

Transdisciplinary Approach in Studying Organisational Transformations: A case study in Evolution of Military Enterprises

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Abstract: Digital transformation has a notorious record of failures. Maybe the enterprise architects do not have a holistic model to study and model the organisational transformation. An enterprise consists of several structural components, which vary from culture to technology layers defined in the Enterprise Architecture. Usually, the transformation of an enterprise involves most of the interrelated layers in connection to the environment around the organisation. Seemingly, no single science provides frameworks to study the transformation of a whole system of systems (including the layers of enterprise strategy, culture, business, information, and technology). Therefore, the paper proposes a transdisciplinary approach combined with spiral research design as a framework for the business sciences and enterprise architecture. The proposed framework connects different sciences of sociology, business, strategy, history, information, and technology to understand the evolutionary particularities of each layer of enterprise in transformation. The transdisciplinary approach supports the modelling of the entire enterprise in all of its complexities and over a longer time. In contrast, the current monodisciplinary focuses only on parts of an enterprise at a particular window of time. By definition, transdisciplinary research fuses findings across the disciplines, between the disciplines and beyond the disciplines. Furthermore, the framework supports spiralling between scientific methods and non-scientific practices. The case study utilised a spiralling research process that provided a tighter feedback loop from application in practice to model development in theory. The transdisciplinary spiralling approach provided an iterative approach to verify the outcome, reduce the complexity, and address the practitioner's reality. Hopefully, the research approach used in the case study and the tool created will improve enterprise architecture practice to ensure a successful digital transformation of military organisations.

Keywords: Organisational transformation, Enterprise architecture, Transdisciplinary research, Mixed methods, Research process, Evolution of socio-technical system

1. Introduction

The paper is a part of a larger research project (Mattila, 2020) and focuses on proposing a research method that improves the understanding and orchestration of enterprise transformation. The improvement is achieved with an enterprise architecture tool that reflects the dynamics of an enterprise better than the existing body of knowledge. The tool was designed based on an improved model created by combining several discipline-specific sub-studies that focused on the dynamics of an enterprise at layers of culture, process, information, and technology. The improvement was partially due to the combination of the multidiscipline research method and the spiral of design-feedback between theory and practice.

Over the past 15 years, there is evidence that the success in the transformation of the enterprise remains an exception, not the rule (Bucy, et al., 2021). The environment outside the enterprise is changing, e.g., in ways of Industry 4.0 (Schwab, 2016), Society 5.0 (Cabinet Office, Government of Japan, 2017), Smart Governance (Bolivar & Meijer, 2015), Knowledge-Economy (The World Bank, 2013), and Platform Economy (Neittaanmäki, et al., 2016). Furthermore, the old competitors are catching up in competition, new competitors are popping up while customer expectations rise beyond imagination, and the supply chain evolves (Porter, 1985). Therefore, companies need to transform or perish when longstanding competitive advantages diminish. (Becker, et al., 2018)

The emerging technologies (e.g., 5G, Edge computing, Artificial Intelligence, Big Data, Quantum and Biotechnology) (Michlelotti, 2020) are driving enterprises towards a digital transformation that may be perceived as anything from IT modernisation to implementing new business models. (Gartner, 2004) The drive has been there for over 20 years, and organisations are challenged to keep up with competition as the average company lifespan of the Standard & Poor 500 list is down to 18 years. (Garelli, 2016) At the same time, Enterprise Architecture (EA) has been helping companies to understand their structure and its transformation. (The Business Architecture Group, 2019) Is it possible that EA frameworks do not support the understanding of the dynamic nature of an enterprise (Ulrich & McWhorter, 2011), or maybe the existing models and reality differ too much for the practitioners' benefit?

The complex socio-technical, adaptive system called an enterprise comprises various layers and components modelled according to enterprise architecture (EA). The layers of enterprise vary from culture down to technology. (Open Group, 2019) The transformation involves all the interrelated layers in connection to the environment around the enterprise. Hence, no one science possesses all the tools to study the whole system of systems (unless we consider systems science). Hence, a multidisciplinary approach is required to connect the different sciences of sociology, business, strategy, history, information, and technology needed to understand the particularities of each organisational layer in transition. Furthermore, the forces of interrelationships between the layers need to be understood since they either enable or prohibit the transformation of the entire enterprise in Figure 1.

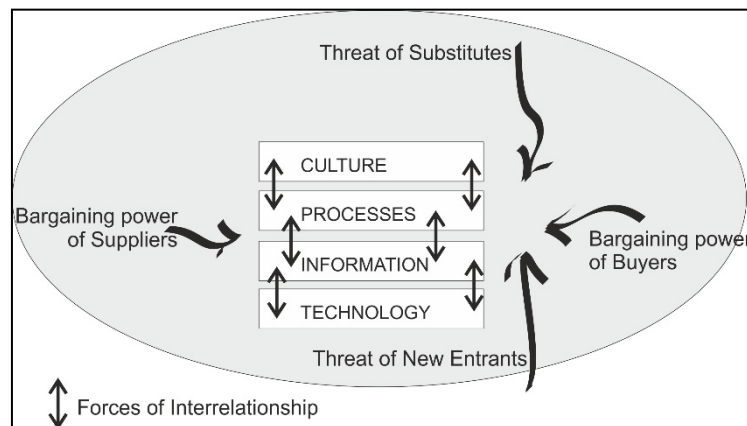


Figure 1: Challenge in understanding the powers and forces impacting enterprise transformations

The research focuses on improving the modelling of the evolution of enterprise dynamics during a transformation seeking a practical approach for multidiscipline study and making the enterprise architecture tooling more feasible for practitioners. The questions related to the research approach are:

1. How to orchestrate multidisciplinary research covering the complex evolution of culture, processes, information, and technology in a way that would create a model for the transformation of the system of systems?
2. How to design an artefact that is perceived beneficial among enterprise architecture practitioners?

The following sections provide an overview of finding answers to the questions above. Section 2 will review the existing knowledge on both the challenges in multidisciplinary research and making practical EA tools. Section 3 explains the transdisciplinary method with spiralling feedback between practice and theory. Section 4 summarises the results both from the practical tool and research method viewpoints. Finally, section 5 concludes the paper.

2. Literature review

Since the research questions are divided into two separate viewpoints: the challenge of multidisciplinary and practicality of EA, the current theoretical status is illustrated according to these lines of approach.

2.1 Multidisciplinary challenge

Enterprises are often characterised as complex adaptive socio-technical systems (Buckley, 1968) where an organisation is defined as a network of components that interact with each other, typically in a nonlinear fashion (Sayama, 2015). When observing and modelling an enterprise, the researchers need to comprehend micro-level interactions and macro-level emergent behaviour. (Chiva, et al., 2013) Therefore, researchers need to understand how organisational science affects knowledge science and technical science as a team. Unfortunately, each scientist prefers their own mental models or definitions of their branch of research, which hinders gaining a system of systems understanding within the team. For example, engineers like to think and talk about algorithms and ontology, whereas sociologists prefer the jargon of behavioural or cognitive features. Sometimes, the power relationships within the research team may define the understanding of the overall system and create bias to analyses of the data. (Bell & Kozlowski, 2012)

Consequently, the research seeks to minimise bias in the multidisciplinary research process. Multidisciplinary is “a sequential process whereby researchers in different disciplines work independently, each from their

discipline-specific perspective, to eventually combine efforts to address a common research problem.” (Stokols, et al., 2008) The key in researching the dynamics between the stack of enterprise layers is the ability to transfer the impact of powers and forces from one layer or component to another. (Sanders & Wagner, 2011) Therefore, the research seeks the foundational transfer methods from a transdisciplinary approach.

Transdisciplinarity is “an integrative process in which researchers work jointly to develop and use a shared conceptual framework that synthesises and extends discipline-specific theories, concepts, methods, or all three to create new models and language to address a common research problem.” (Stokols, et al., 2008) It has been long used to solve ‘wicked problems’ (Rittel & Webber, 1973) but may present challenges in managing and fusing data within the research team. (Palmer, et al., 2018) The key is the integrative process, which uses a shared conceptual framework that helps synthesise and extend the discipline-specific research. (Bergmann, et al., 2013) The method provides several ways to integrate different disciplines and understandings, such as theoretical framing, research questions, assessment process, modelling and simulation, or boundary objects. (Fiore & Wiltshire, 2016) Of the integration options, the framing seems to fit well to support collaboration over an enterprise architecture problem. (Brown, et al., 2010)

2.2 Enterprise Architecture Challenge

First, the contemporary approach of linear evolution constraints EA practitioners with a predetermined roadmap for enterprise change (United States government Accountability Office, 2011). One of the current challenges from the enterprise affairs viewpoint is the existing frameworks’ lack of value stream and evolutionary transformation understanding (Bankauskaite, 2019) or as David Bohm (Ulrich & McWhorter, 2011, p. 61) says:

“What is needed is a relativistic theory, to give up altogether the notion that the world is constituted of basic objects or building blocks. Rather one has to view the world in terms of the universal flux of events and processes.”

Furthermore, there has been criticism that the current body of EA knowledge is too narrowly focused (Vargas, et al., 2014), technologically oriented or static (Akhigbe, et al., 2014) (Bryl, 2009) (Korhonen, et al., 2016). Therefore, the practitioners of EA need a more dynamic set of tools to understand the complexity of enterprise transformation.

Second, the realisation of the EA benefits is not straightforward. Besides the apparent technical issues, the concern is also in socio-political-cultural matters. (Wan, et al., 2013) Therefore, the scope of multidisciplinary research needs to be more inclusive. Hence, the layers describing an enterprise include cultural aspects concerning the environment. Fortunately, enterprise architecture has been previously used to help in unifying transdisciplinary research processes. (Yamamoto, 2019)

In conclusion, a benefit perceivable from the EA viewpoint requires a model that simplifies a complex socio-technical organisation's flux of events and processes. Next, the paper proposes an approach to improve the transdisciplinary research orchestration to further reach the complexity of an organisation and create a practical set of tools to realise the benefits of a clearer understanding of dynamics in transformation.

3. Research method

The research process follows the sequence of Design Science Research Framework (Hevner & Chatterjee, 2010) that introduces the problem, designs the artefact, demonstrates its applicability, and evaluates its feasibility. However, despite the engineered artefact outcome, complex adaptive systems research requires a transdisciplinary approach and multidimensional research design. Furthermore, the research chooses to view the challenge from a pragmatic position (Creswell, 2014, p. 11) because of the emergent nature of the challenge and the aim of the research:

1. Firstly, the challenge has emerged to the author and his colleagues over the years practising enterprise architecture. The long experience gathered over the years has led to seeking a broader context for the possible causes of failures in transformation. Therefore, the research is reaching out along the social, historical, political, and technical dimensions in an attempt to understand the broader phenomena.
2. Secondly, the aim is to provide a feasible tool for enterprise architects to understand and predict better the digital transformation of armed forces. Therefore, the overall research method follows design science focusing on problem-solving and designing an artificial tool (Dresch & Anantunes, 2015, pp. 11-13). Each partial research tries to use the applicable methods of the chosen scientific approach.

Therefore, the research uses mixed methods to understand the socio-technical evolution (Trist & Bamforth, 1951) from an interpretive viewpoint (Blumberg, et al., 2014, pp. 16-18).

Consequently, the flow of the research was divided into two slopes: The deductive approach to capture the bigger picture of the phenomena and the inductive approach to see if the details support the bigger picture. The research storyline is illustrated in Figure 2.

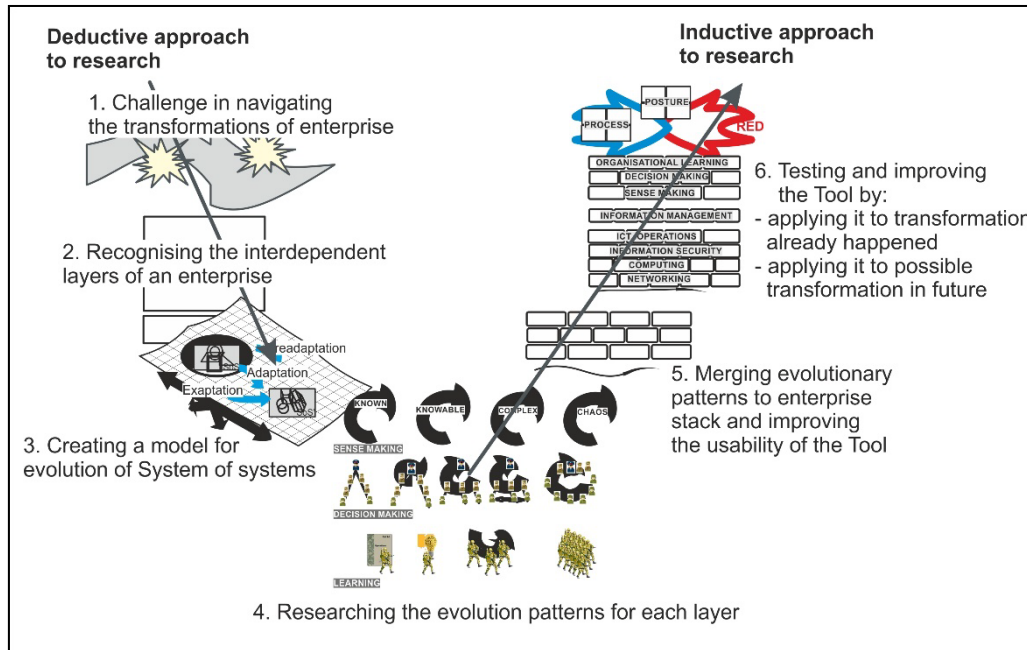


Figure 2: The two slope storyline of the research design

Because of the transdisciplinary nature, the research design created the necessary theoretical frames (Bergmann, et al., 2013) to integrate all the science-specific parts of research. These frameworks included:

- A generic business model (1, see Figure 2) and its evolution from a historical perspective for an organisation in the given context,
- An enterprise model describing the independent but relational layers of enterprise structure (2), and
- A model of dynamics in an open socio-technical system (3) to study the evolution of an organisation.

Further on, armed with these frameworks, the research was divided into five pieces of research (in lines of strategy and culture, processes, information, information security, and technology) to study the evolution of each layer separately (4). The layers were chosen based on the ontologies of the TOGAF architecture framework (Harrison, 2013) to understand how the different components at each layer interact in transformation. Each layer of lifeline was constructed separately from a post-positivistic view (Creswell, 2014, p. 7) but used a common ontology for the organisational evolution based mainly on Mokyr's knowledge economy model (Mokyr, 2002).

Table 1 illustrates the approaches and methods used in sub-studies. Each study used the appropriate scientific approach without forgetting the complexity of the bigger picture. For example, most evolutionary studies used the model deducted and tested in Report 1. Nevertheless, Report 2 used historical reasoning (McCullagh, 1984), and Report 3 used the path-creation model (Garud & Karnoe, 2013) to triangulate the primary evolutionary approach defined in Report 1. Since the foremost challenge was to manage the evolution of enterprise architecture, the time dimension is primarily longitudinal. However, the demonstration and evaluation of the holistic architecture model used a cross-sectional approach because of the practical scope of architecture work in assessing an existing situation and analysing optional paths for the development ahead.

Table 1: List of mono-disciplinary reports and their main research design

Report vs Research Approach	Appropriate scientific approach	Data	Research Methodology	Time dimension
1. Evolution of the socio-technical system	Systems	Extreme case sampling of historical data	Experiment	Longitudinal
2. Affairs & Culture	History	Heterogeneous sampling of historical data	Case study, experiment	Longitudinal
3. Knowledge management & Culture	Knowledge	Typical case sampling of historical data	Experiment	Longitudinal
4. Information management & Culture	Engineering	Typical case sampling of historical data	Design, Demonstration, Evaluation	Longitudinal
5. Information security & Security culture	Engineering	Typical case sampling of historical data	Survey	Longitudinal
6. ICT architecture	Engineering	Heterogeneous sampling of observations and historical data	Case study	Longitudinal
7. Enterprise architecture in change management	Design	Heterogeneous sampling of case study data	Demonstration = Experimentation with case study data	Cross-sectional
8. EA tool helping to apply artificial intelligence in an enterprise	Design	Heterogeneous sampling	Demonstration = Experimentation with case study data	Cross-sectional

After the deductive slope, the inductive design research took over since the artefact's purpose was to predict the journey of transformation better. First, it started designing and developing a comprehensive schematic framework for each layer of enterprise structure with a lifeline of the featured evolution for each layer (5). The ontological paradigm assumed enterprise as a combination of interacting systems made of interdependent components that are affected when engaging the environment in a manner that is not evident by direct observation (Sayama, 2015, pp. 3-9). Therefore, the two-dimensional dynamic enterprise architecture tool went through cycles of testing in practice (Gummersson, 2017) and adjusting the theoretical model (Blumberg, et al., 2014, pp. 20-24), as illustrated in Figure 3. The spiralling approach was inspired by the ways of agile development (McMahon, 2011) and spiral acquisition (Boehm, 1988) and driven by the requirements for the Enterprise Architecture body of knowledge (Whittle & Myrick, 2005) and the reality of practitioners' work.

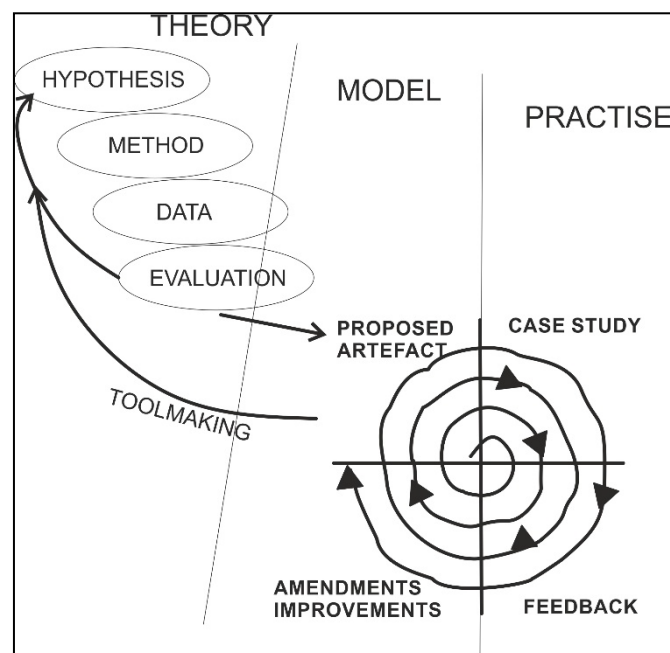


Figure 3: Iterative method in improving the feasibility of an academic artefact

Eventually, the researchers created a holistic system model (EA tool) and demonstrated it to confirm the parts' feasibility and the whole model (Weerakkody, 2015, p. 23). The demonstration included two scenarios (6): post-analysis of transformation and pre-analysis of possible futures. First, the post-change demonstration included experimentation where a group of seasoned enterprise architects analysed three different military transformations after their implementation. The aim was to evaluate the designed EA tool in two measurable dimensions:

1. Ability to define stages on the EA and foresee the transformation challenges of evolution (Akhigbe, et al., 2014) and forces of change from within and outside of the enterprise (Geels, 2002),
2. Ability to focus efforts over the three phases of organisational change (Unfreeze, move, and refreeze) (Cameron & Green, 2012, pp. 120-123).

Second, the pre-analysis of the EA tool included experimentation where a group of enterprise architects analysed how an organisation could gain benefits by utilising features of Artificial Intelligence (AI). The demonstration aimed to apply the tool in three measurable missions of an Enterprise Architecture:

1. Enterprise journey to its current posture, capabilities, and structure (Morecroft, 2015),
2. Forces that may help or hinder the enterprise in their further developments (Maisel & Cokins, 2014), and
3. Ability to address the AI-specific (Bostrom, 2014, pp. 95-109) opportunities or challenges and how they may be exploited or mitigated (Mokyr, 1998).

4. Results and discussion

The results of this research project can be approached from two points of view: 1. the feasibility of the engineered artefact (EA Tool) for the Enterprise Architecture practitioners, and 2. the novel way of solving research problems in the evolution of a complex socio-technical, adaptive system for academia.

4.1 The EA Tool

The research designed an EA tool for EA practitioners (Mattila, 2020). When demonstrating and evaluating the EA tool, it appeared to fulfil the standard requirements for an EA model satisfactorily, addressed the particular challenges in modelling the dynamics of enterprise evolution, and did well in advising how to implement artificial intelligence features in an enterprise. Therefore, the engineering tool met the expectations for quality and usefulness in (Mattila, 2020, pp. 48-49):

- Illustrating the dynamism within the layers of enterprise structure, and
- Assessing the impact of interrelationships between the layers, inside and outside of the enterprise as shown in Figure 4.

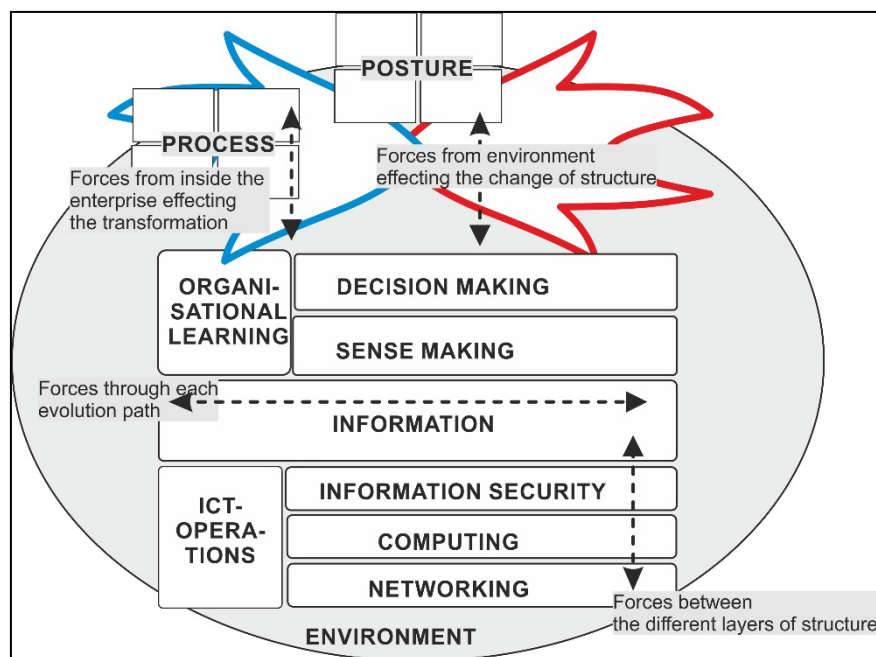


Figure 4: Recognising the interrelation forces between the layers and components of an enterprise

From theoretical and practical viewpoints, the EA Tool provides potential advantages in ways to (Mattila, 2020, pp. 50-51):

1. Analyse the strategic transformation ability of both competitors and their organisations.
2. Plan and implement a successful, holistic transformation of an enterprise.
3. Require and build more integrated business capabilities based on a layered system of systems architectures.
4. Manage small changes in the continuous development of business capabilities.
5. Improve the integration of existing systems and components of an enterprise.

Following the nature of design science, the EA tool was demonstrated in two separate case studies using different measurement approaches for quality: 1. explaining an enterprise transformation after it has happened, and 2. helping to foresee opportunities and challenges in adopting emerging technology. Therefore, the feasibility evaluation was triangulated with two independent groups and viewpoints. The practitioners contributing to these case studies were fully supported through the process, so there may be challenges to utilising the EA tool independently. Through additional training and educational material, the skill required will be achieved. Furthermore, the small number of researchers and contributing practitioners (two crews of five people) leave the research open to the bias of constrained focus and competency. Further practice of the EA tool will mitigate this bias. Since the data used for the research was from armed forces only and the goal was to understand transformations of western military enterprises, the applicability of the EA tool may prove specific to similar organisations only.

4.2 The Research Method

The research project faced the following research methodological challenges, as illustrated in Figure 5, in seeking a better understanding of enterprise transformations:

- A. How to keep multidisciplinary research projects on course and transfer findings from one science to other fields of science?
- B. How to create a feasible artefact that meets the expectations of the body of EA knowledge and practitioners' reality?

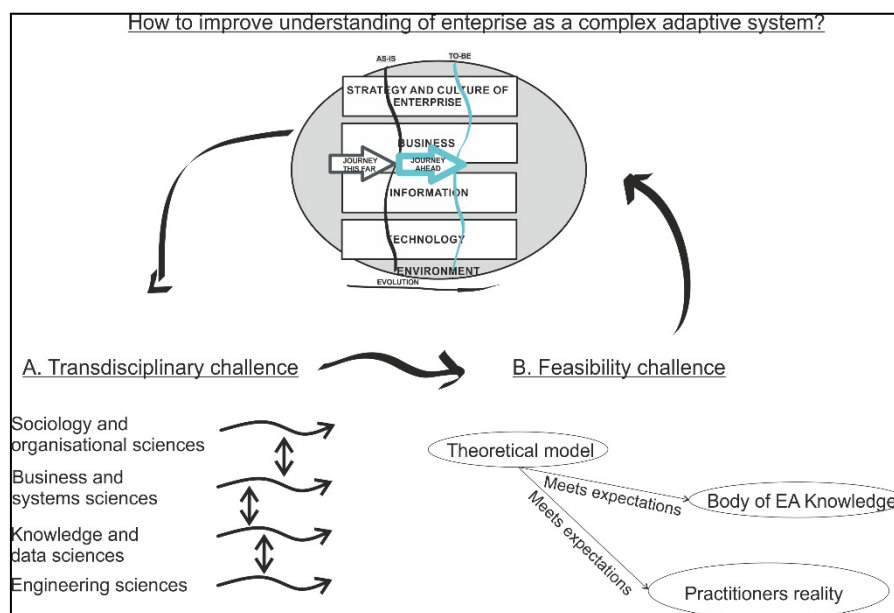


Figure 5: Challenges for research methodology

First, the framing method of transdisciplinary research kept the partial studies aligned within the holistic model of enterprise evolution, business model and interacting forces. Hence, the results of each partial study were fluently interpreted with other results when the layered dynamic model of the enterprise was composed. Furthermore, the small number of researchers made it easier to orchestrate the research process, so challenges may emerge with a larger group of researchers. Wider research teams should apply normal project management practices to mitigate the challenge of size.

Second, the spiralling method between theory and practice assisted in adjusting the theoretical model to meet the expectations of both the body of EA knowledge and practitioners' reality. The spiral included case studies engaging small groups of EA practitioners, and lessons were collected back to model and hypothesis formulation. However, the research was focused on the defence sector where the architecture taxonomy may be more established than in other sectors. Established terms and definitions may help to scale the EA tool in other sectors.

5. Conclusions

The complex socio-technical, adaptive system called enterprise is composed of various layers and components according to the practice of enterprise architecture (EA). The EA has been supporting the enterprise in its organisational transformations since the 1990s. Nevertheless, there is evidence of several partial or complete failures in the recent history of digital transformations. Hence, the main research question is "How to model the enterprise evolution more clearly to anticipate the challenges of its transformation"?

Modelling the enterprise requires reaching out along the social, historical, political, and technical dimensions trying to understand the transformation. Furthermore, the theory needs to be feasible for practitioners to create a more detailed account of the dynamics of the case. From the research design viewpoint, the main question required answers to two sub-questions:

1. How to orchestrate multidisciplinary research covering the complex evolution of culture, processes, information, and technology in a way that would create a model for the transformation of system of systems?
2. How to design an artefact that is perceived beneficial among enterprise architecture practitioners?

The multidisciplinary challenge was mitigated by a transdisciplinary approach that allowed the transfer of force vectors from one particular research to another. The framing appeared as an essential tool to align each monodisciplinary study and focus on engineering needs. In this research, it was imperative to approach the problem first from a deductive view and define the three dimensions of enterprise evolution (business model, interdependency model and model of dynamics) for the frames of specialised studies.

Spiralling between scientific methods and enterprise architecture practices improved the feasibility of the EA tool in daily architecture work. Furthermore, the intensive feedback loop from practise to theory provided additional empirical data for conforming to the results and adjusting further the model. The significance of the artefact produced as a result of the research was proven both in retrospect analysis and forward-looking evaluation, especially in the chosen area of business. Furthermore, the research method provided a novel way to combine multidiscipline studies with the engineered design of an artefact within one project. Naturally, the detailed research design may not appear as a scalable practice to other fields of business, but the generic approach may help other business researchers to create an improved understanding in their specific fields.

The main limitations of this research emerge from the small size of the original research group, tight focus on the defence sector, and from the variety of understanding and philosophy between disciplines. Therefore, there is room to improve the current model with a wider number of cases studied by broader groups of researchers and practitioners. Established taxonomy and project management practices may support the scaling of the research method. The profound challenge of knowledge transfer between separate disciplines was mitigated in an effort to improve the understanding of the evolution of the complex dynamic military enterprise. A transdisciplinary approach with established architecture taxonomy and motivated EA practitioners were the key enablers in this accomplishment.

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