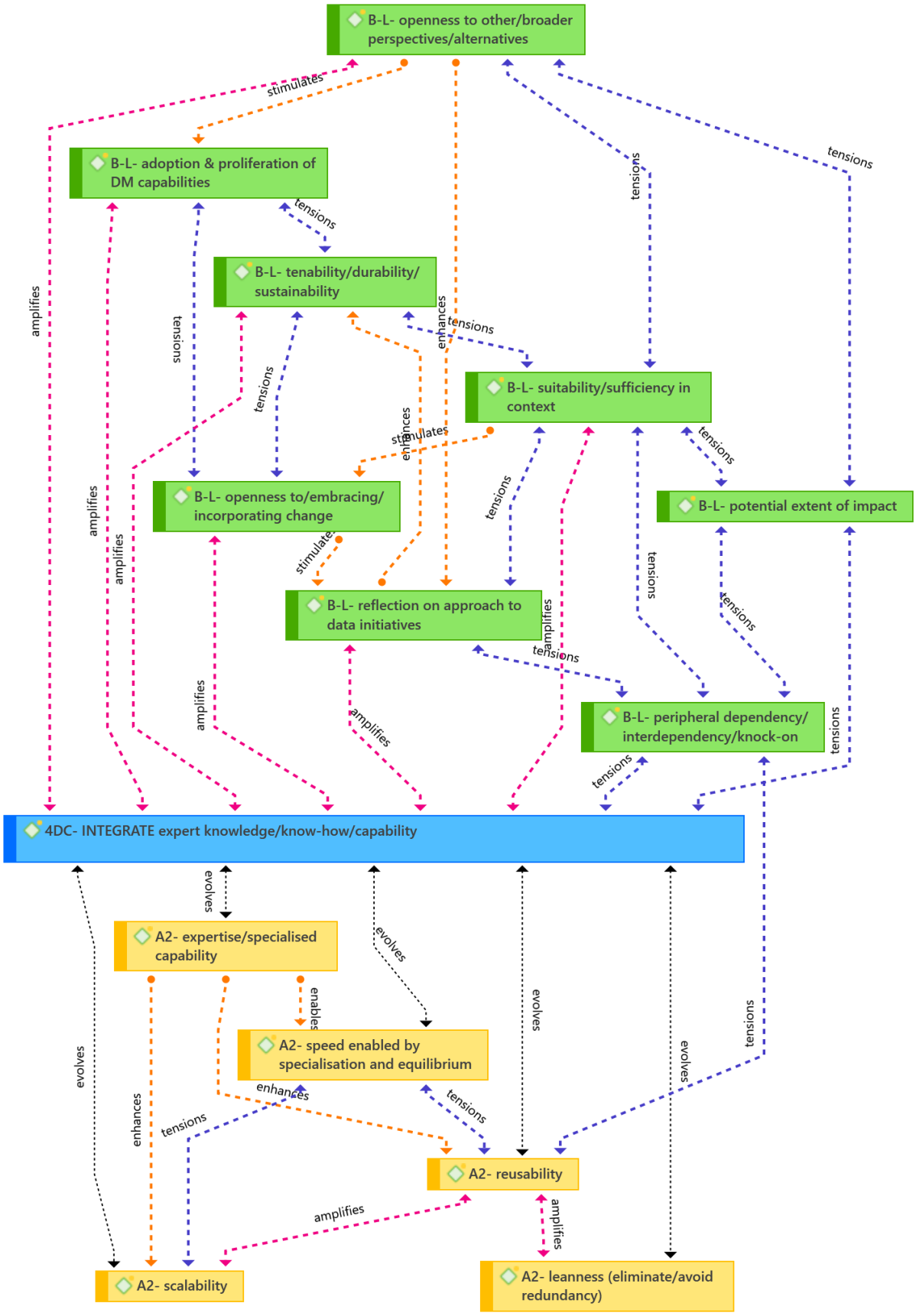


Figure 6-27: Sources of legitimation influencing integration in complicatedness with evolving agility consequences

6.3 ANALYSIS OF FINDINGS

The coding scheme applied during the qualitative thematic analysis, as presented in Figure 6-5 on page 242, provided structure and consistency to the data coding and analysis process, and aligned the qualitative case study to the design of the DSR artefact. This section presents an analysis of the findings of the qualitative case study of agile EDM conducted at BankGroup.

The in-depth analysis of the coded qualitative data aimed to provide insights into agility in real-world EDM practices and policies. An inductive approach was used to find and code micro-level boundary judgements (sources of motivation, power, knowledge and legitimation) in the data that underlay heuristics, and, therefore, influenced agility. The constructs of the structural and dynamic components of agile EDM underpinning the conceptual framework presented in Figure 6-4 on page 238 provided a coding scheme (see Figure 6-5 on page 242) for the qualitative analysis of the coded data.

The thematic analysis in the first DSR cycle applied the structural components of agile EDM to the qualitative data. The thematic analysis in this second DSR cycle used inductive reasoning to refine the meso-level components of agile EDM, refine the definitions of the agility features, and develop the micro-level components that influence agility in EDM. This process derived new knowledge, presented as the 45 boundary judgements, from the qualitative data as micro-level influences on agility features. At the meso-level, seven distinct dynamic capabilities were found to govern EDM activities in complex and complicated contexts. Eleven features for thriving agility and three for faltering agility were found in the data, describing the intended and unintended outcomes and consequences of agility in the CAS of agile EDM.

The various dimensions of analysis of the findings presented in this section aimed to provide the following perspectives on agility in EDM:

- Sources of influence on agility in EDM as boundary judgements used in boundary critique related to EDM practice and EDM policy. (“M” = source of motivation; “P” = source of power; “K” = source of knowledge; and “L” = source of legitimation)
- Emergence and evolution of agility features in EDM
- Emergence and evolution of agility in EDM practices and policies/standards

- Influences on agility in EDM as boundary judgements related to sources of motivation, knowledge, power and legitimation
- Sources of influence on agility in EDM as boundary judgements related to main boundary critique questions and categories of stakeholder roles, stakes and stakeholding issues
- Approaches to reflect on and understand thriving and faltering agility in EDM

6.3.1 Sources of influence on emerging agility in enterprise data management

When analysing the sources of influence on emerging agility from the EDM practice and policy perspectives, the analysis found that the five most influential boundary judgements, in order of their emphasis, only overlapped at two sources of influence, indicated in bold in Table 6-11:

Table 6-11: Top 5 sources of influence on emerging agility features

Perspective	Top 5 sources of influence on emerging agility features
The organisation's data management practices as expressed by the interview participants:	1. M- intention to improve/support agility in DM **2. K- shared understanding (business & data)** 3. K- defined, prioritised DM/data capability requirement **4. M- clear, shared data-centric purpose** 5. P- collaborative culture, synergy
The organisation's data management policy and standards documents:	1. P- data governance processes **2. M- clear, shared data-centric purpose** **3. K- shared understanding (business & data)** 4. M- feedback loops (assess/monitor/test) 5. L- adoption & proliferation of DM capabilities

The detailed analysis of findings for sources of influence on emerging agility in EDM from the practice, policy, and standards perspectives are presented in Figure 6-28, Figure 6-29 and Figure 6-30 on pages 289, 290 and 291, respectively.

Discrepancies between the influences on **emerging** agility in policy and practice were apparent in the data, as illustrated in Figure 6-30 on page 291. The graph is based on the total co-occurrences of sources of influence on combined features of **emerging** agility in the **policy** and standards documents and the participants' **narratives**, respectively.

The two most notable differences in ranking of influences on evolving agility in policy and standards versus practice were **P- data governance processes** (ranked higher in EDM policy than by data management practitioners) and **K- experience and ability/competence** (ranked higher by data management practitioners than in EDM policy).

Sources of influence on emerging agility in practice

The findings related to emerging agility based on the analysis of the data collected in the **interviews** with data management **practitioners** at the case study organisation are presented in Figure 6-28:

TOP 12 | Top 3 | Bottom 3

	TOP 12	K=Sources of knowledge L=Sources of legitimation M=Sources of motivation P=Sources of power	Total code co-occurences of boundary judgements AND emerging agility in practice	Emerging agility features - practice: Competence/aptitude	Flexibility	Leanness (limit work-in-progress)	Repurpose-ability/extensibility	Responsiveness	Speed enabled by competence and resilience
Boundary judgements - practice	1	**M- intention to improve/support agility in DM**	387	99	59	28	29	86	86
	2	**K- shared understanding (business & data)**	370	109	49	23	26	86	77
	3	**K- defined, prioritised DM/data capability requirement**	346	80	44	30	21	84	87
	4	**M- clear, shared data-centric purpose**	336	95	46	21	20	84	70
	5	**P- collaborative culture, synergy**	308	85	43	16	34	78	52
	6	**K- experience and ability/competence**	288	95	37	12	24	57	63
	7	**P- effective stakeholder engagement**	278	76	41	19	19	62	61
	8	**M- share & integrate capabilities (avoid silos)**	270	70	41	23	35	55	46
	9	**L- suitability/sufficiency in context**	257	65	41	26	25	55	45
	10	**K- resource capability (socio/tech/data)**	250	70	36	19	21	54	50
	11	**L- potential extent of impact**	246	59	36	21	24	52	54
	12	**K- specialist knowledge/skills/expertise/understanding**	238	83	30	4	17	56	48
	13	P- data leadership mandate/direction/support	231	63	38	13	21	55	41
	14	M- intention to be responsive	226	52	28	12	15	69	50
	15	K- iteratively/continuously keep up & improve capability	219	49	41	16	21	44	48
	16	M- business value/impact of DM initiative	216	54	35	17	21	46	43
	17	L- openness to/embracing/incorporating change	210	50	38	9	16	54	43
	18	L- reflection on approach to data initiatives	199	54	28	15	11	45	46
	19	P- business area strategy/priority	196	46	24	20	14	44	48
	20	L- openness to other/broader perspectives/alternatives	193	50	41	9	21	44	28
	21	K- learning from safe-to-fail trying/innovating/exploring	192	52	31	17	23	34	35
	22	L- adoption & proliferation of DM capabilities	189	58	22	13	17	40	39
	23	P- team/role/organisation maturity	163	53	20	8	12	38	32
	24	P- uncertainty in internal environment	162	43	26	12	13	35	33
	25	P- resource capacity for DM (socio/tech)	149	40	19	16	12	28	34
	26	L- tenability/durability/sustainability	138	38	16	9	10	29	36
	27	M- buy-in/commitment from stakeholders of data priority	132	34	20	7	10	28	33
	28	L- peripheral dependency/interdependency/knock-on	122	28	19	12	10	26	27
	29	P- trust/trustworthiness	118	32	19	8	7	26	26
	30	P- uncertainty in external environment	117	26	19	7	15	27	23
	31	M- feedback loops (assess/monitor/test)	115	31	17	10	9	23	25
	32	P- autonomy at execution level	111	26	20	6	10	28	21
	33	P- formalised delivery processes	103	25	18	10	4	22	24
	34	M- data role/function clarity	100	32	14	4	6	21	23
	35	P- data ownership, stewardship, custodianship	99	24	14	8	8	23	22
	36	P- data management strategy	96	27	13	6	8	23	19
	37	P- data governance processes	88	29	11	4	7	18	19
	38	K- modularised/standardised/foundational capability	83	17	16	10	11	14	15
	39	M- intention to be proactive	69	20	8	2	6	18	15
	40	P- data management policies	56	16	11	4	4	10	11
	41	P- data management principles	53	15	8	4	4	11	11
	42	P- unilateral/BU decision-making	47	13	6	0	3	15	10
	43	P- legal/regulatory/audit compliance requirements	41	10	4	3	4	10	10
	44	M- avoid technical debt/rework/redundancy	30	7	4	3	2	8	6
	45	K- process automation capability	29	8	3	1	0	11	6

Figure 6-28: Sources of influence on the emergence of non-repeatable agility features in practice

Sources of influence on emerging agility in policies and standards

The findings related to emerging agility based on the analysis of the data management **policy and standards documents** collected at the case study organisation are presented in Figure 6-29:

	TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power	Total code co-occurences of boundary judgements AND non-repeatable agility in Policies	Emerging agility features - policies & standards TOP 12 / Top 3 / Bottom 3 Competence/aptitude	Flexibility	Leanness (limit work-in-progress)	Repurpose-ability/extensibility	Responsiveness	Speed enabled by competence and resilience
Boundary judgements - policies & standards	1	**P- data governance processes**	154	49	18	17	15	38	17
	2	**M- clear, shared data-centric purpose**	153	45	19	20	15	37	17
	3	**K- shared understanding (business & data)**	135	41	18	17	12	32	15
	4	**M- feedback loops (assess/monitor/test)**	133	46	13	11	12	37	14
	5	**L- adoption & proliferation of DM capabilities**	123	40	16	10	13	31	13
	6	**P- data ownership, stewardship, custodianship**	116	34	14	14	13	27	14
	7	**K- defined, prioritised DM/data capability requirement**	114	37	16	12	13	25	11
	8	**P- effective stakeholder engagement**	113	37	10	13	13	28	12
	9	**L- suitability/sufficiency in context**	112	31	20	19	11	24	7
	10	**K- modularised/standardised/foundational capability**	110	26	18	15	9	29	13
	11	**K- resource capability (socio/tech/data)**	110	29	18	13	10	25	15
	12	**M- data role/function clarity**	101	33	12	13	13	19	11
	13	P- data management policies	99	32	16	10	9	22	10
	14	M- share & integrate capabilities (avoid silos)	97	24	17	9	12	23	12
	15	L- potential extent of impact	92	27	13	12	10	19	11
	16	L- tenability/durability/sustainability	87	25	11	9	8	20	14
	17	P- business area strategy/priority	86	25	12	12	11	17	9
	18	P- legal/regulatory/audit compliance requirements	85	28	10	10	6	19	12
	19	P- data management strategy	84	21	13	10	14	17	9
	20	M- intention to improve/support agility in DM	81	20	13	10	7	17	14
	21	K- specialist knowledge/skills/expertise/understanding	80	28	9	10	8	18	7
	22	M- business value/impact of DM initiative	80	24	14	12	9	14	7
	23	K- iteratively/continuously keep up & improve capability	76	22	13	7	10	18	6
	24	L- reflection on approach to data initiatives	75	25	6	10	6	19	9
	25	P- collaborative culture, synergy	69	20	9	9	8	18	5
	26	P- data leadership mandate/direction/support	68	23	10	7	9	14	5
	27	P- data management principles	68	20	11	6	6	17	8
	28	M- buy-in/commitment from stakeholders of data priority	64	19	7	8	9	13	8
	29	P- trust/trustworthiness	64	19	7	7	4	18	9
	30	M- intention to be responsive	60	16	7	5	4	20	8
	31	P- formalised delivery processes	53	15	8	6	4	16	4
	32	L- openness to other/broader perspectives/alternatives	43	8	9	6	6	9	5
	33	K- experience and ability/competence	37	13	4	5	3	8	4
	34	K- process automation capability	37	10	5	2	3	10	7
	35	L- openness to/embracing/incorporating change	27	6	5	5	2	6	3
	36	P- resource capacity for DM (socio/tech)	26	8	4	3	2	6	3
	37	M- intention to be proactive	23	7	3	2	2	7	2
	38	L- peripheral dependency/interdependency/knock-on	21	7	1	3	2	5	3
	39	K- learning from safe-to-fail trying/innovating/exploring	16	4	2	2	2	4	2
	40	P- team/role/organisation maturity	15	5	3	1	1	4	1
	41	P- autonomy at execution level	13	2	2	2	2	3	2
	42	P- uncertainty in external environment	11	2	2	1	1	3	2
	43	P- uncertainty in internal environment	11	2	2	1	1	3	2
	44	M- avoid technical debt/rework/redundancy	2	1	0	1	0	0	0
	45	P- unilateral/BU decision-making	1	0	1	0	0	0	0

Figure 6-29: Sources of influence on the emergence of non-repeatable agility features in policies and standards

Ranked sources of influence on emerging agility in policies and standards versus practice

Discrepancies between the influences on **emerging** agility in policies and standards, and practice were apparent in the data, as illustrated in Figure 6-30. This graph is based on the total co-occurrences reported in Figure 6-28 and Figure 6-29 on the preceding pages.

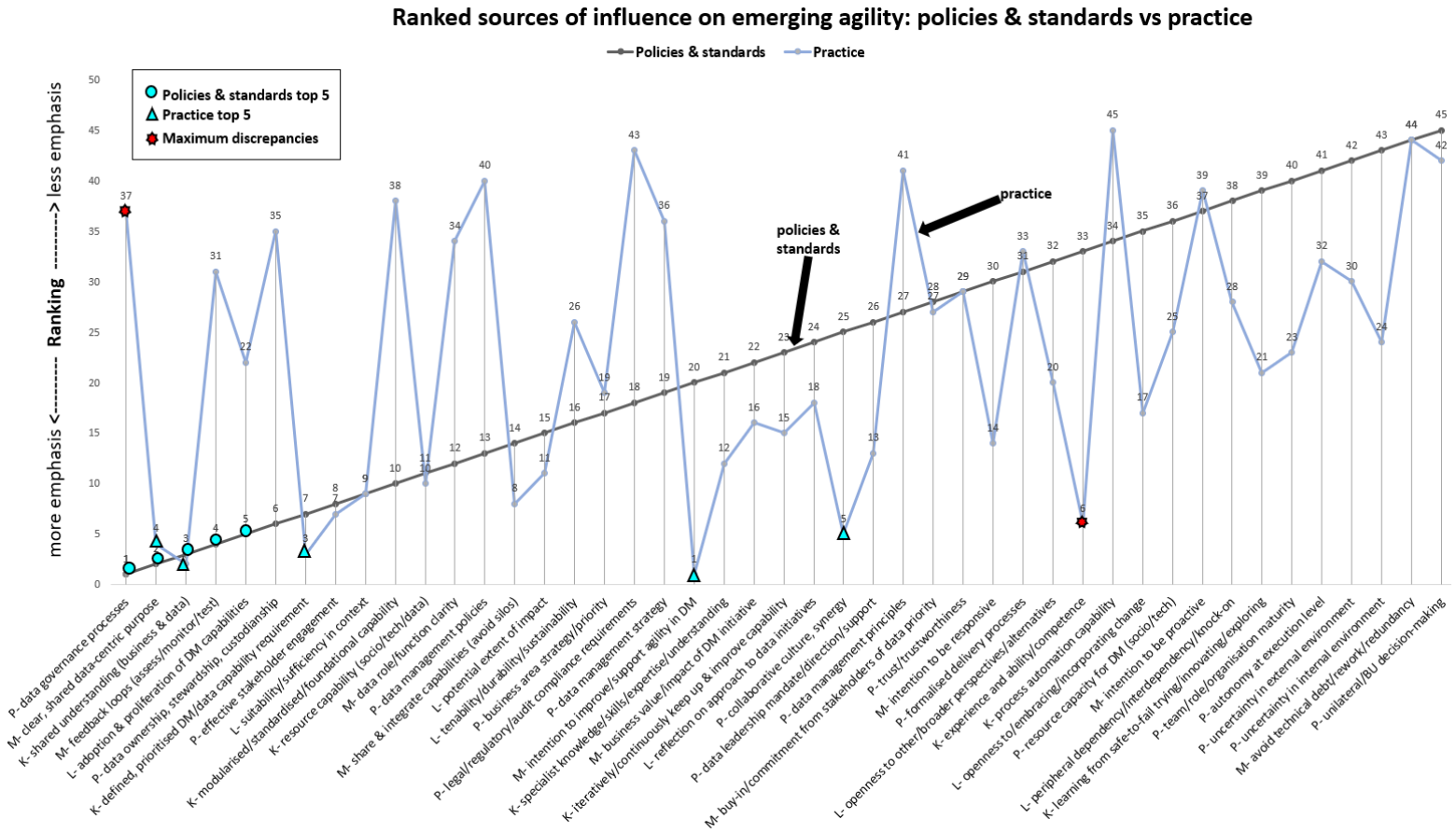


Figure 6-30: Ranked sources of influence on emerging agility: policies vs practice

6.3.2 Sources of influence on evolving agility in enterprise data management

When analysing the sources of influence on evolving agility from the EDM practice and policy perspectives, the analysis found that the five most influential boundary judgements, in order of their emphasis, overlapped on only three sources of influence, indicated in bold in Table 6-12:

Table 6-12: Top 5 sources of influence on evolving agility features

Perspective	Top 5 sources of influence on evolving agility features
The organisation's data management practices as expressed by the interview participants:	**1. K- shared understanding (business & data)** 2. M- intention to improve/support agility in DM **3. M- clear, shared data-centric purpose** **4. M- share & integrate capabilities (avoid silos)** 5. P- collaborative culture, synergy
The organisation's data management policy and standards documents:	**1. M- clear, shared data-centric purpose** 2. L- adoption & proliferation of DM capabilities 3. P- data governance processes **4. K- shared understanding (business & data)** **5. M- share & integrate capabilities (avoid silos)**

The detailed analysis of findings for sources of influence on evolving agility in EDM from the practice and policy and standards perspectives are presented in Figure 6-31, Figure 6-32 and Figure 6-33 on pages 293, 294 and 295, respectively.

Discrepancies between the influences on **evolving** agility in policy and practice were apparent in the data, as illustrated in Figure 6-33 on page 295. The graph is based on the total co-occurrences of sources of influence on combined features of **evolving** agility in the **policy** and standards documents and the participants' **narratives**, respectively.

The two most notable differences in ranking of influences on evolving agility in policy and standards versus practice were **L- adoption & proliferation of DM capabilities** (ranked higher in EDM policy than by data management practitioners) and **K- experience and ability/competence** (ranked higher by data management practitioners than in EDM policy).

Sources of influence on evolving agility in practice

The findings related to evolving agility based on the analysis of the data collected in the **interviews** with data management **practitioners** at the case study organisation are presented in Figure 6-31:

	TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power	Total code co-occurences of boundary judgements AND repeatable agility in practice	Evolving agility features - practice: Expertise/specialised capability	Leanness (eliminate/avoid redundancy)	Reusability	Scalability	Speed enabled by specialisation and equilibrium
Boundary judgements - practice	1	**K- shared understanding (business & data)**	344	107	24	71	60	82
	2	**M- intention to improve/support agility in DM**	311	86	28	70	52	75
	3	**M- clear, shared data-centric purpose**	308	97	22	69	52	68
	4	**M- share & integrate capabilities (avoid silos)**	304	83	28	83	59	51
	5	**P- collaborative culture, synergy**	273	80	19	75	52	47
	6	**K- defined, prioritised DM/data capability requirement**	253	72	20	56	40	65
	7	**K- resource capability (socio/tech/data)**	245	74	19	58	40	54
	8	**K- specialist knowledge/skills/expertise/understanding**	232	94	5	46	33	54
	9	**P- effective stakeholder engagement**	221	72	19	45	35	50
	10	**L- adoption & proliferation of DM capabilities**	220	70	13	46	44	47
	11	**K- experience and ability/competence**	209	81	10	35	31	52
	12	**L- potential extent of impact**	190	50	17	45	35	43
	13	P- data leadership mandate/direction/support	190	60	14	45	33	38
	14	L- suitability/sufficiency in context	185	58	16	44	29	38
	15	L- reflection on approach to data initiatives	167	55	11	37	21	43
	16	L- tenability/durability/sustainability	165	47	12	40	28	38
	17	M- business value/impact of DM initiative	158	47	14	36	24	37
	18	P- business area strategy/priority	157	45	17	40	18	37
	19	K- iteratively/continuously keep up & improve capability	149	42	11	32	25	39
	20	P- resource capacity for DM (socio/tech)	146	43	14	31	24	34
	21	P- team/role/organisation maturity	144	52	7	28	24	33
	22	L- openness to other/broader perspectives/alternatives	143	42	11	38	30	22
	23	M- intention to be responsive	141	41	7	37	21	35
	24	K- modularised/standardised/foundational capability	132	28	14	42	27	21
	25	P- data ownership, stewardship, custodianship	114	30	14	24	19	27
	26	K- learning from safe-to-fail trying/innovating/exploring	112	33	11	24	20	24
	27	L- peripheral dependency/interdependency/knock-on	112	28	11	30	16	27
	28	P- data governance processes	112	36	7	27	17	25
	29	M- feedback loops (assess/monitor/test)	109	33	6	26	18	26
	30	L- openness to/embracing/incorporating change	106	35	6	20	17	28
	31	P- uncertainty in internal environment	99	28	10	18	17	26
	32	M- buy-in/commitment from stakeholders of data priority	98	31	6	18	15	28
	33	P- data management strategy	97	31	6	23	17	20
	34	M- data role/function clarity	86	33	5	13	11	24
	35	P- formalised delivery processes	82	22	4	20	12	24
	36	P- autonomy at execution level	80	21	5	22	14	18
	37	P- trust/trustworthiness	76	26	7	13	9	21
	38	P- data management policies	72	23	3	19	11	16
	39	P- uncertainty in external environment	66	17	5	15	12	17
	40	M- intention to be proactive	65	21	6	14	8	16
	41	P- data management principles	64	19	7	14	10	14
	42	K- process automation capability	53	16	3	16	8	10
	43	P- unilateral/BU decision-making	50	14	2	14	11	9
	44	M- avoid technical debt/rework/redundancy	37	7	6	12	7	5
	45	P- legal/regulatory/audit compliance requirements	31	9	2	7	5	8

Figure 6-31: Sources of influence on the evolution of repeatable agility features in practice

Sources of influence on evolving agility in policies and standards

The findings related to evolving agility based on the analysis of the data management **policy and standards documents** collected at the case study organisation are presented in Figure 6-32:

	TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power	Total code co-occurences of boundary judgements AND repeatable agility in Policies	Evolving agility features - policies & standards (TOP 12 / Top 3 / Bottom 3)				
				Expertise/specialised capability	Leanness (eliminate/avoid redundancy)	Reusability	Scalability	Speed enabled by specialisation and equilibrium
Boundary judgements - policies & standards	1	**M- clear, shared data-centric purpose**	297	79	46	77	65	30
	2	**L- adoption & proliferation of DM capabilities**	274	79	34	77	61	23
	3	**P- data governance processes**	265	78	40	68	52	27
	4	**K- shared understanding (business & data)**	257	69	41	68	54	25
	5	**M- share & integrate capabilities (avoid silos)**	228	58	32	66	49	23
	6	**L- suitability/sufficiency in context**	225	61	42	62	45	15
	7	**M- feedback loops (assess/monitor/test)**	221	68	31	58	45	19
	8	**K- defined, prioritised DM/data capability requirement**	213	62	33	52	45	21
	9	**P- data ownership, stewardship, custodianship**	204	55	31	53	43	22
	10	**P- data management policies**	200	66	25	55	37	17
	11	**K- modularised/standardised/foundational capability**	197	54	29	57	39	18
	12	**P- effective stakeholder engagement**	188	56	28	46	40	18
	13	M- data role/function clarity	183	53	31	44	36	19
	14	K- specialist knowledge/skills/expertise/understanding	176	56	22	48	37	13
	15	K- resource capability (socio/tech/data)	175	47	27	44	37	20
	16	P- business area strategy/priority	162	42	28	41	36	15
	17	L- tenability/durability/sustainability	161	42	27	37	32	23
	18	M- business value/impact of DM initiative	153	41	26	39	35	12
	19	P- data leadership mandate/direction/support	148	42	20	39	35	12
	20	P- collaborative culture, synergy	145	39	23	38	34	11
	21	K- iteratively/continuously keep up & improve capability	138	38	20	37	32	11
	22	L- potential extent of impact	134	38	21	31	27	17
	23	P- data management principles	130	39	17	39	25	10
	24	M- intention to improve/support agility in DM	129	31	20	29	26	23
	25	P- trust/trustworthiness	128	34	21	31	25	17
	26	L- reflection on approach to data initiatives	126	42	18	35	20	11
	27	P- legal/regulatory/audit compliance requirements	119	40	18	24	20	17
	28	M- buy-in/commitment from stakeholders of data priority	109	32	17	25	23	12
	29	P- data management strategy	106	27	16	27	24	12
	30	P- formalised delivery processes	100	33	12	32	16	7
	31	M- intention to be responsive	62	18	9	17	10	8
	32	K- process automation capability	55	14	6	15	10	10
	33	L- openness to other/broader perspectives/alternatives	54	12	9	15	13	5
	34	L- peripheral dependency/interdependency/knock-on	52	14	8	13	11	6
	35	K- experience and ability/competence	49	16	7	12	9	5
	36	M- intention to be proactive	33	10	5	9	7	2
	37	L- openness to/embracing/incorporating change	32	8	8	7	5	4
	38	P- resource capacity for DM (socio/tech)	24	8	3	5	5	3
	39	K- learning from safe-to-fail trying/innovating/exploring	19	5	4	4	3	3
	40	P- team/role/organisation maturity	19	6	1	5	5	2
	41	P- autonomy at execution level	18	3	4	4	4	3
	42	P- uncertainty in internal environment	12	4	2	2	2	2
	43	P- uncertainty in external environment	9	3	2	1	1	2
	44	M- avoid technical debt/rework/redundancy	7	2	2	1	1	1
	45	P- unilateral/BU decision-making	5	1	1	2	1	0

Figure 6-32: Sources of influence on the evolution of repeatable agility features in policies

Ranked sources of influence on evolving agility in policies and standards versus practice

Discrepancies between the influences on **evolving** agility in policies and standards, and practice were apparent in the data, as illustrated in Figure 6-33. This graph is based on the total co-occurrences reported in Figure 6-31 and Figure 6-32 on the preceding pages.

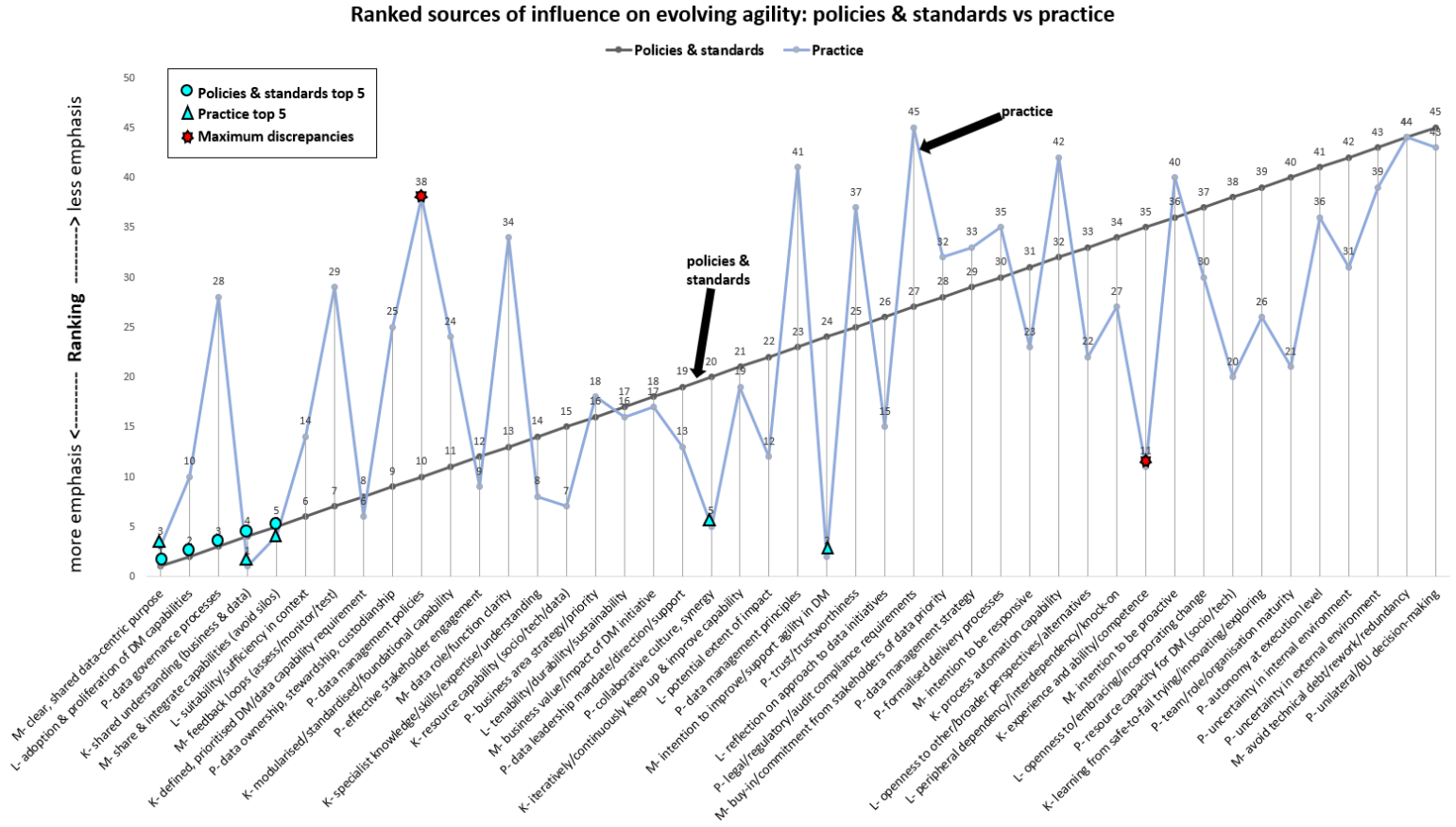


Figure 6-33: Ranked sources of influence on evolving agility: policies vs practice

6.3.3 Thriving and faltering agility in enterprise data management

Thriving agility is the sustained functional emergence and evolution of constraints that iteratively create and enhance agility features. In contrast, faltering agility is the emergence and evolution of constraints that iteratively disintegrate agility features with consequential loss of the system's overall agility coherence. Both thriving and faltering agility can emerge and evolve intentionally or unintentionally.

Ranked sources of influence on thriving agility

The top five sources of influence on evolving and emerging agility, in order of emphasis in the EDM policies and practices of the case study organisation, are presented in Table 6-13.

Table 6-13: Top 5 sources of influence on evolving and emerging agility

Perspective	Top 5 sources of influence on agility
Evolving agility features are relevant to complicated contexts and are adopted and embedded, evolving as part of good EDM practice.	**1. M- clear, shared data-centric purpose** **2. K- shared understanding (business & data)** 3. M- share & integrate capabilities (avoid silos) 4. L- adoption & proliferation DM capabilities **5. K- defined, prioritised DM/data capability requirement**
Emerging agility features are relevant to complex contexts, enabling adaptation under uncertainty and emerging to support the evolution of new patterns for evolving agility in EDM.	**1. K- shared understanding (business & data)** **2. M- clear, shared data-centric purpose** **3. K- defined, prioritised DM/data capability requirement** 4. M- intention to improve/support agility in DM 5. P- collaborative culture, synergy

Discrepancies between the influences on **emerging** agility and **evolving** agility were apparent in the data, as illustrated in Figure 6-34. This graph is based on the total co-occurrences of sources of influence on combined features of emerging agility and features of evolving agility, respectively.

The two most notable differences in the ranking of the influences on evolving versus emerging agility were **P- data management policies** (ranked higher for evolving agility than for emerging agility) and **L- openness to/embracing/incorporating change** (ranked higher for emerging agility than for evolving agility).

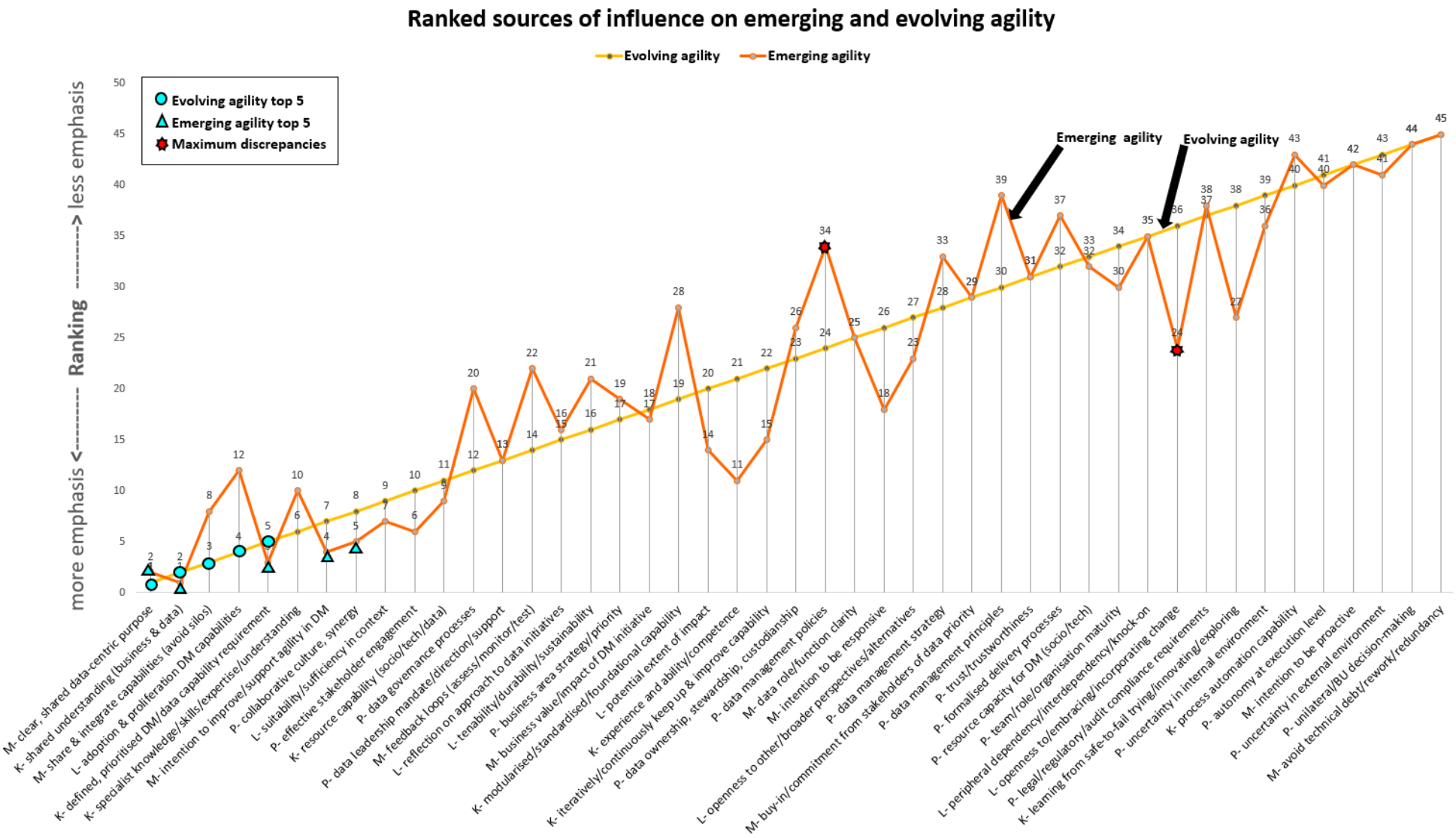


Figure 6-34: Ranked sources of influence on emerging and evolving agility

Faltering agility in enterprise data management

The findings related to faltering agility based on the analysis of the data collected in the **interviews** with data management **practitioners** at the case study organisation are presented in Figure 6-35:

	TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power	Total co-occurrences of boundary judgements and faltering agility in practice	Faltering agility - practice: Disintegrating agility	Faltering agility - practice: Precarious agility	Faltering agility - practice: Unprioritised/ unvalued/unrealisable agility
Boundary judgements - practice	1	**K- shared understanding (business & data)**	139	36	47	56
	2	**M- intention to improve/support agility in DM**	121	35	42	44
	3	**K- defined, prioritised DM/data capability requirement**	113	30	38	45
	4	**M- clear, shared data-centric purpose**	112	30	35	47
	5	**M- share & integrate capabilities (avoid silos)**	102	21	30	51
	6	**P- collaborative culture, synergy**	98	25	32	41
	7	**P- effective stakeholder engagement**	90	20	33	37
	8	**K- experience and ability/competence**	84	24	23	37
	9	**L- reflection on approach to data initiatives**	83	23	27	33
	10	**K- specialist knowledge/skills/expertise/understanding**	79	18	25	36
	11	**P- business area strategy/priority**	79	18	23	38
	12	**L- adoption & proliferation DM capabilities**	75	18	21	36
	13	K- resource capability (socio/tech/data)	73	19	23	31
	14	P- team/role/organisation maturity	69	21	21	27
	15	L- potential extent of impact	68	13	26	29
	16	P- uncertainty in internal environment	59	22	18	19
	17	L- suitability/sufficiency in context	55	15	18	22
	18	M- intention to be responsive	55	16	19	20
	19	L- openness to other/broader perspectives/alternatives	54	15	17	22
	20	K- iteratively/continuously keep up & improve capability	53	12	20	21
	21	L- peripheral dependency/interdependency/knock-on	53	10	19	24
	22	M- business value/impact of DM initiative	53	10	20	23
	23	P- resource capacity for DM (socio/tech)	52	11	17	24
	24	L- tenability/durability/sustainability	49	10	15	24
	25	P- data leadership mandate/direction/support	48	14	17	17
	26	L- openness to/embracing/incorporating change	47	11	21	15
	27	M- buy-in/commitment from stakeholders of data	41	11	13	17
	28	K- learning from safe-to-fail trying/innovating/exploring	40	10	15	15
	29	M- data role/function clarity	36	9	12	15
	30	P- unilateral/BU decision-making	35	10	9	16
	31	P- trust/trustworthiness	29	10	9	10
	32	K- modularised/standardised/foundational capability	28	5	8	15
	33	P- formalised delivery processes	28	5	11	12
	34	P- data governance processes	27	5	9	13
	35	P- data ownership, stewardship, custodianship	26	5	6	15
	36	P- autonomy at execution level	25	6	9	10
	37	P- uncertainty in external environment	23	7	11	5
	38	M- feedback loops (assess/monitor/test)	21	6	5	10
	39	P- data management strategy	17	4	5	8
	40	P- data management principles	14	3	4	7
	41	M- avoid technical debt/rework/redundancy	13	2	5	6
	42	P- data management policies	13	3	3	7
	43	M- intention to be proactive	12	5	3	4
	44	P- legal/regulatory/audit compliance requirements	12	3	5	4
	45	K- process automation capability	8	0	4	4

Figure 6-35: Faltering agility due to failing practice of sources of influence on repeatable and non-repeatable agility features

Ranked sources of influence on thriving and faltering agility

The top five sources of influence on thriving and faltering agility, in order of emphasis in the case study organisation's EDM policies and practices, are presented in Table 6-14.

Table 6-14: Top 5 sources of influence on thriving and faltering agility

Perspective	Top 5 sources of influence on agility
Thriving agility	**1. K- shared understanding (business & data)** **2. M- clear, shared data-centric purpose** **3. K- defined, prioritised DM/data capability requirement**

	4. M- intention to improve/support agility in DM
	5. M- share & integrate capabilities (avoid silos)
Faltering agility	**1. K- shared understanding (business & data)**
	2. M- intention to improve/support agility in DM
	3. M- clear, shared data-centric purpose
	4. P- collaborative culture, synergy
	5. K- defined, prioritised DM/data capability requirement

Discrepancies between the influences on **thriving** agility and **faltering** agility were apparent in the data, as illustrated in Figure 6-36. This graph is based on the overall co-occurrences of thriving agility (evolving and emerging agility) and faltering agility (disintegrating, precarious and unrealised agility).

The two marked differences in ranking of influences on thriving versus faltering agility were **P- data governance processes** (ranked higher for thriving agility than for faltering agility) and **P- uncertainty in internal environment** (ranked higher for faltering agility than for thriving agility).

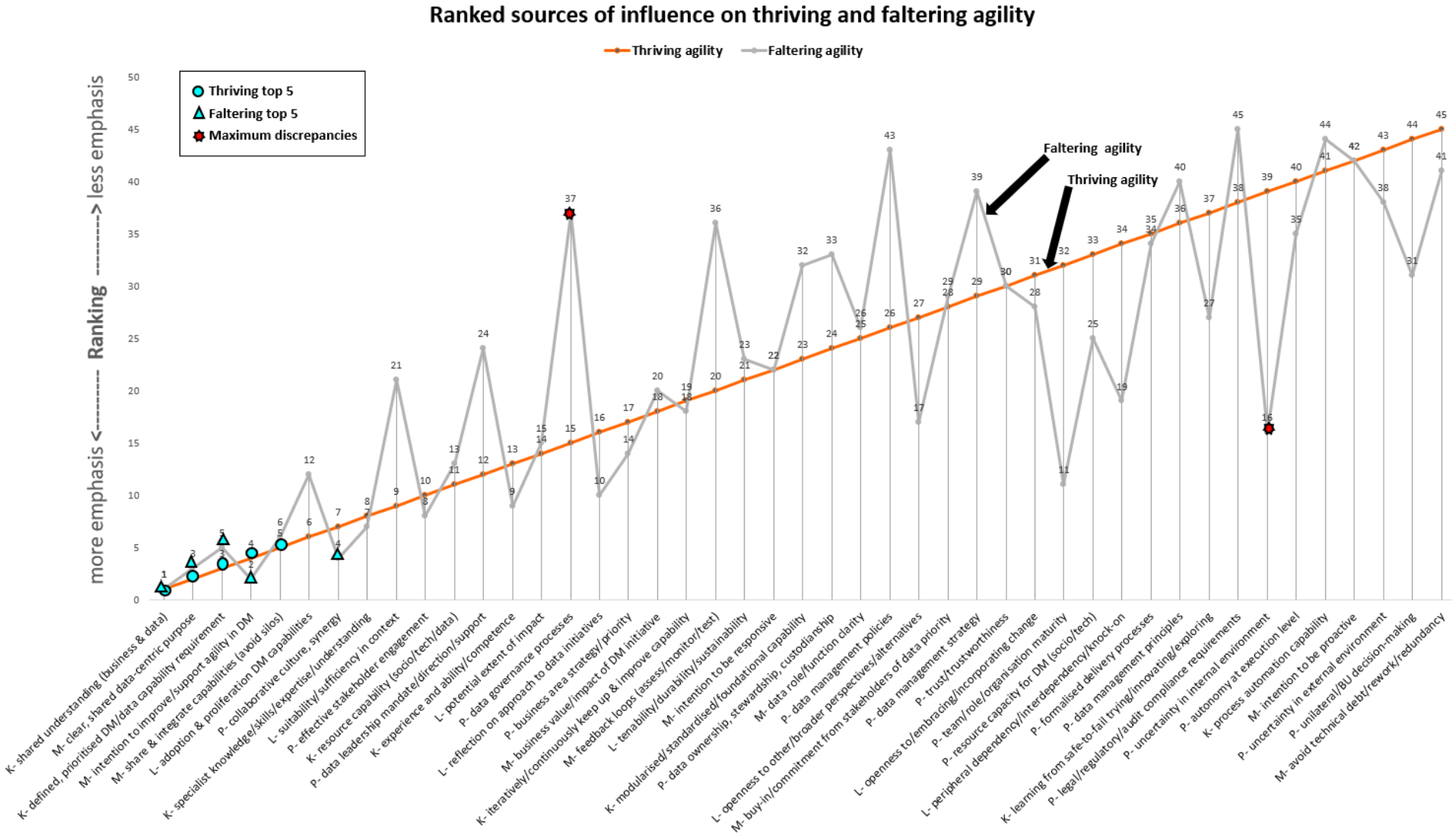


Figure 6-36: Ranked sources of influence on thriving agility and faltering agility

6.3.4 Main boundary critique questions and categories

The 12 main boundary critique questions of critical systems heuristics proposed by Ulrich and Reynolds (2020) were mapped to the 45 sources of influence codes representing the detailed boundary judgements found in the qualitative data, as documented in Table 6-7 (page 256), Table 6-8 (page 263), Table 6-9 (page 272) and Table 6-10 (page 279). This section presents an analysis of the main boundary questions revealing influences on the emergence and evolution of agility in EDM. The agility features of expertise/specialised capability, competence/aptitude, reusability and responsiveness were strongly emphasised across all three boundary critique categories, and leanness, repurpose-ability, scalability, and flexibility were the least emphasised.

Boundary critique regarding stakeholder roles influencing agility in EDM

Boundary critique pertaining to stakeholders (social roles) revealed the following emphasis in EDM agents' boundary judgements influencing thriving agility, as presented in Figure 6-37:

- The strongest emphasis was on the main boundary question, "**07. Expert: Who should contribute their expertise and experience?**" influencing the **evolving** agility feature of **expertise/specialised capability**.
- The weakest emphasis was on the main boundary question, "**10. Witness: Who voices concerns of those not involved?**" influencing the **emerging** agility feature of **leanness (limit work-in-progress)**.

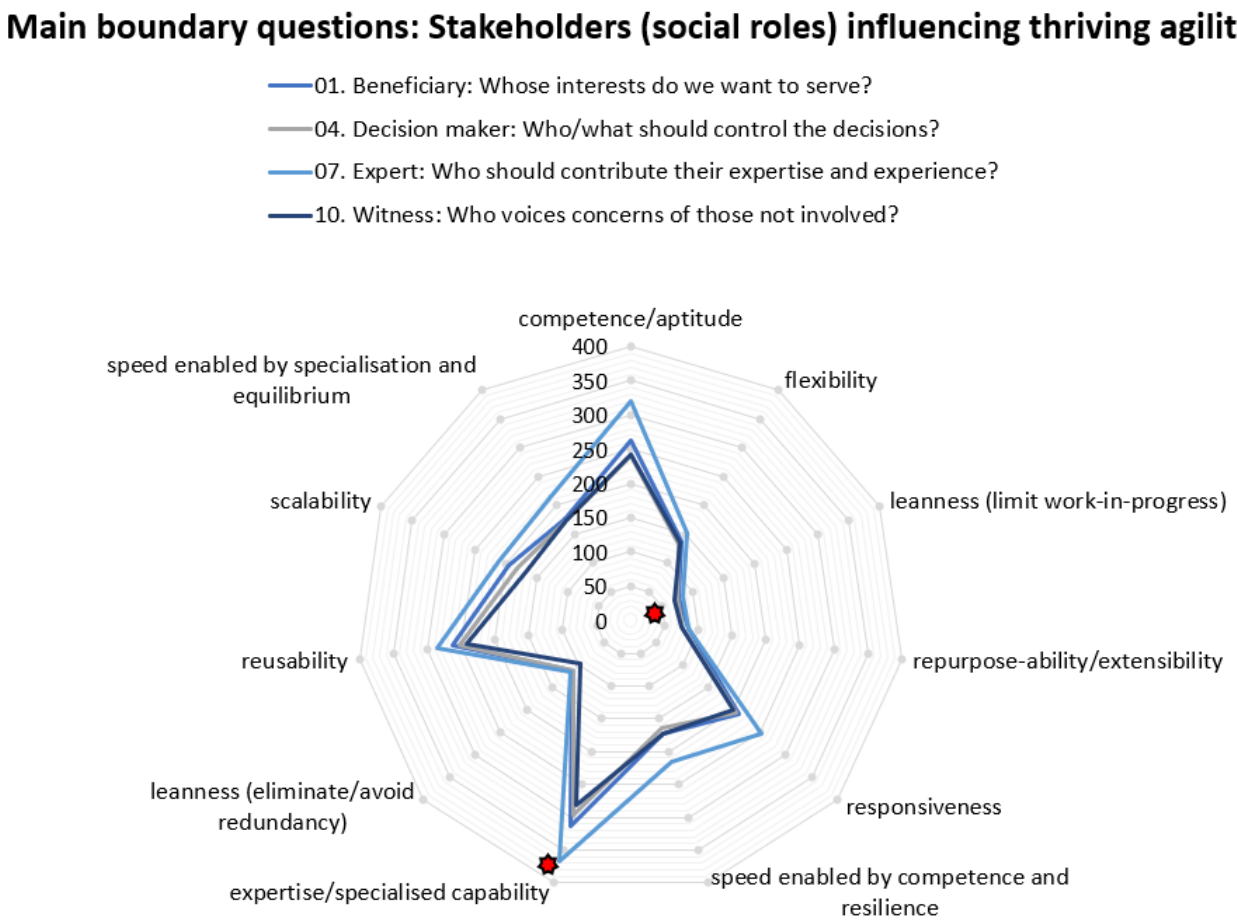


Figure 6-37: Stakeholders (social roles) influencing thriving agility in EDM

Boundary critique regarding stakes influencing agility in EDM

Boundary critique pertaining to stakes (specific concerns) revealed the following emphasis in EDM agents' boundary judgements influencing thriving agility, as presented in Figure 6-38.

- The strongest emphasis was on the main boundary question, "**08. Expertise: What information, knowledge and skills must be contributed?**" influencing the **evolving** agility feature of **expertise/specialised capability**.
- The weakest emphasis was on the main boundary question, "**11. Emancipation: Who/what emancipates stakeholders from our promises and premises?**" influencing the **emerging** agility feature of **leanness (limit work-in-progress)**.

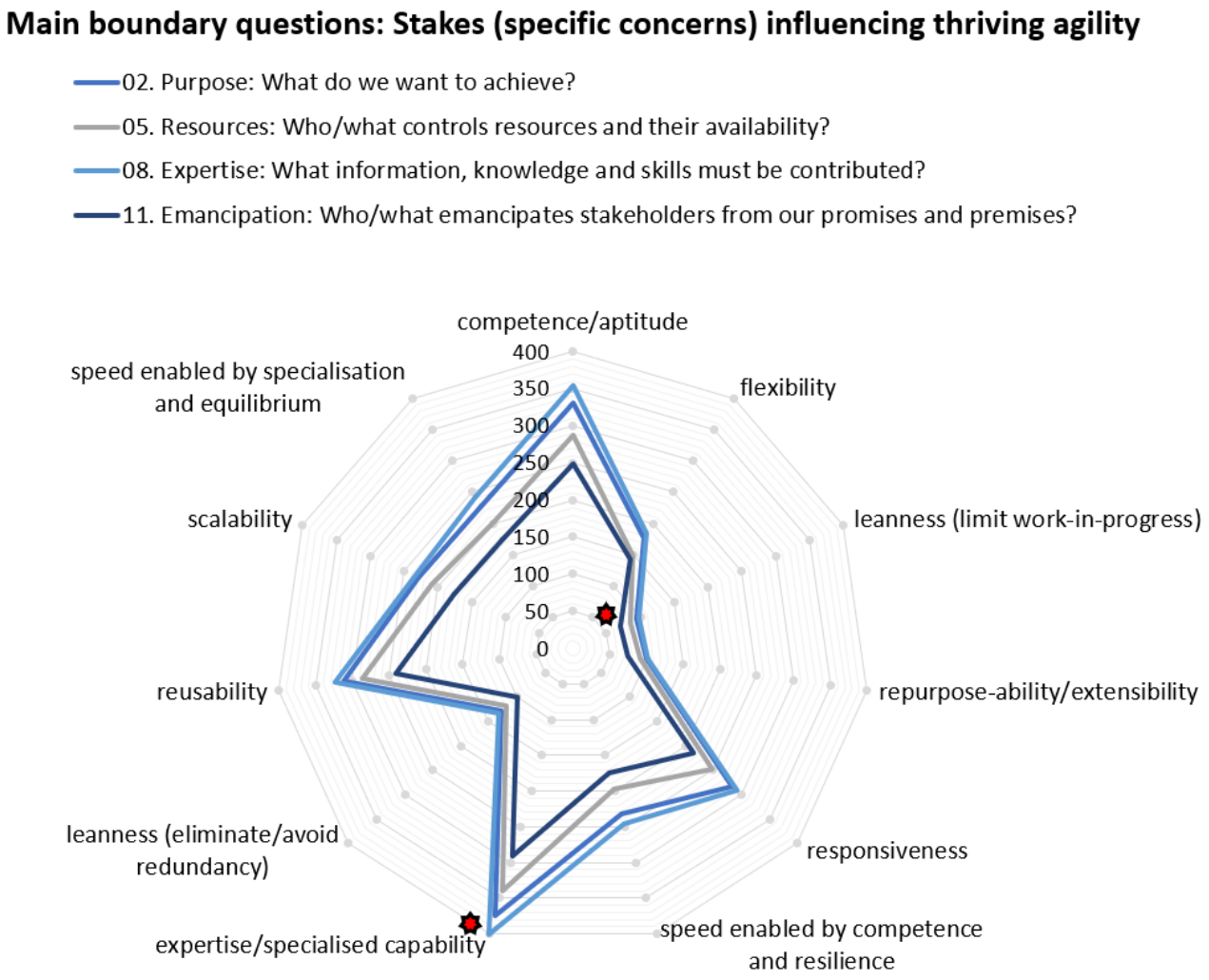


Figure 6-38: Stakes (specific concerns) influencing thriving agility in EDM

Boundary critique regarding stakeholding issues influencing agility in EDM

An analysis of the boundary critique about stakeholding issues (key problems) revealed the following emphasis on EDM agents' boundary judgements influencing thriving agility, as presented in Figure 6-39.

- The strongest emphasis was on the main boundary question, "**12. Worldview: What different visions of "improvement" must be considered?**" influencing the **evolving** agility feature of **expertise/specialised capability**.
- The weakest emphasis was on the main boundary question, "**03. Evaluate improvement: What constitutes an improvement?**" influencing the **emerging** agility feature of **leanness (limit work-in-progress)**.

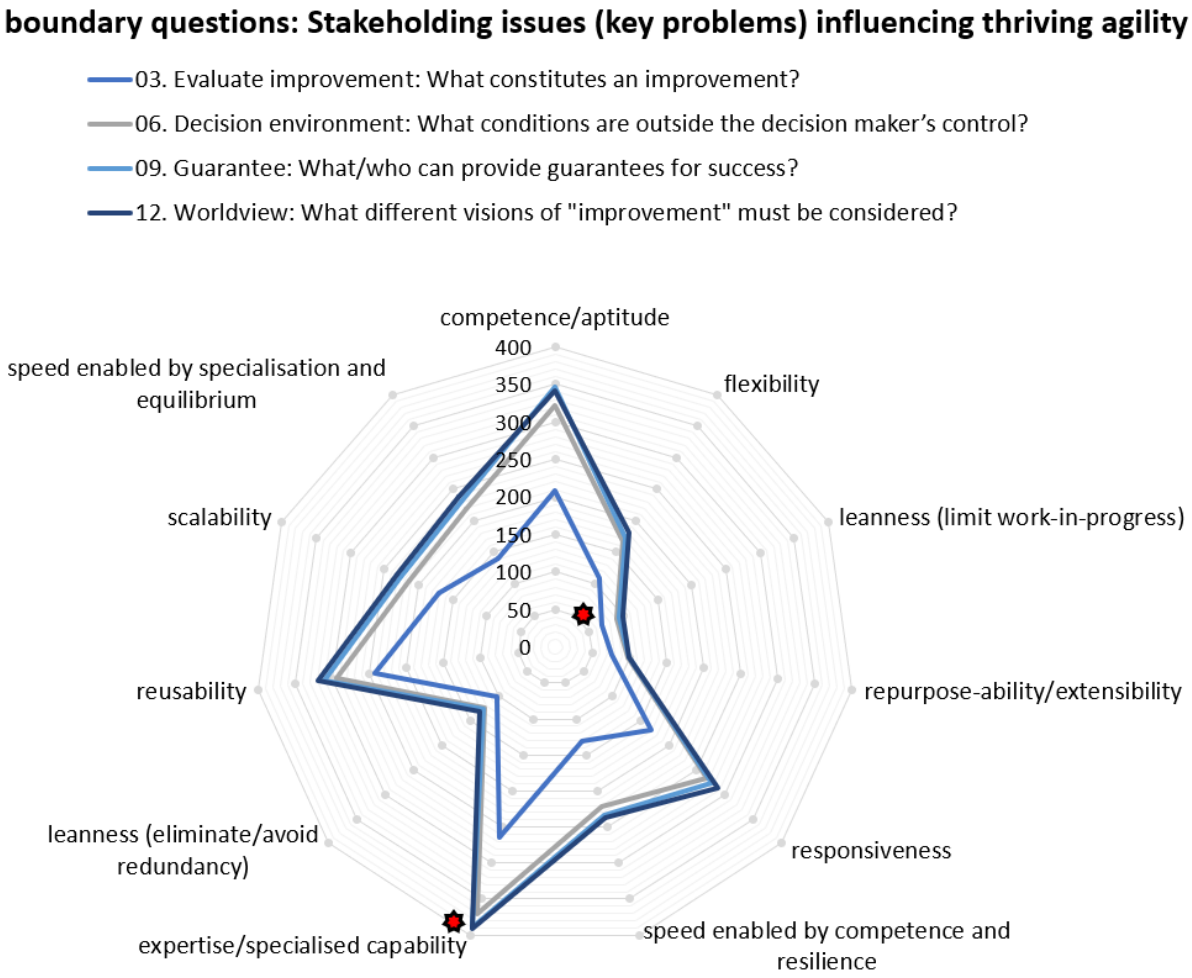


Figure 6-39: Stakeholding issues (key problems) influencing thriving agility in EDM

6.3.5 Summarised findings of emerging and evolving agility in EDM

Overall, the high-level analysis using the 12 boundary questions mapped to the boundary judgements practised in the data management functions, or prescribed in the EDM policy documents, at the case study organisation revealed the most substantial emphasis on the agility features of competence and aptitude, expertise and specialised capability, reusability and responsiveness.

The EDM policy and standards documents prescribe how EDM functions ought to be performed in the organisation. Therefore, to some degree, the EDM policy documents provided prescriptions reflecting the 'values' for improving agility in EDM. In contrast, the interview participants described their experiences and opinions about the emergence and evolution of agility in the described context and also, in some cases, how it should be. Thus, the narrative data provided by the interviewed data management practitioners provided 'facts' and 'values' for emerging and evolving agility in EDM. The EDM policy data was juxtaposed with the data management practitioners' narratives, which presented interesting qualitative data coding and analysis opportunities (for example, see Figure 6-30 on page 291) for investigating how agility should be influenced according to EDM policies and standards, and how it was being influenced in reality to emerge and evolve in the organisation's EDM. Overall, the following six boundary judgements, in the given order, were the most emphasised in the case study data as influencing agility ("M" = source of motivation; "P" = source of power; "K" = source of knowledge; and "L" = source of legitimation):

1. K- shared understanding (business & data)
2. M- clear, shared data-centric purpose
3. M- intention to improve/support agility in DM
4. P- data governance processes
5. K- defined, prioritised DM/data capability requirement
6. L- adoption & proliferation of DM capabilities

The nodes of the network diagram in Figure 6-40 on page 306 show the top six sources of influence, the activities (sensing, learning, coordinating and integrating) and outcomes of non-repeatable agility features in complicated EDM contexts at the case study organisation. Similarly, Figure 6-41 on page 307 illustrates the top six sources of influence, activities and repeatable agility features in complex contexts. The relationships between the nodes (as

defined in Table 6-3 on page 246) indicate the tensioning or enabling nature of influences affecting agility. Interrelationships across the meso- and micro-levels of the system (EDM as a CAS) indicate the entangled nature of interactions in EDM at the case study organisation.

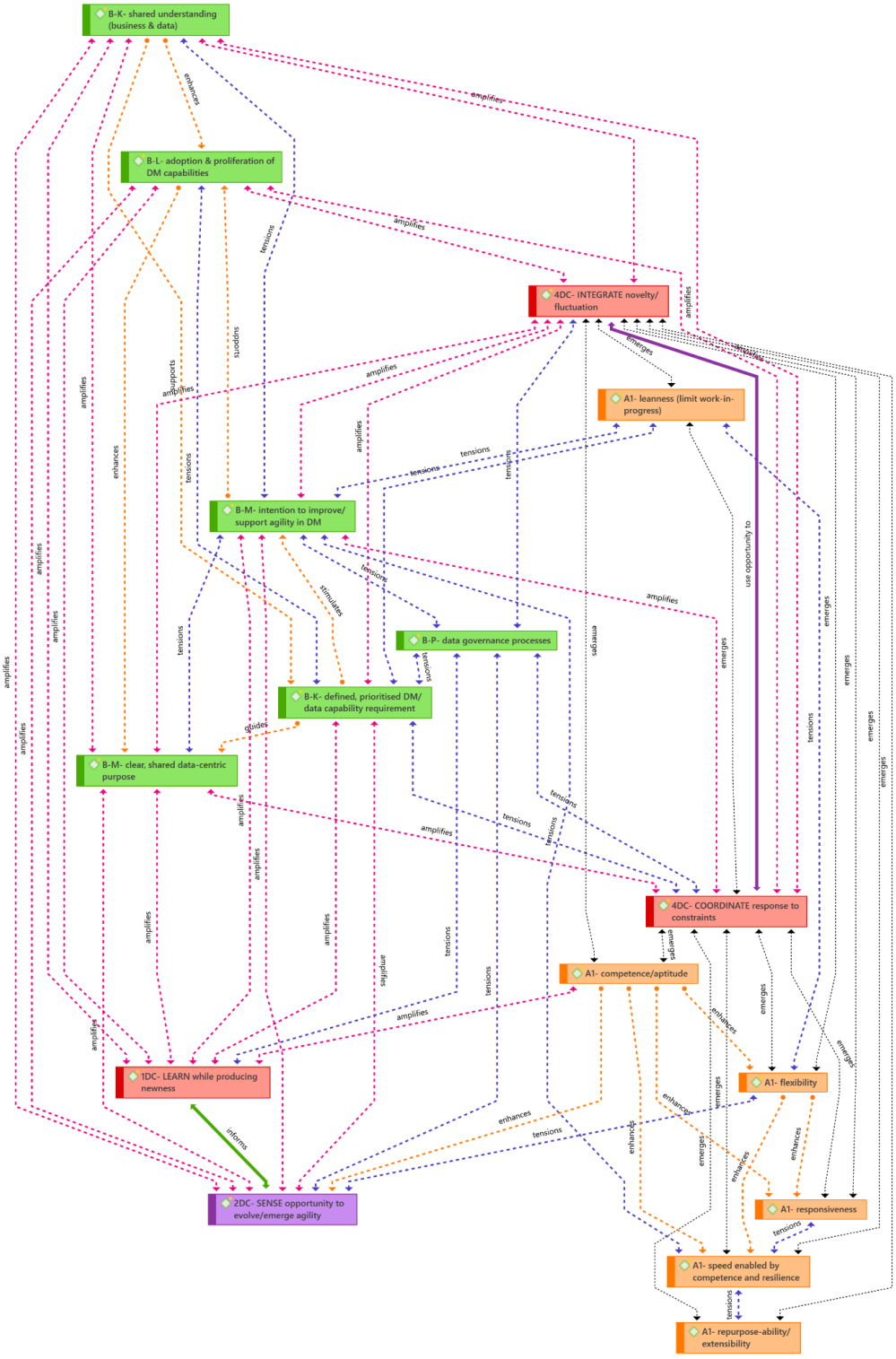


Figure 6-40: Top sources of influence on emerging agility in complex EDM contexts

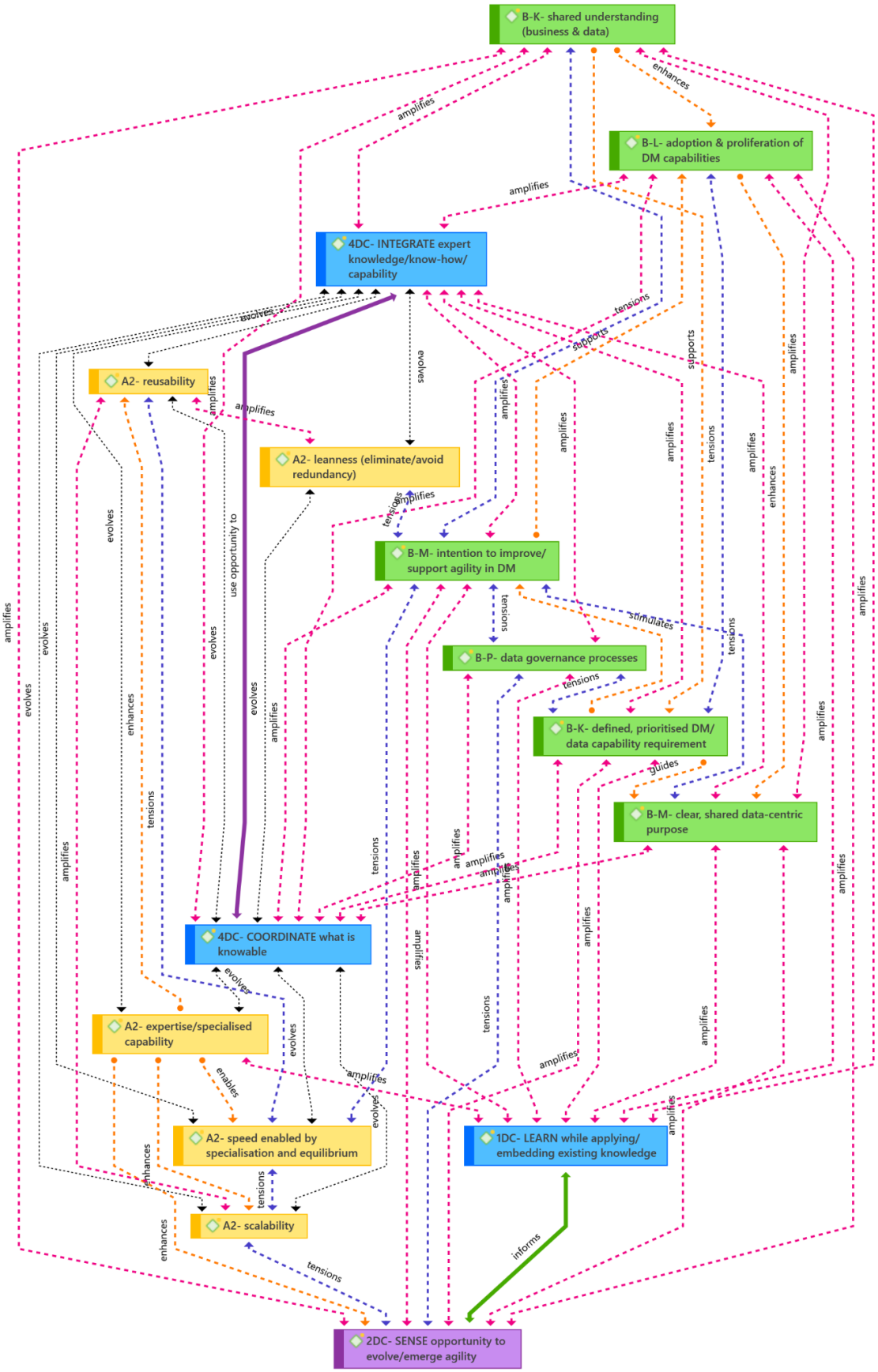


Figure 6-41: Top sources of influence on evolving agility in complicated EDM contexts

Figure 6-42 presents a high-level summary of the emphasis placed on sources of influence with agility outcomes of thriving (emerging and evolving) agility and faltering (missed opportunities to improve) agility in EDM. From left to right, the Sankey diagram summarises all codes applied (per source of influence) where the participants' narratives or the organisation's policy documents described or prescribed an opportunity to amplify agility.

	EDM policies & standards Gr=147	Interviews Gr=529	EMERGING (non-repeatable) agility Gr=478	EVOLVING (repeatable) agility Gr=508	opportunity missed to EVOLVE agility Gr=113	opportunity missed to EMERGE agility Gr=77	opportunity not fully utilised to EMERGE agility Gr=84
Interviews Gr=529	0	529	391	361	110	77	84
EDM policies & standards Gr=147	147	0	87	147	0	0	0
all BC- Sources of Knowledge Gr=582	147	435	448	484	109	76	82
all BC- Sources of Legitimacy Gr=564	147	417	436	475	108	75	80
all BC- Sources of Motivation Gr=575	147	428	444	481	110	76	84
all BC- Sources of Power Gr=579	147	432	444	480	110	77	83

Total thriving agility	Emerging agility	Evolving agility	Total faltering agility	Fail to EMERGE agility	Fail to EVOLVE agility
752	52%	48%	271	59%	41%
234	37%	63%	n/a	n/a	n/a

Emphasis in practice:
EMERGING agility= 52%
EVOLVING agility=48%

Emphasis in practice:
Fail to EMERGE agility= 59%;
Fail to EVOLVE agility 41%

Emphasis in policies & standards:
EVOLVING agility= 63%;
EMERGING agility 37%

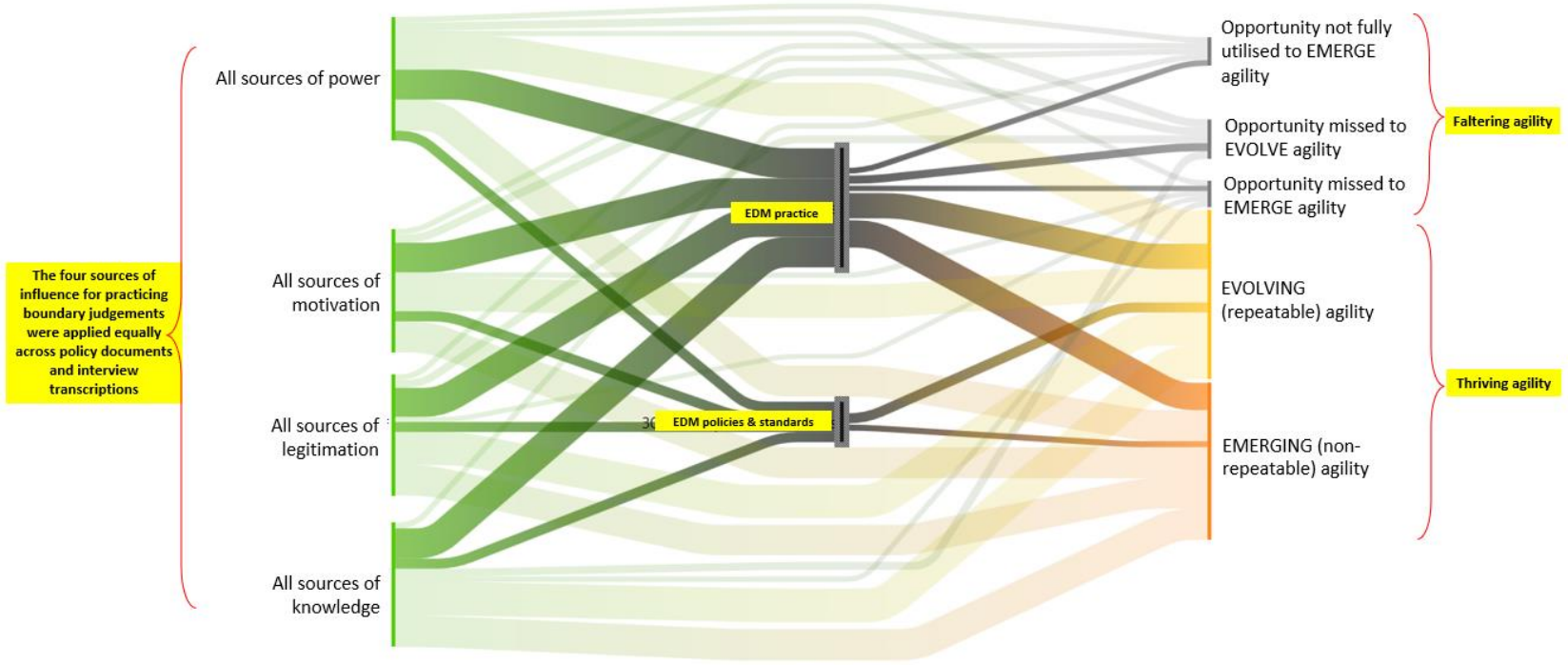


Figure 6-42: Summary of all sources of influence on thriving and faltering agility identified in the case study

The findings produced by the analysis presented in Figure 6-42 include the following:

- The **interview** participants (data management practitioners in the case study organisation) placed **4% more emphasis on emerging** agility than on evolving agility.
- The EDM **policy and standards** documents placed **26% more emphasis on evolving** agility than emerging agility.
- The interview participants **emphasised the failure to emerge agility 18% more** often than the failure to evolve agility.

Possible implications of these findings are that the discrepancy between the enterprise's EDM policies and standards emphasising evolving agility and the interview participants' focus on, and expressed frustrations with, emerging agility could be addressed to improve outcomes of thriving agility and opportunities to learn from cases of faltering agility.

Dynamic capabilities (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011) provided the theoretical constructs for the meso-level interactions in complex and complicated sociotechnical contexts, such as the activities and interactions found in EDM. The practice of boundary critique (Ulrich, 2000) provided a theoretical foundation for explaining the micro-level heuristics' boundary judgements, influencing interactions that can shift the system of agile EDM towards favourable agility outcomes.

The main boundary questions of CSH provided the mechanisms for moving between the meso-level of EDM activities and the micro-level of boundary critique in EDM for an improved agility state at the macro-level. In other words, by asking questions about agility at the system's boundaries and critically reflecting on the stakeholder roles, the stakes and stakeholding issues, opportunities can be identified and utilised with intended and unintended consequences and outcomes, thereby moving the overall system's agility to an improved state (Ulrich and Reynolds, 2020). Figure 6-43 presents an analysis of the critical reflection conducted on main boundary questions while performing EDM activities with agility consequences and outcomes.

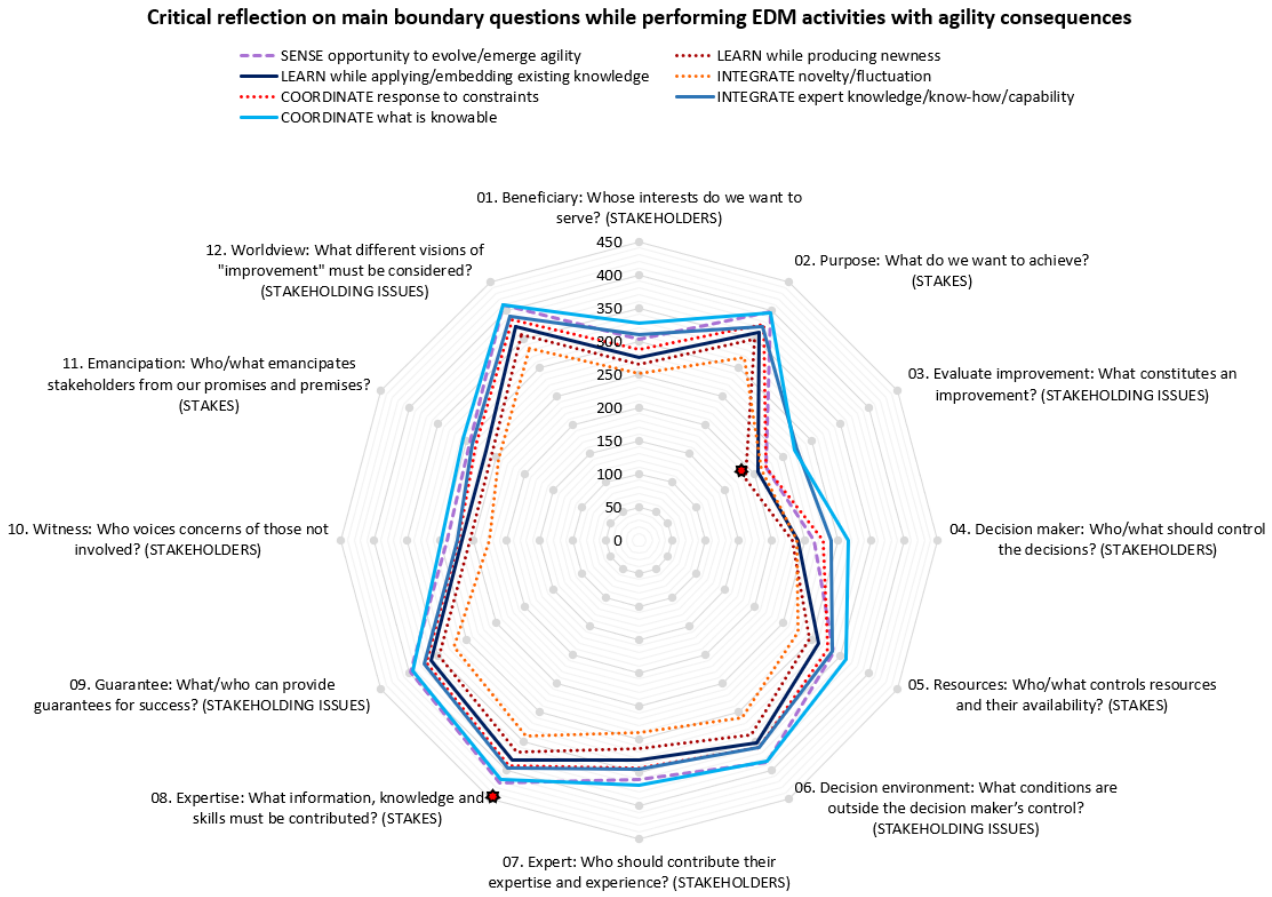


Figure 6-43: Critical reflection on main boundary questions while performing EDM activities with agility consequences and outcomes

The co-occurrence counts for codes combined occurrences in the policy documents and interview transcriptions, regardless of the resulting agility consequences. This is because, in many cases, both the "facts" and "values" that are at play in the system and the "facts" and "values" that ought to be at play in the system (Ulrich, 2005) were described in the participant's narrative. Whether agility thrived or faltered was strongly related to sensing an opportunity to influence the emergence or evolution of agility, and whether the opportunity was utilised in the particular context described in the data.

Non-repeatable agility features enable the evolution of repeatable agility features as changes to practice must emerge before they can be adopted and evolved. Figure 6-44 illustrates the main boundary questions influencing thriving agility in EDM practices, policies, and standards based on the 14 interview transcriptions and 8 policy and standards documents collected at the case study organisation.

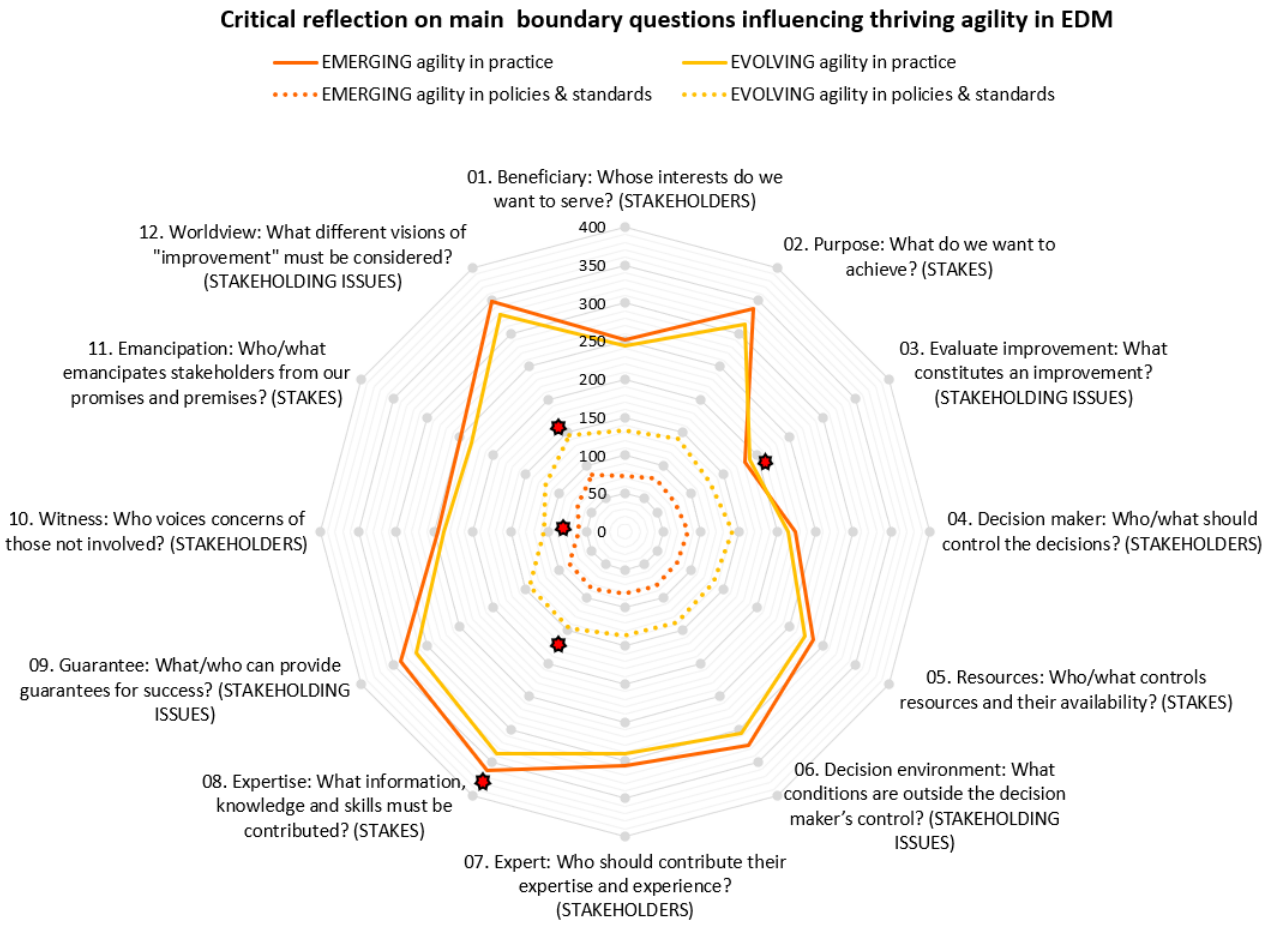


Figure 6-44: Main boundary questions influencing thriving agility in EDM practice and policies

As presented in Figure 6-44, EDM practices at the case study organisation emphasised the main boundary question, "**08. Expertise: What information, knowledge and skills must be contributed?**" as influencing emerging and evolving agility. In the EDM policies and standards at the case study organisation, the strongest emphasis was also on "**08. Expertise: What information, knowledge and skills must be contributed?**" and additionally on "**12. Worldview: What different visions of "improvement" must be considered?**" for influencing emerging and evolving agility. However, the emphasis in the EDM policies and standards was fairly even across all boundary questions except for "**10. Witness: Who voices concerns of those not involved?**" and "**11. Emancipation: Who/what emancipates stakeholders from our promises and premises?**", which received less emphasis. The EDM practices, however, emphasised "**03. Evaluate improvement: What constitutes an improvement?**" the least for influencing thriving agility in the organisation's EDM.

Figure 6-45 presents the main boundary questions influencing faltering agility in EDM at the case study organisation. The co-occurrence counts for failing agility included all instances where the agents of the EDM context missed the opportunity to assess and influence the state of agility, thus leading to faltering agility.

The most prominent influence resulting in faltering agility was where **the opportunity was missed to evolve (repeatable) agility** because of insufficient critical reflection on the main boundary question, "**08. Expertise: What information, knowledge and skills must be contributed?**".

The least emphasised influence resulting in faltering agility was for **opportunities missed to emerge (non-repeatable) agility** while reflecting on the main boundary question: "**03. Evaluate improvement: What constitutes an improvement?**".

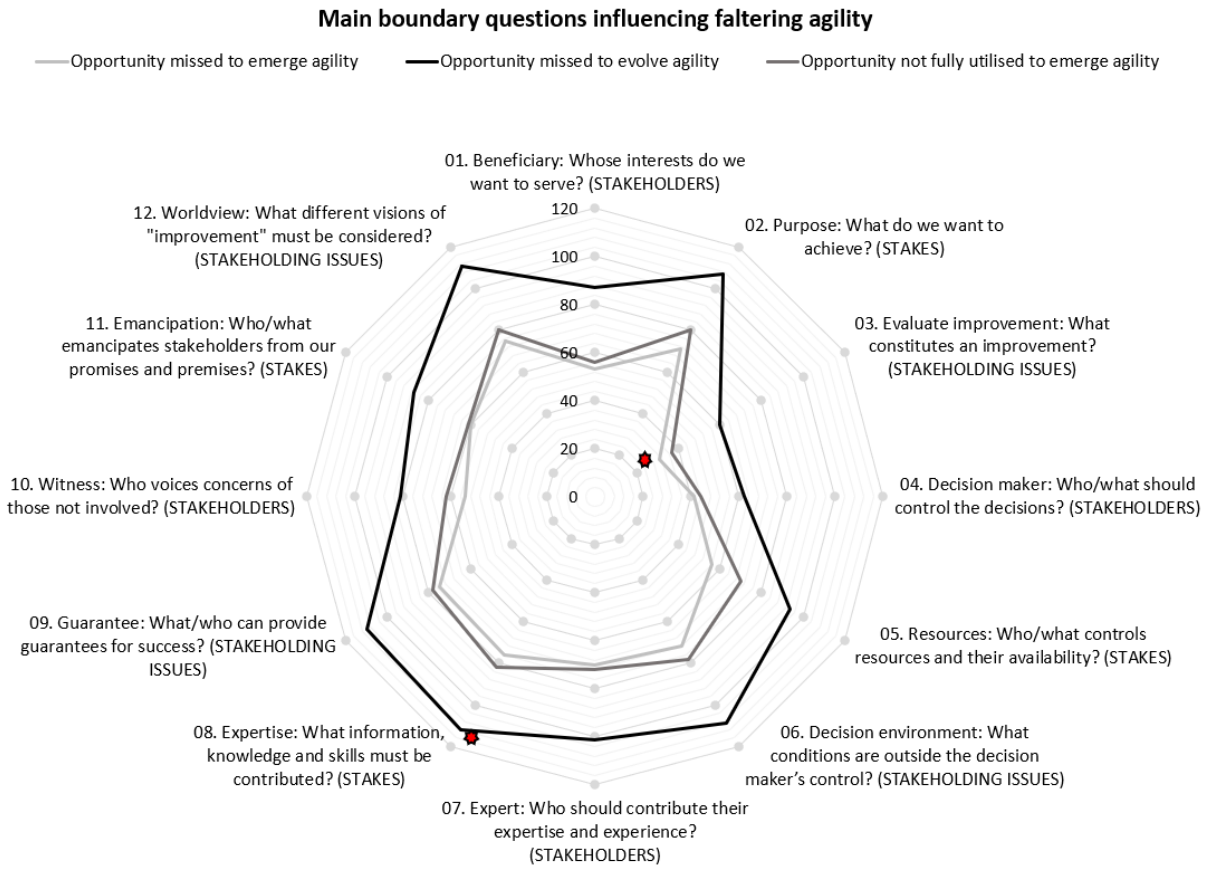


Figure 6-45: Main boundary questions influencing faltering agility in EDM practice

6.4 CONCLUSION — A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

The constructs and relationships of the dynamic part of a framework for agile EDM were applied to the qualitative case study data to develop and propose a framework for agile EDM, thereby answering the fifth and final sub-question of DSR Cycle 2:

Sub-RQ2:	What are the dynamic components of agile enterprise data management?
SQ2.5:	How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?

6.4.1 Discussion of findings

The dynamic components of agile EDM contexts explain relationships between structural components, contextualised differentiation for structural components in complex versus complicated contexts, and the emergence and evolution of agility features in EDM. The boundary judgements underlying the sources of influence (sources of knowledge, power, motivation and legitimation) on agility in EDM emerged from the data and are specific to the case study organisation's EDM contexts. The sources of influence on thriving and faltering agility and their relationships with the structural components of EDM could be explained based on the framework constructs' scientific underpinnings of CAS and dynamic capabilities. However, the influences of boundary judgements were found to be highly sensitive to the EDM contexts.

Because data in enterprises is both managed and governed (EDM, as delineated in Chapter 2 of this study, encompasses both), there is the real-world tension of balancing the ideal situation (governance that prescribes policies to ensure principles, standards, and guidelines are followed), and the actual situation (data management activities that execute data management work in the EDM organisation). This provided an exciting opportunity when applying the theoretical constructs of CSH to understand the influences on agility from a data management practitioner and data management policy and standards perspectives at the case study organisation.

The qualitative case study confirmed an existing real-world requirement for agile EDM, thereby confirming the relevance of the research problem. By applying the refined

conceptual framework for a qualitative case study of influences on agility in EDM (see Figure 6-4 on page 238), the micro-level mechanisms could be investigated to explain how agility emerges and evolves in EDM. Boundary judgements influence heuristics at the micro-level, consequently influencing how EDM work is coordinated and integrated at the meso-level resulting in intended and unintended consequences and outcomes for emerging and evolving agility features for the EDM organisation as a whole.

By binding the data coding scheme (see Figure 6-5 on page 242) for the case study data to the conceptual framework for conducting a qualitative case study of agile EDM (see Figure 6-4 on page 238), agility could be investigated in real-world EDM contexts and interactions at the case study organisation, confirming that EDM is a complex and complicated sociotechnical system that iteratively emerges and evolves agility features through multiple levels of actions, interactions, heuristics and feedback loops. At the meso-level, dynamic capabilities represented the actions and interactions of the case study organisation's sociotechnical EDM agents. The EDM practitioners used boundary judgements in heuristics at the micro-level, thereby influencing the agility consequences and outcomes upwards at the meso-level, feeding back to influence the overall agility state of the organisation's EDM at the macro-level.

The findings arising from the data analysis confirmed the importance of understanding the difference between complex and complicated EDM contexts because the influences on interactions result in different consequences and outcomes for agile EDM. The analysis found that agility has different features depending on whether the EDM context is complicated or complex. In complex EDM contexts, non-repeatable agility features emerge and enable the agents of EDM to navigate uncertainty. In contrast, complicated EDM contexts require the evolution of repeatable agility features to bring balance and stability to the complex adaptivity of the organisation's EDM. Therefore, the agility features themselves served as enabling (context-sensitive) and governing (context-free) constraints in the complex and complicated system of EDM by feeding back into subsequent iterations and improving the agents' ability to emerge and evolve thriving agility in EDM. This finding supports Juarrero's (2015b, p. 514) postulation that feedback and catalysts in a CAS provide the system with context-sensitive constraints as they "change the probability landscape of subsequent events". Constraints influence how the components in a CAS interconnect and combine. Heeding feedback loops in a CAS can shift the system state from the complex to

the complicated domain as previous unknowns become knowable through improved experience and expertise gained within the current timeframe and context (Snowden and Rancati, 2021).

Policies and standards encourage the embedment of patterns for improved discipline-specific and collective management of the organisation's data. However, the case study organisation's policies and standards documents did not explicitly specify how to achieve agile EDM and were more prescriptive on aspects of how the different data management disciplines should execute their work to collectively bring value from data to the organisation's strategy execution efforts. The case study organisation did have pockets of teams using agile approaches successfully, however there was not yet a coordinated effort to achieve agile EDM collectively. The case study's findings support the proposition by Appelbaum *et al.* (2017) that deliberate efforts to create agility are generally unsuccessful. The results are artificial and inert when they do not relate to a context specifically requiring nimbleness.

This study found that, in the complex and complicated contexts of agile EDM, there are continuous opportunities for renegotiating how the system's agility state is and should be (Cilliers, 2001; Ulrich, 2005), requiring management of governing (context-free) and enabling (context-sensitive) constraints to achieve favourable consequences and outcomes (Juarrero, 2015b; Snowden and Rancati, 2021). Conflicts arise in transitional states, and practising boundary critique provides opportunities for framing contexts with the right questions and considering options to move towards a future, more favourable agility state. The case study found that engaging critical systems heuristics as a mechanism to continuously observe and frame agility in the complex and complicated contexts of agile EDM at transitional boundaries informs decisions, influencing actions and interactions, and can transition the system towards the emergence and evolution of agility features.

As found in this qualitative study of agility in real-world EDM contexts, humans continuously engage in decision-making, with or without awareness, involving a normative analysis of reality (facts) and a descriptive analysis of beliefs and preferences (values) (Kahneman, 2011). Critical systems heuristics provides a method to consider the system's values and facts and how they ought to be (Ulrich, 2000). The boundary critique practised at the complicated and complex boundaries in EDM contexts should test agility coherence in EDM's complex and complicated system so that agents with conflicting perceptions or

unawareness of agility consequences have opportunities to engage and negotiate viable cooperation to shift the system towards favourable agility consequences and outcomes. The critical systems heuristics at the case study organisation were found to be enacted in the dynamic capabilities of the EDM agents, bearing consequences for agility in EDM. Practising boundary critique holds the potential for the organisation's overall EDM to continuously pivot towards favourable agility outcomes and consequences through iterations of learning from feedback, sensing opportunities to improve agility, and then adapting and adopting the ways of coordinating and integrating EDM activities for improved agility consequences and outcomes. This process enables coordination and integration at the meso-level in complex and complicated contexts to traverse liminality while being influenced by boundary judgements used in quick contextualised decision-making (heuristics) at the micro-level for improved future states of agility in EDM.

The case study findings indicated that rigid governing constraints that remain inflexible in complex contexts where change is required fail and move the complex and complicated system of EDM towards precarious or disintegrating agility. As proposed by Snowden and Rancati (2021, p. 37), "If we are managing well a complexity-informed method, the answers emerge from the same group who is researching and acting in the landscape. This implies that leadership is expressed through engagement and empowerment rather than prescription and direction. In this context, leaders become 'strategic observers' and intervene to provide a meta-level of coherence and clarity to facilitate action". The following example from the case study supports this approach:

> *"P6: The thing to remember is we work in a bank, and the bank has got controls in place for very good reasons. So we don't break these things willy-nilly or bypass them. We find agility within the bank's risk and control process requirements. We're not scared to challenge them, but I don't want to give the impression that we're a cowboy outfit because we're certainly not. We abide by the processes. But where there's red tape and where it's restrictive, we'll challenge those processes if need be."*

It is essential to understand that even though actors in a complex adaptive system need to constantly be adaptable to changes in the internal or external environment, they also need to continuously stabilise that which is repeatable, at least for the foreseeable future (Juarrero, 2015b). It is not only about continuously changing and innovating but also about

creating equilibrium by adopting and embedding emergent properties that have favourable consequences (Juarrero, 2015a). Reinventing the wheel by facing each problem posed to EDM as though seeing it for the first time will not make the system more agile. The distinction between repeatable agility as evolving and non-repeatable agility as emerging is, therefore, a key finding of this study.

The agents in the complex and complicated system of EDM need to continuously maintain a current view of what is repeatable and what is non-repeatable to amplify agility. For example, a data management component created by one project might be reusable, serving exact requirements elsewhere in the enterprise. The cycles of repeatability must be long enough to warrant the embedment of practices. In contrast, the cycles for non-repeatability are shorter as they depend on successful outcomes of iteratively trying new solutions in the given context. If the new solution, after one or more short iterations, proves to serve a broader application, it can be repeated, thereby contributing to evolving scalability in the organisation. The following example from the case study illustrates how faltering agility results from a lack of integration and reuse when EDM agents work in silos:

> *"P6: I think the silos get created through tech, like we've got our analytical capability that runs in SAS. So SAS has created their own silo and comes with its own little ecosystem in a silo. We've got our Netezza environment which builds models and that, and they're sort of siloed around, again, their tech. So I think technology sort of forces silos. Databases, as such, force [silos] [e.g.] I've got my stuff in the SQL databases, this guy's got his in a Sybase database. And then you've got your historical stuff that's been around for the last 30 years in a database somewhere. We got these silos and, I think, within BankX, there are about 50 odd [data] warehouses around the organisation. And I'll give you a little bit of history around this. When BankY took over BankX way back in 1998 or 2000, they said to the CEOs, look down at your business and make sure you understand your business. More or less in the following years, 2005 to 2006, data became more and more important. So what the guys were doing is they built their own warehouses and their own data marts in each of the business units. And then when data absolutely exploded, we suddenly found that that has been proliferated throughout the organisation to the extent of about 50 plus*

> *warehouses, and significantly warehouses. Those are the silos that I'm talking about. A lot of these silos have common data because most of the data comes from our transactional systems. So you got all this duplication of the same data with a business unit flavour sitting around the organisation. So how do you now integrate data like that? How do you integrate proliferated data?"*

As is apparent from this example, working in silos presented a threat to evolving repeatable agility features and stymied the evolution of agility in the case study organisation's EDM. Limaj and Bernroider (2022, p. 8) found that "organizations attempting to scale agility are shifting from work assignments within functional silos to inter-disciplinary (also referred to as cross-functional) teams. This approach challenges traditional expertise boundaries, stimulates knowledge sharing and collaboration, and shifts the focus from individual to group performance."

Benfeldt, Persson and Madsen (2020) stress the importance of deconstructing silos and promoting cross-organisational collaboration along with high levels of autonomy and trust in data management practices. When agents practice formal and informal integration of their work efforts and results, information and knowledge sharing can flourish, overcoming cognitive, political, structural and behavioural barriers (Uhl-Bien and Arena, 2018). In a CAS, adaptive entities continually balance exploitation with exploration shifting the system towards more favourable outcomes (Uhl-Bien and Arena, 2018). However, the agents' behaviour is not necessarily intentional (Giddens, 1984; Ulrich, 2000) and can have positive and negative unintentional consequences (Snowden and Rancati, 2021).

What is evident in this example provided from the case study is that the less evolved agility is in the organisation, the less stable (repeatable) agility there is to rely on, as everything is tried "from scratch" by the actors in the given context. For example, agents are unaware that what they are trying to build already exists elsewhere in the organisation and could be reused for their use case. Even if the data management component is not a perfect fit, it could be repurposable or extendable, which, in turn, could emerge agility in EDM. The solution might then be scalable to a broader stakeholder group, resulting in evolving agility in the organisation. In other words, there are continuous feedback loops between the complicated and complex domains through learning, sensing, deciding (critical heuristics) and acting (coordinating and integrating). However, the potential of these iterative flows

towards improved agility in EDM is only realisable if the actors in the EDM context are continuously aware, willing and able to traverse the liminal space between what is unknown and what can be known, between complexity and complicatedness.

Zheng, Venters and Cornford (2011, p. 328) propose that “to exert gentle pressure, to persuade and to negotiate are important elements in coordinating a collective performance”, such as achieving collective agility. Negotiations occur at the level of interactions amongst the agents in the system, where boundary judgements influence the agents' contextual perceptions (sensing) at the meso-level, and heuristics at the micro-level, thus influencing how they act (coordinating and integrating) at the meso-level in EDM contexts with resulting agility consequences and outcomes. These outcomes and consequences feed back into the organisation’s EDM, thereby influencing the overall agility state of EDM in the organisation at the macro-level.

Bolman and Deal (2017, p. 323) warn against “a romanticized view of human nature in which everyone hungers for growth and collaboration. When they are too optimistic about integrating individual and organizational needs, they may neglect both structure and the stubborn realities of conflict and scarcity”. This was reflected in the case study findings that revealed discrepancies in the rankings of sources of influence in the interactions of the EDM practitioners and the organisation’s policy and standards documents, as shown in Figure 6-30 on page 291 and Figure 6-33 on page 295.

This study found that having (or not having) a shared understanding of business and data requirements was ranked top for influencing both thriving agility and faltering agility. This finding supports Nagle and Sammon's (2017, p. 1439) proposition that a lack of shared understanding between data stakeholders is of critical concern because “[w]hile organisations regularly claim that data is one of their most important assets, they regularly fail to articulate or fully leverage its value. This leads to impacts such as missed opportunities, a reactive nature to data issues, and poorly defined/failed data projects”. In concurrence, the study by Legner, Pentek and Otto (2020) found that a lack of shared understanding along with low levels of expertise and experience presented emergent “fuzzy” problems in the data management domain that were inadequately addressed. Bolman and Deal (2017, p. 174) emphasise that it is crucial for groups of people to agree on basics before driving forward with work execution: “Down the road, people continue to stumble over

unresolved issues. Shared understanding and commitment around the basics are a powerful glue to hold things together in the face of the inevitable stress of group life".

Even though EDM agents can be intentional in their heuristics and actions to amplify agility outcomes and consequences, this study found learning to be the only dynamic capability in EDM that had a direct amplifying influence on the agility features of competence/aptitude and expertise/specialised capability. This finding supports Juarrero's (1999) argument that the agents in a CAS may well be intentional in their actions to produce the desired result; however, there is seldom transitivity between mental events, such as heuristics bounded by innate judgements, and the outcome allegedly caused. Juarerro concludes that "none of the mental events proposed as causes of action (intentions, reasons, wants and beliefs, desires, volitions, and the like) qualifies as a legitimate cause." (Juarrero, 1999, p. 38). Therefore, this research acknowledges that opacity exists between the EDM agents' actions and the resulting agility outcomes and consequences. Further investigation was thus necessary to explain how the dynamic components of complex and complicated sociotechnical contexts, such as EDM, enable agility to emerge and evolve continuously.

Applying Bhaskar's critical realism philosophy, Crick and Chew (2020) propose that agility can be caused in sociotechnical organisational contexts. However, this study of agile EDM found that the inherently complex nature of sociotechnical contexts, such as EDM, renders causal mechanisms for agility ineffective. Instead, this research found that practising critical thinking techniques, such as CSH (Ulrich and Reynolds, 2020), in complex and complicated sociotechnical contexts (Orlikowski, 2000) such as EDM, can influence agility where opportunities arise in the liminal space between complexity and complicatedness, and thinking and acting (Kurtz and Snowden, 2003), shifting the agility state of the system towards thriving agility consequences and outcomes.

6.4.2 A framework for agile enterprise data management

Based on the analysis and findings of the qualitative case study of agile EDM conducted at BankGroup using a conceptual framework based on the structural and dynamic components of agile EDM developed in DSR Cycle 1 and DSR Cycle 2 Part I, this section concluded by proposing a framework for agile EDM, as presented in Figure 6-46, in preparation for the DSR artefact evaluation phase of this study. (The components of the framework were formalised in DSR Cycle 2 Part I and are described in Table 5-6 on page 223).

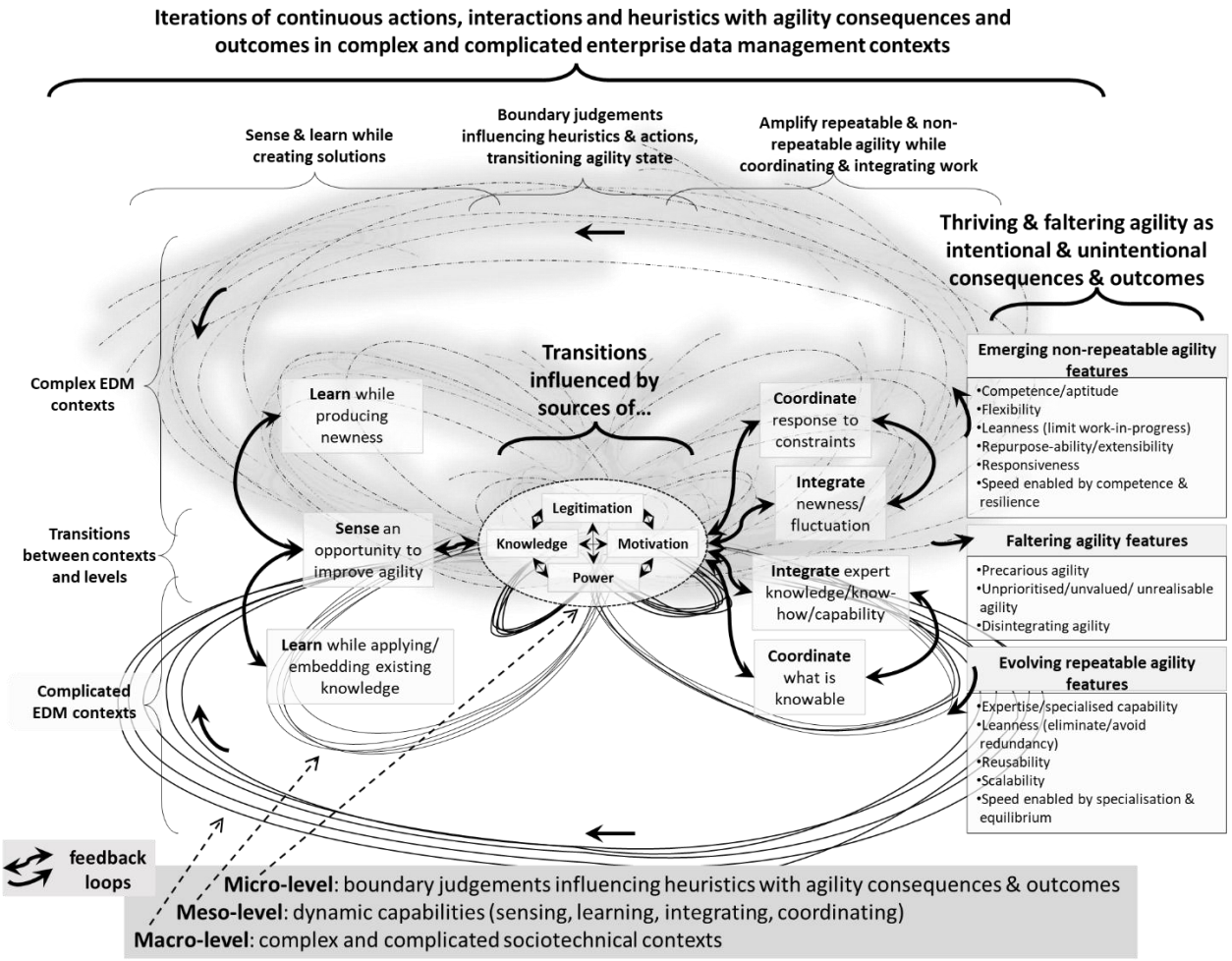


Figure 6-46: A proposed framework for agile enterprise data management (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

For the framework to be viable in a real-world context, it is critical to agree on a contextualised understanding of the agility features' definitions, including the repeatability and non-repeatability of each feature within the specific real-world setting. Additionally, a shared understanding of the boundary categories' definitions and questions must be established to enable the best possible outcomes of reflective practice in the transitional space between complex and complicated EDM contexts. This approach sets a general direction towards favourable agility consequences when practising boundary critique to reveal boundary judgements by using the boundary questions of CSH contextualised for the organisation (see Table 6-7 on page 256, Table 6-8 on page 263, Table 6-9 on page 272 and Table 6-10 on page 279). A common understanding of agility features, boundary categories, and questions enables the organisation to operate the sociotechnical complex and complicated system of EDM for thriving agility consequences and outcomes.

In order to demonstrate that the DSR artefact solves the identified problem, practical knowledge of how to use the artefact is required (Peffers *et al.*, 2007). Even though this research did not include the implementation and testing in a real-world situation of the framework for agile enterprise data management, the following approach is suggested for its application in a real-world EDM setting.

1. Use the boundary judgements' suggested questions (see Table 6-7 on page 256, Table 6-8 on page 263, Table 6-9 on page 272 and Table 6-10 on page 279) to conduct periodic internal surveys to investigate and understand the current state of agility in the organisation's EDM functions.

2. Capture details of the participants' roles and data management functions on each survey questionnaire to enable the desired level of analysis of the collected data.

3. Analyse the collected data to identify the current issues influencing thriving (emerging and evolving) agility and faltering (precarious, unvalued and disintegrating) agility.

4. Use the findings from the data analysis to design and conduct workshops with EDM functions and roles to discuss and understand the top issues currently influencing the agility state of the organisation's EDM.

5. Use the feedback and knowledge gained in the workshops to actively influence the desired agility mindset and change approaches in the organisation's EDM functions, and update the EDM policies.

6. Keep a history of the survey outcomes for monitoring purposes and input to EDM strategies for emerging and evolving desired agility consequences.

7. Co-evolve the boundary judgement definitions, questions and suggested actions with ongoing changes in the organisation's EDM contexts and interactions.

This study found that boundary judgements underlie and inform heuristics in EDM contexts at the boundaries between complicated and complex, influencing patterns for emerging and evolving agility in EDM. Where data management maturity models assess the current state of the organisation's data management by scoring against a fixed set of rules or compliance

requirements, this study, in contrast, proposes that practising boundary critique provides an approach to continuously assess, renegotiate and influence the agility state of an organisation's EDM.

The boundary critique (boundary judgements and related questions) that forms the four sets (total of 45 codes) of sources of knowledge, motivation, legitimation, and power emerged from the data and is, therefore, grounded in the context of EDM at the case study organisation. It is highly probable, if not guaranteed, that these four sets of codes will be very different for another organisation's EDM contexts. Should an organisation, therefore, develop a set of boundary criteria particularly relevant to its EDM context and then allow these to evolve, this would better support the emergence and evolution of agility with an ever-maturing understanding of how agility could be improved contextually as opposed to mechanistically applying a pre-determined set of boundary criteria for agile EDM. In addition, EDM stakeholders' ongoing contextualised interpretations of the agility problem can provide opportunities to renegotiate EDM situations for improved agility consequences. This approach promotes empathy for and embedment of thriving agility as it feeds back into the ongoing complex and complicated contexts of agile EDM, allowing for micro-level interventions, reducing the energy costs of collecting information and thus avoiding catastrophic change (based on Snowden and Rancati (2021)).

The next chapter examines how the proposed framework for agile EDM was evaluated to finalise the DSR artefact for this study of agile EDM.

7 EVALUATION OF THE FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

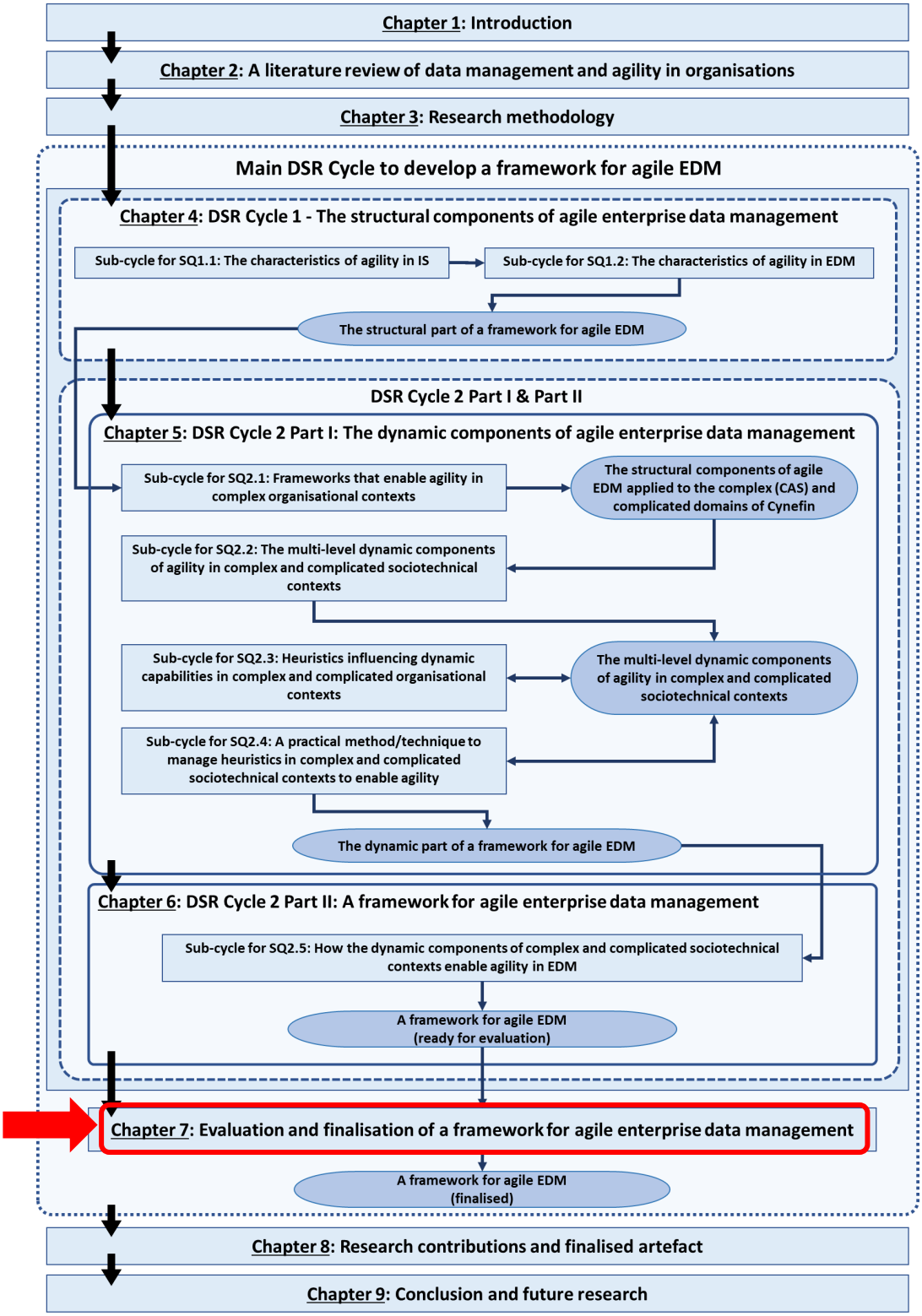


Figure 7-1: Chapter map — Chapter 7

The process of addressing the three sub-questions of this DSR study in three iterative DSR cycles developed and refined the DSR artefact. Each DSR cycle started with the awareness of a problem and a suggestion to solve it. The first cycle produced structural components of a framework for agile EDM from IS literature on agility and the coding and analysis of the qualitative data collected at the case study organisation. DSR Cycle 2 first produced a conceptual framework for a qualitative case study of agile EDM based on the structural components of agile EDM and the literature reviewed to develop the dynamic components of agile EDM. Then, the conceptual framework was applied to code and analyse the qualitative case study data to develop and propose a framework for agile EDM. In this chapter, the proposed framework for agile EDM was evaluated to finalise the artefact, answering the main research question of this study:

Main-RQ:	*How* can agile enterprise data management be achieved?

7.1 ARTEFACT EVALUATION STRATEGY

Design science as a research strategy requires building an artefact that solves an identified organisational problem and the subsequent evaluation of that artefact in its applicability to solving the organisational problem in practice (Hevner *et al.*, 2004). The proposed framework provides a model and a method whereby opportunities to achieve agile EDM can be sensed, assessed, and utilised by reflecting on and managing agents' boundary judgements, thereby identifying ways to influence the CAS of EDM iteratively towards improved agility through adaptive and adoptive ways of learning, coordinating and integrating EDM work.

The naturalistic evaluation of a DSR artefact evaluates the artefact empirically in a setting that "embraces all of the complexities of human practice in real organizations" (Venable, Pries-Heje and Baskerville, 2012, p. 429). Therefore, in a sense, the qualitative case study conducted as part of the second DSR cycle executed a precursory, naturalistic formative evaluation of the framework for agile EDM by applying all the constructs and relationships of the dynamic part of a framework for agile EDM at BankGroup. However, the qualitative case study in DSR Cycle 2 aimed to further develop and refine the artefact addressing the fifth sub-question of the second DSR cycle, which empirically investigated how the dynamic components of complex and complicated sociotechnical contexts enable agility in EDM. The evaluation presented in this chapter aims to conduct a summative evaluation of the

framework for its potential to address the main research question of how agile EDM can be achieved in contexts beyond the case study organisation.

Successful data management frameworks bring structure to data management practices, address the challenges and practical requirements of data management, and constitute a substantial body of design knowledge established and synthesised through ongoing efforts by practitioners and researchers (Legner, Pentek and Otto, 2020). The worldview of interpretivism perceives organisations as not fixed or stable and acknowledges that the relationships between individuals, groups of people, and technology are dynamic and continuously changing (Klein and Myers, 1999). According to Klein and Myers (1999), interpretive research strives to understand a moving target in the real world. The framework for agile EDM that this study developed must integrate and co-evolve with data management frameworks in practice if it is to succeed in achieving desired agility outcomes for EDM practices.

Evaluating the design artefact is a key step in a DSR study because it assures the research's rigour and provides valuable feedback to inform the artefact's further development (Venable, Pries-Heje and Baskerville, 2016). Design science research must strongly emphasise research rigour by drawing on and adding to the existing theoretical knowledge base while substantiating its relevance to the real world (Gregor and Hevner, 2013).

Artefact evaluation is essential to a DSR contribution (Hevner *et al.*, 2004). Having established an awareness of the problem that there is a need for, yet lack of, a scientifically founded means to achieve agile EDM, the overall objective of this research was to create an artefact, a framework for agile EDM, that can be applied in practice to emerge and evolve agility in complex and complicated EDM contexts.

Peffers *et al.* (2007) propose a methodology for conducting DSR in IS that includes demonstrating how the artefact solves the identified problem and subsequently evaluating the artefact. In the evaluation process, the objectives of the solution are compared to how well the artefact solves the problem by using actual observed results from the demonstration (Peffers *et al.*, 2007). However, various popular combinations of artefact type and evaluation method exist in current DSR literature (Peffers, Rothenberger, Tuunanen and Vaezi, 2012). Peffers *et al.* (2012) found that across all academic journals perused in their study, a technical experiment was the most common evaluation method in DSR. The most popular

methods for evaluating frameworks produced in DSR were logical argumentation, expert evaluation, case study and illustrative scenario (Peffers *et al.*, 2012). For this study of agility in EDM, expert evaluation was the chosen method because of the data management expert discernment required to understand the functions and implications of the structural components of agile EDM in real-world data management contexts. A DSR artefact is evaluated for its usability, applicability, completeness, functionality and accuracy (Hevner *et al.*, 2004). The Delphi method, as proposed by Okoli and Pawlowski (2004), was deemed appropriate because it provides a practical, scientific process for engaging a panel of experts to evaluate an artefact such as the framework for agile EDM produced by this DSR study.

Venable, Pries-Heje and Baskerville (2016) propose four steps for approaching the process of DSR artefact evaluation: (1) clarify the objectives of the evaluation, (2) decide on an evaluation strategy, (3) determine which properties of the artefact to evaluate, and (4) design each of the evaluation episodes. Formative and summative evaluation distinguishes the functional purpose of evaluating the DSR artefact. Through formative evaluation, the research produces empirically founded interpretations, thereby establishing a constructive foundation for taking action to improve the performance and features of the artefact (Venable, Pries-Heje and Baskerville, 2016). A summative evaluation produces empirically founded interpretations, establishing a basis that creates common meanings about the artefact despite differing contexts (Venable, Pries-Heje and Baskerville, 2016).

Design science in research strives to create “what is effective” with a focus on inventing artefacts that organisations may use in practice to address important information-related requirements (Hevner *et al.*, 2004). This research proposed a framework that emerges and evolves specific, identifiable agility features in an organisation’s EDM as consequences and outcomes of boundary judgements influencing the agents' actions and interactions in complex and complicated EDM contexts. The effectiveness of the framework for agile EDM that this DSR study developed depends on its ability to cope with those factors that influence agility. The main objective of the developed artefact’s evaluation was to gain a qualitative view of consensus and suggestions for improvement among data management experts in assessing the artefact’s probable practicability and relevance in real-world EDM contexts.

The justification and evaluation of knowledge production are crucial in design science research (Baskerville, Kaul and Storey, 2015). The evaluation could comprise any logical proof or empirical evidence (Peffers *et al.*, 2007). Venable, Pries-Heje and Baskerville

(2016) propose a Framework for Evaluation in Design Science (FEDS) that guides researchers in designing and executing an effective process for evaluating a DSR artefact for achieving its goals and objectives. The different evaluation strategies proposed by Venable, Pries-Heje and Baskerville (2016) are: “Quick & Simple” — if the artefact is simple and small to construct with limited social and technical risks and high certainty of outcomes, the “Human Risk & Effectiveness” — if the artefact is primarily social and requires long-term effectiveness for real users in real-world contexts, the “Technical Risk & Efficacy” — if the artefact is primarily technical with a high cost to implement, and the “Purely Technical Artefact” — if the artefact is purely of a technical nature. Due to the complex adaptive sociotechnical nature of the target implementation environment of the proposed framework for agile EDM, the “Human Risk & Effectiveness” strategy was deemed appropriate.

The approach that was used by this study to evaluate the proposed framework for agile EDM is presented in Table 7-1.

Table 7-1: DSR artefact evaluation process (based on Venable, Pries-Heje and Baskerville (2016, pp. 82–84))

FEDS process step	**Application of the process step to the evaluation of the proposed framework for agile EDM**
1. Explicate the goals of the evaluation	Due to the nature of emergence in complex adaptive sociotechnical contexts, the risk of not being able to confirm that the artefact “causes” agility exists. Nonetheless, the artefact was evaluated for its effectiveness and efficiency in influencing agility consequences and outcomes in EDM contexts. The qualitative case study applied the conceptual framework for agile EDM, addressing uncertainties and risks of the artefact's scientifically-founded design, thus achieving a partial naturalistic, formative evaluation of the artefact. The DSR artefact evaluation aimed to conclude a formative and summative naturalistic evaluation of the proposed framework for agile EDM. The experts’ assessments of the framework can provide a summative evaluation of the artefact. Incorporation of the experts’ feedback into the framework’s design improvements can contribute to the artefact’s formative evaluation. The University’s ethics requirements for the artefact evaluation process of this study were fulfilled. The efficiency and exhaustiveness of the artefact’s evaluation were resource-constrained as this was a research project conducted by a single researcher.

FEDS process step	Application of the process step to the evaluation of the proposed framework for agile EDM
2. Choose a strategy for the evaluation	For the artefact's evaluation, the "Human Risk & Effectiveness" strategy proposed by Venable, Pries-Heje and Baskerville (2016) was deemed appropriate because of EDM's complex adaptive sociotechnical nature, the high level of dependency of its performance on human interaction and its goal of perpetually emerging and evolving agility in real-world EDM contexts. Due to the large and complex nature of EDM organisations within enterprises, a naturalistic implementation of the artefact was not feasible. For example, the case study organisation's EDM organisation comprised approximately 2 500 people in 150 data management roles.
3. Determine the properties to evaluate	Based on the objectives proposed by Venable, Pries-Heje and Baskerville (2012), the required artefact properties targeted for its evaluation were: • **Relevance**: there is a real-world requirement for the artefact • **Usability**: the artefact is fit for use in real-world EDM contexts • **Flexibility**: the artefact can be adopted and adapted to changing requirements in EDM contexts • **Comprehensibility**: the artefact makes sense and is easy to understand • **Completeness**: the artefact comprises all elements that its users would expect for its application in a real-world EDM context • **Efficiency**: the artefact can perform well for the amount of resources required • **Effectiveness**: the artefact can achieve its intended goals in the real-world
4. Design the individual evaluation episodes	The Delphi method was used to conduct a qualitative empirical evaluation episode that collected the views and opinions of a panel of data management experts on the real-world practicability of the framework for agile EDM. A minimum of 70% consensus among the expert panel members was set as the target for concluding the artefact evaluation process (Hohmann, Cote and Brand, 2018).

7.2 ARTEFACT EVALUATION METHOD

7.2.1 Delphi method

Peffers *et al.* (2012) define expert evaluation in DSR as the process whereby one or more experts assess the artefact for aspects such as its usability, applicability, completeness, functionality and accuracy (Hevner *et al.*, 2004). The RAND Corporation conducted studies in the 1950s that created the Delphi method as a technique that could be applied to "obtain

the most reliable opinion consensus of a group of experts by subjecting them to a series of questionnaires in depth interspersed with controlled opinion feedback" (Dalkey and Helmer, 1963, p. 458). A Delphi study is a "group decision mechanism requiring qualified experts who have deep understanding of the issues" and does not rely on a statistical sample representing a particular population (Okoli and Pawlowski, 2004, p. 6).

Okoli and Pawlowski (2004) found that the Delphi method was a widely used technique in IS research on prioritisation and identification during managerial decision-making. Furthermore, studies that developed concepts of frameworks have successfully applied the Delphi method. Okoli and Pawlowski (2004) proposed rigorous guidelines and principles to guide appropriate expert selection and research design choices that can contribute to the validity of a study. Venable, Pries-Heje and Baskerville (2012) identified the following five objectives to consider when evaluating a DSR artefact: (1) the artefact is efficient and helpful in achieving its intended purpose in the real world; (2) the artefact's design theory is valid; (3) the artefact holds greater utility than existing artefacts usable for the same purpose; (4) the artefact does not pose any detrimental consequences of its use; and (5) identify areas of the artefact for refinement and improvement. Guided by the evaluation objectives suggested by Venable, Pries-Heje and Baskerville (2012) and the process described in Table 7-1 on page 329, the questionnaire was designed to collect each data management expert's views and opinions based on their experience and knowledge as a data management practitioner, on how well the proposed framework for agile EDM embodies the required properties for achieving its purpose in the real world.

A target of at least 70% consensus among the expert panel members was set (Diamond *et al.*, 2014; Hohmann, Cote and Brand, 2018). If consensus was less than 70% after the first round, a second shorter questionnaire would be sent out to get additional input from the expert panel, asking the participating experts for more detailed descriptions of their responses to those questions where consensus was below 70%. Diamond *et al.* (2014) proposed key quality indicators for Delphi studies, which was adopted for this artefact evaluation process as shown in Table 7-2.

Table 7-2: Quality indicators applied to the Delphi method for the artefact evaluation (based on Diamond *et al.* (2014, p. 406))

Quality indicators	Quality indicators applied to the Delphi method for the evaluation of the proposed framework for agile EDM
Study objective: Does the Delphi study aim to address consensus, and is the consensus quantified or presented as a statement/list?	In their literature review, Diamond *et al.* (2014) found that the average target consensus for Delphi studies was around 74%. Due to the complex and multi-dimensional nature of the artefact being evaluated, the target consensus for this study was set at 70%.
Participants: How will participants be selected?	Participants will be selected based on their expert data management knowledge and senior positions as data management professionals.
Consensus definition: How will consensus be defined, and, if applicable, is a threshold value specified to terminate the Delphi process if achieved? If consensus is not reached, what criteria will determine the termination of the Delphi process?	Consensus will be defined as the percentage agreement. The first round's questionnaire questions will each require a "yes" or "no" answer and optional comments. Consensus will be calculated based on the number of "yes" answers for each question and overall across all the questions. If a consensus of at least 70% is not reached, only one additional round of additional questions will be sent out to clarify discrepancies in participants' answers in the first round. The responses will then be qualitatively analysed and conclude the Delphi process.
Items: What criteria will be used to drop items?	Items for which at least a consensus of 70% is achieved will be dropped.
Rounds: What criteria will be used to determine the number of rounds?	The Delphi process will conclude after the first round if the target consensus of 70% is achieved. If not, only one more round will be conducted, after which the Delphi process will terminate and conclude the findings.

7.2.2 Data collection

The questionnaire, included in Appendix D, was designed to provide the participants with the opportunity to confirm or contradict and comment on the following critical aspects of the proposed framework for agile EDM:

- There exists a real-world requirement for agile EDM, thus confirming the research problem and the necessity and potential usefulness of a framework for agile EDM. (Evaluation properties: relevance, effectiveness, efficiency)

- The actions and interactions of EDM are broadly defined by the dynamic capabilities of sensing, learning, coordinating and integrating. (Evaluation properties: comprehensibility, completeness)
- EDM contexts can be described as complex and complicated, which differ in nature. (Evaluation properties: relevance, comprehensibility)
- The emerging non-repeatable agility features identified in this study can improve overall agility under complex EDM conditions. (Evaluation properties: usability, effectiveness)
- The evolving repeatable agility features identified in this study can improve overall agility under complicated EDM conditions. (Evaluation properties: usability, effectiveness)
- The sources of motivation, knowledge, legitimation and power as based on CSH and contextualised for this study, are broad categories of influences on agility in EDM. (Evaluation properties: comprehensibility, completeness, effectiveness)
- The boundary judgements defined for sources of motivation, knowledge, legitimation and power as based on CSH and contextualised for this study exert influence on agility consequences and outcomes in EDM both in practice and in policies. (Evaluation properties: comprehensibility, effectiveness, usability)
- The ranking of influence based on the emphasis that the boundary judgements have on agility features, as found in the case study organisation, makes sense. (Evaluation properties: comprehensibility, effectiveness, usability)
- The findings from the case study for the sources of influence on agility in EDM provide valuable insights. (Evaluation properties: relevance, comprehensibility)
- The proposed framework for agile EDM, including its constructs and flows, makes sense and is comprehensible. (Evaluation properties: relevance, comprehensibility, completeness)
- If the proposed framework was to be implemented in a real-world EDM context, it is most likely to improve agility consequences and outcomes. (Evaluation properties: usability, flexibility, effectiveness, efficiency)
- The proposed framework is complete in its design, fulfilling its purpose of achieving agility in EDM. (Evaluation properties: relevance, usability, flexibility, completeness, effectiveness)

The questions posed to the participants focused on whether they agreed with the definitions of the proposed framework's constructs and whether the qualitative case study findings supported the probability of the framework’s effectiveness and efficiency in a real-world setting. The questionnaire (see Appendix D) comprised 21 questions, of which 20 questions each required a “yes”/“no” response. A field for optional comments or explanations

supporting the response was available for each question. The 21st question asked participants to indicate, as a percentage, the extent to which they felt the artefact would achieve agile EDM if implemented in the real world. A final optional field on the questionnaire offered participants the opportunity to provide additional comments and thoughts on any aspect of the proposed framework for agile EDM.

In preparation for evaluating the artefact produced by this DSR study, 15 experienced data management practitioners were identified as potential members of the Delphi expert panel, and individual emails were sent, inviting them to participate. The panel of experts was selected from the community of highly experienced data management practitioners in leadership roles who were known to the researcher from her career in IT spanning 36 years, of which 14 years were spent in the financial services industry. The email invitation provided a brief background to the study, an explanation of the role of the invitee in the artefact evaluation process and the informed consent form. On the data management expert's acceptance of the invitation to participate in the expert panel, the response email to the participant included a 20-page research background document (see Appendix D) and the questionnaire for their completion.

Of the 15 data management experts invited to participate in the study, 9 candidates accepted and formed part of the Delphi expert panel to evaluate the DSR artefact. At the time of this evaluation process, four expert panel members were employees at the case study organisation, which formed part of the second DSR cycle that constructed the artefact being evaluated. However, only three had participated in the case study's qualitative interviews and were somewhat familiar with the concepts of agility features and dynamic capabilities applied in this study of agility in EDM. All nine expert panel members were performing leadership roles in data or information management and collectively had 158 years of experience in data management practice. The expert participants' roles included the following past and present positions held involving the areas of expertise relevant to this study:

- Data Architect Lead; Data Analyst
- Head of Information Architecture
- Information Governance Head
- Lead Enterprise Data Architect

- Enterprise Information Architect
- Senior Manager for Data Management
- Head of Data Engineering
- Chief Information Officer leading Digital transformation and Agile approaches
- DAMA Advisory and Training; Operated in all the DM-BOK Knowledge Areas
- Lead Solutions and Enterprise Architect for Data storage and operations
- Data Management Programme and Project Manager
- Data Architect; Data Integration and movement; Agile [software development]

This questionnaire requested the participating data management experts to provide their views and opinions based on their experience as data management practitioners and did not limit them to the scope of their current data management role. The industries within which the participating data management experts had performed current and previous data management roles were diverse, thus contributing to the generalisability of the proposed framework for agile EDM:

- Financial Services
- Education
- Utilities
- Medical Industry
- Telecommunications
- Natural Resources & Environment
- Retail
- Manufacturing
- Media/Commerce

7.3 DATA ANALYSIS AND FINDINGS

The questionnaire responses were extracted and anonymised before collating the data for simple qualitative analysis in Microsoft Excel. The collated questionnaire responses from the nine expert panel participants presented a consensus of 94%, which exceeded the set target of 70% for evaluating the proposed framework for agile EDM.

Even though there was consensus from a single round of questionnaires, the Delphi expert panel participants provided candid, valuable feedback in the comments field of each question. The respondents' comments and reasons highlighted weaknesses, lack of clarity and omissions, suggesting possible improvements and refinements to the proposed framework for agile EDM. Figure 7-2 presents the collated anonymised responses and the consensus reached. Table 7-3 on page 338 presents, for each question, the consensus reached by the expert panel, the evaluated artefact properties and examples of feedback extracted from the comments and reasons provided by the participants. The background document referred to in the questionnaire is included in the last section of Appendix D.

Questionnaire questions	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Consensus
1. Do you believe that there is a need for agility in enterprise data management (EDM)? Please provide a reason for your answer.	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
2. Do you agree that the dynamic capabilities of sensing, learning, integrating, and coordinating as defined for this study describe the general actions and interactions with agility consequences in EDM? (Sect. 1.4 pg. 6)	Yes	Yes	Yes				Yes		Yes	No	Yes	Yes	Yes			89%
3. Do you agree that EDM contexts are sometimes complicated, thus requiring expertise and specialised capabilities to create repeatable solutions in EDM? (Sect. 1.4 pg. 6)	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
4. Do you agree that EDM contexts are sometimes complex, thus requiring competence, flexibility, responsiveness, and resilience to create non-repeatable solutions in EDM? (Sect. 1.4 pg. 6)	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
5. Do you agree with this study's definitions of repeatable agility features in the context of complicated EDM conditions? (Sect. 1.4 pg. 7) Please describe any repeatable agility features that you believe are missing or should be defined differently.	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
6. Do you agree with this study's definitions of non-repeatable agility features in the context of complex EDM conditions? (Sect. 1.4 pg. 7) Please describe any non-repeatable agility features that you believe are missing or should be defined differently.	Yes	Yes	Yes				No		Yes	Yes	Yes	Yes	Yes			89%
7. Do you agree that evolving repeatable agility features can improve overall agility under complicated EDM conditions (situations with high levels of certainty; problems are solvable by experts and "good practice")? (Sect. 1.4 pg. 7)	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
8. Do you agree that emerging non-repeatable agility features can improve overall agility under complex EDM conditions (situations with high levels of uncertainty, no cause and effect, and non-linear relationships between events and their consequences)? (Sect. 1.4 pg. 7)	Yes	Yes	Yes				No		Yes	Yes	Yes	Yes	Yes			89%
9. Referring to the four categories of boundary judgements, is it probable that the boundary judgements are likely to influence the emergence and evolution agility features in the EDM? (Sect. 1.4 pg. 8)	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
10. Referring to the detailed definitions of boundary judgements (Sect. 2 pg. 9-13), is it probable that the boundary judgements are likely to influence the emergence and evolution of agility in EDM?	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
11. Referring to the detailed definitions of boundary judgements (Sect. 2 pg. 9– 13), is taking the suggested action for each boundary judgement likely to result in an improved agility state of an organisation's EDM?	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
12. Referring to the findings (Sect. 3.1 pg. 14), do you agree that, if the top rated sources of influence on emerging agility are practiced, the non-repeatable agility features are very likely to emerge in EDM?	Yes	Yes	Yes				null		Yes	Yes	Yes	Yes	Yes			89%
13. Referring to the findings (Sect. 3.2 pg. 15), do you agree that, if the top rated sources of influence on emerging agility are incorporated into policies, the non-repeatable agility features are very likely to emerge in EDM?	Yes	Yes	Yes				null		Yes	Yes	Yes	Yes	Yes			89%
14. Referring to the findings (Sect. 3.3 pg. 16), do you agree that, if the top rated sources of influence on evolving agility are practiced, the repeatable agility features are very likely to evolve in EDM?	Yes	Yes	Yes				null		Yes	Yes	Yes	Yes	Yes			89%
15. Referring to the findings (Sect. 3.4 pg. 17), do you agree that, if the top rated sources of influence on evolving agility are incorporated into policies, the repeatable agility features are very likely to evolve in EDM?	Yes	Yes	Yes				null		Yes	Yes	Yes	Yes	Yes			89%
16. Referring to the findings (Sect. 3.5 pg. 18), do you agree that, if the top rated sources of influence on agility are not practiced, the repeatable and non-repeatable agility features are very likely to falter in EDM?	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
17. Do the findings for the sources of influence on agility in EDM, as presented in section 3, provide valuable insights? Please provide the reason for your answer. (Sect. 3 pg13-18)	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
18. Does the framework for agile enterprise data management, in terms of its components and flows, make sense and is it comprehensible? (Figure3pg5) Please describe any aspects that require refinement and provide your reasons.	Yes	Yes	Yes				Yes		Yes	Yes	Yes	Yes	Yes			100%
19. If implemented in a real-world context, as proposed in Sect. 1.5 on page 8, is the framework for agile enterprise data management likely to be effective in achieving agility in EDM? Please describe any issues that you foresee regarding its effectiveness in a real-world context. (Sect. 1&2 pg 2 -12)	Yes	Yes	Yes				Yes		null	Yes	Yes	Yes	Yes			89%
20. If implemented in a real-world context, as proposed in Sect. 1.5 on page 8, is the framework for agile enterprise data management likely to be efficient in achieving agility in EDM? Please describe any issues that you foresee regarding its efficiency in a real-world context. (Sect. 1&2 pg 2 -12)	Yes	Yes	Yes				Yes		null	Yes	Yes	Yes	Yes			89%
21. To what degree would you say the framework for agile enterprise data management is complete in its design for its purpose of achieving agility in EDM? Please describe any aspects that you believe are missing from the framework. (Sect. 1&2 pg 2 -12) 0%-100%	90	100	90				80			80	100	50	85			84%
																94%

Figure 7-2: Expert confirmations and contradictions of the artefact evaluation aspects

Table 7-3: Questionnaire responses, consensus and artefact properties

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
1. Do you believe that there is a need for agility in enterprise data management (EDM)?	100%	Relevance Effectiveness Efficiency	*"To stay relevant in a competitive environment and satisfy both customer and regulator requirements enterprise data management needs to respond quickly to both changing business structures and needs as well as the external environment requirements."* *"Despite the many pockets of expert information about data management available, after all this time we still battle to put the proces together ellegantly and cost effectively."*
2. Do you agree that the dynamic capabilities of sensing, learning, integrating, and coordinating as defined for this study describe the general actions and interactions with agility consequences in EDM?	89%	Comprehensibility Completeness	*"One continually needs to scan the environment, build knowledge and skill and then integrate them while ensuring co-ordination across the enterprise."* *"Only for those tasks that require Learning & Sensing. This is not always the case. Certain DM deliverables have best-practices."*
3. Do you agree that EDM contexts are sometimes complicated, thus requiring expertise and specialised capabilities to create repeatable solutions in EDM?	100%	Relevance Comprehensibility	*"EDM is complicated and without a certain level of expertise found in data specialists to understand the root cause it is difficult to identify and build repeatable rules to govern activities."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
4. Do you agree that EDM contexts are sometimes complex, thus requiring competence, flexibility, responsiveness, and resilience to create non-repeatable solutions in EDM?	100%	Relevance Comprehensibility	*"Given the ever changing environment there are always situations that develop that result in uncertainty. To find solution in this situation the teams need to be highly competent, flexible and resilient to respond to said situation."*
5. Do you agree with this study's definitions of repeatable agility features in the context of complicated EDM conditions? Please describe any repeatable agility features that you believe are missing or should be defined differently.	100%	Comprehensibility Completeness	*"Yes. looks comprehensive and I can't think of any missing"* *"They are all valid. I cannot think of anything else."*
6. Do you agree with this study's definitions of non-repeatable agility features in the context of complex EDM conditions? Please describe any non-repeatable agility features that you believe are missing or should be defined differently.	89%	Comprehensibility Completeness	*"Provide more specific/detailed features for each of the six main features [...] For example, that the agility feature of Competence/aptitude should have sub-features or critical success factors below it that link to specific EDM roles or tasks."* *"Yes - maybe consider modularity as a feature or definition to allow for partition and replacement without disruption to the whole."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
7. Do you agree that evolving repeatable agility features can improve overall agility under complicated EDM conditions (situations with high levels of certainty; problems are solvable by experts and "good practice")?	100%	Usability Effectiveness	*"Good practice has already developed the recipes for complicated situations and thus agents with the relevant expertise are able to apply the good practice in the right context quickly."*
8. Do you agree that emerging non-repeatable agility features can improve overall agility under complex EDM conditions (situations with high levels of uncertainty, no cause and effect, and non-linear relationships between events and their consequences)?	89%	Usability Effectiveness	*"Experts who are flexible and able to take existing capabilities and adapt / re-purpose them quickly to solve the complex situation can improve EDM agility in the organisation."* *"Provide more specifics [sub-features] on non-repeatable agility features."*
9. Referring to the four categories of boundary judgements, is it probable that the boundary judgements are likely to influence the emergence and evolution of agility features in the EDM?	100%	Comprehensibility Completeness Effectiveness	*"I believe the 4 categories influence the agility features. As the expertise of agents develop so will their resourcefulness. The agents stakeholder perspective will also expand as their expertise develops. Motivation may be a lesser factor as usually the intent is to solve the emerging situation but it may develop to include evolving existing solutions to deal with the ones that emerge. The sources of power are highly influential as they will either limit what the agent can do quickly versus making sure the powers change to enable the flexibility and speed needed to evolve EDM."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
10. Referring to the detailed definitions of boundary judgements, is it probable that the boundary judgements are likely to influence the emergence and evolution of agility in EDM?	100%	Comprehensibility Completeness Effectiveness	*"Yes - it looks very comprehensive"* *"Yes, it is. Making these judgements more tangible and also more comparable across poliocy and practice lead to new insights."*
11. Referring to the detailed definitions of boundary judgements, is taking the suggested action for each boundary judgement likely to result in an improved agility state for an organisation's EDM?	100%	Comprehensibility Effectiveness Usability	*"The proposed actions are valid, but are mostly the question re-writen as an action rather than more detail better describing the action. I also feel that the action dont necessarily lead to a agility state but pre-requisite for an agility state, particular for non-repeatable emerging agility."*
12. Referring to the findings, do you agree that, if the top rated sources of influence on emerging agility are practiced, the non-repeatable agility features are very likely to emerge in EDM?	89%	Comprehensibility Effectiveness Usability	*"The top rated sources of influences on emerging agility speak directly to the non-repeatable agility features. Putting the suggested actions into practice will definitely ensure the emergence of non-repeatable agility features."* *"…I feel the top rated should be B-M share and intergrate capabilties."* *"I would also put emphasis on process automation and technical rework"*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
13. Referring to the findings, do you agree that if the top rated sources of influence on emerging agility are incorporated into policies, the non-repeatable agility features are very likely to emerge in EDM?	89%	Comprehensibility Effectiveness Usability	*"Putting the top rated sources of influence suggested actions into policies will definitely ensure the emergence of non-repeatable agility features."* *"Roughly 50% overlap between top rated sources between policy and practice casts a shaddow of doubt over the validity of the sources. My gut tells me that practice perhaps gets it more right than policy, but who knows? The discrepancy is indicative of ill alignment, either way."*
14. Referring to the findings, do you agree that if the top rated sources of influence on evolving agility are practiced, the repeatable agility features are very likely to evolve in EDM?	89%	Comprehensibility Effectiveness Usability	*"For repeatable agility features for practicies, I feel the top rated should be B-K defined, prioritised DM/data capability requirement and B-L adoption & proliferation of DM capabilities."*
15. Referring to the findings, do you agree that if the top rated sources of influence on evolving agility are incorporated into policies, the repeatable agility features are very likely to evolve in EDM?	89%	Comprehensibility Effectiveness Usability	*"For repeatable agility features for policies, I feel the top rated should be B-M clear shared data centric purpose, B-P data governance processes, B-P data management policies."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
16. Referring to the findings, do you agree that, if the top rated sources of influence on agility are not practiced, the repeatable and non-repeatable agility features are very likely to falter in EDM?	100%	Comprehensibility Effectiveness Usability	*"Without the top rated sources of influence being practiced agility is hindered as each agent is working on what is priority to them and not really benefitting the enterprise."* *"I think this is an absolute "Yes"! If we cannot even do what we know is right, agility will fail."*
17. Do the findings for the sources of influence on agility in EDM, as presented in the background document, provide valuable insights?	100%	Relevance Comprehensibility	*"These findings clearly highlight how agility in EDM is influenced. The findings provide valuable insight into key focus areas to work on if an organization were to adopt an agile EDM strategy or if an organization were finding the adoption of an agile EDM strategy to be troublesome."* *"Confirms the impact of Training & Culture I am a bit concerned about data governance Processes in non-repeatable agility features in Policies"* *"The discrepancy between the main focus of policy vs practice tells its own story."* *"Soft factors (codified B-M) Motivation Boundary Judgments are primary"*
18. Does the framework for agile enterprise data management, in terms of its components and flows, make sense and is it comprehensible?	100%	Relevance Comprehensibility Completeness	*"Framework is clear and easy to understand."* *"I feel a final table of top rated boundary questions and how they would be used in a practical sense would help conclude the framework."* *"It took some time and discussion to clearly understand. I feel that it would be very helpful to map certain DMBOK Activities & Deliverables to the different areas so that it provides examples & clarity."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
19. If implemented in a real-world context, is the framework for agile enterprise data management likely to be effective in achieving agility in EDM?	89%	Usability Flexibility Effectiveness	*"Surveys are time-consuming and not always well received or responded to, so data collected may not be comprehensive, thus may not be as effective as we anticipate. The frequency of collection would be critical in the ever changing environment - it would not be effective if the collection period was to far apart."* *"The framework would be useful and effective for a governance function to monitor the maturity towards agility but is unlikely to be continually applied by management."* *"Frameworks are great but we have to convert into application and practical steps and logical gates for people to follow or embed into work as habits / culture / intuition. i would suggest add a section about how this framework would be trained and key elements to emphasize in the training for certain audiences"*
20. If implemented in a real-world context, is the framework for agile enterprise data management likely to be efficient in achieving agility in EDM?	89%	Usability Flexibility Efficiency	*"A bit concerned around how agile organisations generally are to evolve & update policies. The research does not extend into making the processes etc. around this agile with the appropriate change management"* *"Large corporates often have rigid processes when it comes to policy updating - this could hamper efficiency of agility implementation."* *"Clear mapping to DMBOK Activities & Deliverables and positioning of these in the complex, liminal and complicated. There is also a dependency on the type of questions that business require data to provide answers / insights"* *"I think the framework could be efficient for agility. It will ensure the focus shifts to where it is needed most. Exactly the opposite normally happens, whereby people focus on what they know and shy away from what they do not know."*

Questionnaire questions	Consen-sus	Artefact properties	Extracts from participant comments and reasons
21. To what degree would you say the framework for agile enterprise data management is complete in its design for its purpose of achieving agility in EDM?	84%	Relevance Usability Flexibility Completeness Effectiveness	*"I think completeness in terms of application could be improved with a training aspect that is informed / guided by this framework"* *"The problem is the absolute reliance on people to achieve agility."* *"Missing:1. Mapping to DMBOK Activities 2. Understanding the context of Business Questions (Complex, Complicated, Simple: Digital Decisioning)"*
Please provide any additional comments or thoughts that you have regarding any aspect of the framework for agile enterprise data management.	-	All	*"Well though through assessment questions in the boundary judgement. simple enough to be filled in with business. i still would like to see the link between the boundary judgement quesitons and the data capability(s)"* *"I can only comment from my own theory of agile teams and how important the application aspects are in terms of changes / training / impact / disruption required in order to achieve the expected benefits."* *"The framework adds tremendous value in analysing the EDM context and the use of Snowden's Cynefin model is very appropriate and useful:- it allows people to quickly see where increased focus would deliver more benefit- it highlights the reliance on human interaction- it clearly shows the discrepancy between policy and practice"*

All nine of the expert panel members agreed that the need for agile EDM was a relevant problem in practice that should be addressed. The data management experts' critique of the proposed framework's comprehensibility, completeness, usability, effectiveness, efficiency and flexibility presented opportunities to improve and refine the proposed framework for agile EDM. The experts' feedback offered the following suggestions:

1. Provide practical steps and guidelines for data management practitioners to embed ways of working that improve agility consequences and outcomes in EDM. Train data management practitioners on using the framework for agile EDM and techniques to assess whether the context at hand is complex or complicated.
2. Provide practical guidance on reflecting and acting on top-rated boundary judgements and questions. The rankings of sources of influence found at the case study organisation are not necessarily generalisable. For example, process automation and avoiding technical debt ranked very low, where they could potentially play a more significant role in achieving agility in EDM elsewhere.
3. Add more granularity to the agility features, for example, splitting scalability orthogonally and creating critical success factors linked to specific data management activities as sub-features of the non-repeatable competence/aptitude agility feature. Add modularity as an agility feature.
4. Include a means to address the apparent discrepancies between practice and policy rankings for sources of influence.
5. Enhance the framework diagram to clarify its mechanisms for emerging and evolving agility in EDM.
6. Provide more clarity on how to keep the framework updated and relevant. Surveys are ineffective as they are time-consuming, while the EDM organisation needs to change constantly.
7. Centralise the overall management and governance of the framework for agile EDM with data management leadership, but allow for autonomy and implementation decisions of the framework's boundary critique in a particular EDM context at the project team level.
8. Define clear links between dynamic capabilities and the data management roles, activities and best practices.
9. Include skills development and training on agile capabilities and culture contextualised for data management.

In the next section, the evaluation process iterated back to amending the artefact design to refine its design and improve its effectiveness (Peffers *et al.*, 2007), thereby producing the final DSR artefact.

7.4 DISCUSSION OF FINDINGS AND ARTEFACT FINALISATION

Evaluating an artefact produced by a DSR study is a crucial activity that, if correctly executed, ensures research rigour and provides feedback for the improvement and refinement of the proposed artefact (Venable, Pries-Heje and Baskerville, 2016). In this section, changes were applied to the evaluated framework for agile EDM based on the feedback from the data management experts who participated in the artefact evaluation process.

The Delphi method was deemed an appropriate technique for the qualitative evaluation by an expert panel of the artefact produced by this study. Qualitative data was collected through questionnaires from a panel of nine data management experts and analysed using qualitative data analysis techniques. On reaching 94% consensus among the expert panel members in the first round of questionnaires, the artefact evaluation phase of this DSR study was concluded. Despite the overall high level of consensus among the Delphi panel members, the critique offered in their comments on each question provided valuable feedback for the improvement of the proposed framework.

The Delphi expert panel raised concerns that, despite the comprehensive definition of sources of influence, their rankings were unlikely to be generalisable to other EDM situations because they represent a contextualised agility state of the case study organisation's EDM. The panel's concerns concurred with the conclusion in the qualitative case study in the second DSR cycle that the rankings, definitions and related boundary questions of the 45 sources of motivation, power, knowledge and legitimation included in the proposed framework for agile EDM are context-specific. Thus, they would not necessarily apply as-is to other organisations' EDM contexts. In addition, the expert panel raised concerns that the framework did not provide clear, practical guidance for keeping the framework up-to-date in continuously changing EDM environments. The proposed framework also lacked practical guidelines for data management practitioners to embed the framework for agile EDM in their work practices and data management activities.

To address the context-dependence of the sources of influence, the study returned to the qualitative case study data to investigate a more suitable level for reflection on boundary judgements that influence agility in EDM. The 45 related boundary questions proposed in DSR Cycle 2 Part II for sources of motivation (Table 6-7 on page 256), sources of power

(Table 6-8 on page 263), sources of knowledge (Table 6-9 on page 272) and sources of legitimation (Table 6-10 on page 279), do not adequately consider the perspectives of stakeholder roles, stakes and stakeholding issues, respectively. Additionally, the related boundary questions must be contextualised to be meaningful in a real-world EDM context. Therefore, this study considered "*contextualised* boundary questions" to be a more precise term.

Based on the findings of the artefact evaluation, the proposed framework required refinement in its specifications for practising boundary critique to improve agility in EDM. The 12 main boundary questions in CSH aim to make sense of the wide-ranging issues that underpin agents' awareness and "big picture" thinking about the system of interest as a whole (Ulrich and Reynolds, 2020). Therefore, asking the more generalisable 12 main boundary questions while considering identified underlying boundary judgements provides an approach to unfold detailed contextualised boundary questions for reflecting on how agility in an ongoing EDM context is and how it ought to be.

The in-depth qualitative data coding and analysis performed in the qualitative case study in the second DSR cycle used inductive reasoning to uncover the boundary judgements, as sources of influence on agility in EDM, from the data. The case study interview participants were not asked directly about the main boundary questions related to stakeholders, stakes and stakeholding issues. Instead, the data was searched and coded for boundary judgements at the micro-level of the framework (see Figure 6-4 on page 238) and the codes were grouped according to the 12 main boundary questions. This approach and its findings implied that boundary judgements cannot be wholly understood or interpreted outside of their context and are highly likely to be differently defined and ranked for the EDM contexts at other organisations. The data analysis process created the connections between the boundary judgements found in the data and the 12 main boundary questions in a bottom-up fashion.

This study acknowledges that the boundary judgements and their rankings are not necessarily generalisable to other EDM contexts. Nonetheless, they can provide a starting point or at least serve as a practical example for an organisation to reflect on the influences of its data management stakeholders' boundary judgements on the agility state of its EDM. The following figures (Figure 7-3, Figure 7-4, Figure 7-5, and Figure 7-6) present an analysis of the main boundary questions and boundary judgements from the case study data and

highlight the top 5 emphasised boundary judgements for the main boundary questions of each source of influence as empirically derived from the case study data through inductive reasoning. The code occurrences of sources of motivation, power, knowledge and legitimation are summarised for each of the main boundary question groups (see Table 6-7 on page 256, Table 6-8 on page 263, Table 6-9 on page 272 and Table 6-10 on page 279 for the grouping of boundary judgements for each of the 12 boundary questions).

		Top 5	Main boundary questions - Motivation		
Boundary judgements	**Sources of motivation influencing agility**		**01. Beneficiary: Whose interests do we want to serve? (STAKEHOLDERS)**	**02. Purpose: What do we want to achieve? (STAKES)**	**03. Evaluate improvement: What constitutes an improvement? (STAKEHOLDING ISSUES)**
	M- avoid technical debt/rework/redundancy		10	18	18
	M- business value/impact of DM initiative		124	124	124
	M- buy-in/commitment from stakeholders of data priority		80	80	40
	M- clear, shared data-centric purpose		231	231	144
	M- data role/function clarity		97	86	52
	M- feedback loops (assess/monitor/test)		87	102	120
	M- intention to be proactive		20	41	18
	M- intention to be responsive		54	105	48
	M- intention to improve/support agility in DM		105	179	96
	M- share & integrate capabilities (avoid silos)		190	190	190

Figure 7-3: Code occurrences for sources of motivation summarised for main boundary questions 1-3 (based on Ulrich and Reynolds (2020, p. 256))

		Top 5	Main boundary questions - Power		
Boundary judgements	**Sources of power influencing agility**		**04. Decision maker: Who/what should control the decisions? (STAKEHOLDERS)**	**05. Resources: Who/what controls resources and their availability? (STAKES)**	**06. Decision environment: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)**
	P- autonomy at execution level		45	34	37
	P- business area strategy/priority		124	124	124
	P- collaborative culture, synergy		100	170	170
	P- data governance processes		129	108	111
	P- data leadership mandate/direction/support		138	138	123
	P- data management policies		96	71	96
	P- data management principles		71	54	71
	P- data management strategy		77	63	77
	P- data ownership, stewardship, custodianship		90	101	91
	P- effective stakeholder engagement		114	160	160
	P- formalised delivery processes		54	72	55
	P- legal/regulatory/audit compliance requirements		57	46	57
	P- resource capacity for DM (socio/tech)		36	67	67
	P- team/role/organisation maturity		39	52	74
	P- trust/trustworthiness		55	63	80
	P- uncertainty in external environment		21	20	40
	P- uncertainty in internal environment		25	35	59
	P- unilateral/BU decision-making		27	27	27

Figure 7-4: Code occurrences for sources of power summarised for main boundary questions 4-6 (based on Ulrich and Reynolds (2020, p. 256))

Boundary judgements	Sources of knowledge influencing agility	Top 5	Main boundary questions - Knowledge		
			07. Expert: Who should contribute their expertise and experience? (STAKEHOLDERS)	08. Expertise: What information, knowledge and skills must be contributed? (STAKES)	09. Guarantee: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)
	K- defined, prioritised DM/data capability requirement		195	195	195
	K- experience and ability/competence		127	127	127
	K- iteratively/continuously keep up & improve capability		90	124	102
	K- learning from safe-to-fail trying/innovating/exploring		38	66	66
	K- modularised/standardised/foundational capability		87	110	110
	K- process automation capability		27	40	30
	K- resource capability (socio/tech/data)		154	154	154
	K- shared understanding (business & data)		228	228	228
	K- specialist knowledge/skills/expertise/understanding		160	160	160

Figure 7-5: Code occurrences for sources of knowledge summarised for main boundary questions 7-9 (based on Ulrich and Reynolds (2020, p. 256))

Boundary judgements	Sources of legitimation influencing agility	Top 5	Main boundary questions - Legitimation		
			10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS)	11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES)	12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)
	L- adoption & proliferation of DM capabilities		97	179	179
	L- openness to other/broader perspectives/alternatives		86	86	86
	L- openness to/embracing/incorporating change		29	78	78
	L- peripheral dependency/interdependency/knock-on		71	71	71
	L- potential extent of impact		125	66	125
	L- reflection on approach to data initiatives		129	129	129
	L- suitability/sufficiency in context		90	96	160
	L- tenability/durability/sustainability		121	72	121

Figure 7-6: Code occurrences for sources of legitimation summarised for main boundary questions 10-12 (based on Ulrich and Reynolds (2020, p. 256))

Ulrich and Reynolds (2020) propose a practical method for evaluating a system of interest through “ideal mapping”, providing a normative view of how the system “ought to be”, and “actual mapping”, providing a descriptive view of how the system “is”. Ideal and actual mapping offers a tool for practising ongoing reflection on the agility state of EDM as influenced by the underlying boundary judgements of the EDM agents, not external observers. It provides a means to be continuously aware of what is or should be influencing agility consequences and outcomes in a given EDM context. It is valuable and necessary to allow any stakeholder at any time within the system’s context, regardless of their status or role, to reflect on the system’s ideal and actual state and provide their perspective on improving the agility state (Ulrich, 2000). Ulrich (2000, p. 9) defines three types of boundary questioning: (1) Self-reflective boundary questioning: “What are my boundary judgements?”; (2) Dialogical boundary questioning: “Can we agree on our boundary judgements?”; and (3) Controversial boundary questioning: “Don’t you claim too much?”. It is, therefore, essential for the EDM agents to understand the underlying boundary judgments employed by the agents when practising boundary critique to reveal the sources of influence on the agility state of EDM.

By starting with a “master list” of boundary judgements underlying the sources of influence on agility, such as the list of 45 derived from the qualitative case study, an ideal and actual mapping template based on Ulrich and Reynolds (2020) provides the data management project team with an opportunity to consider, by asking relevant questions in the data management team, how the most prevalent boundary judgements in the organisation’s EDM might influence the emergence and evolution of agility in the context of their particular data management initiative or project. Conversely, by using the template to document their ongoing visions (ideal) and experiences (actual) of agility consequences and outcomes, each data management project team can provide feedback “from the wild” to the EDM policymakers to update the “master list” of boundary judgements and contextualised boundary questions for the organisation’s EDM as a whole. Table 7-4 provides an example specification of contextualised boundary questions for ideal mapping (“ought to” mode) for a data management initiative or project using the “master list” of boundary judgements derived from the case study data. To consider the actual mapping for the example below, simply substitute the word “should” for “do” or “is”.

Table 7-4: Example specification of contextualised boundary questions for ideal-mapping ("ought to" mode) (based on Ulrich and Reynolds (2020, p. 290))

Boundary issues	**Root issues** **Top-rated boundary judgements influencing agility** **(taken from the case study "master list")**	**Main boundary questions**	**Contextualised boundary questions** **Develop contextualised questions for a DM project/initiative by focusing on the boundary judgements influencing agility in the EDM context** **(example questions)**
Sources of motivation	**What are the motivating factors?** **(what agents are motivated to effect, with or without intent)** *M- business value/impact of DM initiative* *M- clear, shared data-centric purpose* *M- data role/function clarity* *M- intention to improve/support agility in DM* *M- share & integrate capabilities (avoid silos)*	01. **Beneficiary**: Whose interests do we want to serve? (STAKEHOLDERS)	*Which business areas **should** benefit from the DM initiative?* *Who **should** our stakeholders be, and what are their roles?* *Who in the organisation **should** have DM capabilities that we can leverage?* *Who in the organisation **should** leverage our DM initiative?...*
		02. **Purpose**: What do we want to achieve? (STAKES)	*What **should** the objectives of our DM initiative be?* *What **should** the specific roles and associated tasks for the DM initiative be?* *How **should** we change our ways of working to amplify agility?* *How **should** we share and integrate the outcomes of our DM initiative?...*
		03. **Evaluate improvement**: What constitutes an improvement? (STAKEHOLDING ISSUES)	*How **should** we ensure that we deliver value?* *How **should** our DM initiative contribute to the overall EDM goals of the organisation?* *How **should** our role/function clarity contribute to improved agility in delivering our DM initiative?* *How **should** we encourage intentions to improve agility in our team?* *How **should** our feedback loops with stakeholders work?...*

Boundary issues	**Root issues** **Top-rated boundary judgements influencing agility** **(taken from the case study "master list")**	**Main boundary questions**	**Contextualised boundary questions** **Develop contextualised questions for a DM project/initiative by focusing on the boundary judgements influencing agility in the EDM context** **(example questions)**
Sources of power	**Who or what is in control?** **(what empowers, overrides, and guides the agents)** *P- business area strategy/priority* *P- collaborative culture, synergy* *P- data governance processes* *P- data leadership mandate/direction/support* *P- effective stakeholder engagement*	04. **Decision make**r: Who/what should control the decisions? (STAKEHOLDERS)	*Who **should** determine the priority of our DM initiative?* *Who and what **should** override the priority of our DM initiative?* *Who **should** decide how we assess the agility of our DM initiative?* *Who **should** decide how we collaborate within our team and with other teams?* *Who **should** decide how we engage with our stakeholders?* *Who **should** provide EDM leadership?...*
		05. **Resources**: Who/what controls resources and their availability? (STAKES)	*Who **should** prioritise our resource allocation?* *Who **should** be available for collaboration?* *Who and what **should** monitor our data governance processes?* *Who **should** lead our DM initiative?* *Who **should** be actively engaging in our DM initiative?...*
		06. **Decision environment**: What conditions are outside the decision maker's control? (STAKEHOLDING ISSUES)	*Who and what **should** influence our priorities?* *Who and what **should** create opportunities for us to collaborate?* *Who and what **should** define our data governance processes?* *Who **should** engage stakeholders who are affected but not involved?...*

Boundary issues	Root issues Top-rated boundary judgements influencing agility (taken from the case study "master list")	Main boundary questions	Contextualised boundary questions Develop contextualised questions for a DM project/initiative by focusing on the boundary judgements influencing agility in the EDM context (example questions)
Sources of knowledge	**What information and skills are relevant?** **(agents' resourcefulness to do what can/should be done)** *K- defined, prioritised DM/data capability requirement* *K- experience and ability/competence* *K- resource capability (socio/tech/data)* *K- shared understanding (business & data)* *K- specialist knowledge/skills/ expertise/ understanding*	07. **Expert**: Who should contribute their expertise and experience? (STAKEHOLDERS)	*Who **should** understand the DM/data requirement?* *Who has the required experience and competence and thus **should** be part of our team?* *Who and what has the required capability and thus **should** be part of our DM initiative?* *Who and what **should** create a shared understanding of our DM initiative?* *Who **should** be the required specialists for our DM initiative?...*
		08. **Expertise**: What information, knowledge and skills must be contributed? (STAKES)	*What experience **should** our DM initiative require?* *What capabilities **should** our DM initiative require?* *What understanding **should** our DM initiative require?* *What specialised knowledge, expertise, and skills **should** our DM initiative require?...*
		09. **Guarantee**: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	*What experience **should** guarantee the success of our DM initiative?* *What capabilities **should** guarantee the success of our DM initiative?* *What understanding **should** guarantee the success of our DM initiative?* *What specialised knowledge, expertise and skills **should** guarantee the success of our DM initiative?...*

Boundary issues	Root issues Top-rated boundary judgements influencing agility (taken from the case study "master list")	Main boundary questions	Contextualised boundary questions Develop contextualised questions for a DM project/initiative by focusing on the boundary judgements influencing agility in the EDM context (example questions)
Sources of legitimation	**Which stakeholders should be considered?** **(the amplitude of the agents' stakeholder perspective)** *L- adoption & proliferation of DM capabilities* *L- openness to other/broader perspectives/alternatives* *L- openness to/embracing/incorporating change* *L- potential extent of impact* *L- reflection on approach to data initiatives* *L- suitability/sufficiency in context* *L- tenability/durability/sustainability*	10. Witness: Who voices concerns of those not involved? (STAKEHOLDERS)	*Who **should** ensure the adoption and proliferation of our DM initiative by those affected but not involved?* *How **should** we be open to other/broader perspectives/alternatives with our DM initiative?* *How **should** we be open to embracing/incorporating change in our DM initiative?* *How **should** we consider the potential impact of our DM initiative?* *How **should** we reflect on our approach to our DM initiative?* *How **should** we confirm the suitability/sufficiency of our DM initiative?* *How **should** we confirm the tenability /durability/ sustainability of our DM initiative?...*
		11. Emancipation: Who/what emancipates stakeholders from our promises and premises? (STAKES)	*Who or what **should** ensure that our stakeholders are emancipated by the data/DM capabilities we deliver?* *How **should** we determine a reasonable level of stakeholder inclusion?* *How **should** we determine a reasonable level to embrace/incorporate changes?...*
		12. Worldview: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	*What alternatives **should** we consider for the suitability/ sufficiency of our DM initiative?* *What **should** we consider as the boundaries of openness to other/broader perspectives/alternatives for our DM initiative?* *What alternatives **should** we consider for the tenability/durability/sustainability of our DM initiative?* *…*

7.5 CONCLUSION

The actions taken to improve the framework for agile EDM, based on its evaluation by data management experts, are summarised in Table 7-5. The next chapter presents the finalised framework for agile EDM, including all the changes based on the Delphi expert panel members' feedback.

Table 7-5: Improvements applied to the artefact based on the expert panel's feedback

Data management expert feedback	Changes applied to improve and finalise the framework for agile EDM
1. Enhance the framework diagram to clarify its mechanisms for emerging and evolving agility in EDM.	Refined the representation of the phase-shifting components and the feedback loops on the framework diagram.
2. Provide practical steps and guidelines for data management practitioners to embed ways of working that improve agility consequences and outcomes in EDM.	Included the ideal and actual mapping template and process as adopted from Ulrich and Reynolds' (2020, p. 290) CSH practice guidelines.
3. Provide practical guidance on reflecting and acting on top-rated boundary judgements and questions.	The rankings of sources of influence found at the case study organisation are not necessarily generalisable due to their context dependency. However, this study suggested that the definitions and rankings for the boundary judgements, as found in the case study organisation, could be used as a starting point and contextually refined over time.
4. The agility features might be incomplete. Add more granularity to the agility features. Add modularity as an agility feature.	The case study findings differentiated agility feature definitions for complex and complicated. This suggestion for more granularity of framework components confirms the fractal (multi-level) nature of the complex and complicated system of EDM. It is possible to define sub-levels for the agility features. However, that could make the implementation and maintenance of the situated framework more cumbersome.
5. Include a means to address the apparent discrepancies between practice and policy rankings for sources of influence.	The detailed definitions of the framework components should be maintained by the organisation's data management leadership and data management policy-makers for top-down governance of the framework. However, using the ideal and actual mapping process on data management projects and initiatives must provide bottom-up feedback to emerge and evolve framework component definitions and boundary questions. This dual ownership of the framework should continually reveal discrepancies between data management policies and data management practices.

Data management expert feedback	**Changes applied to improve and finalise the framework for agile EDM**
6. Provide more clarity on how to keep the framework updated and relevant.	Even though initially proposed in DSR Cycle 2, the experts raised the issue that surveys are impractical as they are time-consuming while the EDM organisation needs to change constantly. Instead of surveys, the ideal and actual mapping process performed by data management practitioners while working on their projects can provide bottom-up feedback to emerge and evolve framework component definitions and boundary questions relevant to the EDM context of an ongoing data management initiative or project.
7. Centralise the overall management and governance of the framework for agile EDM with data management leadership, but allow for autonomy and implementation decisions of the framework's boundary critique in a particular EDM context at the project team level.	Dual ownership of the framework for agile EDM was proposed. This allows for *data management leadership* to make governance and management decisions for the overall framework at the macro-level, feeding down through the meso-level. In contrast, the *data management practitioners* working on data management projects provide current real-world feedback originating from the micro-level feeding up through the meso-level of the framework.
8. Define clear links between dynamic capabilities and the data management roles, activities and best practices.	The ideal and actual mapping process should link the data management roles and activities as they relate to the stakeholders, stakes and stakeholding concerns of the data management initiative or project.
9. Include skills development and training on agile capabilities and culture contextualised for data management.	Train the data management leadership and practitioners on using and evolving the framework for agile EDM within the context of their organisation. The training should be augmented by building knowledge and skills in applying sense-making, strategic and critical thinking skills and Agile techniques to reveal and overcome challenges to achieving agile EDM, for example, the Cynefin framework, Wardley mapping and Agile frameworks.

8 RESEARCH CONTRIBUTIONS AND FINALISED ARTEFACT

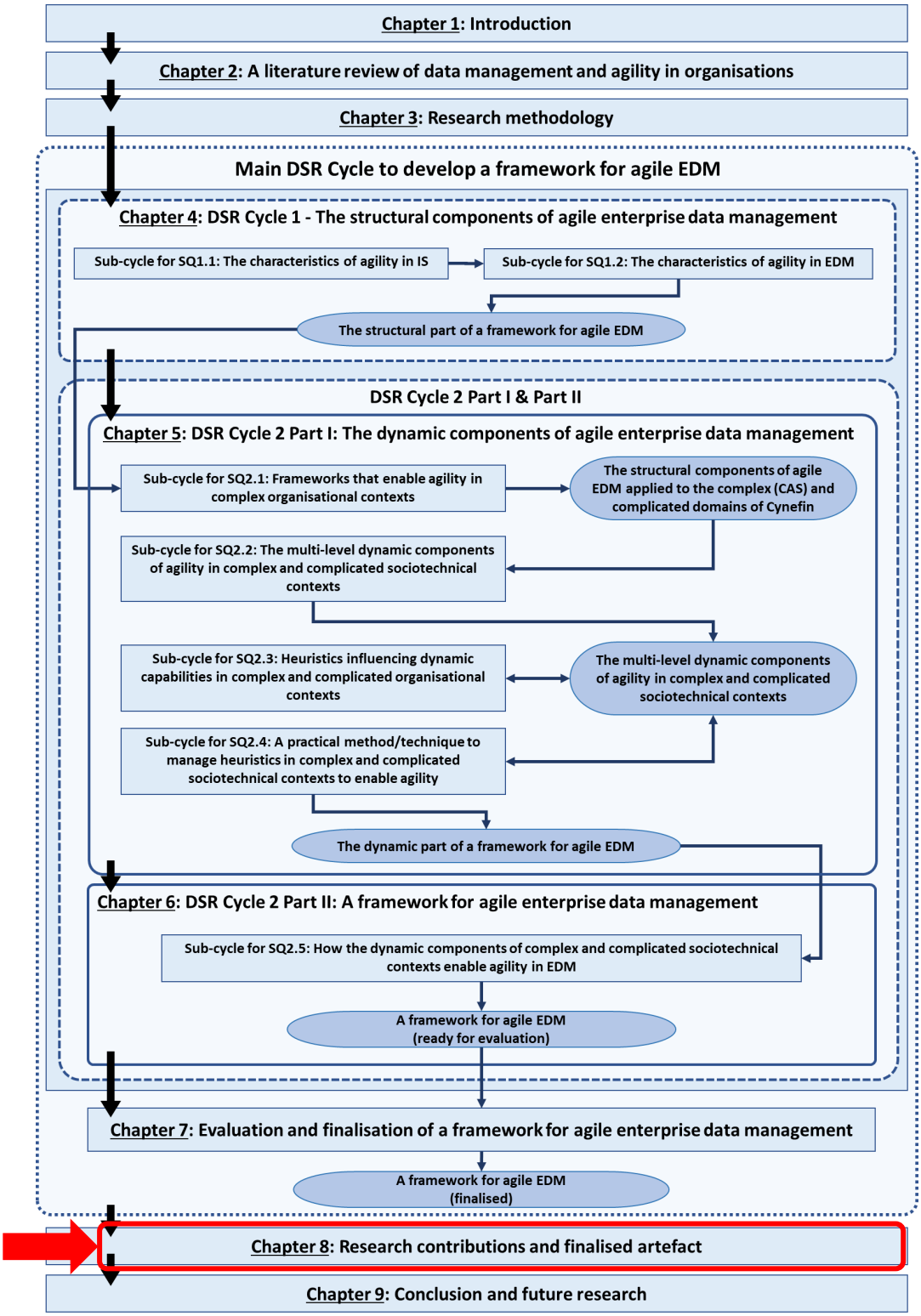


Figure 8-1: Chapter map — Chapter 8

The primary objective of this DSR study was to develop a framework for assisting organisations in achieving agile EDM. For this purpose, a framework for agile EDM was developed in two DSR cycles to produce an artefact that is founded on scientific knowledge and research methods. The primary contribution to data management practice and scientific IS knowledge is a framework for agile EDM that was developed from scientific knowledge underpinned by the theories of dynamic capabilities, CAS and CSH, refined through a qualitative case study at a large financial services organisation (BankGroup), and evaluated by a panel of data management experts as being potentially viable for achieving agility in real-world EDM contexts.

The structural and dynamic parts of the framework for agile EDM were developed in the first and second DSR cycles respectively. For each of the two cycles, systematic reviews of the literature were conducted, creating an abstract artefact used as a conceptual framework which was then applied to the qualitative case study data. Therefore, the structural and dynamic parts of the framework for agile EDM formed the secondary contributions of this study.

8.1 PRIMARY CONTRIBUTION: A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

The requirement for a framework for agile EDM was confirmed in a review of scientific literature in Chapter 2, revealing that there exists a clear, acknowledged need for agile EDM (Marchand and Peppard, 2013; Tallon, Ramirez and Short, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019). In addition, the qualitative case study's interview participants, and the expert panel who evaluated the DSR artefact, confirmed that achieving agile EDM is a relevant, real-world problem.

The DSR artefact, a framework for agile EDM, was developed from the scientific theories of dynamic capabilities (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016), CAS (Holland, 1992; Juarrero, 2000) and CSH (Ulrich, 2000). The qualitative case study present in each DSR cycle applied the conceptual frameworks developed from the respective SLRs to the qualitative case study conducted at BankGroup.

8.1.1 Overview and purpose of the framework for agile enterprise data management

The DSR artefact produced by this study of agile EDM is a model and a method for implementing the framework for agile EDM in real-world contexts. The framework for agile EDM does not strive to provide a rigid model comprising categories, descriptions, labels, and rules to be applied to EDM to achieve agility. Instead, acknowledgement of the sociotechnical complex adaptive nature of EDM, and the emergent and evolutionary nature of agility, is foundational to the framework's design and function. Therefore, the framework embodies systemic mechanisms for acknowledging that opportunities for improving agility arise from the given EDM context where agility is required. When the relevance of context is ignored, and agents apply rigid rules in an attempt to achieve the desired system state, for example, agile EDM, opportunities to bring about the required changes for the current and future state of the system are often masked and lost (Lissack, 2016).

This thesis proposed that agile EDM is not achievable by setting agility as a goal to be secured by linearly applying a prescriptive method while ignoring the EDM context that requires agility. The framework for agile EDM proposes, instead, that agile EDM is a state that emerges from and evolves through the ongoing actions and interactions of data management agents. At the same time, the agents' boundary judgements influence the thriving and faltering of agility features in complex and complicated EDM contexts resulting in intended and unintended outcomes and consequences for agile EDM as a whole.

According to CAS theory, the nature of complexity is fractal as it displays self-similarity up and downward through self-repeating patterns across multiple levels (Ramos-Villagrasa *et al.*, 2018). Thus, it would not be meaningful to investigate a complex and complicated sociotechnical CAS, such as EDM, as a single-level construct (Cilliers, 1998; Salthe, 2012; Juarrero, 2015b; Ramos-Villagrasa *et al.*, 2018; Snowden and Rancati, 2021). Therefore, the framework for agile EDM was constructed from the theories using three levels, and conceptualised as a CAS (Holland, 1992; Juarrero, 2000). The macro-level represents EDM's complex and complicated sociotechnical contexts for which an improved agility state is desired. The meso-level is where agents enact dynamic capabilities (Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016) in complex and complicated EDM contexts. The micro-level is where EDM agents' boundary judgements (Ulrich, 2000) influence their effectiveness in utilising opportunities to improve agility outcomes and consequences for EDM. The highest level, the sociotechnical complex and complicated system of EDM, is the primary

focus, with the sub-levels iteratively providing the macro-level with cumulative initial conditions through feedback loops (Salthe, 2012).

Enabling (context-sensitive) constraints emerge from the micro-level (influences on CAS outcomes and consequences) functioning bottom-up, thus supporting emerging phenomena through the meso-level (actions and interactions) upwards to the macro-level (overall context) (Juarrero, 2015b). In contrast, governing (context-free) constraints are restrictive, functioning downwards from the macro-level (overall context), integrating isolated and independent components through the meso-level (actions and interactions) to the micro-level (influences on CAS outcomes and consequences) into a coherent whole, thus maintaining, regenerating and evolving phenomena in the overall complex and complicated system (Juarrero, 2015b, p. 515).

Boundary critique is a reflecting practive that reveals the boundary judgements made by participating agents to understand a given situation and design ways to improve the systems involved (Ulrich and Reynolds, 2020). Adoption of the CSH practice of boundary critique as a practical, systemic mechanism to influence agile EDM at the micro-level, renders the framework for agile EDM inherently flexible, enabling its combination with other methods, approaches and tools that support agility. By incorporating feedback from each iteration, EDM's agility state can continuously be reassessed and renegotiated, thus supporting the ongoing emergence and evolution of thriving agility in the organisation's EDM.

The overall objective of the framework for agile EDM is to continuously and iteratively embody the following properties for which it was evaluated in Chapter 7:

- **Relevance**: There exists a real-world requirement for the framework for agile EDM that defines its purpose.
- **Usability**: The artefact is fit for use in real-world EDM contexts.
- **Flexibility**: The artefact can be adopted and adapted to changing requirements in EDM contexts.
- **Comprehensibility**: The artefact is comprehensible and is easily understood by data management practitioners.
- **Completeness**: The artefact comprises all elements that its users would expect for its application in a real-world EDM context.
- **Efficiency**: The artefact can perform well for the amount of resources required.

- **Effectiveness**: The artefact can achieve its intended goals of emerging and evolving agility in real-world EDM contexts.

8.1.2 Model and component definitions

The final, post-evaluation version of the framework for agile EDM is presented in Figure 8-2, as a model providing a visual representation for understanding the framework's components, relationships and flows and how EDM contexts can be navigated and operated for thriving agility outcomes and consequences in complex and complicated EDM contexts.

The dynamic capabilities of sensing and learning are about the EDM agents' contextualised understanding and knowing to inform decisions on possible courses of action. The dynamic capabilities of coordinating and integrating are about the enactment and management of individuals' and teams' actions. Therefore, it represents what the EDM agents have made sense of to choose their actions for improved agile EDM.

However, agility is a phenomenon that emerges from how the agents act and interact, intentionally or unintentionally, in the given EDM context. Agility does not emerge merely from knowing or sensing what to do to improve agile EDM. Even though agents' actions are triggered by sensing and knowing, it is the heuristics, including the underlying boundary judgements, that the EDM agents practice as actors in the sociotechnical CAS of EDM that influence how they act with consequences and outcomes of agility either thriving or faltering in the complex and complicated sociotechnical contexts of agile EDM.

Figure 8-2 presents the finalised model of the framework for agile EDM. The iterations of the sociotechnical agents' continuous actions, interactions and heuristics have outcomes and consequences for agility in complex and complicated EDM contexts. In the top part of the model, iterations in complex EDM contexts are represented by multiple dashed, dispersing lines, illustrating the dissipative, discontinuous and dispositional nature of complexity. In contrast, the bottom part of the model shows the more predictable, governable and repeatable nature of complicated contexts as solid-lined iterations. Transitions between complexity and complicatedness occur when heuristics, undergirded by boundary judgements, influence the sociotechnical agents' dynamic capabilities, resulting in intended outcomes and unintended consequences for the overall agility of EDM.

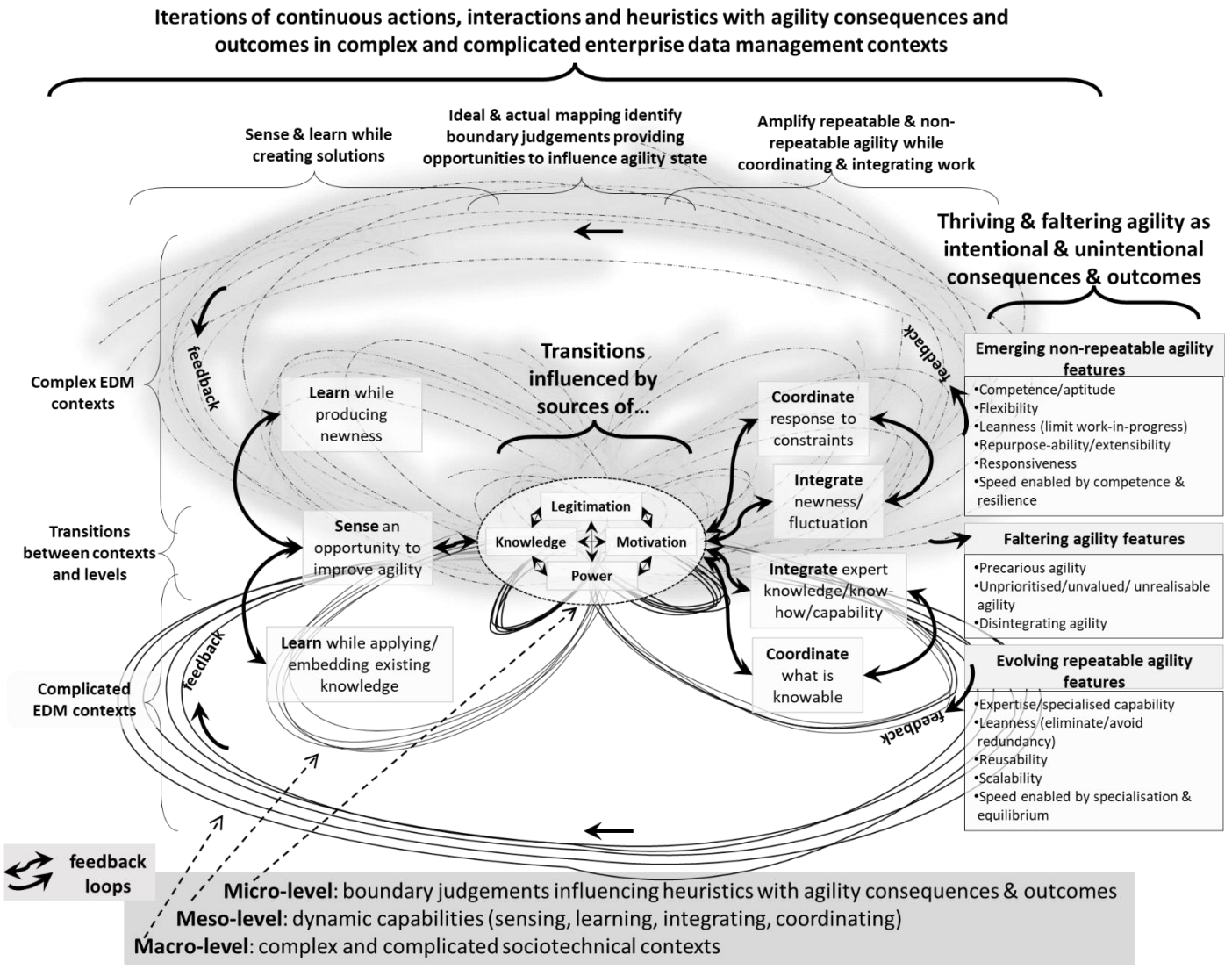


Figure 8-2: A framework for agile enterprise data management (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

The definitions of the framework's components were adopted from the underlying theories (dynamic capabilities, CAS and CSH) and refined through induction in an empirical case study at a large financial services organisation (BankGroup). The finalised component definitions are presented in Table 8-1.

Table 8-1: Component definitions for the framework for agile EDM

Component	Definition
Macro-level	At the macro-level, the **sociotechnical** context of agile EDM is **complex and complicated** (Kurtz and Snowden, 2003), for which an improved agility state is desired.
Meso-level	At the meso-level, EDM activities and interactions are governed by **dynamic capabilities** (learning, sensing, coordinating and integrating), and how they are performed can be influenced to have intended and unintended agility consequences and outcomes for EDM (Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016).
Micro-level	At the micro-level, influences of agility in EDM contexts are defined as CSH **sources of influence** (motivation, power, knowledge and legitimation) which are underlying boundary judgements influencing the enactment of EDM activities, thereby having intended and unintended agility consequences and outcomes for EDM (Ulrich, 2000).
Complicated EDM contexts	Complicated contexts in EDM are **ordered situations with sufficient levels of certainty** for experts and specialised technologies to solve EDM problems. Cause and effect exist, but only **experts** can analyse and understand the causality — events can be predicted, and rules can be used to govern activities and outcomes (Snowden and Boone, 2007). Complicatedness is the domain of **governing constraints** where "good practice" is enabled by expertise and know-how (Snowden and Rancati, 2021).
Complex EDM contexts	Complex contexts in EDM are **unordered situations with high levels of uncertainty**. There is no cause and effect, relationships between events and their consequences are non-linear, and constraints must be managed to enable adaptation to the ongoing changes (Snowden and Boone, 2007). Complexity is the domain of **enabling constraints** and exaptive practice enabled by experimentation and monitoring responses (Snowden and Rancati, 2021).
Transitions (liminality) in EDM	The liminal area between complicated and complex practice in EDM has a **transitionary and iterative nature**, where good practice can establish and evolve in the complicated domain through a transitionary process requiring energy to shift and adopt new emergent practices from the complex domain (Snowden and Rancati, 2021).

Component	Definition
Dynamic capabilities in EDM	The concepts of dynamic capabilities that were adopted by this study were based on the research done by Pavlou and El Sawy (2011). Dynamic capabilities govern actions and interactions with agility consequences in EDM contexts. In the framework for agile EDM, dynamic capabilities provide a mechanism for moving iteratively and recursively between the macro-level and micro-level of EDM. This study defined activities and interactions in EDM contexts as follows: **Learning** is defined as the process of building knowledge and skills while being productive and creating solutions. In **complexity**, learning occurs while producing newness or novelty. In **complicated** contexts, learning occurs while applying and embedding existing knowledge. **Sensing** is defined as the process of scanning for and making sense of opportunities to improve agility. This process involves sense-making: "how do we make sense of the world so we can act in it" (Turner, Snowden and Thurlow, 2022, p. 1). In other words, becoming aware of, understanding and being able to act to utilise an opportunity for improving agile EDM. **Coordinating** is defined as the process of collaborating and working collectively towards a shared purpose. In **complexity**, the response to constraints in the complex adaptivity of EDM should be managed to support enabling constraints that amplify non-repeatable agility features, for example, creating a safe-to-fail environment that allows for flexibility and responsiveness. In **complicatedness**, managing governing constraints supports repeatable agility features, for example, standardising and embedding reusable data management objects. **Integrating** is defined as the process of combining work effort and outcomes for collective benefit in EDM contexts. Integration of new and existing knowledge is essential to managing transition shifts in the complex and complicated system of EDM (Snowden and Rancati, 2021). When individual agents intend and proceed to integrate their efforts, the team's effort transcends the individual (Bolman and Deal, 2017). In **complexity**, non-repeatable agility features enable the monitoring of fluctuations and support the integration of emerging novelty that is beneficial to EDM as a whole. In **complicatedness**, existing expertise, know-how, and capabilities should be integrated to evolve repeatable agility features.
Transitions in EDM	Transitions in the complex and complicated system of EDM occur when the system shifts from complexity towards complicatedness (when the unknown becomes knowable and known by experts) and when the system shifts from complicatedness into complexity (when experts can no longer know what to do). While performing activities and interactions on their data management initiatives, **ideal and actual mapping** exercises can guide the data management agents to reflect on their underlying boundary judgements and, in doing so, become aware of and utilise opportunities to influence the agility state of EDM towards thriving agility.

Component	Definition
Categories of boundary judgements in EDM	The definitions of boundary judgements in EDM contexts were based on the research conducted by Ulrich and Reynolds (2020). Boundary judgements **inform heuristics** when agents consider and decide **how agility is** and **how agility ought to be** considering its facts and values within the given EDM context: **Sources of motivation** relate to agents' impetus. These sources change the system (agile EDM) based on what agents are motivated to effect, with or without intent. **Sources of power** relate to things that control the system. These sources change the system (agile EDM) based on what empowers, overrides, and guides the agents. **Sources of knowledge** relate to agents' abilities. These sources change the system (agile EDM) based on agents' resourcefulness to do what can and should be done. **Sources of legitimation** relate to taking a broad stakeholder view. These sources change the system (agile EDM) based on the amplitude of the agents' stakeholder perspective.
Emerging agility in EDM	**Emerging agility** in EDM constitutes non-repeatable agility features that are relevant to **complex EDM contexts**. These features enable adaptation under uncertainty and emerge to support the evolution of new patterns for evolving agility. The following emerging agility features were defined for the framework as identified in the case study organisation: • **Competence and aptitude** are defined as having experience, discernment, aptness and generalist skills • **Flexibility** is defined as being adaptable and open to alternative solutions and approaches • **Leanness (limit work-in-progress)** is defined as being able to limit work-in-progress to prioritised, essential value delivery • **Repurpose-ability and extensibility** are defined as being able to extend or use an existing capability for something other than its original purpose • **Responsiveness** is defined as being able and motivated to comprehend and to act on what is required • **Speed enabled by competence and resilience** is defined as being able to deliver value quickly due to being competent and resilient These agility features should be revised for their relevance and completeness in the EDM context for any situational implementation of the framework for agile EDM.

Component	Definition
Evolving agility in EDM	**Evolving agility** in EDM constitutes repeatable agility features that are relevant to **complicated EDM contexts**. Evolving agility features are adopted and embedded, thereby evolving as part of good practice. The following evolving agility features were defined for the framework as identified in the case study organisation: • **Expertise or specialised capability** is defined as having expert or specialised knowledge, skills and capability • **Leanness (eliminate or avoid redundancy)** is defined as being able to avoid or eliminate wastage of resources • **Reusability** is defined as being able to repeat the use of an existing capability in a new or similar context • **Scalability** is defined as being applicable to a wider scope, vertical or horizontal, by repeating or recombining existing capabilities • **Speed** enabled by specialisation and equilibrium is defined as being able to deliver value quickly due to expert capability and stability in the environment These agility features should be revised for their relevance and completeness in the EDM context for any situational implementation of the framework for agile EDM.
Thriving agility in EDM	**Thriving agility** in EDM is the sustained functional emergence and evolution of enabling (context-sensitive) and governing (context-free) constraints that iteratively amplify agility features.
Faltering agility in EDM	**Faltering agility** in EDM is the emergence and evolution of failed enabling and governing constraints that iteratively erode agility features with consequential loss of the system's overall agility coherence. This study defines three types of faltering agility: • **Disintegrating agility** is defined as being unable to understand and respond to the current state of agility to move towards an improved state. • **Precarious agility** is defined as being unable to fully understand and respond to the current state of agility to move towards an improved state. • **Unprioritised, unvalued or unrealisable agility** is defined as understanding the current state of agility but deciding that no value can be added by amplifying agility features.

The following section describes how to practise CSH boundary critique using ideal and actual mapping, reflecting on the prevailing boundary judgements for improving agility outcomes and consequences in an organisation's EDM.

8.1.3 Method for the ideal and actual mapping process

The practice of boundary critique is an iterative process that systematically considers stakeholders' perspectives about what they view as an "improvement" (Ulrich, 2005). How well agents understand the situated context of a problem and how it can be improved, along with how they validate and rationalise resolving tensions between the ideal and actual system state, are crucial for becoming competent at practising boundary critique (Ulrich and Reynolds, 2020). The "system" of agile EDM constantly shifts as agents' understanding of agile EDM changes, and as new or changed "facts" and "values" become apparent, thus prompting a revision of the prevailing boundary judgements. As Ulrich and Reynolds (2020) explain, the same boundary judgements condition the "facts" and the "values" considered for improving the agility state of EDM. For example, when certain conditions for successfully improving the agility state of EDM were previously ignored, but subsequently become apparent in the given EDM context, agents' value judgements require revision due to the new facts that came to light.

In the same way, when agents' value judgements change, their boundary judgements require revision accordingly, resulting in new facts becoming relevant. Therefore, boundary judgements operate as enabling (context-sensitive) and governing (context-free) constraints in ongoing EDM contexts. Ulrich (2000, p. 6) refers to "the eternal triangle: whenever we change one of the three angles, the other two will equally change", as presented in Figure 8-3.

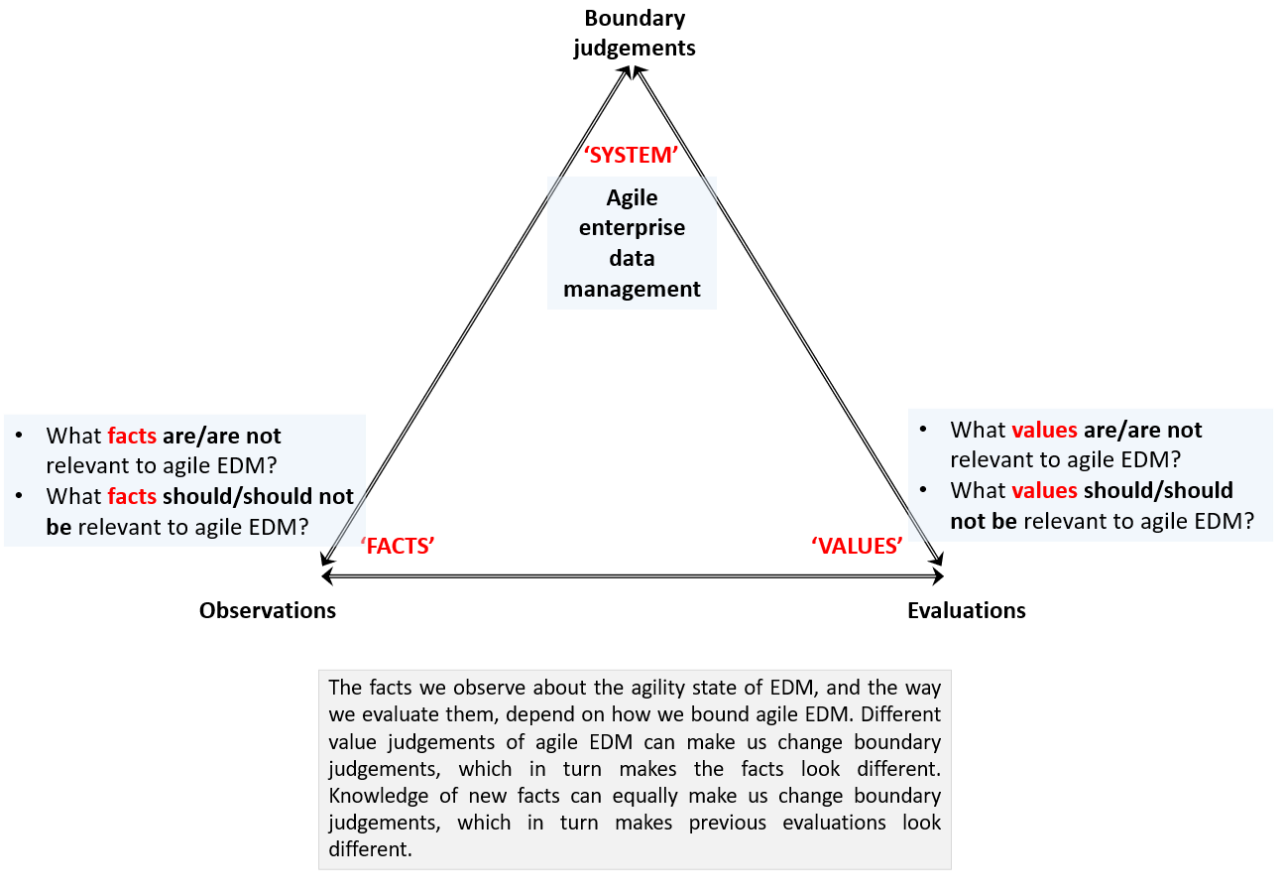


Figure 8-3: The interdependence of boundary judgements, observations, and evaluations of agile EDM (based on Ulrich (2000, p. 252, 2005, p. 8))

Ulrich and Reynolds (2020, p. 298) emphasise that "getting to grips with real-world situations of intervention does not usually allow us to stay within the pristine conceptual world of our systems methodologies" and that "[w]e all bring into professional interventions a background of personal experiences and skills that shape our views of the context, and it will hardly ever be possible that we render all those background assumptions fully explicit. What matters more is that we develop a sense of openness and flexibility with respect to the differing contexts that matter to different people, and that we are accordingly prepared to revise our initial notion of the relevant context". Bolman and Deal (2017, p. 22) propose that when fearing ambiguity and loss of control while dealing with uncertainty, agents should "develop creativity, risk-taking, and playfulness in response to life's dilemmas and paradoxes, and focus as much on finding the right question as the right answer, on finding meaning and faith amid clutter and confusion".

Boundary judgements represent agents' partiality concerning their empirical and normative perspectives of the system of interest (Ulrich, 2005), which is, in this case, agile EDM. As

clarified by Ulrich (2000, p. 8), “boundary judgements stand for the inevitable selectivity and thus partiality of our propositions”, and “below the surface of expert knowledge and professional behaviour, there exists a deep symmetry of all claims to knowledge and rationality”.

This section presents an ideal (normative) and actual (empirical) mapping template and a process for unfolding contextualised boundary questions to continuously identify opportunities that can be utilised to improve EDM agility. The framework for agile EDM proposes that this process is embedded in the ongoing activities and interactions of the organisation’s data management initiatives to create feedback loops for iteratively developing and refining a contextualised “master list” of the organisation’s boundary judgements and rankings. Through this approach, the agents’ perceptions of agility problems in the organisation’s EDM and the claims they raise regarding agile EDM are conditioned. Table 8-2 presents the four perspectives for reflecting on how the state of agile EDM ought to be and how it is.

Table 8-2: Four perspectives for examining the state of agile EDM (based on Ulrich (2005, p. 8))

Perspective	**Normative selectivity:** **The “ought to” mode asks, “what boundary assumptions ought we to rely on to achieve agile EDM?”**	**Empirical selectivity:** **The “is” mode asks, “what boundary assumptions are at work to achieve agile EDM?”**
Facts	**Ideal mapping:** What “facts” ought to be considered relevant to achieving agile EDM, and which ones should be left out?	**Actual mapping:** What “facts” are considered relevant to achieving agile EDM, and which ones are left out?
Values	**Ideal mapping:** What “values” ought to be considered relevant to achieving agile EDM, and which ones should be left out?	**Actual mapping:** What “values” are considered relevant to achieving agile EDM, and which ones are left out?

Ulrich and Reynolds (2020) describe the practice of boundary critique as an iterative process that cycles through multiple revisions involving changes in the sequences of reflection on boundary categories. Reynolds (2007) proposes a sequence for the process of unfolding

the boundary questions first in the ideal or “ought to” mode and subsequently in the actual or “is” mode.

The organisational structure of EDM comprises teams of data management specialists who are required to continuously and collaboratively deliver data value to the organisation. A data management team’s activities are thus typically constrained by business requirement specifications and delivery timelines. This study defines data initiatives as any coordinated data management activities with a clear purpose that are executed for projects that aim to derive business value from data, such as data analytics and BI reporting, and data governance work, such as policy-making and standard-setting. Therefore, the framework for agile EDM suggests the adoption of Reynolds' (2007) process presented in Figure 8-4 to continuously influence thriving agility in EDM contexts by practising boundary critique as an ongoing part of each data management initiative undertaken in the organisation. Nonetheless, the CSH boundary questions are interdependent, ultimately resulting in all the questions being considered. Thus, it is not crucial to address the questions in any particular order (Ulrich and Reynolds, 2020).

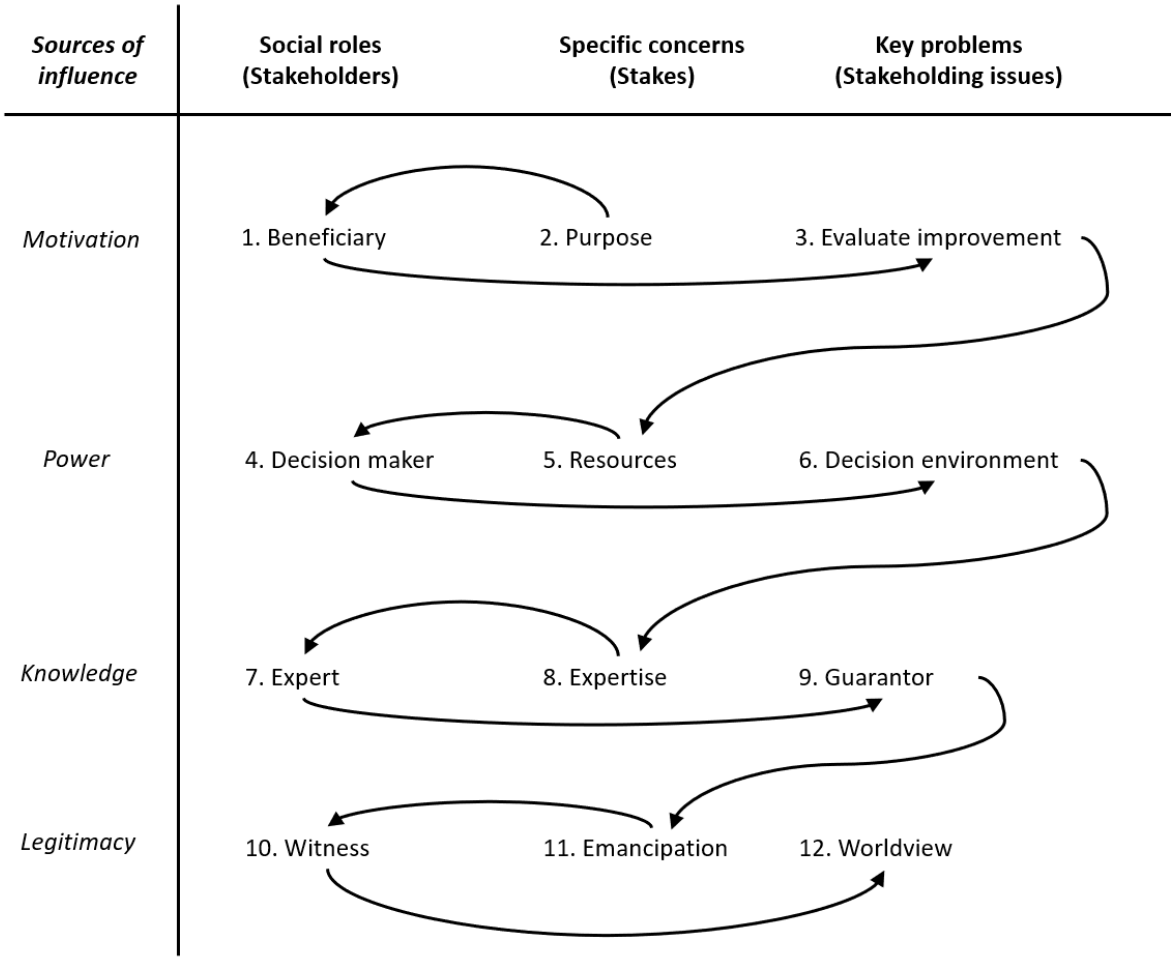


Figure 8-4: The unfolding sequence of CSH questions (adopted from Reynolds (2007, p. 107))

The framework for agile EDM proposes that the ideal ("ought to" mode) and actual ("is" mode) mapping template presented in Table 8-3 is used to develop contextualised boundary questions within the context of each data management initiative in an organisation striving to achieve agile EDM. The mapping process can reveal new or changed underlying boundary judgements, thereby feeding back to evolve the organisation's "master list" of boundary judgements that are shareable across the organisation's EDM for use in subsequent data management initiatives. The specification of contextualised boundary questions applied to the case study data presented in Table 7-4 on page 353 provides an example of ideal mapping.

Table 8-3: Ideal and actual mapping template for agile EDM (based on Reynolds (2007, p. 107); Ulrich and Reynolds (2020, p. 290))

Boundary issues	**Root issues** **Top-rated boundary judgements (sources of influence) from the organisation's "master list"**	**Main boundary questions**	**Contextualised boundary questions** **Developed by focusing on the boundary judgements for the EDM context**
Sources of motivation	**What are the motivating factors?** **(what agents are motivated to effect, with or without intent)** *<Source of Motivation 1>* *<Source of Motivation 2>* *<Source of Motivation 3>* *<Source of Motivation 4>* *<Source of Motivation 5>* *…*	02. **Purpose**: What do we want to achieve? (STAKES)	*<formulate questions about how our DM initiative's primary and secondary objectives **should be/are** achieved while influencing agile EDM>*
		01. **Beneficiary**: Whose interests do we want to serve? (STAKEHOLDERS)	*<formulate questions about how our DM initiative's primary and secondary stakeholders **should be/are** served while influencing agile EDM>*
		03. **Evaluate improvement**: What constitutes an improvement? (STAKEHOLDING ISSUES)	*<formulate questions about how our DM initiative's contribution to influencing agile EDM **should be/is** assessed>*
Sources of power	**Who or what is in control?** **(what empowers, overrides, and guides the agents)** *<Source of Power 1>* *<Source of Power 2>* *<Source of Power 3>* *<Source of Power 4>* *<Source of Power 5>* *…*	05. **Resources**: Who/what controls resources and their availability? (STAKES)	*<formulate questions about who and what **should be/are** controlling resources for our DM initiative while influencing agile EDM>*
		04. **Decision maker**: Who/what should control the decisions? (STAKEHOLDERS)	*<formulate questions about who and what **should be/are** controlling decisions for our DM initiative while influencing agile EDM>*
		06. **Decision environment**: What conditions are outside the decision-maker's control? (STAKEHOLDING ISSUES)	*<formulate questions about what conditions **should be/are** outside of the control of our DM initiative's decision-makers that influences agile EDM>*
Sources of knowledge	**What information and skills are relevant?**	08. **Expertise**: What information, knowledge and skills must be contributed? (STAKES)	*<formulate questions about what information, knowledge and skills **should be/are** being contributed to our DM initiative while influencing agile EDM>*

Boundary issues	**Root issues** **Top-rated boundary judgements (sources of influence) from the organisation's "master list"**	**Main boundary questions**	**Contextualised boundary questions** **Developed by focusing on the boundary judgements for the EDM context**
	(agents' resourcefulness to do what can/should be done) *<Source of Knowledge 1>* *<Source of Knowledge 2>* *<Source of Knowledge 3>* *<Source of Knowledge 4>* *<Source of Knowledge 5>* *…*	07. **Expert**: Who should contribute their expertise and experience? (STAKEHOLDERS)	*<formulate questions about who and what **should be/are** contributing their expertise and experience to our DM initiative while influencing agile EDM>*
		09. **Guarantee**: What/who can provide guarantees for success? (STAKEHOLDING ISSUES)	*<formulate questions about who and what **should be/are** guaranteeing the success of our DM initiative while influencing agile EDM>*
Sources of legitimation	**What stakeholders should be considered?** **(the amplitude of the agents' stakeholder perspective)** *<Source of Legitimation 1>* *<Source of Legitimation 2>* *<Source of Legitimation 3>* *<Source of Legitimation 4>* *<Source of Legitimation 5>* *…*	11. **Emancipation**: Who/what emancipates stakeholders from our promises and premises? (STAKES)	*<formulate questions about who and what **should be/are** emancipating stakeholders from the promises and premises of our DM initiative while influencing agile EDM>*
		10. **Witness**: Who voices concerns of those not involved? (STAKEHOLDERS)	*<formulate questions about who **should be/are** voicing the concerns of those affected by but not involved in our DM initiative while influencing agile EDM>*
		12. **Worldview**: What different visions of "improvement" must be considered? (STAKEHOLDING ISSUES)	*<formulate questions about what different versions of agile EDM **should be/are** considered as part of our DM initiative>*

8.1.4 Method for identifying contextualised boundary judgements

The qualitative case study in the second DSR cycle empirically derived a "master list" of boundary judgements influencing agility consequences and outcomes using the data collected from the case study conducted at BankGroup. The boundary judgements and their rankings, based on their emphasis, are not necessarily generalisable as they were derived through inductive reasoning from the narratives of data management practitioners at the case study organisation and thus relate to a particular real-world EDM context at a particular point in time. Therefore, an organisation wishing to implement the framework for agile EDM should conduct its own investigation, using the proposed ideal and actual mapping template and process, to develop and continuously refine a comprehensive list of contextualised boundary judgements that influence agility in their specific organisation's EDM practices and policies. Alternatively, the framework implementation could potentially be initialised by applying the "master list" produced by the qualitative case study as a starting point to review, understand and contextualise the underlying sources of motivation, power, knowledge and legitimation influencing agility for an organisation's EDM. The "master list" of ranked boundary judgements relating to sources of motivation, power, knowledge and legitimation that influenced agile EDM at the case study organisation is presented on the following pages in Table 8-4, Table 8-5, Table 8-6 and Table 8-7, respectively.

Table 8-4: Ranked sources of motivation influencing agile EDM at the case study organisation

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
1	**M- clear, shared data-centric purpose**	a will to contribute to a clear, shared data-centric purpose
2	**M- share & integrate capabilities (avoid silos)**	a will to share and integrate capabilities and to avoid working in silos
3	**M- intention to improve/support agility in DM**	a will to improve and support agility in data management
4	**M- business value/impact of DM initiative**	a will to deliver business value through the data initiative
5	**M- feedback loops (assess/monitor/test)**	a will to reflect on and learn from feedback and results from assessments, monitoring and testing
6	M- data role/function clarity	a will to create clarity about role responsibility and accountability

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
7	M- intention to be responsive	a will to be responsive
8	M- buy-in/commitment from stakeholders of data priority	a will to obtain stakeholder buy-in and commitment to the prioritised data requirement
9	M- intention to be proactive	a will to be proactive
10	M- avoid technical debt/rework/redundancy	a will to avoid technical debt, rework or maintaining redundant capabilities

Table 8-5: Ranked sources of power influencing agile EDM at the case study organisation

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
1	**P- collaborative culture, synergy**	data management resources empowered by a collaborative culture and synergy
2	**P- effective stakeholder engagement**	data management roles and functions empowered through effective stakeholder engagement
3	**P- data leadership mandate/direction/support**	data management work directed and mandated by data leadership
4	**P- business area strategy/priority**	data management work guided by business area strategy and prioritisation
5	**P- data governance processes**	data governance processes control data management work
6	P- data ownership, stewardship, custodianship	data management roles and functions mandated with and held accountable for data ownership, stewardship or custodianship
7	P- data management policies	data management policies control data management work
8	P- data management strategy	data management work directed by data management strategy
9	P- trust/trustworthiness	data management work empowered by trust or trustworthiness
10	P- data management principles	data management principles guide data management work
11	P- formalised delivery processes	formalised delivery processes control data management work

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
12	P- resource capacity for DM (socio/tech)	Human and technical resource capacity enabling data management work
13	P- team/role/organisation maturity	data management work empowered by team, role and organisational maturity
14	P- legal/regulatory/audit compliance requirements	business and data management roles and functions are controlled and held accountable by legal, regulatory and audit compliance requirements
15	P- uncertainty in internal environment	data management work is subject to uncertainty in the internal environment
16	P- autonomy at execution level	decision-making power granted at the execution level
17	P- uncertainty in external environment	data management work is subject to uncertainty in the external environment
18	P- unilateral/BU decision-making	data management decisions overruled by unilateral decisions or decision-making at a business unit level

Table 8-6: Ranked sources of knowledge influencing agile EDM at the case study organisation

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
1	**K- shared understanding (business & data)**	a shared understanding of the business and data requirement
2	**K- defined, prioritised DM/data capability requirement**	a defined, prioritised data management or data capability requirement
3	**K- specialist knowledge/skills/expertise/ understanding**	the required specialist knowledge, skills, understanding and expertise
4	**K- resource capability (socio/tech/data)**	the required social and technical data management capability
5	**K- experience and ability/competence**	the necessary experience, ability and competence to create the required solutions
6	K- iteratively/continuously keep up & improve capability	a culture/patterns to continuously update individual and collective knowledge and to improve the data-related capability

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
7	K- modularised/standardised/ foundational capability	shared reusable, stable rails that enable foundational, standardised data capabilities
8	K- learning from safe-to-fail trying/innovating/exploring	a culture that allows for learning from trying/innovating/exploring without guarantee of the outcome
9	K- process automation capability	a reusable, repeatable capability that is automated

Table 8-7: Ranked sources of legitimation influencing agile EDM at the case study organisation

Overall ranking	Boundary judgements	Considerations for ideal and actual mapping
1	**L- adoption & proliferation of DM capabilities**	a broader stakeholder view considered for adopting and proliferating data management capabilities
2	**L- reflection on approach to data initiatives**	a broader stakeholder view considered for how to approach the data initiative
3	**L- suitability/sufficiency in context**	a broader stakeholder view considered for the suitability and sufficiency of the data capability
4	**L- potential extent of impact**	a broader stakeholder view considered for the extent of the impact on areas outside of the given context
5	**L- tenability/ durability/ sustainability**	a broader stakeholder view considered for the long-term outlook of the data capability
6	L- openness to other/broader perspectives/alternatives	a broader stakeholder view considered for alternative options and perspectives
7	L- peripheral dependency/interdependency/ knock-on	a broader stakeholder view considered for the possible impact on areas outside of the given context
8	L- openness to/embracing/incorporating change	a broader stakeholder view considered for being open to change and embracing and incorporating change

8.1.5 A proposed approach to implementing the framework for agile EDM

To implement the framework for agile EDM in a real-world EDM context, the following approach is proposed based on the theoretical underpinnings of the framework explained in the first and second DSR cycles, the case study findings of the qualitative case study in the

second DSR cycle, and feedback received from the data management experts in the artefact evaluation phase:

1. **Constructs of the framework for agile EDM**: Consider and define the constructs of the framework for agile EDM, as presented in Figure 8-2 on page 364 and Table 8-1 on page 365, within the context of the candidate organisation. Confirm that the definitions of EDM activities and interactions at the meso-level, and the definitions of repeatable and non-repeatable agility features as outcomes and consequences of the sociotechnical complex and complicatedness of EDM, are relevant and valid for the candidate organisation's existing EDM situation. The detailed definitions of the framework components should be owned and evolved by the organisation's data management leadership and data management policy-makers for top-down governance of the framework for agile EDM in the organisation.

2. **Boundary judgements influencing agile EDM**: The definitions and rankings for the boundary judgements found at the case study organisation are not necessarily generalisable and applicable to the candidate organisation's EDM. However, they could be used as a starting point and then iteratively refined for the organisation's specific EDM contexts over time by continuously conducting contextualised ideal and actual mapping in the ongoing data management initiatives of the organisation.

3. **Ideal and actual mapping revealing boundary judgements influencing agile EDM**: The ideal and actual mapping process should be performed by data management practitioners while working on data management initiatives and must provide feedback to the organisation's data management leadership regarding their contextualised boundary questions, underlying boundary judgements and overall perceptions and experience of the framework components. This approach embeds the ideal and actual mapping process into the organisation's data management initiatives, providing bottom-up feedback to emerge, evolve and integrate refinements of the framework component definitions and boundary judgements influencing agility for the organisation's EDM as a whole.

4. **Data management roles and activities for integrating and coordinating agile EDM**: The main boundary questions, debated and reflected on during the ideal and actual mapping process, should contextualise the data management roles and activities

(practised and governed at the meso-level of the framework) for the data management initiative as they relate to the stakeholders, stakes and stakeholding concerns of the data management initiative/project.

5. **Dual ownership of agile EDM**: The proposed dual ownership of the framework for agile EDM allows data management leadership to make governance and management decisions for the overall framework and definitions of its components at the macro-level (agile EDM) feeding down through the meso-level (EDM activities and interactions) to the micro-level (boundary judgements influencing agile EDM). At the same time, the data management practitioners working on data management initiatives contribute their contextualised real-world feedback originating from the micro-level (boundary judgements influencing agile EDM) feeding up through the meso-level (EDM activities and interactions) to the macro-level (agile EDM) of the framework. This dual ownership of the framework should also continually reveal discrepancies between definitions and rankings of boundary judgements influencing agility in data management policies and standards, and data management practices, for example, as presented in Figure 6-30 on page 291 and Figure 6-33 on page 295.

6. **Training for achieving agile EDM**: Continuously train the data management leadership and practitioners on using and evolving the framework for agile EDM within the context of their organisation. The training should be augmented by building knowledge and skills in applying sense-making, strategic and critical thinking skills and ISD Agile techniques (as tools not aggregations) to reveal and overcome challenges to achieving agile EDM, for example, the Cynefin framework, Wardley mapping and Agile frameworks. The flexible nature of the framework for agile EDM aims to allow for integration and co-evolution with other frameworks that support data management and organisational agility.

8.2 THEORETICAL CONTRIBUTIONS

Design research is a knowledge-building exercise (Gregor and Jones, 2007), and the justification and evaluation of knowledge production are crucial in design science research (Baskerville, Kaul and Storey, 2015). Baskerville, Kaul and Storey (2015) explain the challenges of two dualities influencing knowledge production processes in DSR studies: (1) the knowledge goals of science versus the knowledge goals of design; and (2) the scope of the knowledge under production as nomothetic or idiographic. Processes of nomothetic knowledge production strive to produce generalisable concepts or theories covering complete sets of specific classes. On the other hand, idiographic processes study and produce knowledge about particular cases, such as organisational teams or organisational processes (Baskerville, Kaul and Storey, 2015). Depending on the stage of the knowledge production in achieving the design's goals, the iterative process might focus, at a certain point in time, on knowledge of contextualised specifics or, at another time, more abstract concepts (Baskerville, Kaul and Storey, 2015).

Venable (2006) contended that theory production should be a primary objective of DSR and that theorising and theory have a central role in advancing DSR in IS and other research fields. A novel DSR artefact's description can contribute to design knowledge, and its initial conceptualisation presents the first step in theorising (Baskerville *et al.*, 2018). According to Popper (2002, p. 57), scientific theories are "universal statements" that are "nets cast to catch what we call 'the world': to rationalize, to explain and to master it. We endeavour to make the mesh ever finer and finer". DSR produces, by its definition, an artefact which consequently embodies some form of a developing design theory, even if not presented explicitly as such (Baskerville *et al.*, 2018, p. 367). The design theory construction opportunities of this DSR study are mapped in Figure 8-5. However, this study does not present its contributions as IS design theories (ISDT) or design relevant explanatory/predictive theory (DREPT – a theory that links a design with its underlying phenomena), but rather as nascent concepts that, despite the omission of real-world instantiation, offer potential artefact development approaches to future scientific studies through which design theories might evolve.

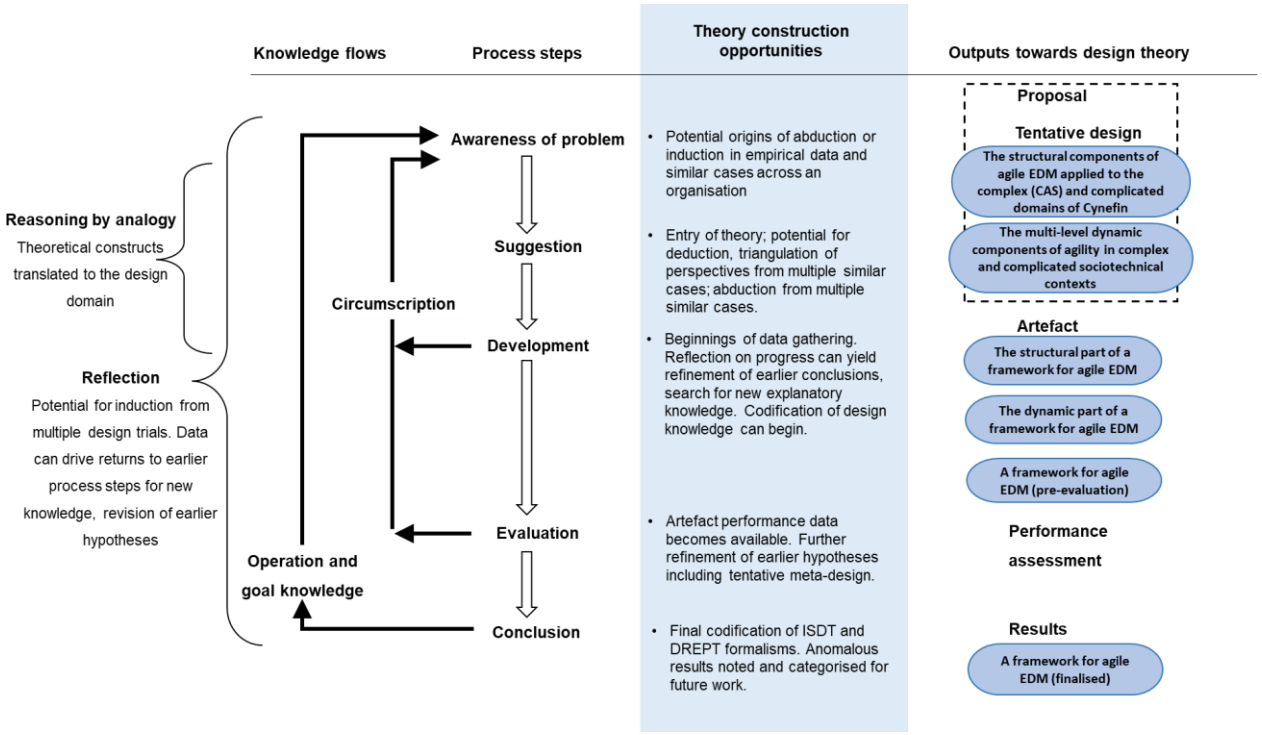


Figure 8-5: Design theory construction in the DSR process (based on Baskerville *et al.* (2018, p. 365))

The framework for agile EDM that was developed through this study comprises concepts bounded by assumptions and constraints that originate from an empirical understanding of an existing real-world problem. This problem concerns how to achieve agile EDM. Even though this study did not set out to create "a theory of agile enterprise data management", this study produced and proposed a novel theoretical construct grounded in existing scientific theory and empirically evaluated in real-world EDM contexts. The dynamic part of a framework for agile EDM defined the meta-requirements for achieving agile EDM as this intermediate version of the framework for agile EDM was founded in the multi-level dynamic components of agility in complex and complicated sociotechnical contexts. The dynamic part of a framework for agile EDM is more nomothetic and, therefore, generalisable as it was built up from the characteristics of agility in IS and the well-established theories of CAS (used inductively) and CSH (used abductively) that underpin the foundational sense-and-respond capability for achieving agility in complex and complicated organisational contexts.

The structural part of a framework for agile EDM, produced by the first DSR cycle, served as a proxy and bound the search for scientific literature and underlying theories for the dynamic part of the framework for agile EDM. In the qualitative case study part of the second DSR cycle, the dynamic part of a framework for agile EDM was applied in the real world by

conducting an in-depth qualitative case study at BankGroup to produce the evaluation-ready version of a framework for agile EDM, that is a more idiographic version of the DSR artefact.

According to Bacharach (1989, p. 496), “A theory is a statement of relations among concepts within a set of boundary assumptions and constraints. It is no more than a linguistic device used to organize a complex empirical world”. The literature review in Chapter 2 concluded that there is limited scientific knowledge of agility in EDM and that the existing EDM frameworks do not extensively or specifically address agility requirements. Thus, the components that constitute agile EDM, including their structure and relational dynamics, first had to be identified, described and explained. This study's primary question is, “**How** can agile EDM be achieved?” However, the construct of agility is, by its nature, not directly observable, nor can it be precisely measured. According to Bacharach (1989, p. 498), a theory can be defined as “a statement of relationships between units observed or approximated in the empirical world”. This study does not aim to have created “a theory of agile enterprise data management”. Nonetheless, it produced a novel generalisable theoretical construct, deduced from existing scientific theory and empirically evaluated in real-world EDM contexts using an inductive approach and qualitative methods.

8.3 SECONDARY CONTRIBUTIONS

A novel DSR artefact’s description can contribute to design knowledge, and its initial conceptualisation presents the first step in theorising (Baskerville *et al.*, 2018). In this section, it is proposed that the two abstract artefacts produced during the construction of the framework for agile EDM present secondary knowledge contributions: (1) an approach to develop the structural components of a phenomenon of interest in a sociotechnical domain of interest, and (2) an approach to develop the dynamic components of agility in a sociotechnical domain of interest.

Gregor and Jones (2007, p. 312) identified eight distinct parts of a design theory: “(1) purpose and scope, (2) constructs, (3) principles of form and function, (4) artifact mutability, (5) testable propositions, (6) justificatory knowledge (theories), (7) principles of implementation, and (8) an expository instantiation”. Table 8-8 documents how the development process of the framework for agile EDM incorporated these components towards the development of design theory in its knowledge production.

Table 8-8: Components of a design theory for emerging and evolving agility in complex and complicated sociotechnical contexts (adopted from Gregor and Jones (2007, p. 322))

Design theory component	Incorporation of the design theory component
(1) **purpose and scope** — the purpose of the artefact	The purpose was to develop an artefact that could achieve agile EDM. To this end, the structural and dynamic parts of the framework were developed in two DSR cycles that grounded the artefact's components in scientific knowledge and theories, and tested the fulfilment of the artefact's structural and dynamic parts in their purpose through empirical case study methods.
(2) **constructs** — the representations of the entities of the artefact being studied	The constructs of the artefact were the structural and dynamic components of the framework for agile EDM. These components were the units of analysis formulated from the respective SLR findings and constructs of the underpinning theories (dynamic capabilities, CAS and CSH) that were applied to the qualitative case study data.
(3) **principles of form and function** — the abstract architecture of the artefact	The abstract architecture of agile EDM included its structural and dynamic components, framed as a multi-level flow concept for emerging and evolving agility in complex and complicated sociotechnical contexts. The macro-level represents EDM as complex and complicated sociotechnical contexts, the meso-level defines the activities and interactions in EDM as governed by dynamic capabilities, and the micro-level defines the systemic mechanism for influencing agility in EDM as CSH boundary judgements that underlie agents' heuristics.
(4) **artefact mutability** — to what degree the theory anticipates changes in the artefact	Because of the nature of CAS, the artefact's design must inherently support uncertainty and continuous change to be viable in a real-world setting. Enabling constraints are highly context-sensitive and enable agents to navigate complex contexts for favourable agility consequences. Thus it is designed to function in complex and complicated sociotechnical contexts. However, practical challenges to successfully implementing the artefact will likely arise in a naturalistic setting due to the constructs' context sensitivity in complex contexts, requiring refinements of the framework's method.
(5) **testable propositions** — to what degree do the propositions of the design theory hold true when empirically tested in a real-world setting	The artefact's propositions were applied to a qualitative case study in each DSR cycle, thus providing a precursory, naturalistic formative evaluation of the artefact's design. In addition, the artefact evaluation obtained 94% consensus from a panel of data management experts. However, the final artefact was not implemented in a real-world setting. Therefore, the propositions of the artefact's design cannot be conclusively tested and confirmed as truth presenting a design theory.

Design theory component	Incorporation of the design theory component
(6) **justificatory knowledge (theories)** — the underlying scientific theories that provide the basis and explanation of the artefact's design	The design of the artefact was founded on the scientific theories of dynamic capabilities (Pavlou and El Sawy, 2011; Teece, Peteraf and Leih, 2016), CAS (Holland, 1992; Juarrero, 2000) and CSH (Ulrich, 2000).
(7) **principles of implementation** — a description of how to implement the theory in specific contexts	Principles for implementing the artefact in a real-world EDM context are described as part of the primary research contribution in section 8.1.5 on page 379. The contributions towards design theories of the structural and dynamic parts of the framework for agile EDM are discussed in sections 8.3.1 and 8.3.2 below.
(8) **an expository instantiation** — a physical implementation of the artefact providing a representation of the design theory as a test and expository device	The design of the final artefact of this DSR study is closely bounded by its adopted scientific theories. The qualitative case study in each DSR cycle provided an initial physical "test" of the artefact's design in the real world. Experts evaluated the artefact to be 94% viable for real-world implementation. However, the artefact was not instantiated in a real-world context.

8.3.1 An approach to develop the structural components of phenomena in sociotechnical contexts

The first DSR cycle developed the structural components of a phenomenon (agility) in a sociotechnical domain (EDM) to answer the first sub-question: "What are the structural components of agile enterprise data management?"

Dynamic capabilities involve sensing, learning, integrating and coordinating (Pavlou and El Sawy, 2011) and have been generalised to capabilities that govern an organisation's activities to enable the organisation to cope with uncertainty and seize opportunities and deal with threats (Teece, Pisano and Shuen, 1997; Teece, Peteraf and Leih, 2016). Based on the generalisability of dynamic capabilities theory, the ubiquitousness of decision-making in organisations (Kurtz and Snowden, 2003), and the broad consensus in IS research that sociotechnical contexts are complex (involve uncertainty) and complicated (require

expertise) (Gregor, 2009; Park, El Sawy and Fiss, 2017; Crick and Chew, 2020), the first DSR cycle offers an approach for developing the structural components of phenomena in sociotechnical contexts (see Figure 8-6).

The method used to design the structural components of agile EDM could potentially be used as an approach to study a phenomenon of interest other than agility, such as strategy, innovation or teamwork in a sociotechnical domain of interest other than EDM, for example, digital transformation, cyber security or IT infrastructure management. Conducting an SLR and analysis similar to that of DSR Cycle 1 that identified the features of agility in IS, the features of the phenomenon of interest could be searched and reviewed in the IS literature to develop the structural components of the phenomenon in the sociotechnical domain. For example, the method could be used as an approach to develop “the structural components of innovative IT infrastructure management”.

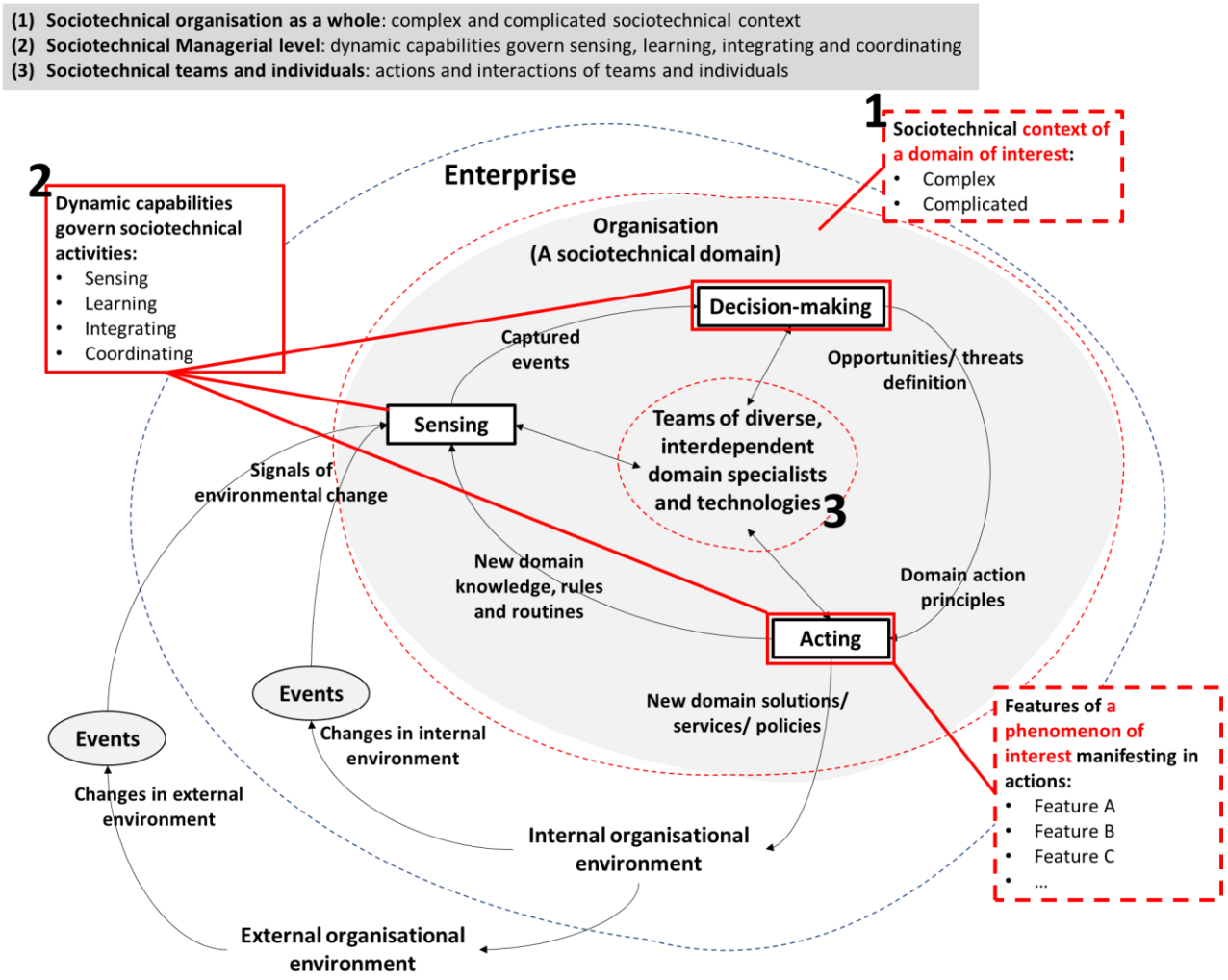


Figure 8-6: An approach to develop the structural components of a phenomenon of interest in a sociotechnical domain of interest (based on Pavlou and El Sawy (2011); Park, El Sawy and Fiss (2017, p. 653))

8.3.2 An approach to develop the dynamic components of agility in sociotechnical contexts

The second DSR Cycle developed the dynamic components of agility in a sociotechnical domain of interest (EDM) to answer the second sub-question: "What are the dynamic components of agile enterprise data management?"

The multi-level dynamic components of agility in complex and complicated sociotechnical contexts are underpinned by the theories of dynamic capabilities (from DSR Cycle 1), CAS and CSH. The macro-level represents complex and complicated sociotechnical contexts, the meso-level defines the actions and interactions in sociotechnical contexts governed by

dynamic capabilities, and the micro-level defines the systemic mechanism for influencing agility in sociotechnical contexts as CSH boundary judgements that underlie agents' heuristics. Based on the generalisability of the underpinning theories (dynamic capabilities, CAS and CSH), the method used to develop the dynamic components of agility in sociotechnical contexts shaped the dynamic part of a framework for agile EDM, potentially offering an approach to study agility in other sociotechnical domains (see Figure 8-7).

The method used for designing the dynamic components of agile EDM could potentially be used as an approach to study agility in a sociotechnical domain of interest other than EDM, for example, cloud computing or robotic process automation. Even though seven agility features were identified in the IS literature in DSR Cycle 1, these features were further developed through the qualitative case study. Therefore, the development approach proposed in Figure 8-7 does not assume that the seven agility features represent a complete list of relevant features for all studies of agility in a sociotechnical domain of interest other than EDM. Nonetheless, the proposed approach can potentially be applied to develop the dynamic components of agility in the sociotechnical domain of interest. For example, the approach could be applied to develop "the dynamic components of agile robotic process automation".

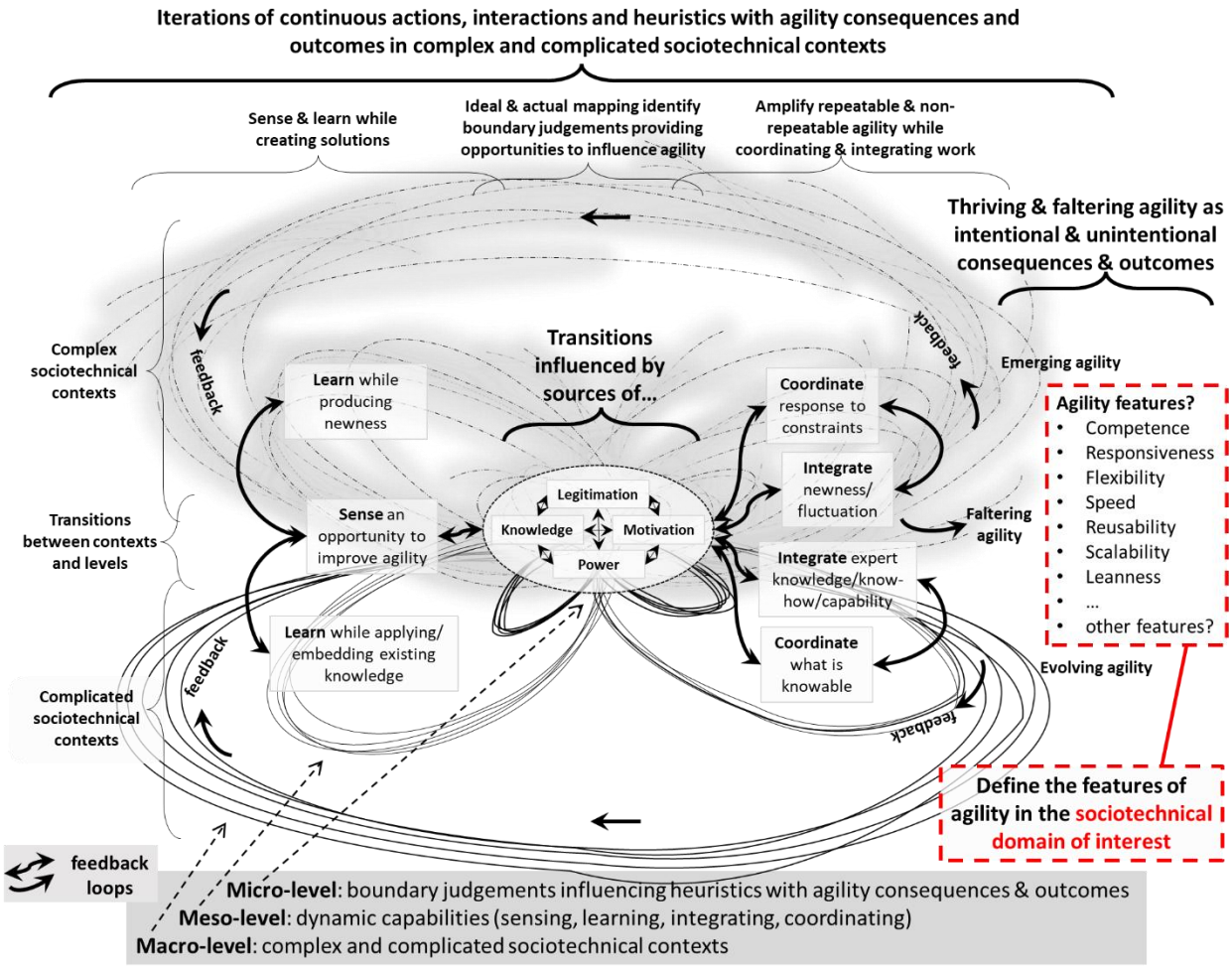


Figure 8-7: An approach to develop the dynamic components of agility in a sociotechnical domain of interest (based on Holland (1992); Juarrero (2000); Ulrich (2000); Kurtz and Snowden (2003); Pavlou and El Sawy (2011); Salthe (2012); Park, El Sawy and Fiss (2017); Snowden (2021c))

8.4 CONCLUSION

This chapter presented the primary and secondary contributions of this DSR study of agile EDM to data management practitioners and IS scientific knowledge. The primary contribution was a framework for agile EDM. The primary contribution developed a framework for emerging and evolving agility in complex and complicated EDM contexts, thus answering the main research question:

Main-RQ:	*How* can agile enterprise data management be achieved?

The secondary contributions provided an approach to bounding and synthesising the underlying theories (dynamic capabilities, CAS and CSH), offering two development approaches towards design theory that are potentially useful for conducting research that explains the structural and dynamic components of phenomena of interest in complex and complicated sociotechnical domains of interest.

The last chapter of this thesis concludes with an overview of the study and its limitations, and provides suggestions for future research on agile EDM and, perhaps more broadly, emergent and evolutionary phenomena in complex and complicated sociotechnical contexts.

9 CONCLUSION AND FUTURE RESEARCH

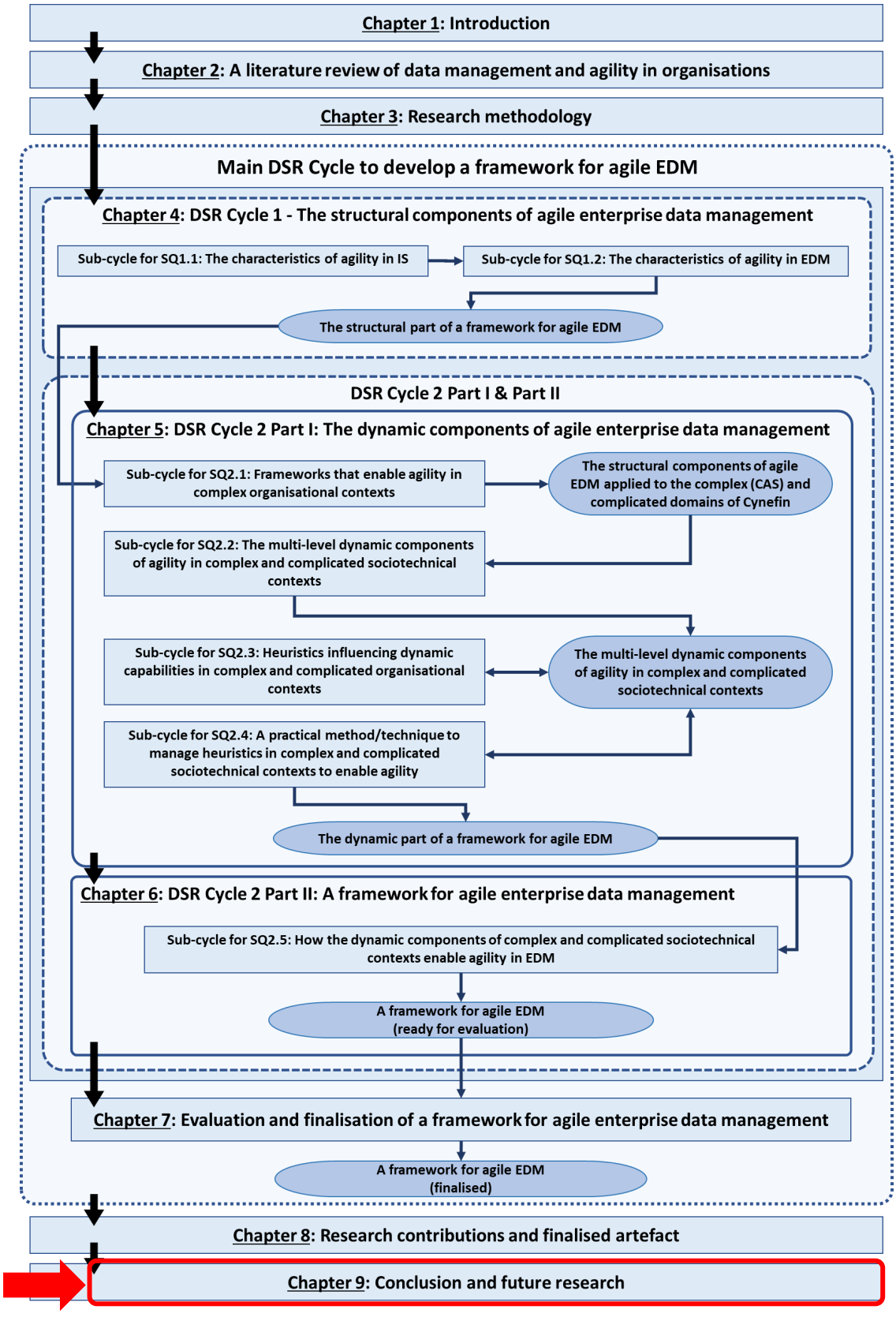


Figure 9-1: Chapter map — Chapter 9

This chapter concludes this study of agility in EDM, which applied a DSR strategy to design and develop a framework for achieving agile EDM. This study argued that agility in organisations is not a monolithic construct that can be achieved as a goal in a linear causal way. Instead, agility in EDM was explained as a phenomenon with domain-specific features that continually emerge and evolve as intended and unintended outcomes and consequences, feeding back into the complex and complicated sociotechnical contexts from where they originate. Even though this study aimed to answer how agile EDM can be achieved, addressing this problem required a thorough investigation into scientific literature and theories, and current data management practices, iteratively excavating and solving sub-questions about the structural and dynamic parts of agile EDM to produce an answer that satisfied the research objectives.

9.1 RESEARCH PROBLEM STATEMENT AND PURPOSE

A review of scientific and practitioner literature in Chapter 2 highlighted the strategic importance of data in organisations, and that achieving agility in organisations requires IT agility. This implicated agility in data management, presented agile EDM as a requirement in real-world contexts (Marchand and Peppard, 2013; Tallon, Ramirez and Short, 2013; Al-Ruithe, Benkhelifa and Hameed, 2019), and confirmed a research-worthy gap in IS scientific and practitioner knowledge to generate the main research question of this thesis:

Main-RQ:	*How* can agile enterprise data management be achieved?

Practical methods for achieving organisational agility remain elusive (Sanchez and Nagi, 2001; Teece, Peteraf and Leih, 2016; Wendler, 2016; Sidky, 2017; Walter, 2021). Additionally, the concept of agility is abstract, and perspectives in management, strategy and IS literature for constructs for agility in organisational contexts are diverse in their content and structure (Tallon and Pinsonneault, 2011; Teece, Peteraf and Leih, 2016; Wendler, 2016; Appelbaum *et al.*, 2017; Sidky, 2017; Knabke and Olbrich, 2018; Werder and Maedche, 2018). As Wendler (2013, 2016) suggests, there is no consistent definition of agility in organisational contexts.

A search for scientific literature addressing agility in data or information management did not find any theoretical or practical frameworks or models that specifically addressed the requirement for agile EDM.

According to Pentek, Legner and Otto (2017), frameworks addressing data management requirements aim to answer “how” questions by providing prescriptive knowledge for pragmatic solutions to problems. This study answered the research question by developing a framework for agile EDM, presented as a model and a method, rooted in scientific knowledge and theory, and the findings of an empirical, qualitative case study conducted at a large financial services organisation (BankGroup).

9.2 RESEARCH QUESTIONS AND STRATEGY

Having formulated the research problem of agile EDM using the existing literature spanning multiple scientific disciplines, it was apparent that a coherent structure was needed before the research topic’s underlying concepts, “agile” and “enterprise data management”, could be logically and scientifically approached (Webster and Watson, 2002).

The problem statement of this thesis presented the gap in scientific knowledge that this study aimed to close by developing a framework for agile EDM using a DSR strategy. Even though sensing and responding are well-researched antecedents for organisational agility (Sambamurthy, Bharadwaj and Grover, 2003; Teece, Peteraf and Leih, 2016; Tallon *et al.*, 2019), there is limited consensus on the characteristics of agile organisations (Wendler, 2013, 2016). In addition, existing scientific research offers explanations for capabilities that enable organisational agility (Teece, 2016; Appelbaum *et al.*, 2017), but the processes for achieving agility in organisations are undeveloped (Park, El Sawy and Fiss, 2017; Walter, 2021; Limaj and Bernroider, 2022).

Therefore, this study of agile EDM first developed the structural part of the framework for agile EDM (explaining what the framework components are) and subsequently developed the dynamic part of the framework (explaining how the structural components interrelate and function to produce agility outcomes and consequences). This approach defined the problem space for “agile EDM”, including its boundaries, nature and rationale, within which a solution to the research problem could be sought (Simon, 1996). This approach provided the scaffolding to build an understanding of the scope of an investigation into agile EDM, prompting an iterative excavation of the sub-questions as the research process unfolded (Ravitch and Riggan, 2017).

The requirement for an iterative investigation of the research problem, combined with the research objective to produce a framework for agile EDM, deemed DSR a suitable strategy

for this study. In DSR studies, the problem and solution space are synchronously constructed, thus iteratively dealing with the inherent complexity of sociotechnical problems as the solution design and construction progresses and matures through multiple DSR cycles (Baskerville *et al.*, 2018). The iterative construction of the research questions, synchronised with the DSR cycles that developed the DSR artefact of this study, is presented in Table 9-1. (Detailed representations of the iterative research process are presented in Figure 3-4 on page 60, Table 3-4 on page 61, and Figure 3-6 on page 67).

Table 9-1: Iterative construction of research questions, DSR cycles, methods and outputs

	Research questions	Output	Methods
Main DSR cycle (Chapters 4, 5 and 6)	**Main-RQ:** How can agile enterprise data management be achieved?	**A framework for agile EDM (finalised)**	SLRs, qualitative case study, and Delphi method
DSR Cycle 1 (Chapter 4)	**Sub-RQ1:** What are the structural components of agile enterprise data management?	**The structural part of a framework for agile EDM**	SLR and qualitative case study
	SQ1.1: What are the characteristics of agility in Information Systems?	The characteristics of agility in IS	SLR
	SQ1.2: What are the characteristics of agility in enterprise data management?	The structural components of agile EDM	Qualitative case study
DSR Cycle 2 (Chapters 5 and 6)	**Sub-RQ2:** What are the dynamic components of agile enterprise data management?	**A proposed framework for agile EDM (pre-evaluation)**	SLR and qualitative case study
Part I (Chapter 5)	**SQ2.1**: What scientific frameworks, models or methods enable agility in complex organisational contexts?	The structural components of agile EDM applied to the complex (CAS) and complicated domains of Cynefin	SLR
	SQ2.2: What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?	A concept for the multi-level components of agility in complex and complicated sociotechnical contexts	Synthesis of CAS, dynamic capabilities, and the structural part of the framework
	SQ2.3: How do heuristics influence dynamic capabilities in organisational contexts?	The multi-level components of agility in complex and complicated sociotechnical contexts	SLR
	SQ2.4: How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?	**The dynamic part of a framework for agile EDM**	Synthesis of CSH literature and multi-level dynamic components of the framework
Part II (Ch. 6)	**SQ2.5**: How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?	**A framework for agile EDM (ready for evaluation)**	Qualitative case study

This study adopted the DSR process proposed by Vaishnavi, Kuechler and Petter (2004) to develop a framework for agile EDM in two DSR cycles. The output of each of the two DSR cycles prompted the next cycle's awareness of a problem and offered a suggestion for its solution, and then presented its product for refinement and further development in the next cycle, thus iterating the research cycles until the final DSR artefact was developed.

9.3 SUMMARY OF RESEARCH FINDINGS

9.3.1 Requirement for a framework for agile enterprise data management

Data management capabilities perform data governance and specialised technical data management functions that support data lifecycle and usage activities within and across multiple diverse data management disciplines (Legner, Pentek and Otto, 2020), spanning an organisation's operational, tactical and strategic levels (Brous, Janssen and Vilminko-Heikkinen, 2016). Enterprise data management comprises a multitude of diverse social and technical agents, often interacting under uncertain conditions, thus having to constantly adapt to changes in the internal and external environment of the organisation (Böhmer, Dabrowski and Otto, 2017; DalleMule and Davenport, 2017; Al-Ruithe, Benkhelifa and Hameed, 2019). The context-sensitive, interdependent and diverse nature of data management activities, the non-linear interactions of data management agents, the importance of data to organisations, and the difficulties organisations face in defining and achieving agility, were evident in the literature. The findings of the qualitative case study, and the expert evaluation of the proposed framework for agile EDM supported the relevance and importance of agile EDM as an exciting and valuable research problem to pursue.

A review of the scientific and practitioner literature about the current state of and requirement for agile EDM confirmed the relevance of the main research question:

Main-RQ:	*How* can agile enterprise data management be achieved?

9.3.2 DSR Cycle 1: The structural components of agile enterprise data management

The SLR conducted in the first DSR cycle developed the structural components of agile EDM based on the characteristics of agility in IS, thereby rooting the DSR artefact's design in existing IS research. The research questions addressed in DSR Cycle 1 were as follows:

Sub-RQ1:	*What* are the structural components of agile enterprise data management?
SQ1.1:	What are the characteristics of agility in Information Systems?
SQ1.2:	What are the characteristics of agility in enterprise data management?

SQ1.1 was addressed by developing the structural components of agile IS based on the SLR. The findings from analysing the SLR data produced the structural components of agile IS: (1) the sociotechnical contexts of IS are complex and complicated, (2) the dynamic capabilities of sensing, learning, coordinating and integrating govern actions and interactions at the IS managerial level, and (3) competence, responsiveness, flexibility, speed, reusability, scalability and leanness are agility features that manifest in IS agents' actions.

To address **SQ1.2**, the structural components of IS were applied to the qualitative case study data and analysed using qualitative thematic analysis techniques. The findings of the qualitative data analysis confirmed that the structural components of agile IS applied to EDM, and produced the structural part of a framework for agile EDM: (1) the sociotechnical contexts of EDM are complex and complicated, (2) the dynamic capabilities of sensing, learning, coordinating and integrating govern actions and interactions at the EDM managerial level, and (3) competence, responsiveness, flexibility, speed, reusability, scalability and leanness are agility features that manifest in EDM agents' actions.

The qualitative data analysis found differences in agility features and dynamic capabilities depending on whether the EDM context was complex or complicated. The structural components of agile EDM could not yet explain these differences or the underlying causes and influences resulting in achieving or failing to achieve agility in EDM. Therefore, the dynamic mechanisms for achieving agility in the complex and complicated contexts of EDM could not be explained by the structural components of agile EDM alone. This raised the second sub-question, which was addressed in DSR Cycle 2 Part I.

9.3.3 DSR Cycle 2 Part I: The dynamic components of agile enterprise data management

The structural part of a framework for agile EDM that was developed in the first DSR cycle defined the structural components of agile EDM. Part I of DSR Cycle 2 developed the dynamic part of a framework for agile EDM by systematically reviewing the literature on the dynamics of achieving agility in organisational and sociotechnical contexts, and answering the following research questions:

Sub-RQ2:	*What* are the dynamic components of agile enterprise data management?
SQ2.1:	What scientific frameworks, models or methods enable agility in complex organisational contexts?
SQ2.2:	What are the multi-level dynamic components of agility in complex and complicated sociotechnical contexts?
SQ2.3:	How do heuristics influence dynamic capabilities in organisational contexts?
SQ2.4:	How can heuristics be managed to enable agility in complex and complicated sociotechnical contexts?

To address **SQ2.1**, an SLR was conducted to find existing frameworks, models and methods which enable organisations to achieve agility. A concept matrix was used to analyse the literature, and considered each construct's objectives, theoretical foundations, application contexts and scope. The most appropriate construct found was the Cynefin framework by Kurtz and Snowden (2003). Cynefin is a decision-making framework that is founded in systems theory (complicated domain) and CAS (complex domain), and explains the dynamics of sensing and responding in complex, complicated, clear and chaotic organisational contexts (see Figure 5-5 on page 149). Key decision points offer opportunities for effective decision-making at the boundary between complex and complicated to transition the system towards a favourable state (Snowden, 2021c; Snowden and Rancati, 2021).

Teece, Peteraf and Leih (2016) argued that dynamic capabilities could enable an organisation to achieve agility. However, the complexity of sociotechnical contexts renders causal mechanisms for agility ineffective (Kurtz and Snowden, 2003). Instead, critical thinking approaches, such as CSH (Ulrich and Reynolds, 2020), can effectively influence

how agents in a CAS navigate complex and complicated sociotechnical contexts, such as EDM, for the emergence and evolution of phenomena, such as agility. The opportunities to influence the agility state of the complex and complicated sociotechnical CAS towards favourable agility consequences and outcomes surface in the liminal space between complexity and complicatedness, and thinking and acting (Kurtz and Snowden, 2003).

In the Cynefin framework, CAS is a foundational theory for the complex domain, and System Thinking guides sensing and responding in the complicated domain (Kurtz and Snowden, 2003; Snowden, 2015a; Snowden and Rancati, 2021). A CAS comprises agents that learn and adapt in response to their interactions (Holland, 2014), thereby continuously reconfiguring the CAS's structure through self-organisation (Juarrero, 1999; Turner and Baker, 2019; Snowden and Rancati, 2021). By adopting Cynefin for developing the dynamic part of the framework for agile EDM, CAS theory must be incorporated into the artefact's design.

Emergent and evolutionary phenomena in complexity can only be meaningfully studied across multiple levels due to the fractal nature of complexity (Cilliers, 1998; Salthe, 2012; Juarrero, 2015b; Ramos-Villagrasa *et al.*, 2018; Snowden and Rancati, 2021). Analogously, the structural part of a framework for agile EDM incorporated three organisational levels, as concluded in SQ1.2. Therefore, **SQ2.2** developed a concept for the multi-level components of agility in complex and complicated sociotechnical contexts from synthesising the structural components of agile EDM and CAS literature, conceptualising agile EDM as a CAS.

The macro-level in the system represents the overall complex and complicated sociotechnical context, and the meso-level is where dynamic capabilities govern agents' actions and interactions (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011). At the micro-level, decision-making at the boundary between complex and complicated can transition the system towards favourable agility outcomes and consequences (Snowden, 2021c; Snowden and Rancati, 2021). The emergence of phenomena in a CAS is supported by enabling (context-sensitive) constraints, functioning part-to-whole in the system, whereas governing (context-free) constraints restrict the system from the top down (whole-to-part), evolving the system as a whole (Juarrero, 2015b).

However, complex organisational contexts pose challenges to decision-making, and agents must find “good enough” answers to questions for which the best answers are unknowable (Simon, 1996). Humans have evolved to continuously assess and scan the environment, enabling responses to opportunities and threats to survive the ongoing context (Kahneman, 2011). Humans typically use heuristics to make decisions based on incomplete information, trying to solve unclear problems with uncertain probabilities of outcomes (Gigerenzer & Gaissmaier, 2011). Heuristics are integral to professional practice that deals with ill-defined, qualitative issues, and uncertainty about which changes would constitute an improvement for an identified problem to be solved for which there is no right or wrong solution (Ulrich, 2005).

Therefore, **SQ2.3** was raised to explain the relationship between heuristics, decision-making and dynamic capabilities from the literature. To address this question, an SLR was conducted to find and analyse articles based on the concepts of (1) the purpose and effects of heuristics, (2) the implications for decision-making when using heuristics, and (3) the influence of heuristics on dynamic capabilities. The findings of the SLR confirmed that there is an evident relationship between heuristics and dynamic capabilities. The findings were applied to refine and further develop the multi-level components of agility in complex and complicated sociotechnical contexts.

Through abductive reasoning, **SQ2.4** was raised, proposing that a practical method or technique is required for managing the relationship between heuristics and dynamic capabilities so that the CAS of EDM can iteratively transition towards thriving agility. This would offer an explanation for the micro-level of the multi-level components of agility in complex and complicated sociotechnical contexts. For this purpose, CSH (Ulrich, 2000) was adopted as the theory explaining how boundary judgements underlying heuristics can influence agents’ actions and interactions to shift the complex and complicated sociotechnical CAS’s agility state towards more favourable agility consequences and outcomes. Through this process of answering SQ2.4, the dynamic part of a framework for agile EDM was developed and prepared for its application to the qualitative case study data.

9.3.4 DSR Cycle 2 Part II: A framework for agile enterprise data management

The constructs and relationships of the dynamic part of a framework for agile EDM, which was developed in DSR Cycle 2 Part I, were applied to the qualitative case study data. In

addition to the data collected in the semi-structured interviews, the case study organisation's data management policy and standards documents were also collected.

The narratives of data management practitioners' lived experiences, views and opinions on how agility is influenced in EDM actions and interactions were analysed. The theoretical constructs of the dynamic part of a framework for agile EDM were used for *a priori* coding and thematic analysis of the data. The constructs for dynamic capabilities and agility features were respectively refined for complex and complicated EDM contexts described in the data. Perspicuous relationships between dynamic capabilities and agility features were found in the data, but the relationships did not explain the mechanisms for emerging and evolving agility in EDM. This raised the fifth sub-sub-question for explaining the dynamic components of agile EDM:

Sub-RQ2:	*What* are the dynamic components of agile enterprise data management?
SQ2.5:	How do the dynamic components of complex and complicated sociotechnical contexts enable agility in enterprise data management?

To address **SQ2.5**, the thematic analysis process inductively applied the concepts for sources of influence (power, motivation, knowledge and legitimation) from CSH theory (Ulrich, 2000) to the data to uncover the data management practitioners' underlying boundary judgements present in their narratives. It became evident from the data analysis that the data management practitioners' boundary judgements influenced attractor patterns for emerging and evolving agility in EDM. Therefore, this study concluded that practising CSH boundary critique could provide opportunities to continuously assess, renegotiate and influence the agility state of an organisation's EDM.

The case study found that the theoretical constructs of the framework could be meaningfully applied to real-world data, confirming that agile EDM is a CAS, that EDM contexts are sociotechnical, complex and complicated at the macro-level, and confirming data management activities and interactions as dynamic capabilities at the meso-level. At the micro-level, boundary judgements were found to serve as enabling (context-sensitive) and governing (context-free) constraints influencing agility emergence and evolution. However, the 45 boundary judgements inductively derived from the case study data as sources of influence (knowledge, motivation, legitimation, and power) on agility in EDM were inextricable from the context of EDM at the case study organisation. This final part of DSR

Cycle 2 produced a proposed framework for agile EDM, ready for the DSR artefact evaluation phase.

9.3.5 Evaluation of the framework for agile enterprise data management

The framework for agile EDM was developed and refined through two DSR cycles, with two and five sub-cycles, respectively. The output of the second DSR cycle proposed a framework for agile EDM that had to be evaluated as part of a DSR strategy for developing an artefact using scientific methods. Data management experts evaluated the framework for its relevance, usability, flexibility, comprehensibility, completeness, efficiency and effectiveness if it were to be implemented in a real-world EDM context.

The Delphi method was chosen for evaluating the framework for agile EDM. A naturalistic situated instantiation of the framework was not considered a feasible method for evaluating the artefact due to the implementation scale required for the evaluation to be conclusive. Instead, this study consulted a panel of data management experts with diverse and extensive experience as data management practitioners, including in data management leadership roles in large organisations. The depth and width of the data management expert's experience provided insights from a collective 158 years of experience in data management roles across a wide range of data management functions and industries. The expert panel reached a consensus of 94% that the proposed framework for agile EDM was likely to be relevant, usable, flexible, comprehensible, complete, efficient and effective for achieving agile EDM in real-world EDM contexts. Despite the high consensus rate amongst the data management experts who participated in the Delphi evaluation of the framework, their comments in the questionnaire responses provided valuable insights that were analysed and used to further refine and improve the framework for agile EDM.

9.3.6 Main DSR cycle: A framework for achieving agile enterprise data management

This research executed a DSR strategy to develop a framework for agile EDM in two DSR cycles that answered the main question of this thesis:

Main-RQ:	*How* can agile enterprise data management be achieved?

The overall conclusion drawn from the outcomes of the two DSR cycles confirmed a gap in scientific and practitioner knowledge regarding agile EDM and how organisations could

achieve agile EDM. The framework for agile EDM was developed and refined through two iterative DSR cycles, including sub-cycles, and evaluated by data management experts using the Delphi method.

The feedback received from the Delphi expert panel was incorporated to improve and finalise the framework for agile EDM as the primary artefact produced by this DSR study. The framework diagram was refined to clarify the transitions and feedback loops through the three flow levels. In the finalised artefact description, suggestions were offered for how the constructs of the framework could be continuously reviewed to remain relevant for ongoing EDM contexts. A process and template were defined, based on the CSH process of ideal and actual mapping (Ulrich and Reynolds, 2020), for the continuous contextualisation of boundary judgements involved in ongoing EDM initiatives. Suggestions were provided for building and maintaining a "master list" of an organisation's boundary judgements influencing agile EDM. Dual ownership of agile EDM by the organisation's data management leadership (for top-down influencing) and practitioners working on data management projects (for bottom-up influencing) was proposed, and some suggestions on training in complexity, strategic and critical thinking practices were put forward to support an organisation's purpose for achieving agile EDM.

The framework for agile EDM was the primary contribution of this study. Two development approaches towards design theories were offered as potential secondary contributions: (1) an approach to develop the structural components of emergent and evolutionary phenomena in sociotechnical contexts, and (2) an approach to develop the dynamic components of agility in sociotechnical contexts.

9.4 REFLECTION

In aiming to create a solution to the problem of achieving agile EDM that is valuable to the fields of practice and science, the approach was first to clarify the problem space, setting the boundaries for constructing an artefact for the solution from scientific knowledge and well-established theories, and empirical qualitative case study research.

The seven guidelines for DSR, as proposed by Hevner *et al.* (2004), provided an understanding for this study of agile EDM of what effective DSR is. These guidelines, and how they were applied in this research to design and build a framework for agile EDM that contributes to scientific and practical knowledge, are presented in Table 9-2.

Table 9-2: Design science research guidelines applied to the study of agile EDM (adopted from Hevner *et al.* (2004, p. 83))

Guideline	Description and application to this study of agile EDM
Guideline 1: Design as an Artefact	A viable artefact, which could be a method, model, construct or instantiation, is produced from the DSR. A framework for agile EDM was developed in two DSR cycles, producing an artefact based on scientific knowledge and underlying theories, applied in a qualitative case study and evaluated by expert data management practitioners for its relevance and fitness for application in real-world EDM contexts.
Guideline 2: Problem Relevance	The artefact produced by the DSR should aim to solve a relevant, “real world” and important business problem. The literature review in Chapter 2 confirmed the relevance of the research problem which is, “How do organisations achieve agile EDM?” The relevance of agile EDM was confirmed in a qualitative case study in DSR Cycle 1.
Guideline 3: Design Evaluation	The methods used for evaluating the DSR artefact should be well-executed and rigorously demonstrate the artefact’s quality, utility and effectiveness in solving the problem. The Delphi method was applied to evaluate the framework for agile EDM. A panel of data management experts with cross-industry experience evaluated the framework for agile EDM, achieving a 94% consensus on the practicability of the artefact. The feedback received from the data management experts was incorporated to improve the artefact’s design as well as its utility, quality and effectiveness.
Guideline 4: Research Contributions	The design artefact, the design methodologies, and the design's foundations should afford clear contributions that can be substantiated. The primary contribution of this study is the DSR artefact produced, a framework for agile EDM. This study offered two secondary contributions: (1) an approach to develop the structural components of phenomena in sociotechnical domains, and (2) an approach to develop the dynamic components of agility in sociotechnical domains.
Guideline 5: Research Rigour	Rigorous methods should be employed to create and evaluate the artefact produced by the study. The literature reviews followed the SLR process and techniques proposed by Webster and Watson (2002) and Okoli (2015). The qualitative case study design and process were guided by Myers (2013). The data collection process was informed by Myers (2013) and King, Horrocks and Brooks (2019). The data analysis process was guided by Braun and Clarke (2012) and Miles, Huberman and Saldaña (2020).
Guideline 6: Design as a Search Process	To produce an artefact with the desired utility, the available means to achieve the desired ends must be utilised while adhering to the laws prescribed by the problem environment. Chapter 8 presents the finalised artefact, including a description of the process and templates to aid its implementation in a real-world EDM context requiring improved agility.

Guideline	Description and application to this study of agile EDM
Guideline 7: Communication of Research	The DSR should be communicated effectively and be comprehensible to audiences from both a technical/practitioner and a management perspective. At least two research papers were submitted to respectable journals interested in publishing articles related to agile EDM.

The sequential process of the DSR artefact's construction started in the problem space with the structural components of agile EDM, then constructed the artefact's design from theories and completed the artefact development through empirical study that collected and analysed qualitative data. This approach unfolded naturally as each DSR cycle started with the awareness of a problem and a suggestion to solve it, thereby iteratively moving from the problem space towards the solution space.

9.5 RESEARCH LIMITATIONS

At the micro-level, boundary judgements influencing agile EDM are acutely dependent on their context and represent contextualised enabling (context-sensitive) and governing (context-free) constraints. As proposed in the implementation approach for the framework in section 8.1.5 on page 379, the organisation's "master list" of boundary judgements would have to be updated continuously through bottom-up feedback loops originating from the ongoing data management initiatives in the organisation. Therefore, the framework for agile EDM would have to be implemented in a real-world context where its relevance, usability, flexibility, comprehensibility, completeness, efficiency and effectiveness will be continuously shaped by its practical use in an organisation's EDM contexts.

The implementation guidelines describe how the framework could be put into practice. However, the framework for agile EDM was not instantiated and tested in the real world. Therefore, no authentic evidence of its practicability in real-world EDM contexts can be provided. As illustrated by DAMA International's (2017) functional view of data management activities in Figure 2-6 on page 28, EDM in organisations can comprise large numbers of human and technological agents performing diverse, specialised, interdependent data management functions. At the time of this research, the case study organisation employed approximately 2 500 data management practitioners in 150 data management roles. Therefore, a large-scale implementation would likely be necessary, albeit resource intensive, to obtain reliable results providing evidence that the framework for agile EDM is viable for achieving agile EDM in the real world.

It will require training and experience for data management leadership and specialists in the organisation to build the ability to know whether a given EDM context is complex or complicated and to institute strategic and critical thinking approaches to agility in data management initiatives. However, organisations are not new to complex contexts, and data management is a field of idiosyncratic expertise. Therefore, an organisation should discern where their abilities to deal with complex adaptive contexts require improvement and investigate what training is relevant and available to their EDM practitioners.

Other limitations that challenge the framework for agile EDM in its practicability to achieve agile EDM were raised by the data management experts who participated in the artefact evaluation process:

- The sociotechnical nature of EDM implies that any successful implementation of the framework would rely heavily on the collective commitment of people. As one participant of the data management expert panel pointed out: *"The problem is the absolute reliance on people to achieve agility. (Much) more research into the human component will be required to understand how to unleash that potential to achieve agility in EDM".*
- Integration of the framework for agile EDM with existing data management processes through change management in an organisation was a concern raised by an expert panel participant: *"A bit concerned around how agile organisations generally are to evolve and update policies. The research does not extend into making the processes etc. around this agile with the appropriate change management"*, and "*I believe it falls outside the boundaries of the research, however change management around policy updates and assimilation into operations might negatively impact agility*".
- Integration of the framework for agile EDM with the data management functions and data capabilities of the organisation, as suggested by an expert panel participant: *"I still would like to see the link between the boundary judgement questions and the data capability(s)"*. However, an organisation's data management functions are structured and operated according to the organisation's ongoing contexts. The proposed implementation of the framework suggested that the data management functions and data capabilities should be assigned as part of the ideal and actual mapping processes for data management initiatives, but this is likely to require further refinement to be practical.

9.6 FUTURE RESEARCH

This study's primary and secondary contributions, as documented in Chapter 8, offer potential opportunities for future research, which are discussed in this section. Having first identified that there is a requirement in organisations for agile EDM, this study developed and proposed a framework for agile EDM that, if successfully implemented, could lead an organisation to achieve thriving agility in EDM for the benefit of all its stakeholders. From the scientific and practitioner literature, it seems that the pursuit of agility is widespread in IS and in organisations in general. The interim products produced during the iterative development of the DSR artefact presented abstract artefacts as development approaches towards design theories that could potentially be applied more broadly to study emergent and evolutionaty phenomena other than agility in sociotechnical contexts other than EDM.

The abstract artefact for the structural part of the framework for agile EDM, which was conceptualised during the first DSR cycle, could potentially be used as an approach to develop solutions for a phenomenon of interest, other than agility, in a complex and complicated sociotechnical domain of interest, other than EDM.

The abstract artefact for the dynamic part of the framework for agile EDM, which was conceptualised during the second DSR cycle, could potentially be applied as an approach to develop solutions for the emergence and evolution of agility in a complex and complicated sociotechnical context other than EDM. However, agility does not have a formalised definition in IS or organisational science. Thus, different agility features could be identified depending on the search terms used for the thematic coding and analysis of the articles included in the SLR of agility in IS.

Snowden (2002) reflects that systems involving human agents are invariably complex, comprising many interacting agents who can have multiple identities, depending on their role in the unfolding context. A qualitative case study could be undertaken at an enterprise in an industry other than financial services, using a similar approach to how this study first applied the constructs of the proposed framework for agile EDM to the qualitative data, and then inductively derived the contextualised influences on the emergence and evolution of agility from the case study data. However, as CSH was adopted through abductive reasoning based on the relevance of critical systems thinking to complex organisational contexts, other researchers could most likely identify other scientific methods applicable to

the practical management of influences on heuristics and decision-making for agility outcomes and consequences.

The primary contribution of this study, a framework for agile EDM, was the finalised product of the two DSR cycles and the artefact evaluation. Due to EDM's sociotechnical complex adaptive nature, context is embedded in the artefact's design and thus cannot be ignored. However, future research could further enhance the framework for agile EDM to improve its contextualised aspects for integration into other organisational structures that must interact and integrate with EDM in a real-world setting. For example, the framework for agile EDM could be integrated with an organisation's practice of one of the data management frameworks (other than DAMA) presented in Figure 2-5 on page 25 or with a specific framework for monitoring and measuring its data management maturity.

Action research could be an effective methodology to further the study of agile EDM because action researchers work with practitioners to address a significant practical problem (Järvinen, 2007). The relevance and importance of agile EDM and the role of data management practitioners and their technological tools, acting as the agents perpetuating agility in the complex and complicated system of EDM, have been established by this research. Even though this study proposed the framework for agile EDM as a solution to the practical problem of achieving agile EDM, its constructs and relationships could be refined or refuted through more rigorous research in diverse EDM contexts or other sociotechnical domains.

Due to the qualitative nature of the phenomenon studied (agility in EDM), and the limited clarity and consensus in the literature on what agility is, this study first had to find explanations for agility in IS. The findings from the qualitative case study using an inductive approach showed that agility has different features depending on whether the EDM context is complicated or complex. The findings also showed, through abductive, inductive and qualitative reasoning, that the nature of heuristics is highly qualitative and context-dependent because individuals practise heuristics within a given situation. Furthermore, the individuals' boundary judgements underpin their heuristics, influencing how agility emerges and evolves through complex adaptation and routinisation processes. Future research could potentially quantify the agility features and boundary judgements found in this research for the quantitative study of agility across different types of organisations or industries and over

longer timeframes, thereby further refining the framework for agile EDM and improving its generalisability.

9.7 CONCLUSION

The main DSR artefact of this research, a framework for agile EDM, is the primary contribution of this study to scientific IS and data management practitioner knowledge. It offers a model and a method for implementing the framework in real-world contexts, potentially improving agility outcomes for the enterprise's EDM. The framework proposed a solution to an identified, unsolved problem of how organisations can achieve agile EDM to support the enterprise's requirement for timeous, accurate information enabling its sensing and responding capabilities in fast-paced, unpredictable environments (DalleMule and Davenport, 2017; Park, El Sawy and Fiss, 2017).

The development approaches produced from the SLRs of the two DSR cycles for explaining the structural and dynamic components of a phenomenon of interest (agility) in a sociotechnical domain of interest (EDM) constitute the secondary contributions. The first DSR cycle developed the structural components of agile EDM founded in the process proposed by Park, El Sawy and Fiss (2017) for sensing, decision-making and acting in high-speed predictable and unpredictable organisational contexts. Due to the generalisability of dynamic capabilities theory (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011), the ubiquitousness of decision-making in organisations (Kurtz and Snowden, 2003), and the broad consensus in IS research that sociotechnical contexts are complex (involve uncertainty) and complicated (require expertise) (Gregor, 2009; Park, El Sawy and Fiss, 2017; Crick and Chew, 2020), the first DSR cycle's development approach could potentially be used to study the structural components of a phenomenon of interest, other than agility, in a sociotechnical domain of interest, other than EDM.

The second DSR cycle developed the dynamic components of agile EDM and applied them to a qualitative case study. A conceptual framework was developed through SLRs and literature synthesis, and utilised the theories of dynamic capabilities (Teece, Pisano and Shuen, 1997; Pavlou and El Sawy, 2011), CAS (Holland, 1992), and CSH (Ulrich, 2000) to explain the multi-level dynamic components of agility in complex and complicated sociotechnical contexts. Due to the generalisability of these three theories, the development

approach used in DSR Cycle 2 could potentially be applied in the study of dynamic components of agility in a sociotechnical domain of interest other than EDM.

The framework for agile EDM produced through this DSR study will, by its nature, never be complete and in a final state because its validity as a viable artefact is inseparable from the initial conditions and ongoing context of its iterative functioning in the real world. This concurs with the view of Gregor and Hovorka (2011, p. 9) that "[a]ttribution of causality in this situation is difficult precisely because the outcomes emerged from the in situ use of the artifact". A transient state lies at the heart of the design and operation of the framework for agile EDM proposed by this research.

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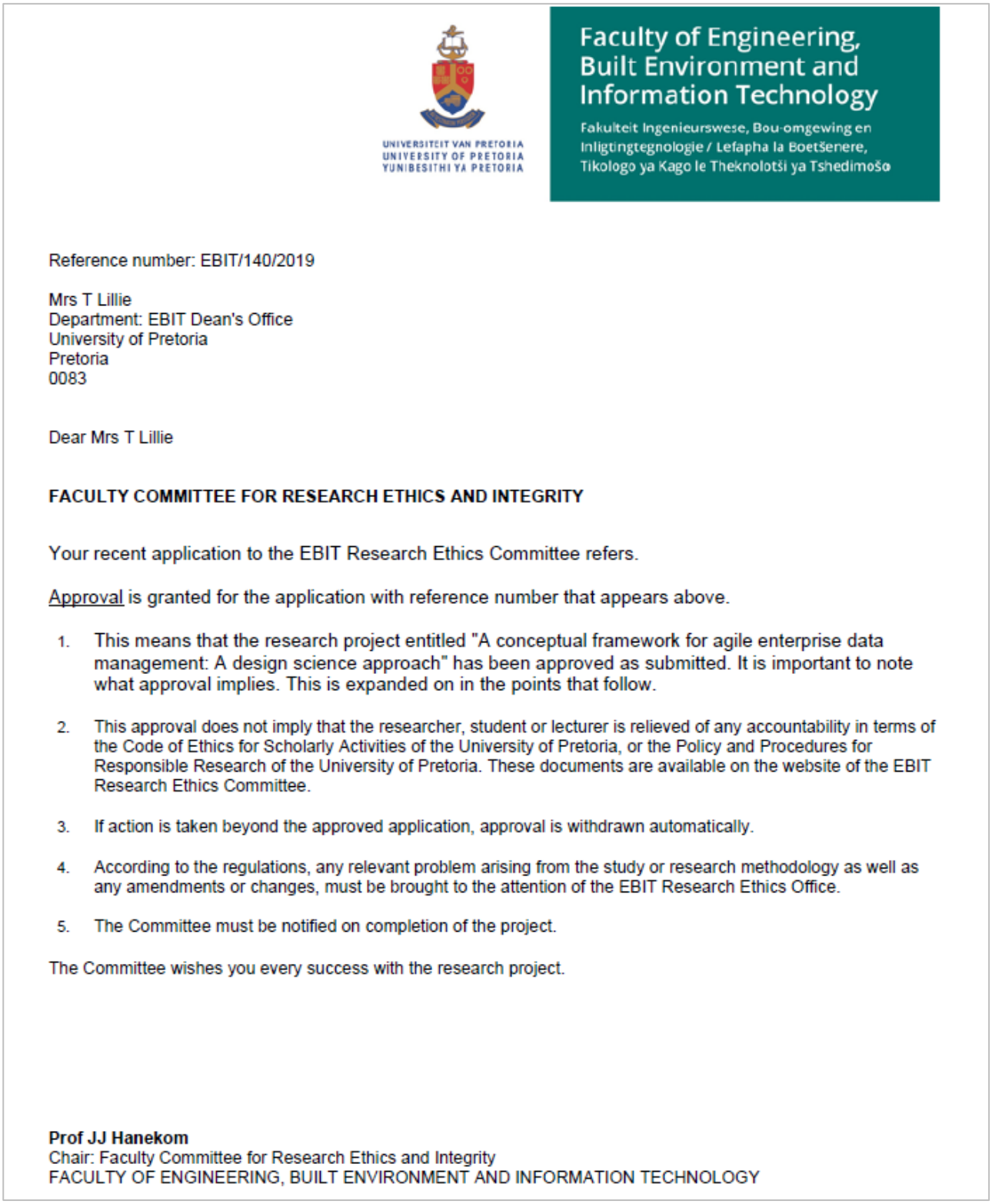
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Appendix A: Ethics approval for qualitative case study

Ethics approval letter from the University of Pretoria



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

Reference number: EBIT/140/2019

Mrs T Lillie
Department: EBIT Dean's Office
University of Pretoria
Pretoria
0083

Dear Mrs T Lillie

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Approval is granted for the application with reference number that appears above.

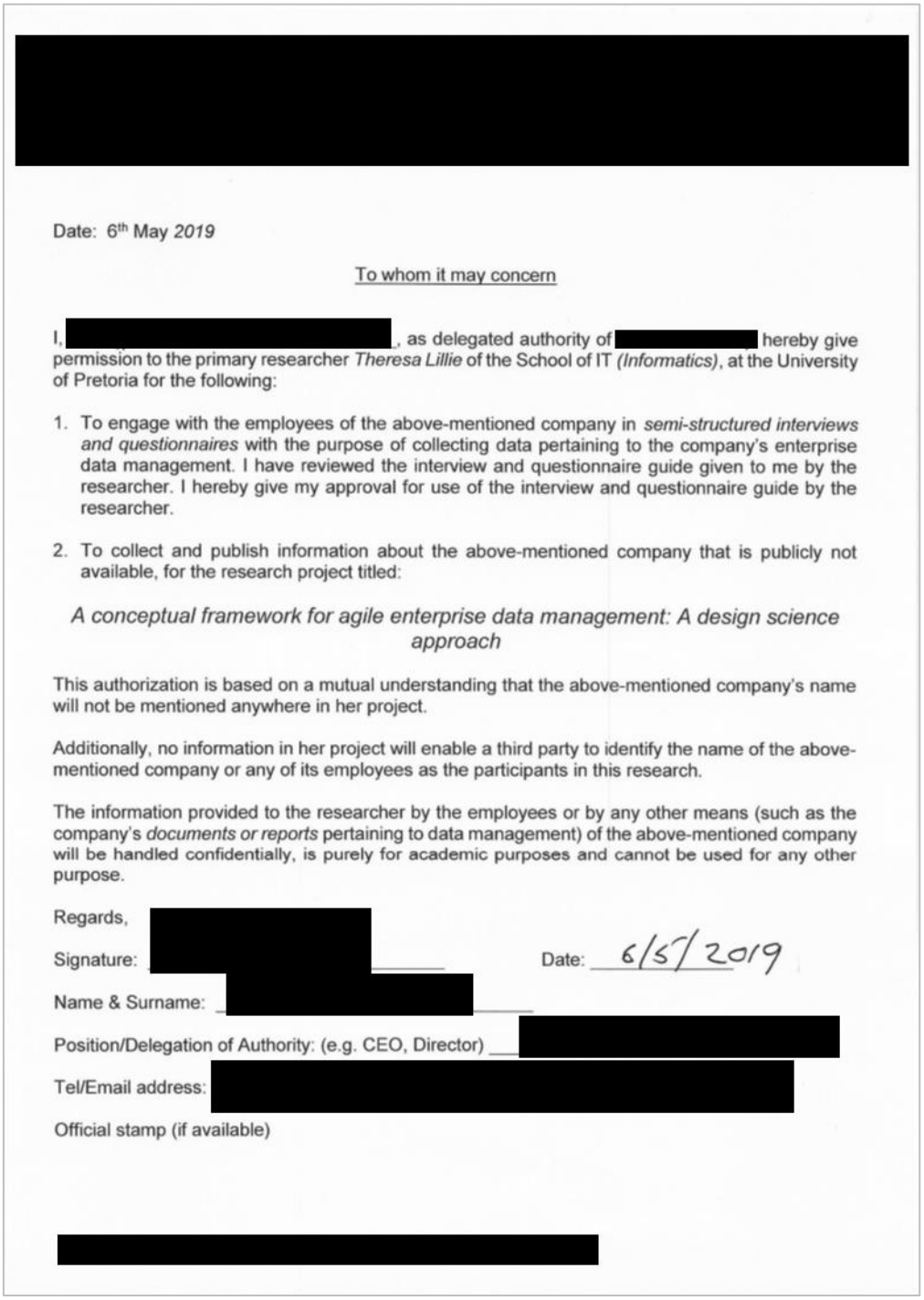
1. This means that the research project entitled "A conceptual framework for agile enterprise data management: A design science approach" has been approved as submitted. It is important to note what approval implies. This is expanded on in the points that follow.
2. This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Research Ethics Committee.
3. If action is taken beyond the approved application, approval is withdrawn automatically.
4. According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.
5. The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof JJ Hanekom
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

Permission letter from the case study organisation (BankGroup)

Note that details have been censored to protect the identity of the case study organisation. A copy of the original letter was provided to the University of Pretoria's ethics committee.



[redacted]

Date: 6th May *2019*

To whom it may concern

I, [redacted], as delegated authority of [redacted] hereby give permission to the primary researcher *Theresa Lillie* of the School of IT *(Informatics)*, at the University of Pretoria for the following:

1. To engage with the employees of the above-mentioned company in *semi-structured interviews and questionnaires* with the purpose of collecting data pertaining to the company's enterprise data management. I have reviewed the interview and questionnaire guide given to me by the researcher. I hereby give my approval for use of the interview and questionnaire guide by the researcher.

2. To collect and publish information about the above-mentioned company that is publicly not available, for the research project titled:

A conceptual framework for agile enterprise data management: A design science approach

This authorization is based on a mutual understanding that the above-mentioned company's name will not be mentioned anywhere in her project.

Additionally, no information in her project will enable a third party to identify the name of the above-mentioned company or any of its employees as the participants in this research.

The information provided to the researcher by the employees or by any other means (such as the company's *documents or reports* pertaining to data management) of the above-mentioned company will be handled confidentially, is purely for academic purposes and cannot be used for any other purpose.

Regards,

Signature: [redacted] Date: 6/5/2019

Name & Surname: [redacted]

Position/Delegation of Authority: (e.g. CEO, Director) [redacted]

Tel/Email address: [redacted]

Official stamp (if available)

[redacted]

Appendix B: Ethics approval for Delphi method



Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

24 April 2022

Reference number: EBIT/16/2022

Mrs T Lillie
Department: Informatics
University of Pretoria
Pretoria
0083

Dear Mrs T Lillie,

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Approval is granted for the application with reference number that appears above.

1. This means that the research project entitled "A conceptual framework for agile enterprise data management: A design science approach" has been approved as submitted. It is important to note what approval implies. This is expanded on in the points that follow.
2. This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Research Ethics Committee.
3. If action is taken beyond the approved application, approval is withdrawn automatically.
4. According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.
5. The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof K.-Y. Chan
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

Appendix C: Case study semi-structured interview materials

Invitation to participate in the semi-structured interviews

An email invitation was sent to each of the potential case study interview participants:

Dear [prospective participant name],

I'm a Data Architect in the Chief Risk Office, and I'm studying part-time towards my PhD in Information Systems at the University of Pretoria. To collect data for my research, I am conducting one-on-one semi-structured interviews with various data and information management specialists and stakeholders within the [case study organisation]. The purpose of this email is to invite you to contribute to my study by participating in a 60-minute interview which I will schedule at a time that is convenient for you. Should the meeting time on this invite not be suitable, please feel free to propose a new time.

The topic of my research is agility in enterprise data management. The phenomenon that I am investigating, through a Complexity Science lens, is the emergence of agility in enterprise data management.

I'm interested in how the context, actions and interactions of the organisation's various data management specialists and teams influence agility in data management. More specifically, I am investigating which capabilities could be engaged to continuously emerge agility, thereby sustaining the competence, flexibility, leanness, responsiveness, reusability, speed and scalability that business needs from data management.

In adherence to the required processes, I have obtained ethics approval for my research from the University of Pretoria as well as formal permission from the [case study organisation] to collect the data that I need for my research. To allow me to audio record the interview, please could you complete and sign the attached informed consent form and return it to me? I will then countersign and return a copy to you for your records.

Thank you in advance, your input will be of great value to me.

I hope that you will be willing to participate in my research and I look forward to interviewing you.

Kind regards,

Theresa Lillie

Informed consent for the semi-structured interviews

An informed consent form was included as an attachment on the invitation email sent to the interview participants at the case study organisation:

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Research Title: A conceptual framework for agile enterprise data management

University of Pretoria: Philosophiae Doctor (Information Systems) - T Lillie (82224872)

Interview Consent Form

Dear participant, thank you very much for your time and valuable input. Please check the boxes below to confirm your agreement with / acknowledgement of the following statements:

I confirm that the researcher presented me with an information sheet which outlines the purpose of the case study and that I was given the opportunity to ask questions.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time. In addition, should I not wish to answer any particular question or questions, I am free to decline.	☐
I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials, and will not be identified or identifiable in the report or reports that result from the research.	☐
I agree for this interview to be audio-recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any conference presentation, report or journal article developed as a result of the research. I understand that no other use will be made of the recording without my written permission, and that no one outside the research team will be allowed access to the original recording.	☐
I agree that my anonymised data will be kept for future research purposes such as publications related to this study after the completion of the study. I am aware that the results of the investigation may be used for the purposes of publication.	☐
I understand my right to choose whether to participate in this interview and that the information furnished will be handled confidentially.	☐

I, _____ hereby voluntarily grant my permission for my participation in the project as explained to me by the researcher, Theresa Lillie.

_____ _____
Participant signature Date

Thank you, your participation in my research is truly appreciated.

Kind regards,

_____ _____
Theresa Lillie Date

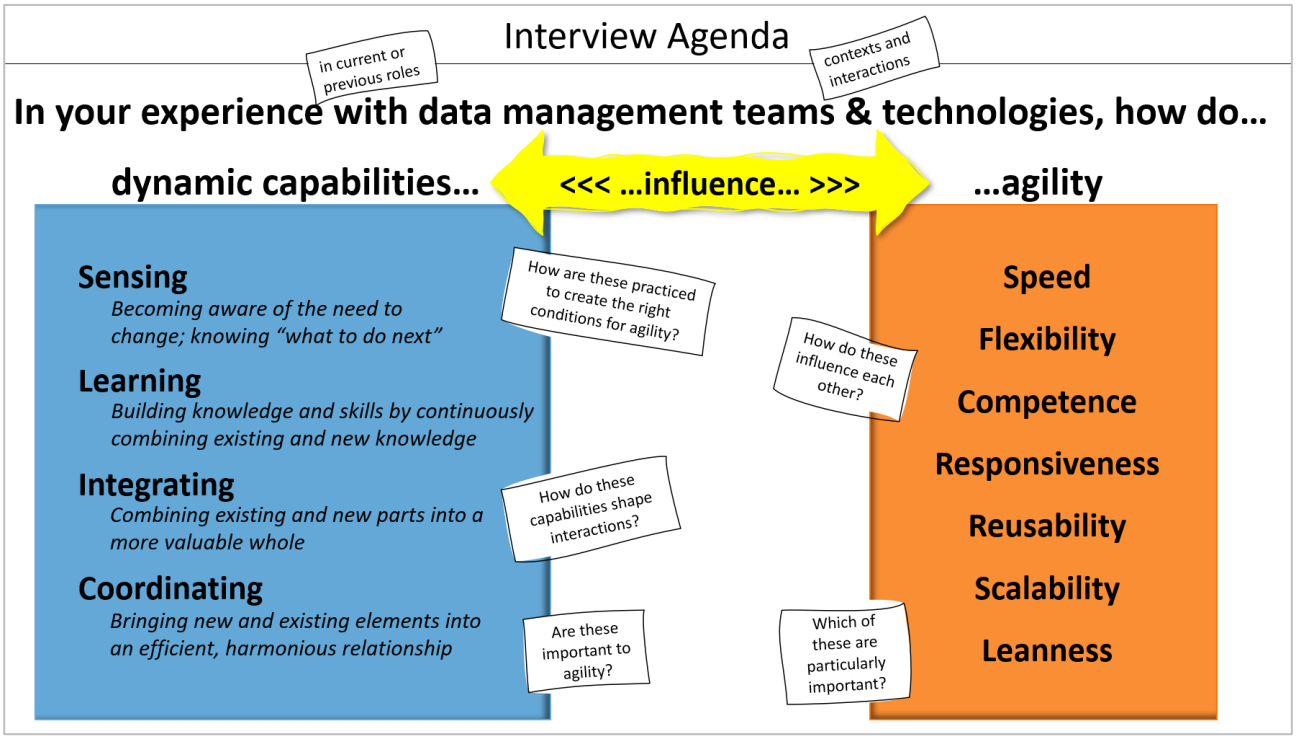
Page 1 of 1 Interview Number: ☐

Script and agenda for the semi-structured interviews

A pre-prepared script was used to present an overview of the research concepts to the participant: the sociotechnical nature of EDM as complex and complicated, CAS concepts, dynamic capabilities and agility features considered relevant to EDM.

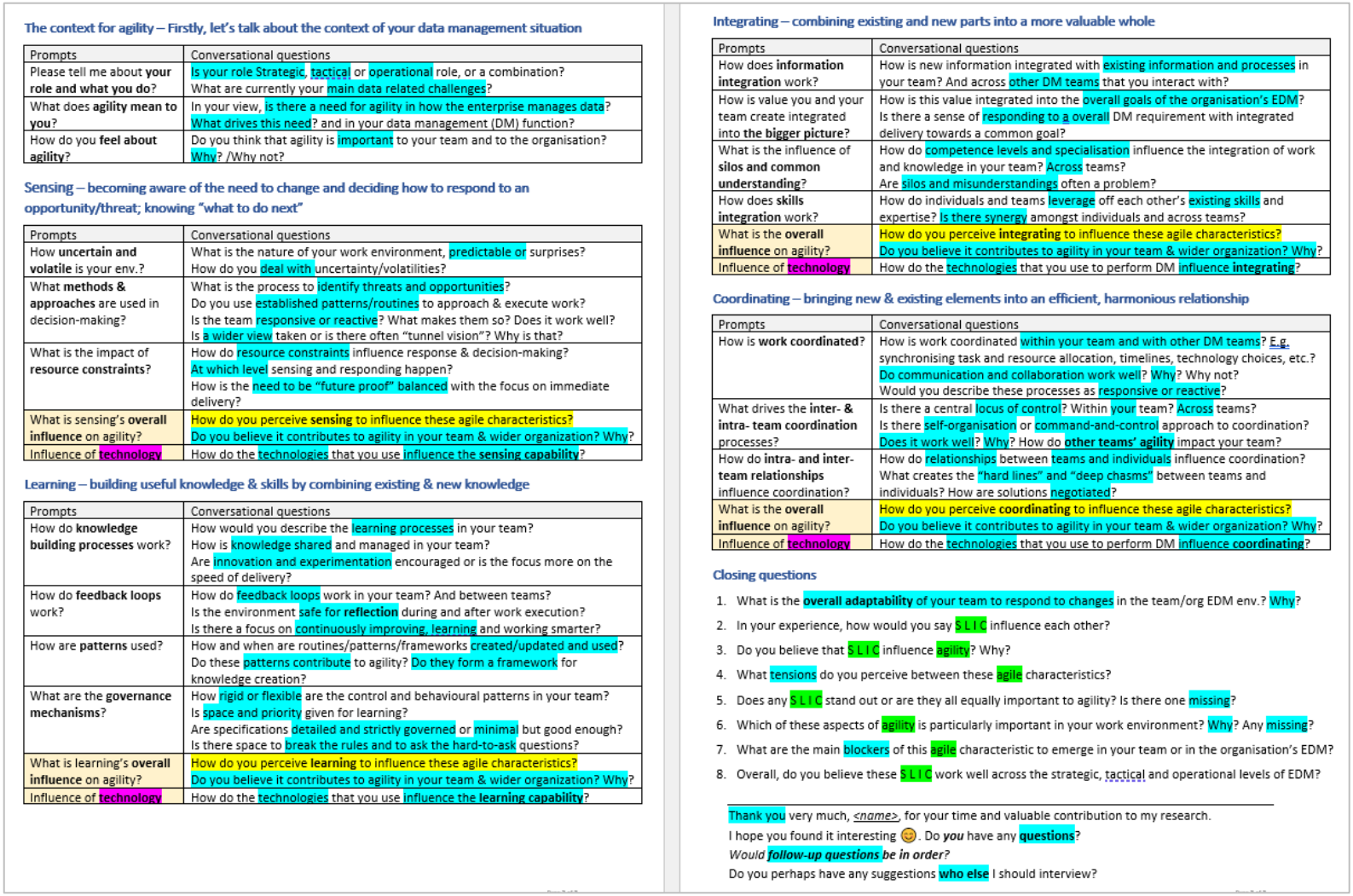
Agenda for the semi-structured interviews

The “Interview agenda” presented the topics of interest in everyday language and was displayed for the duration of the interview to stimulate unconstrained storytelling and sharing of opinions by the participant, keeping the discussions focused on the main themes of dynamic capabilities and agilty features in EDM.



Question guide for the semi-structured interviews

The pre-prepared question guide was used only to keep narrative flowing and focused on the main topics:



The context for agility – Firstly, let's talk about the context of your data management situation

Prompts	Conversational questions
Please tell me about **your role and what you do**?	Is your role Strategic, tactical or operational role, or a combination? What are currently your main data related challenges?
What does **agility mean to you**?	In your view, is there a need for agility in how the enterprise manages data? What drives this need? and in your data management (DM) function?
How do you **feel about agility**?	Do you think that agility is important to your team and to the organisation? Why? /Why not?

Sensing – becoming aware of the need to change and deciding how to respond to an opportunity/threat; knowing "what to do next"

Prompts	Conversational questions
How **uncertain and volatile** is your env.?	What is the nature of your work environment, predictable or surprises? How do you deal with uncertainty/volatilities?
What **methods & approaches** are used in decision-making?	What is the process to identify threats and opportunities? Do you use established patterns/routines to approach & execute work? Is the team responsive or reactive? What makes them so? Does it work well? Is a wider view taken or is there often "tunnel vision"? Why is that?
What is the impact of **resource constraints**?	How do resource constraints influence response & decision-making? At which level sensing and responding happen? How is the need to be "future proof" balanced with the focus on immediate delivery?
What is sensing's **overall influence** on agility?	How do you perceive **sensing** to influence these agile characteristics? Do you believe it contributes to agility in your team & wider organization? Why?
Influence of **technology**	How do the technologies that you use influence the **sensing capability**?

Learning – building useful knowledge & skills by combining existing & new knowledge

Prompts	Conversational questions
How do **knowledge building processes** work?	How would you describe the learning processes in your team? How is knowledge shared and managed in your team? Are innovation and experimentation encouraged or is the focus more on the speed of delivery?
How do **feedback loops** work?	How do feedback loops work in your team? And between teams? Is the environment safe for **reflection** during and after work execution? Is there a focus on continuously improving, learning and working smarter?
How are **patterns** used?	How and when are routines/patterns/frameworks created/updated and used? Do these patterns contribute to agility? Do they form a framework for knowledge creation?
What are the **governance mechanisms**?	How rigid or flexible are the control and behavioural patterns in your team? Is space and priority given for learning? Are specifications detailed and strictly governed or minimal but good enough? Is there space to break the rules and to ask the hard-to-ask questions?
What is learning's **overall influence** on agility?	How do you perceive **learning** to influence these agile characteristics? Do you believe it contributes to agility in your team & wider organization? Why?
Influence of **technology**	How do the technologies that you use influence the **learning capability**?

Integrating – combining existing and new parts into a more valuable whole

Prompts	Conversational questions
How does **information integration** work?	How is new information integrated with existing information and processes in your team? And across other DM teams that you interact with?
How is value you and your team create integrated into **the bigger picture**?	How is this value integrated into the overall goals of the organisation's EDM? Is there a sense of responding to a overall DM requirement with integrated delivery towards a common goal?
What is the influence of **silos and common understanding**?	How do competence levels and specialisation influence the integration of work and knowledge in your team? Across teams? Are silos and misunderstandings often a problem?
How does **skills integration** work?	How do individuals and teams leverage off each other's existing skills and expertise? Is there synergy amongst individuals and across teams?
What is the **overall influence** on agility?	How do you perceive **integrating** to influence these agile characteristics? Do you believe it contributes to agility in your team & wider organization? Why?
Influence of **technology**	How do the technologies that you use to perform DM influence **integrating**?

Coordinating – bringing new & existing elements into an efficient, harmonious relationship

Prompts	Conversational questions
How is **work coordinated**?	How is work coordinated within your team and with other DM teams? E.g. synchronising task and resource allocation, timelines, technology choices, etc.? Do communication and collaboration work well? Why? Why not? Would you describe these processes as responsive or reactive?
What drives the **inter- & intra- team coordination** processes?	Is there a central locus of control? Within your team? Across teams? Is there self-organisation or command-and-control approach to coordination? Does it work well? Why? How do **other teams' agility** impact your team?
How do **intra- and inter-team relationships** influence coordination?	How do relationships between teams and individuals influence coordination? What creates the "hard lines" and "deep chasms" between teams and individuals? How are solutions negotiated?
What is the **overall influence** on agility?	How do you perceive **coordinating** to influence these agile characteristics? Do you believe it contributes to agility in your team & wider organization? Why?
Influence of **technology**	How do the technologies that you use to perform DM influence **coordinating**?

Closing questions

1. What is the **overall adaptability** of your team to respond to changes in the team/org EDM env.? Why?
2. In your experience, how would you say S L I C influence each other?
3. Do you believe that S L I C influence agility? Why?
4. What tensions do you perceive between these agile characteristics?
5. Does any S L I C stand out or are they all equally important to agility? Is there one missing?
6. Which of these aspects of agility is particularly important in your work environment? Why? Any missing?
7. What are the main blockers of this agile characteristic to emerge in your team or in the organisation's EDM?
8. Overall, do you believe these S L I C work well across the strategic, tactical and operational levels of EDM?

Thank you very much, *<name>*, for your time and valuable contribution to my research.
I hope you found it interesting 🙂. Do ***you*** have any **questions**?
*Would **follow-up questions** be in order?*
Do you perhaps have any suggestions **who else** I should interview?

Appendix D: Artefact evaluation – Delphi method

Invitation to participate in artefact evaluation

An email invitation was sent to each of the data management experts identified as potential candidates for the Delphi expert panel:

Dear [prospective participant name],

I am currently studying toward a PhD in Information Systems at the University of Pretoria. The reason for my email is to invite you to participate as an expert on the panel selected **to evaluate the framework for agile enterprise data management**, which I have developed through my PhD research.

Participants will receive a short questionnaire that collects their views and opinions on whether the artefact is fit for application in the real world and solves the practical problem of generating agility in EDM. The questionnaire comprises 21 questions, each requiring a "yes"/"no" response, including optional comments or explanations that support the response. An informed consent form and a summary of the framework and supporting findings will accompany the questionnaire.

If the process does not reach a 70% consensus after the first round, I will send a second shorter questionnaire to collect additional input from the expert panel. After that, the evaluation process will conclude for this research.

All data collected from the participants is treated as confidential. No names of participants or organisations will be published in any part of the study, nor will any identifying information be shared with the other participants or with any third party.

A brief overview of my study: There is a need for agility in enterprise data management (EDM). However, agility can be elusive when diverse teams of specialists and generalists must interact to collectively solve complicated and complex data management problems for the enterprise. I developed a framework for agile enterprise data management for my research. The proposed framework provides an approach whereby opportunities to amplify agility can be identified, assessed, and utilised to influence adaptive and adoptive ways of coordinating and integrating EDM work.

Continuous iterations of adaptation emerge non-repeatable agility features. In contrast, iterations of adoption evolve repeatable agility features in the organisation's EDM.

Design science research (DSR) was my chosen methodology for this study. DSR requires the development of an artefact that solves an identified organisational problem. Subsequently, an evaluation of the artefact in its applicability to solving the organisational problem in practice is required. I have chosen the DELPHI method for the artefact evaluation phase, whereby I am inviting a panel of experts to participate in evaluating the artefact.

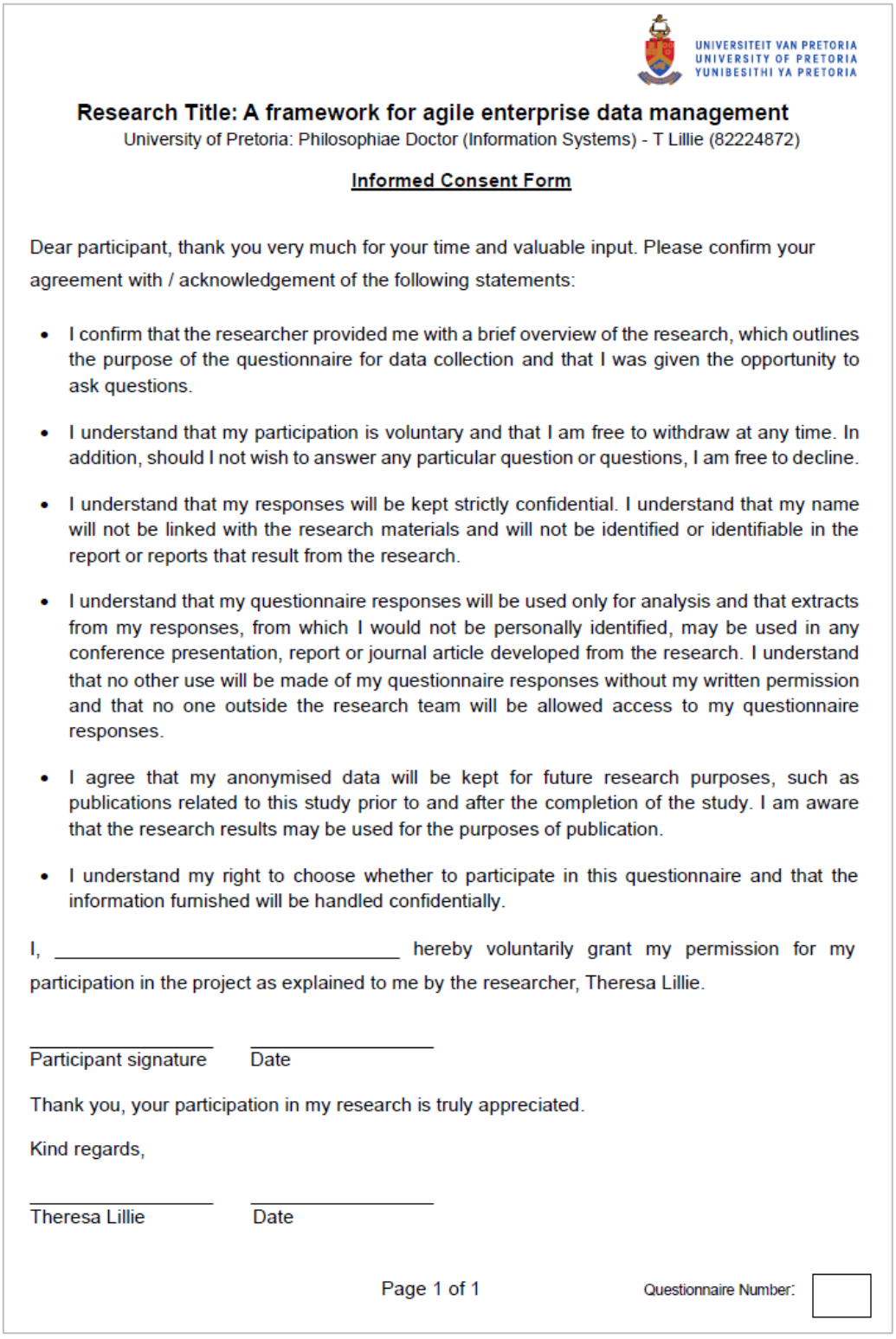
If you are interested and agree to participate, **please reply to this email by signing (electronic or paper scan) and returning the attached informed consent form to me by email as soon as possible (before Monday, 2nd of May, 2022)**. I will subsequently email you the research background and findings summary, the counter-signed informed consent form and the questionnaire for your completion. You are also very welcome to ask any questions to clarify the objectives and findings of the study.

Thank you very much in advance. Your contribution to my research will be highly valued and truly appreciated.

Yours sincerely,

Informed consent to participate in artefact evaluation

An informed consent form was included as an attachment on the invitation email sent to the data management expert:



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Research Title: A framework for agile enterprise data management

University of Pretoria: Philosophiae Doctor (Information Systems) - T Lillie (82224872)

Informed Consent Form

Dear participant, thank you very much for your time and valuable input. Please confirm your agreement with / acknowledgement of the following statements:

- I confirm that the researcher provided me with a brief overview of the research, which outlines the purpose of the questionnaire for data collection and that I was given the opportunity to ask questions.
- I understand that my participation is voluntary and that I am free to withdraw at any time. In addition, should I not wish to answer any particular question or questions, I am free to decline.
- I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials and will not be identified or identifiable in the report or reports that result from the research.
- I understand that my questionnaire responses will be used only for analysis and that extracts from my responses, from which I would not be personally identified, may be used in any conference presentation, report or journal article developed from the research. I understand that no other use will be made of my questionnaire responses without my written permission and that no one outside the research team will be allowed access to my questionnaire responses.
- I agree that my anonymised data will be kept for future research purposes, such as publications related to this study prior to and after the completion of the study. I am aware that the research results may be used for the purposes of publication.
- I understand my right to choose whether to participate in this questionnaire and that the information furnished will be handled confidentially.

I, _____ hereby voluntarily grant my permission for my participation in the project as explained to me by the researcher, Theresa Lillie.

_____ _____
Participant signature Date

Thank you, your participation in my research is truly appreciated.

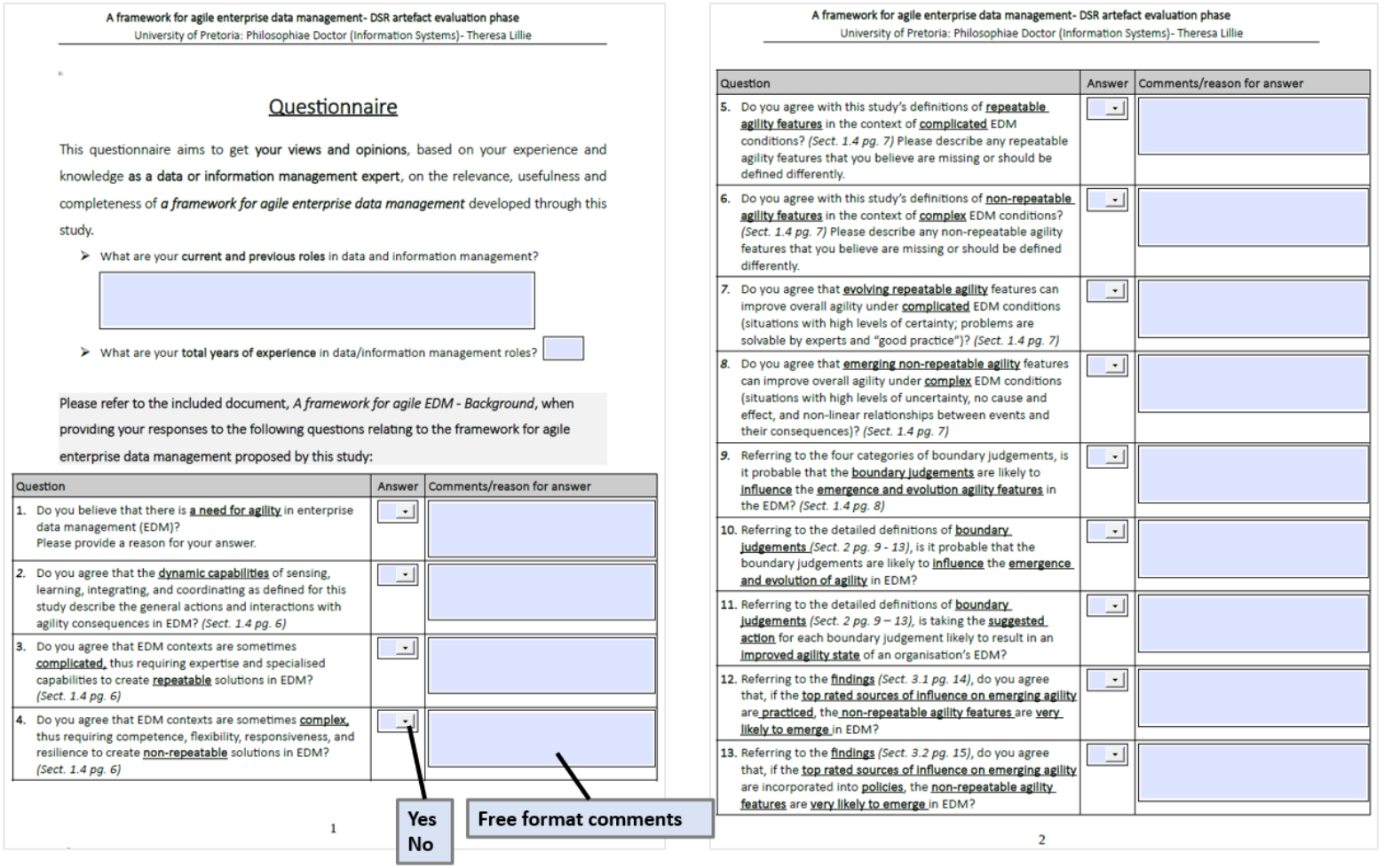
Kind regards,

_____ _____
Theresa Lillie Date

Page 1 of 1 Questionnaire Number:

Questionnaire sent to expert panel members

The questionnaire was included as an attachment on the email sent to each data management expert participating in the study:



A framework for agile enterprise data management- DSR artefact evaluation phase
University of Pretoria: Philosophiae Doctor (Information Systems)- Theresa Lillie

Questionnaire

This questionnaire aims to get **your views and opinions**, based on your experience and knowledge **as a data or information management expert**, on the relevance, usefulness and completeness of ***a framework for agile enterprise data management*** developed through this study.

- What are your **current and previous roles** in data and information management?
- What are your **total years of experience** in data/information management roles?

Please refer to the included document, *A framework for agile EDM - Background*, when providing your responses to the following questions relating to the framework for agile enterprise data management proposed by this study:

Question	Answer	Comments/reason for answer
1. Do you believe that there is **a need for agility** in enterprise data management (EDM)? Please provide a reason for your answer.		
2. Do you agree that the **dynamic capabilities** of sensing, learning, integrating, and coordinating as defined for this study describe the general actions and interactions with agility consequences in EDM? *(Sect. 1.4 pg. 6)*		
3. Do you agree that EDM contexts are sometimes **complicated,** thus requiring expertise and specialised capabilities to create **repeatable** solutions in EDM? *(Sect. 1.4 pg. 6)*		
4. Do you agree that EDM contexts are sometimes **complex,** thus requiring competence, flexibility, responsiveness, and resilience to create **non-repeatable** solutions in EDM? *(Sect. 1.4 pg. 6)*		

1

Yes
No

Free format comments

A framework for agile enterprise data management- DSR artefact evaluation phase
University of Pretoria: Philosophiae Doctor (Information Systems)- Theresa Lillie

Question	Answer	Comments/reason for answer
5. Do you agree with this study's definitions of **repeatable agility features** in the context of **complicated** EDM conditions? *(Sect. 1.4 pg. 7)* Please describe any repeatable agility features that you believe are missing or should be defined differently.		
6. Do you agree with this study's definitions of **non-repeatable agility features** in the context of **complex** EDM conditions? *(Sect. 1.4 pg. 7)* Please describe any non-repeatable agility features that you believe are missing or should be defined differently.		
7. Do you agree that **evolving repeatable agility** features can improve overall agility under **complicated** EDM conditions (situations with high levels of certainty; problems are solvable by experts and "good practice")? *(Sect. 1.4 pg. 7)*		
8. Do you agree that **emerging non-repeatable agility** features can improve overall agility under **complex** EDM conditions (situations with high levels of uncertainty, no cause and effect, and non-linear relationships between events and their consequences)? *(Sect. 1.4 pg. 7)*		
9. Referring to the four categories of boundary judgements, is it probable that the **boundary judgements** are likely to **influence** the **emergence and evolution agility features** in the EDM? *(Sect. 1.4 pg. 8)*		
10. Referring to the detailed definitions of **boundary judgements** *(Sect. 2 pg. 9 - 13)*, is it probable that the boundary judgements are likely to **influence** the **emergence and evolution of agility** in EDM?		
11. Referring to the detailed definitions of **boundary judgements** *(Sect. 2 pg. 9 – 13)*, is taking the **suggested action** for each boundary judgement likely to result in an **improved agility state** of an organisation's EDM?		
12. Referring to the **findings** *(Sect. 3.1 pg. 14)*, do you agree that, if the **top rated sources of influence on emerging agility** are **practiced**, the **non-repeatable agility features** are **very likely to emerge** in EDM?		
13. Referring to the **findings** *(Sect. 3.2 pg. 15)*, do you agree that, if the **top rated sources of influence on emerging agility** are incorporated into **policies**, the **non-repeatable agility features** are **very likely to emerge** in EDM?		

2

A framework for agile enterprise data management- DSR artefact evaluation phase
University of Pretoria: Philosophiae Doctor (Information Systems)- Theresa Lillie

Question	Answer	Comments/reason for answer
14. Referring to the **findings** *(Sect. 3.3 pg. 16)*, do you agree that, if the **top rated sources of influence on evolving agility** are **practiced**, the **repeatable agility features** are **very likely to evolve** in EDM?		
15. Referring to the **findings** *(Sect. 3.4 pg. 17)*, do you agree that, if the **top rated sources of influence on evolving agility** are incorporated into **policies**, the **repeatable agility features** are **very likely to evolve** in EDM?		
16. Referring to the **findings** *(Sect. 3.5 pg. 18)*, do you agree that, if the **top rated sources of influence on agility** are **not practiced**, the **repeatable and non-repeatable agility features** are **very likely to falter** in EDM?		
17. Do the **findings** for the sources of influence on agility in EDM, as presented in section 3, **provide valuable insights**? Please provide the reason for your answer. *(Sect. 3 pg 13 - 18)*		
18. Does the **framework** for agile enterprise data management, in terms of its **components** and **flows**, make sense and is it **comprehensible**? *(Figure 3 pg 5)* Please describe any aspects that require refinement and provide your reasons.		
19. If **implemented in a real-world context**, *as proposed in Sect. 1.5 on page 8,* is the framework for agile enterprise data management likely to be **effective in achieving agility in EDM**? Please describe any issues that you foresee regarding its **effectiveness** in a real-world context. *(Sect. 1 & 2 pg 2 - 12)*		
20. If **implemented in a real-world context**, *as proposed in Sect. 1.5 on page 8,* is the framework for agile enterprise data management likely to be **efficient in achieving agility in EDM**? Please describe any issues that you foresee regarding its **efficiency** in a real-world context. *(Sect. 1 & 2 pg 2 - 12)*		

A framework for agile enterprise data management- DSR artefact evaluation phase
University of Pretoria: Philosophiae Doctor (Information Systems)- Theresa Lillie

Question	Answer	Comments/reason for answer
21. To what degree would you say the **framework** for agile enterprise data management is **complete in its design for its purpose of achieving agility in EDM**? Please describe any aspects that you believe are missing from the framework. *(Sect. 1 & 2 pg 2 - 12)*	0%-100%	
Please provide **any additional comments or thoughts** that you have regarding any aspect of the framework for agile enterprise data management.		

Thank you very much for your input. Your contribution to this research is highly valued and truly appreciated.

Background document sent to expert panel members

A framework for agile EDM – Background

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A framework for agile enterprise data management - DSR artefact evaluation phase
University of Pretoria: Philosophiae Doctor (Information Systems) - Theresa Lillie

1 BRIEF OVERVIEW OF THE RESEARCH

1.1 BACKGROUND

This research aims to develop *a framework for agile enterprise data management* to address the problems enterprises face in achieving agility in managing their data. The framework developed and proposed by this research provides an approach whereby opportunities to amplify agility can be identified, assessed, and utilised to influence adaptive and adoptive ways of coordinating and integrating **enterprise data management (EDM)** work. Continuous iterations of adaptation emerge non-repeatable agility features, whereas iterations of adoption evolve repeatable agility features in the organisation's EDM. The main research question that this study aims to answer is: ***How* can agile enterprise data management be achieved?**

Design science research (DSR), used as a design strategy in this study, required building an artefact that solves an identified organisational problem and the subsequent evaluation of that artefact in its applicability to solving the organisational problem in practice (Hevner et al., 2004). The evaluation phase concludes the development of the DSR artefact, a *framework for agile enterprise data management*.

The scientific theories of complex adaptive systems (Holland, 1992), dynamic capabilities (Teece et al., 1997) and critical systems heuristics (Ulrich, 2000) provided the theoretical foundation for the initial version of the *framework for agile enterprise data management* developed through this research. The proposed framework was applied in an in-depth qualitative case study of agility in EDM at a large financial services organisation to produce the final version of the *framework for agile enterprise data management*.

The final version of the *framework for agile enterprise data management* is presented here for evaluation by a panel of experts using the Delphi method. The Delphi method process requires a panel of experts to provide their views and opinions on whether the *framework for agile enterprise data management* is fit for application in the real world and solves the practical problem of achieving agile enterprise data management.

1.2 THE PROBLEM OF AGILITY IN ENTERPRISE DATA MANAGEMENT

There is a need for agility in enterprise data management (EDM). However, agility can be elusive when diverse teams of specialists and generalists must interact to collectively solve complicated and complex

data management problems for the enterprise. Figure 1 presents a visualisation of the agility problem in EDM.

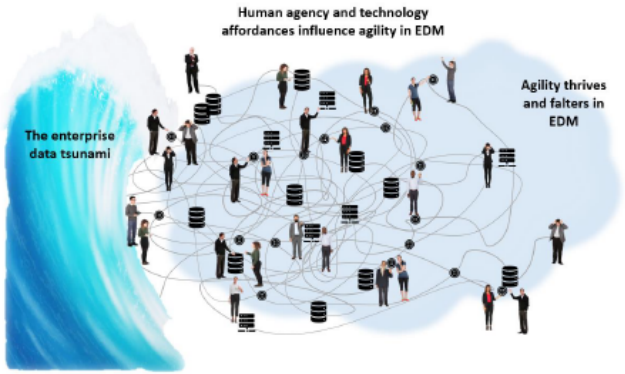


Figure 1: The agility problem in enterprise data management

The pervasiveness of technologies and the entangled nature of the interactions amongst the social and technical agents of EDM leads this research to view the constitution of EDM as complex and complicated sociomateriality (Kurtz & Snowden, 2003; Orlikowski & Scott, 2008; Peppard, 2018). The actors of enterprise data management are **social and technological agents** that operate in **high levels of interdependent interactions** (DAMA International, 2017; Marchand & Peppard, 2013). Human and technological agents are imbricated and entangled as they act and interact in EDM contexts. EDM is, therefore, considered to be **sociomaterial** by nature (Leonardi, 2011; Orlikowski, 2007). In addition, the sociomateriality of EDM is both **complex** (deals with internal and external unpredictability) and **complicated** (requires expertise and specialisation) by nature (Kurtz & Snowden, 2003). A review of existing literature to understand the nature and features of agility in organisations concluded that **agility in enterprise data management has identifiable features** (Lillie & Eybers, 2019) that have meaning and consequences specific to the **contexts** of enterprise data management and that team agility is an **emergent and evolutionary** phenomenon (Werder & Maedche, 2018).

The DAMA-DMBOK (DAMA International, 2017) is widely used in large organisations' data management practices, including the case study organisation of this research. The relevance of agility to EDM's sociomaterial complexity and complicatedness is mapped onto DAMA's functional view of data management in Figure 2.

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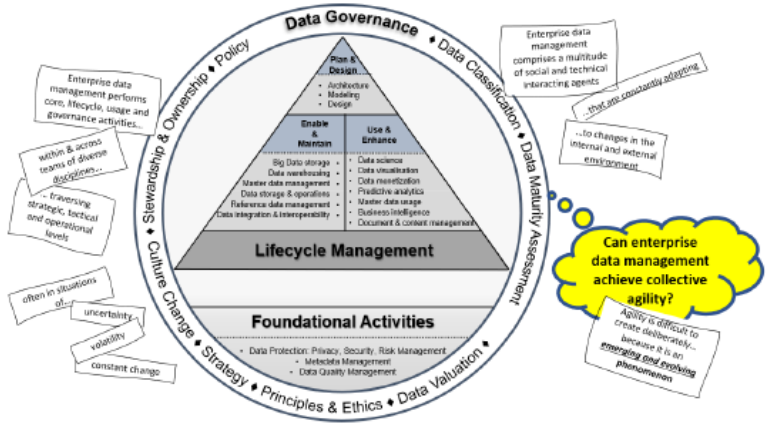


Figure 2: Enterprise data management presents complex and complicated sociomateriality – adopted from (DAMA International, 2017, p. 44)

1.3 THE SOLUTION: A FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

The proposed framework developed through this design science research study provides a practical approach to identifying, assessing and utilising opportunities to amplify agility by influencing adaptive and adoptive ways of coordinating and integrating EDM work. This study proposes that, **by practicing heuristics and using boundary judgements to consider how agility is and how it should be, agility in EDM can be iteratively influenced towards a more favourable state**. Thereby the framework aims to provide an approach to continuously make sense of agility in EDM and actively assess and influence improvements of agility features in EDM. Critical systems heuristics are engaged in the framework for agile EDM in the space between thinking and acting in complexity and complicatedness to reflect and decide how to act in ways that influence the emergence and evolution of agility features in EDM.

The proposed *framework for agile enterprise data management* is presented in Figure 3.

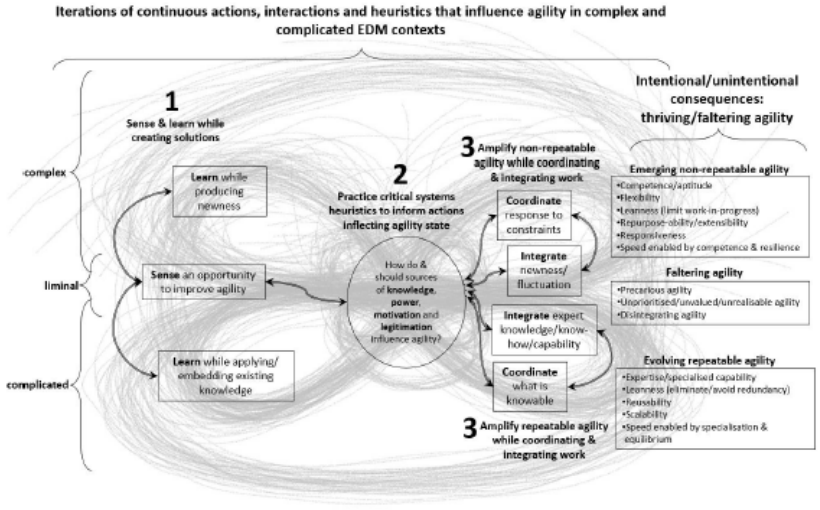


Figure 3: A framework for agile enterprise data management
from (Kurtz & Snowden, 2003; Lillie & Eybers, 2019; Pavlou & El Sawy, 2011; Teece et al., 1997; Ulrich, 2000)

1.4 DEFINITIONS OF CONSTRUCTS AND CONCEPTS

The following table provides the definitions of the terms and constructs of the *framework for agile enterprise data management*:

Table 1: Definitions of the terms and constructs of the framework for agile enterprise data management

Term/construct	Definition
Enterprise data management (EDM)	Data Management is defined as "the development, execution, and supervision of plans, policies, programs, and practices that deliver, control, protect, and enhance the value of data and information assets throughout their lifecycles." (DAMA International, 2017, p. 17)
Agents or actors	People or technologies engaged in enterprise data management work.

Term/construct	Definition
Dynamic capabilities	The concepts of dynamic capabilities used in this study that describe the general actions and interactions with agility consequences within sociomaterial contexts are: 1. **Learning:** Building knowledge and skills while being productive and creating solutions 2. **Sensing:** Scanning for and making sense of opportunities to improve agility 3. **Coordinating:** Collaborating and working collectively towards a shared purpose 4. **Integrating:** Combining work effort and outcomes for collective benefit The definition of dynamic capabilities for this study was primarily based on the research done by Pavlou and El Sawy (2011), and the definition of sense-making was adopted from Turner et al. (2022).
Complicated contexts in EDM	Complicated contexts are **ordered situations with high levels of certainty**. Cause and effect exist, but only **experts** can analyse and understand the causality, events can be predicted, and rules can be used to govern activities and outcomes. Complicatedness is the domain of "good practice" enabled by **expertise and know-how** (Snowden & Rancati, 2021).
Complex contexts in EDM	Complex contexts are **unordered situations with high levels of uncertainty**. There is no cause and effect, relationships between events and their consequences are non-linear, and constraints must be managed to enable adaptation to the ongoing changes (Snowden & Rancati, 2021).
Agility in EDM	This study defines agility as a phenomenon that **emerges from complexity** and **evolves in complicated** contexts. This study defines two sets of agility features whereby agility is recognisable in complex and complicated EDM contexts: 1. **Agility features that emerge from complex situations**: These features depend on the context and are therefore **non-repeatable**. People and technology are required to adapt to ongoing changes. 2. **Agility features that evolve in complicated situations**: These features are **repeatable** and can be adopted and embedded for benefit under predictable conditions. The agility features used in this study are based on the agile characteristics identified by Lillie and Eybers (2019).

Term/construct	Definition
Repeatable agility features – **evolve** in **complicated** contexts	**Repeatable agility** features are relevant to **complicated** EDM contexts. These features can be adopted and embedded, and **evolve** as part of good EDM practice: 1. **Expertise/specialised capability**: having expert or specialised knowledge, skills/know-how, and capability 2. **Leanness (eliminate/avoid redundancy)**: being able to avoid or eliminate wastage of resources 3. **Reusability**: being able to repeat the use of an existing capability in a new or similar context 4. **Scalability**: applying to a broader scope, vertical or horizontal, by repeating and recombining existing capabilities 5. **Speed enabled by specialisation and equilibrium**: being able to deliver value quickly due to expert capability and stability in the environment
Non-repeatable agility features – **emerge** in **complex** contexts	**Non-repeatable agility** features are relevant to **complex** EDM contexts. These features enable adaptation under uncertainty in EDM and **emerge** to support the evolution of new patterns for repeatable agility in EDM. For example, once something has been repurposed or extended, it might then become reusable and scalable: 1. **Competence/aptitude**: having experience, discernment, aptness and generalist skills 2. **Flexibility**: being adaptable and open to alternative solutions and approaches 3. **Leanness (limit work-in-progress)**: being able to limit work-in-progress to prioritised, essential value delivery 4. **Repurpose-ability/extensibility**: being able to extend or use an existing capability for something other than its original purpose 5. **Responsiveness**: being able and motivated to comprehend and act on what is required 6. **Speed enabled by competence and resilience**: being able to deliver value quickly due to being competent and resilient
Critical systems heuristics (CSH)	Ulrich and Reynolds (2020) define critical systems heuristics (CSH) as "a framework for reflective professional practice". Boundary critique is a participatory process central to CSH that reveals the boundary judgements made by participants to understand a given situation and design ways to improve the system (Ulrich and Reynolds, 2020).

Term/construct	Definition
Categories of boundary judgements in EDM	Boundary judgements **inform heuristics** when agents consider and decide **how agility is** and **how agility should be** within the given context: 1. **Sources of knowledge** relate to agents' abilities. These sources change the system based on agents' resourcefulness to do what can/should be done. 2. **Sources of legitimation** relate to taking a broad stakeholder view. These sources change the system based on the amplitude of the agents' stakeholder perspective. 3. **Sources of motivation** relate to agents' impetus. These sources change the system based on what agents intend to effect. 4. **Sources of power** relate to things that control the system. These sources change the system based on what empowers, overrides, and guides the agents. These definitions of boundary judgements in EDM are based on (Ulrich & Reynolds, 2020). **For a detailed list of the boundary judgements identified in this study, please refer to section 2 on page 9.**

1.5 APPLICATION OF THE FRAMEWORK FOR AGILE ENTERPRISE DATA MANAGEMENT

Even though this research did not include the implementation and testing in a real-world situation of the *framework for agile enterprise data management*, the following approach is suggested for its application in an existing EDM setting at a large financial services organisation:

1. Use the boundary judgements' suggested questions to conduct periodic surveys in the organisation to understand the current state of agility in the organisation's EDM functions.
2. Capture details of the participants' role and data management function on each survey questionnaire to enable the desired level of analysis of the collected data.
3. Analyse the collected data to identify the current issues that influence thriving (emerging and evolving) agility and faltering (precarious, unvalued and disintegrating) agility.
4. Use the findings from the data analysis to design and conduct workshops with EDM functions and roles to discuss and understand what the top issues are currently influencing the agility state of the organisation's EDM.
5. Use the feedback and knowledge gained in the workshops to actively influence the desired agility mindset and change approaches in the organisation's EDM functions, and update the EDM policies.
6. Keep a history of the survey outcomes for monitoring purposes and input to EDM strategies for emerging and evolving desired agility outcomes.
7. Co-evolve the boundary judgement definitions, questions and suggested actions with ongoing changes in the organisation's EDM contexts and interactions.

2 DETAILED DEFINITIONS OF BOUNDARY JUDGEMENTS

Boundary judgements comprise four categories: (1) **sources of knowledge** relate to agents' abilities and resourcefulness to do what can or should be done; (2) **sources of legitimation** relate to the amplitude of agents' stakeholder perspective; (3) **sources of motivation** relate to the agents' impetus based on what they intend to effect; and (4) **sources of power** relate to control based on what empowers, overrides and guides the agents. The **boundary judgements** identified for the framework for agile EDM **inform actions** in enterprise data management, thereby **influencing agility outcomes** while coordinating and integrating EDM work – see point 2 in Figure 3 on page 5.

2.1 SOURCES OF KNOWLEDGE IN ENTERPRISE DATA MANAGEMENT

The following **sources of knowledge** were identified in the case study organisation's EDM practices and relate to **agents' abilities and resourcefulness to do what can or should be done**:

Source of knowledge	Related boundary question	Suggested action
B-K- defined, prioritised DM/data capability requirement	Is there a defined, prioritised data management or data capability requirement?	Clearly define, prioritise and communicate the EDM requirement.
B-K- experience and ability/competence	Is there the necessary experience, ability and competence to create the required solutions?	Continuously acquire and build EDM experience and competence.
B-K- iteratively/continuously keep up & improve capability	Is there a culture/patterns to continuously update individual and collective knowledge and to improve the data-related capability?	Create and nurture a culture of learning and knowledge sharing.
B-K- learning from safe-to-fail trying/ innovating/ exploring	Is there a culture that allows for learning from trying/innovating/exploring without guarantee of the outcome?	Create a safe-to-fail, as opposed to fail-safe, environment for EDM work.
B-K- modularised/standardised/foundational capability	Are there shared reusable, stable rails that enable foundational, standardised data capabilities?	Create and maintain shared reusable, stable rails that enable foundational, standardised data capabilities.
B-K- process automation capability	Is there a reusable, repeatable capability that is automated?	Create and automate the required reusable, repeatable capability.
B-K- resource capability (socio/tech/data)	Is there the required social, technical and/or data management capability?	Continuously acquire and build socio-technical data resource capabilities.
B-K- shared understanding (business & data)	Is there a shared understanding of the business and data requirement?	Define and communicate the business and data requirement to create a shared understanding of what needs to be achieved.
B-K- specialist knowledge/skills/expertise/ understanding	Is there the required specialist knowledge, skills, understanding and expertise?	Continuously acquire and build the required specialist knowledge, skills, understanding and expertise.

2.2 SOURCES OF LEGITIMATION IN ENTERPRISE DATA MANAGEMENT

The following **sources of legitimation** were identified in the case study organisation's EDM practices and relate to **the amplitude of agents' stakeholder perspective**:

Source of legitimation	Related boundary question	Suggested action
B-L- adoption & proliferation DM capabilities	Is a broader stakeholder view considered for adopting and proliferating data management capabilities?	Assess the scope and potential value for adopting and proliferating data management capabilities.
B-L- openness to other/broader perspectives/alternatives	Is a broader stakeholder view considered for alternative options and perspectives?	Assess the scope and potential value of alternative options and perspectives.
B-L- openness to/embracing/incorporating change	Is a broader stakeholder view considered for embracing and incorporating change?	Assess the scope and potential value of embracing and incorporating change.
B-L- peripheral dependency/interdependency/knock-on	Is a broader stakeholder view considered for the possible impact on areas outside of the given context?	Assess the scope and potential value of the possible impact on areas outside of the given context.
B-L- potential extent of impact	Is a broader stakeholder view considered for the extent of the impact on areas outside of the given context?	Assess the scope and potential value of the extent of the impact on areas outside of the given context.
B-L- reflection on approach to data initiatives	Is a broader stakeholder view considered for how to approach the data initiative?	Assess the scope and potential value of how to approach the data initiative.
B-L- suitability/sufficiency in context	Is a broader stakeholder view considered for the suitability and sufficiency of the data capability?	Assess the scope and potential value of the suitability and sufficiency of the data capability.
B-L- tenability/durability/sustainability	Is a broader stakeholder view considered for the long term outlook of the data capability?	Assess the scope and potential value of the long term outlook of the data capability.

2.3 SOURCES OF MOTIVATION IN ENTERPRISE DATA MANAGEMENT

The following **sources of motivation** were identified in the case study organisation's EDM practices and relate to **the agents' impetus based on what they intend to effect**:

Source of motivation	Related boundary question	Suggested action
B-M- avoid technical debt/rework/redundancy	Is there a will to avoid technical debt, rework or maintaining redundant capabilities?	Cultivate and nurture a will to avoid technical debt, rework or maintaining redundant capabilities.
B-M- business value/impact of DM initiative	Is there a will to deliver business value through the data initiative?	Cultivate and nurture a will to deliver business value through the data initiative.
B-M- buy-in/commitment from stakeholders of data priority	Is there a will to obtain stakeholder buy-in and commitment for the prioritised data requirement?	Cultivate and nurture a will to obtain stakeholder buy-in and commitment for the prioritised data requirement.
B-M- clear, shared data-centric purpose	Is there a will to contribute to a clear, shared data-centric purpose?	Cultivate and nurture a will to contribute to a clear, shared data-centric purpose.
B-M- data role/function clarity	Is there a will to create clarity about role responsibility and accountability?	Cultivate and nurture a will to create clarity about role responsibility and accountability.
B-M- feedback loops (assess/monitor/test)	Is there a will to reflect on and learn from feedback and results from assessments, monitoring and/or testing?	Cultivate and nurture a will to reflect on and learn from feedback and results from assessments, monitoring and/or testing.
B-M- intention to be proactive	Is there a will to be proactive?	Cultivate and nurture a will to be proactive.
B-M- intention to be responsive	Is there a will to be responsive?	Cultivate and nurture a will to be responsive.
B-M- intention to improve/support agility in DM	Is there a will to improve and support agility in data management?	Cultivate and nurture a will to improve and support agility in data management.
B-M- share & integrate capabilities (avoid siloes)	Is there a will to share and integrate capabilities and to avoid working in siloes?	Cultivate and nurture a will to share and integrate capabilities and to avoid working in siloes.

2.4 SOURCES OF POWER IN ENTERPRISE DATA MANAGEMENT

The following **sources of power** were identified in the case study organisation's EDM practices and relate to **control based on what empowers, overrides and guides the agents**:

Source of power	Related boundary question	Suggested action
B-P- autonomy at execution level	Is decision-making power granted at the execution level?	Assess and grant decision-making power at the lowest possible execution level for data management work.
B-P- business area strategy/priority	Is data management work guided by business area strategy and prioritisation?	Guide data management work by business area strategy and prioritisation.
B-P- collaborative culture, synergy	Are data management resources empowered by a collaborative culture and synergy?	Cultivate and nurture collaboration and synergy in and across data management roles and functions and business stakeholders.
B-P- data governance processes	Is data management work controlled by data governance processes?	Establish and enforce data governance processes.
B-P- data leadership mandate/direction/support	Is data management work directed and mandated by data leadership?	Establish and empower data leadership to direct and mandate data management work.
B-P- data management policies	Is data management work controlled by data management policies?	Establish and enforce data management policies.
B-P- data management principles	Is data management work guided by data management principles?	Establish and create a shared, practical understanding of data management principles.
B-P- data management strategy	Is data management work directed by data management strategy?	Establish a clear, shared data management strategy to direct all data management work.
B-P- data ownership, stewardship, custodianship	Are data management roles and functions mandated with and held accountable for data ownership, stewardship or custodianship?	Establish clear data management roles and functions that are mandated with and held accountable for data ownership, stewardship or custodianship.
B-P- effective stakeholder engagement	Are data management roles and functions empowered through effective stakeholder engagement?	Engage stakeholders effectively to empower data management roles and functions in their work.
B-P- formalised delivery processes	Is data management work controlled by a formalised delivery processes?	Establish and enforce formalised delivery processes for data management work.
B-P- legal/regulatory/audit compliance requirements	Are business and data management roles and functions controlled and held accountable by legal, regulatory and audit compliance requirements?	Empower, support and enable business and data management roles to take accountability for meeting legal, regulatory and audit compliance requirements.
B-P- resource capacity for DM (socio/tech)	Is socio-technical resource capacity enabling data management work?	Establish and maintain sufficient human and technical resources to enable data management work.

Source of power	Related boundary question	Suggested action
B-P- team/role/organisation maturity	Is data management work empowered by team, role and organisational maturity?	Cultivate and nurture data management team, role and organisational maturity.
B-P- trust/trustworthiness	Is data management work empowered by trust or trustworthiness?	Cultivate and nurture trust and trustworthiness amongst all data management stakeholders.
B-P- uncertainty in external environment	Is data management work subject to uncertainty in the external environment?	Manage constraints related to uncertainty in the external environment of data management.
B-P- uncertainty in internal environment	Is data management work subject to uncertainty in the internal environment?	Manage constraints related to uncertainty in the internal environment of data management.
B-P- unilateral/BU decision-making	Are data management decisions overruled by unilateral decisions or decision-making at a business unit level?	Manage prioritisation of data management work and communicate and agree a clear shared purpose with all business stakeholders of data management work.

3 FINDINGS

For brevity, not all findings of this study are included here. Instead, the main results are summarised in groups to provide background information pertinent to the questionnaire questions:

1. Sources of influence on **emerging** agility in **practice**
2. Sources of influence on **emerging** agility in **policies**
3. Sources of influence on **evolving** agility in **practice**
4. Sources of influence on **evolving** agility in **policies**
5. Sources of influence on **faltering** agility in **practice**

This section presents the results of analysing the co-occurrences of the **agility features** and **sources of influence** considered by the case study organisation in practice, as narrated by the fourteen interviewees who participated in the case study, and the organisation's enterprise data management (EDM) policy documents. By counting co-occurrences, the emphasis on individual boundary judgments related to agility features became apparent and indicated what the case study organisation's EDM practitioners and the policy documents deem necessary for achieving agility in EDM. Therefore, the data analysis aims to **present the findings at a practical level** where the EDM agents practice heuristics using boundary judgements to consider how agility is and how it should be, thereby **influencing the state of agility** in EDM.

3.1 SOURCES OF INFLUENCE ON EMERGING AGILITY IN PRACTICE

The findings related to emerging agility based on the analysis of the data collected in the **interviews** with data management (DM) **practitioners** at the case study organisation are presented in the following table:

Figure 4: Sources of influence on the emergence of non-repeatable agility features in practice

TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power (TOP 12 / Top 3 / Bottom 3)	Total code co-occurences of boundary judgements AND non-repeatable agility in interviews	SC-Interviews & A1-competence/aptitude	SC-Interviews & A1- flexibility	SC-Interviews & A1- leanness (limit work-in-progress)	SC-Interviews & A1-response-ability/externability	SC-Interviews & A1-responsiveness	SC-Interviews & A1- speed enabled by competence and resilience
1	S-M- intention to improve/support agility in DM	387	99	59	28	29	89	86
2	S-K- shared understanding (business & data)	370	109	49	23	26	86	77
3	S-K- defined, prioritised DM/data capability requirement	346	90	44	28	21	84	87
4	S-M- clear, shared data-centric purpose	336	93	46	21	28	84	70
5	S-P- collaborative culture, synergy	309	90	43	16	34	70	62
6	S-K- experience and ability/competence	288	93	37	12	24	57	63
7	S-P- effective stakeholder engagement	278	76	41	19	19	62	61
8	S-M- share & integrate capabilities (avoid silioes)	270	70	41	23	36	56	46
9	S-L- suitability/sufficiency in context	267	66	41	28	28	55	45
10	S-K- resource capability (socio/tech/data)	260	70	36	19	21	54	50
11	S-L- potential extent of impact	246	59	36	21	24	52	54
12	S-K- specialist knowledge/skills/expertise/understanding	236	83	30	4	17	56	48
13	B-P- data leadership mandate/direction/support	231	63	33	13	21	55	41
14	B-M- intention to be responsive	226	52	28	12	15	60	50
15	B-K- iteratively/continuously keep up & improve capability	219	49	41	16	21	44	48
16	B-M- business value/impact of DM initiative	216	54	35	17	21	46	43
17	B-L- openness to/embracing/incorporating change	210	50	38	9	16	54	43
18	B-L- reflection on approach to data initiatives	199	54	28	15	11	45	46
19	B-P- business area strategy/priority	196	46	33	20	14	44	48
20	B-L- openness to other/broader perspectives/alternatives	193	50	41	9	21	44	28
21	B-K- learning from safe-to-fail trying/innovating/exploring	192	52	31	17	23	34	30
22	B-L- adoption & proliferation of DM capabilities	189	58	32	13	17	40	39
23	B-P- team/role/organisation maturity	183	53	30	8	13	38	32
24	B-P- uncertainty in internal environment	182	47	26	12	17	36	33
25	B-P- resource capacity for DM (socio/tech)	149	40	19	16	12	26	34
26	B-L- tenability/durability/sustainability	138	38	15	9	18	26	36
27	B-M- buy-in/commitment from stakeholders of data priority	132	34	20	7	18	26	33
28	B-L- peripheral dependency/interdependency/knock-on	122	28	19	12	18	26	27
29	B-P- trust/trustworthiness	118	32	19	8	7	26	26
30	B-P- uncertainty in external environment	117	26	19	7	15	27	23
31	B-M- feedback loops (assess/monitor/test)	115	31	17	18	9	23	26
32	B-P- autonomy at execution level	111	26	20	6	18	26	21
33	B-P- formalised delivery processes	103	25	18	4	4	22	24
34	B-M- data role/function clarity	100	32	14	4	6	21	23
35	B-P- data ownership, stewardship, custodianship	99	24	14	8	8	25	22
36	B-P- data management strategy	96	27	13	6	8	25	19
37	B-P- data governance processes	88	29	11	4	7	18	19
38	B-K- modularised/standardised/foundational capability	83	17	16	18	11	14	15
39	B-M- intention to be proactive	69	20	8	2	6	18	15
40	B-P- data management policies	56	16	11	4	4	10	11
41	B-P- data management principles	53	15	8	4	4	11	11
42	B-P- ariateral/BU decision-making	47	10	6	8	3	15	10
43	B-P- legal/regulatory/audit compliance requirements	41	10	4	3	4	10	10
44	B-M- avoid technical debt/rework/redundancy	30	7	4	3	2	8	6
45	B-K- process automation capability	29	8	3	1	6	11	6

3.2 SOURCES OF INFLUENCE ON EMERGING AGILITY IN POLICIES

The findings related to emerging agility based on the analysis of the data management **policy documents** collected at the case study organisation are presented in the following table:

Figure 5: Sources of influence on the emergence of non-repeatable agility features in policies

TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power (TOP 12 / Top 3 / Bottom 3)	Total code co-occurences of boundary judgements AND non-repeatable agility in Policies	SC- Policies & A1- competence/aptitude	SC- Policies & A1- flexibility	SC- Policies & A1- leanness (limit work-in-progress)	SC- Policies & A1- repurpose-ability/extensibility	SC- Policies & A1- responsiveness	SC- Policies & A1- speed enabled by competence and resilience
1	B-P: data governance processes	158	49	18	17	15	38	17
2	B-M: clear, shared data-centric purpose	150	45	19	23	15	37	17
3	B-K: shared understanding (business & data)	135	41	18	17	12	32	15
4	B-M: feedback loops (assess/monitor/test)	133	45	13	11	12	37	14
5	B-L: adoption & proliferation of DM capabilities	123	40	16	13	13	31	13
6	B-P: data ownership, stewardship, custodianship	116	34	14	14	13	27	14
7	B-K: defined, prioritised DM/data capability requirement	114	37	16	12	13	25	11
8	B-P: effective stakeholder engagement	113	37	10	13	13	28	12
9	B-L: suitability/sufficiency in context	112	31	26	19	11	24	7
10	B-K: modularised/standardised/foundational capability	110	28	18	15	9	29	13
11	B-K: resource capability (socio/tech/data)	110	29	18	13	10	25	16
12	B-M: data role/function clarity	107	33	12	13	13	19	11
13	B-P: data management policies	99	32	16	10	9	22	10
14	B-M: share & integrate capabilities (avoid silos)	97	24	17	9	12	23	12
15	B-L: potential extent of impact	92	27	13	12	10	19	11
16	B-L: treability/durability/sustainability	87	26	11	9	8	20	14
17	B-P: business area strategy/priority	86	26	12	12	11	17	9
18	B-P: legal/regulatory/audit compliance requirements	82	28	10	10	6	19	12
19	B-P: data management strategy	84	21	17	10	14	17	9
20	B-M: intention to improve/support agility in DM	81	20	17	10	7	17	14
21	B-K: specialist knowledge/skills/expertise/understanding	80	28	9	10	8	18	7
22	B-M: business value/impact of DM initiative	80	24	14	12	9	14	7
23	B-K: iteratively/continuously keep up & improve capability	76	22	13	7	10	18	6
24	B-L: reflective on approach to data initiatives	75	25	6	10	5	18	9
25	B-P: collaborative culture, synergy	69	20	5	9	8	18	6
26	B-P: data leadership mandate/direction/support	68	23	10	7	9	14	6
27	B-P: data management principles	68	20	11	5	5	17	8
28	B-M: buy-in/commitment from stakeholders of data priority	64	19	7	8	9	13	8
29	B-P: trustworthiness	64	19	7	7	4	18	9
30	B-M: intention to be responsive	60	16	7	5	4	20	8
31	B-P: formalised delivery processes	53	15	8	5	4	16	4
32	B-L: openness to other/broader perspectives/alternatives	43	8	5	5	5	9	6
33	B-K: experience and ability/competence	37	13	4	5	3	8	4
34	B-K: process automation capability	37	10	5	2	3	10	7
35	B-L: openness to/embracing/incorporating change	27	6	5	5	2	6	3
36	B-P: resource capacity for DM (socio/tech)	26	8	4	3	2	6	3
37	B-M: intention to be proactive	23	7	3	2	2	7	2
38	B-L: peripheral dependency/interdependency/knock-on	21	7	1	3	2	5	3
39	B-K: learning from safe-to-fail trying/innovating/exploring	16	4	2	2	2	4	2
40	B-P: team/role/organisation maturity	16	5	1	1	1	4	1
41	B-P: autonomy at execution level	13	2	2	2	2	3	2
42	B-P: uncertainty in external environment	11	2	2	1	1	3	2
43	B-P: uncertainty in internal environment	11	2	2	1	1	3	2
44	B-M: avoid technical debt/rework/redundancy	2	1	0	1	0	0	0
45	B-P: unilateral/BU decision-making	1	0	1	0	0	0	0

3.4 SOURCES OF INFLUENCE ON EVOLVING AGILITY IN POLICIES

The findings related to evolving agility based on the analysis of the data management **policy documents** collected at the case study organisation are presented in the following table:

Figure 7: Sources of influence on the evolution of repeatable agility features in policies

TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power TOP 12 Top 3 Bottom 3	Total code co-occurences of boundary judgements AND repeatable agility in Policies	SC- Policies & A2- expertise/specialised capability	SC- Policies & A2- leanness (eliminate/avoid redundancy)	SC- Policies & A2- reusability	SC- Policies & A2- scalability	SC- Policies & A2- speed enabled by specialisation and equilibrium
1	B-M- clear, shared data-centric purpose	292	79	46	77	65	30
2	B-L- adoption & proliferation of DM capabilities	274	79	34	77	61	23
3	B-P- data governance processes	265	78	40	68	52	27
4	B-K- shared understanding (business & data)	257	69	41	68	54	25
5	B-M- share & integrate capabilities (avoid silos)	228	58	32	66	45	23
6	B-L- suitability/sufficiency in context	226	61	42	62	45	15
7	B-M- feedback loops (assess/monitor/test)	221	68	31	68	45	19
8	B-K- defined, prioritised DMdata capability requirement	213	62	33	62	45	21
9	B-P- data ownership, stewardship, custodianship	204	55	31	63	43	22
10	B-P- data management policies	200	68	25	55	37	17
11	B-K- modularised/standardised/foundational capability	197	54	29	57	39	18
12	B-P- effective stakeholder engagement	188	56	28	66	48	18
13	B-M- data silo/function clarity	183	53	31	63	36	19
14	B-K- specialist knowledge/skills/expertise/understanding	176	56	22	48	37	13
15	B-K- resource capability (socio/tech/data)	175	47	27	44	37	20
16	B-P- business area strategy/priority	162	42	28	41	36	15
17	B-L- tenability/durability/sustainability	161	42	27	37	32	23
18	B-M- business value/impact of DM initiative	153	41	26	39	35	12
19	B-P- data leadership mandate/direction/support	148	42	20	39	35	12
20	B-P- collaborative culture, synergy	145	39	23	38	34	11
21	B-K- iteratively/continuously keep up & improve capability	138	38	20	37	32	11
22	B-L- potential extent of impact	134	38	21	31	27	17
23	B-P- data management principles	130	39	17	39	25	10
24	B-M- intention to improve/support agility in DM	129	31	20	29	28	23
25	B-P- trust/trustworthiness	128	34	21	31	25	17
26	B-L- reflection on approach to data initiatives	126	42	18	35	28	11
27	B-P- legal/regulatory/audit compliance requirements	119	46	18	24	26	17
28	B-M- buy-in/commitment from stakeholders of data priority	109	32	17	25	27	12
29	B-P- data management strategy	106	27	16	27	24	12
30	B-P- formalised delivery processes	100	33	12	32	16	7
31	B-M- intention to be responsive	62	18	9	17	18	8
32	B-K- process automation capability	55	14	5	15	18	10
33	B-L- openness to other/broader perspectives/alternatives	54	12	9	16	13	5
34	B-L- peripheral dependency/interdependency/knock-on	52	14	8	13	11	6
35	B-K- experience and ability/competence	49	16	7	12	9	5
36	B-M- intention to be proactive	33	16	5	9	7	2
37	B-L- openness to/embracing/incorporating change	32	8	8	7	5	4
38	B-P- resource capacity for DM (socio/tech)	24	8	3	5	5	3
39	B-K- learning from safe-to-fail trying/innovating/exploring	19	5	4	4	3	3
40	B-P- team/role/organisation maturity	19	6	1	6	5	2
41	B-P- autonomy at execution level	18	3	4	4	4	3
42	B-P- uncertainty in internal environment	12	4	2	2	2	2
43	B-P- uncertainty in external environment	9	3	2	1	1	2
44	B-M- avoid technical debt/rework/redundancy	7	2	2	1	1	1
45	B-P- unilateral/BU decision-making	5	1	1	2	1	0

3.5 SOURCES OF INFLUENCE ON FALTERING AGILITY IN PRACTICE

The findings related to faltering agility based on the analysis of the data collected in the **interviews** with data management (DM) **practitioners** at the case study organisation are presented in the following table:

Figure 8: Faltering agility due to failing practice of sources of influence on repeatable and non-repeatable agility features

TOP 12	K=Sources of knowledge L=Sources of legitimacy M=Sources of motivation P=Sources of power	Total co-occurrences of boundary judgements and faltering agility in interviews	F- disintegrating agility	F- precarious agility	F- un-prioritised/ unvalued/unrealisable agility
1	B-K- shared understanding (business & data)	139	36	47	56
2	B-M- intention to improve/support agility in DM	120	36	42	43
3	B-K- defined, prioritised DM/data capability requirement	112	30	35	47
4	B-M- clear, shared data-centric purpose	112	30	38	44
5	B-M- share & integrate capabilities (avoid silos)	101	21	36	60
6	B-P- collaborative culture, synergy	98	25	32	41
7	B-P- effective stakeholder engagement	90	20	33	37
8	B-K- experience and ability/competence	84	24	23	37
9	B-L- reflection on approach to data initiatives	83	23	27	33
10	B-K- specialist knowledge/skills/expertise/understanding	79	18	25	36
11	B-P- business area strategy/priority	79	18	23	38
12	B-L- adoption & proliferation DM capabilities	75	18	21	36
13	B-K- resource capability (socio/tech/data)	73	19	23	31
14	B-P- team/role/organisation maturity	69	21	21	27
15	B-L- potential extent of impact	67	13	26	28
16	B-P- uncertainty in internal environment	59	22	18	19
17	B-L- suitability/sufficiency in context	55	15	18	22
18	B-M- intention to be responsive	55	16	19	20
19	B-L- openness to other/broader perspectives/alternatives	54	15	17	22
20	B-M- business value/impact of DM initiative	53	10	20	23
21	B-K- iteratively/continuously keep up & improve capability	52	12	20	20
22	B-L- peripheral dependency/interdependency/knock-on	52	10	19	23
23	B-P- resource capacity for DM (socio/tech)	52	11	17	24
24	B-L- tenability/durability/sustainability	49	10	15	24
25	B-P- data leadership mandate/direction/support	48	14	17	17
26	B-L- openness to/embracing/incorporating change	47	11	21	15
27	B-M- buy-in/commitment from stakeholders of data	41	11	13	17
28	B-K- learning from safe-to-fail trying/innovating/exploring	40	10	15	15
29	B-M- data role/function clarity	36	9	12	15
30	B-P- unilateral/SU decision-making	35	10	9	16
31	B-P- trust/trustworthiness	29	10	9	10
32	B-K- modularised/standardised/foundational capability	28	5	8	15
33	B-P- formalised delivery processes	28	5	11	12
34	B-P- data governance processes	27	5	9	13
35	B-P- data ownership, stewardship, custodianship	26	5	6	15
36	B-P- autonomy at executive level	24	6	9	9
37	B-P- uncertainty in external environment	23	7	11	5
38	B-M- feedback loops (assess/monitor/act)	20	6	5	9
39	B-P- data management strategy	17	4	5	8
40	B-P- data management principles	14	3	4	7
41	B-M- avoid technical debt/rework/redundancy	13	2	5	6
42	B-P- data management policies	13	3	3	7
43	B-M- intention to be proactive	12	4	3	4
44	B-P- legal/regulatory/audit compliance requirements	12	3	5	4
45	B-K- process automation capability	8	0	4	4

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