MASTER'S THESIS

Towards future-proof Enterprise Architecture in cross organizational business ecosystems in the financial sector

Winkelhorst, Maarten

Award date:
2024

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Opleiding:	Open Universiteit, faculteit Betawetenschappen Masteropleiding Business Process Management & IT
Degree programme:	Open University of the Netherlands, Faculty Science Master of Science Business Process Management & IT
Course:	IM0602 BPMIT Graduation Assignment Preparation IM9806 Business Process Management and IT Graduation Assignment
Student:	Maarten Winkelhorst
Identification number:	
Date:	2024-04-27
Thesis supervisor	Maurice Pattij MSc
Second reader	Prof. dr. Rogier van de Wetering
Version number:	1.0
Status:	final version

Open Universiteit

Abstract

Digital innovations and transformations have led to growing interconnectivity between organisations. Consequently, organizations have become involved in value streams from connected organizations that have resulted in emergence of business ecosystems. Understanding IT landscape complexity requires understanding of business and organizational complexity first. Existing literature about Enterprise Architecture(EA) and Enterprise Architecture Management(EAM) is limited in scope to internal organizations. Although EA and EA artifacts have been used for decades as a practise to outline complexity in organizations, scientific knowledge on how EA can be applied in business ecosystems to develop future-proof architecture is lacking. Therefore, this study focusses on how EA artifacts can design and develop future-proof architecture in business ecosystems. Semi-structured interviews have been conducted in the financial sector in the Netherlands showing a fit-for-purpose of existing EA artifacts in ecosystems. However, additional challenges and complexity require additional artifacts to map the complexity. This study gained scientific knowledge about how EA and EA artifacts help business ecosystems to develop a future-proof architecture.

Key terms

Enterprise Architecture, Business Ecosystems, future-proof architecture, EA artifacts

Summary

Digitalization enables organizations to be more connected with other companies and their value streams, leading to emergence of business ecosystems. Driven by introduction of new technologies and digital transformations emergence of business ecosystems has increased and will continue to do so. For decades, Enterprise Architecture(EA) as a practice manages complexity of organizations and their IT landscape applying EA artifacts. Scientific knowledge about the role of EA is limited to EA in single organizations. However, scientific knowledge about EA in business ecosystems is lacking. This study has gained scientific understanding about EA in ecosystems by answering the question:

"How can EA help organizations in business ecosystems and associating value streams beyond organizational boundaries to establish a future-proof ecosystem?"

Existing theory on this subject was studied and outlined as foundation for this research. Based on available theory the research method was designed including the research questions. Conducting an explorative case study resulted in an in-depth inquiry into this topic according experts that work in the field of expertise. Semi-structured interviews were conducted to collect primary data. The thematic analysis based on the collected data resulted in five themes: EA artifacts, Enterprise Architecture Management(EAM), standardization, decoupling and enterprise purpose differentiation.

The purpose of EA artifacts appeared to be fit for purpose in EA in ecosystems too. Though, managing shared agreements cross organizations involves more official decision making and documenting compared to EA internally. Additionally, standardization plays a key role in future-proof EA in ecosystems, since managed standards makes it easier for organizations to connect to other parties, unlike customized solutions. Equally important in ecosystems is decoupling all the business capabilities and business functions into separate interfaces. It increases simplicity, flexibility and enabling innovations on business capability level without big IT transformations through the entire landscape. Existing artifacts provide sufficient guidance to outline this complexity.

Business ecosystems require more rigour for formal agreements cross organizations. Consequently, EAM that is concerned with the optimal use of EA artifacts in ecosystems requires more attention compared to EA internally. Standardization of IT components and interfacing benefits the simplicity and flexibility of IT landscapes. In order to use standards, organizations have to decouple their entire IT landscape into building blocks based on business capabilities and business functionalities.

Although existing EA artifacts are successfully applied in ecosystems, specific challenges remain to play a part. Business ecosystem architecture requires more formal agreements that lead to less space to experiment. Agreements and decisions have to be specified with context and reasoning and must be formally signed off. Hence, industry acknowledged standards in ecosystems become increasingly critical. Ecosystems that follow standards respected in their industry have certainly been successful and scalable.

Building blocks APIs should follow industry standards that is commonly used by the entire ecosystem. To establish future-proof ecosystem architecture, industry standards that encourage and enable the ecosystem to standardize could be published by an industry respected (third party) organization.

Content

1. Introduction

Enterprise Architecture (EA) is the foundation of successful information system implementation. Increasing digitalization in global professional and private domains enlarge the impact and relevance of EA. Regardless awareness or understanding EA, everyone benefits from good EA in daily work and life. This chapter introduces EA in business ecosystems and defines the research objectives.

1.1. Background

The history of Enterprise Architecture (EA) emerges in the 80s of the previous century when Zachman (1987) addressed the importance of managing the complexity of organizations first, in order to effectively and efficiently use Information systems (IS). Consequently, information systems and organizations infrastructure were impacted significantly. Zachman extended and formalized the framework for information systems architecture and many analysts and engineers adopted the framework (Sowa & Zachman, 1992). Today, Zachman is still seen as the founder of EA and his framework is seen as the fundamental EA framework.

Ross, Weill, and C.Robertson (2006) argued companies in order to successfully execute business strategy, the foundation for execution has to be built first. A foundation for execution is the IT infrastructure and digitized business processes that automates the core capabilities of a company. Enterprises that take EA as strategy are more successful to their business strategy, compared to companies that do not (Ross et al., 2006).

Increasing digitization lead to more collaboration between organizations leveraging products or services from other organizations to deliver value proposition. Consequently, interconnectivity between organizations increases and evolves into business ecosystems, a fairly recent phenomenon. Although research about EA in internal organizations have been executed extensively, scientific knowledge about EA in the context of business ecosystems is lacking.

1.2. Exploration of the topic

Continuous innovations and digitization force organizations to prepare for future innovations. In order to act upon expected and unexpected digital transformations, future-proof organizations need to be agile and adaptable. Enterprises have to shift to a perspective where business and IT are merged as one and the business strategy is intertwined with IT strategy (Sia, Weill, & Zhang, 2021).

New innovations and techniques are introduced so quickly that enterprises have to focus on being future ready instead of focus on digital transformation and innovations only. Consequently, enterprises are forced to develop adaptive capabilities to make the business adaptable to new technologies that exist now and in the future (Weill & Woerner, 2018).

EA can be defined as a description of an enterprise from an integrated business and IT perspective that help bridging communication gaps between business and IT stakeholders and improve business and IT alignment. EA consists of multiple individual documents typically called EA artifacts, describing specific business and IT perspectives about the current state and the desired state of an organization and a roadmap to visualize the transition (Kotusev, 2019). EA capabilities support organizations to innovate and align business and IT to become future ready (Van de Wetering, 2021). Enterprise Architecture Management (EAM) is a discipline that provides

guidelines and principles to effectively implement and continuously develop EA in an organization (Aier, Gleichauf, & Winter, 2011).

Adoption of new technologies rises new business models that combine products and services between multiple organizations. Consequently, organizations can no longer solely focus on their own organization to design an efficient and effective IT landscape. It is necessary to optimize relationships and digital solutions beyond organizational boundaries into the ecosystem where multiple organizations are involved. Optimizing relationships with other organizations results in cross organizational networks that can be defined as business ecosystems (Ehrensperger, Sauerwein, & Breu, 2020). A business ecosystem can also be defined as an economic community of loosely-coupled interacting organisations and individuals who produce valuable goods and services (Senyo, Liu, & Effah, 2019).

This research is executed in the context of the financial sector in the Netherlands. The Dutch financial sector consists of mainly five banks that have over 90 percent market share. The five largest banks and their market share are ING (39%), Rabobank (26%), ABN AMRO (17%), BNG-Bank (6%) and NWB Bank (4%). The financial sector provides services to consumers and business to facilitate payments, savings, loans and insurances. Since 2011 there is a significant decrease in jobs in the sector while at the same time there is an increase in interest in IT-competences (Banken.nl, 2021).

1.3. Problem statement

Prerequisite for organization to be future-proof are significant investments in EA and EAM. Recent academical research extended scientific understanding on how organizations exactly benefit from EA and EAM (Foorthuis, Van Steenbergen, Brinkkemper, & Bruls, 2016). However, the scope of these studies about EA and EAM is limited to organization internally. Organizations will be part of business ecosystems and increasingly depend on ecosystems. Lately, the emergence of business ecosystems has increased driven by introduction of new technologies and digital transformations and will continue to do so. Hence, organizations need to manage the complexity of their business in business ecosystems. Scientific literature about EA within business ecosystems is lacking. The increasing number of ecosystems demands more scientific understanding and attention about EA and EAM in ecosystems.

1.4. Research objective and questions

The research objective is to gain more scientific knowledge about the role of EA and EAM in cross organizational business ecosystems. The research intends to create a better understanding of EA in business ecosystems and how to optimize the value streams within. The research objective is phrased into the research question: *"How can EA help organizations in business ecosystems and associating value streams beyond organizational boundaries to establish a future-proof ecosystem?"*

To answer the research question sub-questions will be answered.

1. What are key characteristics of Business Ecosystems and its architecture compared to Enterprise Architecture?
2. What are main challenges and issues for organizations in existing business ecosystems while adapting to digital transformation?
3. What is needed from EA artifacts to be suitable to describe business ecosystems and its value streams?

1.5. Motivation/relevance

This study provides strategic insights to managers and professionals in organizations (SME's and corporates) how to get ready for an unpredictable and increasingly digital future. It enlarges the attention in scientific literature about cross-organizational EA. The speed of new digital transformations and the constant introduction of new technologies force organizations to have a mindset to get ready for a digitally unpredictable future. It is likely for many organization to become part of business ecosystems because of these digital transformations. The insights of this report sets out why and how to act now to be future ready, and how to apply EA and EAM successfully in organisations that act in the context of an business ecosystem.

1.6. Main lines of approach

Chapter two sets out theoretical framework as guardrails for this study. Chapter three explains the methods used to collect data. Chapter four describes the results of the research that results from the conduct research. In chapter five the conclusions and discussions are described including an answer to the research questions. Finally, recommendations are given to the case organization.

2. Theoretical framework

The theoretical framework in this chapter critically reviews existing literature to provide context and focus. The section emerges from selecting scientific literature articles in a systematic approach and outlines a synthesis to elucidate the overall understanding of the research topic from the researchers perspective (Saunders, Lewis, & Thornhill, 2019).

2.1. Research approach

The synthesis concludes from an integrative review approach. An integrative review analysis of representative literature has been analysed and synthesized in an integrative way to reveal the knowledge gap of where it is unclear what is happening (Saunders et al., 2019). To ensure scientific rigour the systematic literature review (SLR) methodology is adopted for the collection of data and answering research questions from Okoli (2010). A schematic description of this method is delineated in appendix 1.

The parameters defined for the search of this study justifies the approach that has been followed (Saunders et al., 2019). Solely English written references have been selected as search results. The main subject of selected literature had to be Enterprise Architecture. To ensure up-to-date literature, results from the past ten years have been selected. Earlier literature was selected only when considered relevant, for instance when a references has been cited by other articles a lot.

Mainly formally published items are considered relevant such as journals and books, mainly peer-reviewed academic journals (secondary literature) (Saunders et al., 2019). Literature search has been conducted by searching online databases and reading books or articles known in advance. Pre-selected references created a starting point to create research questions and search terms. Online search engines provided access to a vast amount of references. Online databases enabled querying search terms with additional parameters like date published, author, cited by and more (Saunders et al., 2019).

The search strategy commenced with the research question that outlines the purpose of the literature review. The underlined keywords from the research question formed the basis to establish search terms and phrases: *How can EA help organizations in business ecosystems and associating value streams beyond organizational boundaries to establish a future-proof ecosystem?"*

Keywords might have been rephrased to retrieve all potential relevant results, as defined in the next paragraph. Initial reading of relevant and recent articles may have resulted in extra search terms (Saunders et al., 2019). The online library from the open university and Google Scholar have been used as search engines, granting great access to various, reliable and many articles and providing insight in how many times a reference is cited by others and by whom.

2.2. Implementation

Conducting a systematic literature review the guideline of eights steps by Okoli and Schabram (2010) has been applied to accurately find and select articles scientifically. The research objective as stated in paragraph 1.4 contributes to other ongoing researches. Consequently, articles provided from the ongoing research are pre-selected as relevant literature to make sure the literature framework is aligned and not divergent from the ongoing research. Table 1 describes the search parameters and the results.

#	Search parameters	Type	Results
1	(Enterprise Architecture) AND (Business Ecosystems) (publication date max 10 years)	Journal article	126
2	(Abstract:(business ecosystems)) AND (Abstract:(dynamic capabilities))	Journal article	167
3	(Enterprise Architecture) AND (Abstract:(dynamic capabilities))	Journal article	93
4	(Enterprise Architecture) AND (Abstract:(Cross organizational))	Journal article	112
5	(Abstract:(enterprise architecture)) AND (Abstract:(dynamic capabilities))	Journal article	78
6	(Abstract:(business ecosystems architecture)) AND (Abstract:(dynamic capabilities))	Journal article	8
7	(cross organizational enterprise architecture) AND (Enterprise Architecture artifact)	Journal article	1

Table 1 - Search parameters and the results

After collecting the results and removing the duplicates, the titles have been scanned to verify if the title matches the subject of this study. Because of the vast amount of results, titles have been scanned quickly to select the relevant articles. For all the remaining results the abstracts have been studied to verify the alignment of the topic to this study. Next, the introduction and conclusions have been studied. For papers whose considered highly relevant, also the references have been scanned on title. Consequently, relevant references have been added to the references list as relevant articles. Eventually, a final selection of all the papers has resulted in 26 references, as described in Figure 1.

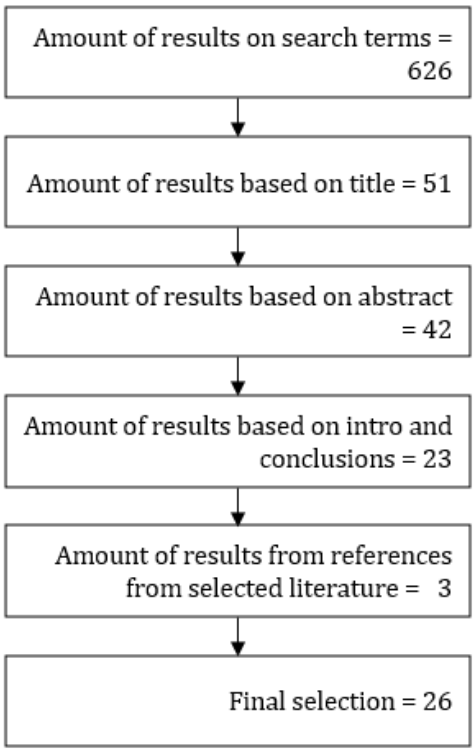

Figure 1 - References selection

2.3. Results and conclusions

EA finds its origin in 1987 when Zachman introduced the EA framework subsequently after a study about increasing size and complexity of IS (Zachman, 1987). To pursue effectively and efficiently use information systems, Zachman concluded the criticality to manage the complexity of organizations first.

To successfully execute a business strategy, Ross et al. (2006) argued that organizations have to build their foundation for execution first. A foundation for execution is the IT infrastructure and digitized business processes, automating the core capabilities of a company. Organizations that take EA as strategy are more successful to their business strategy in comparison to companies that do not (Ross et al., 2006).

EA can be defined as a description of an enterprise from an integrated business and IT perspective that can help bridging the communication gap between business and IT stakeholders to improve business and IT alignment (Kotusev, 2019). Among the variety of definitions of EA and conceptualizations of EA, the majority of these can be distinguished between three or four architecture layers, as visualized in Figure 2 (Janssen, 2009). EA consists of multiple individual documents typically called as EA artifacts, depicting a specific business & IT perspective about the current state and the desired state of an organization and a roadmap to visualize the transition (Figure 3) (Kotusev, 2019). It provides support and guidance to organizations and decision makers to disclose the coherence of technology to the business and ensures managing dependencies between IT systems (Janssen, 2009). EA artifacts are created to describe a system, solution, or state of the enterprise (The Open Group, 2011). Related to EA is the domain of Enterprise architecture management (EAM) which is a practise that aims to achieve optimal utilization of EA and EA artifacts to focus on continuously develop and improve EA (Aier et al., 2011).

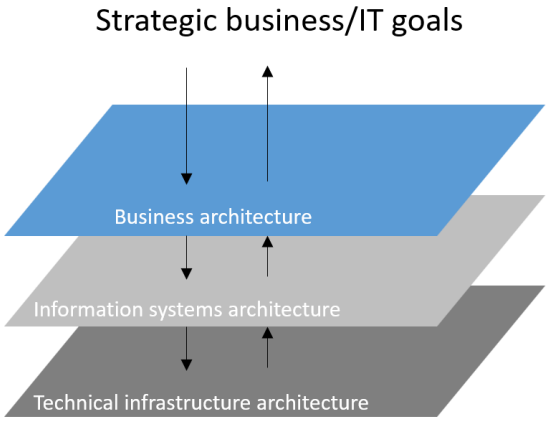

Figure 2 - Enterprise Architecture layers

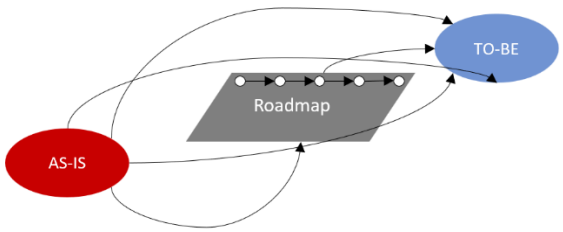

Figure 3 - EA Roadmap visualisation

Innovation and change opportunities for businesses are increasing, and the pace of new technology adoption is speeding up, either from business drivers, information technology (IT) drivers or both. It emphasizes the importance of alignment between business & IT (Ross et al., 2006; Shanks, Gloet, Asadi Someh, Frampton, & Tamm, 2018). Consequently, EAM has become largely important after focussing on understanding EA regarding Zachman his study to utilize the added value of EA (Gampfer, Jürgens, Müller, & Buchkremer, 2018).

Utilizing benefits of IT among several business units within organizations requires alignment of each IT system involved in combination with a strong coherent strategy for integrating, standardizing and leveraging IT systems and its capabilities (Hazen, Bradley, Bell, In, & Byrd, 2017). An IT landscape where cohesion is not ensured could result in IT performance disruptions and eventually disturbance of the entire organization. Hazen et al. (2017) argue that EA ensures alignment on data, applications, IT infrastructure and management to be conducive towards the business strategies that leads to successful organizations. Application of EA delivers value indirectly most notably on compliancy assessments, architectural insights and knowledge sharing (Foorthuis et al., 2016).

EA artifacts vary on scope and range from low detailed level to high-level principles, and are essential resources to apply EA within organizations successfully (Kotusev, 2019). Although popular sources provide lists of 30 to 80 EA artifacts, no single artifact provide clear instructions how to apply EA artifacts in practice. Understanding how to design EA artifacts, boundary objects can be used as a concept. Boundary objects connects organizational communities of practices by providing interfaces (Abraham, 2013). Kotusev, Kurnia, and Dilnutt (2023) argued that EA artifacts function very well as boundary objects within an organization that practices EA and it helps organizations to be ready for the future.

New innovations and techniques are introduced so quickly that enterprises have to focus on being future ready instead of focus on digital transformation and innovations solely, by developing adaptive business capabilities that can adapt to new technologies (Weill & Woerner, 2018). Future ready enterprises transform business so that digital capabilities support the enterprise to become a top performer in the digital economy (Weill & Woerner, 2018). Additionally, organizations need to be agile and adaptable, and act upon expected and unexpected digital transformations. Enterprises have to shift to a perspective where business and IT are merged as one and the business strategy is intertwined with IT strategy and tailored towards enterprise capabilities (Sia et al., 2021).

Teece, Pisano, and Shuen (1997) define dynamic capabilities as the ability for firms to adapt to changing environments. Helfat et al. (2009) define dynamic capabilities as the capacity of organizations to purposefully create, extend or modify capabilities that an organization owns, controls or has access to. Dynamic enterprise architecture capabilities have positive impact on internal processes innovation and alignment between business & IT and results in positive effect on organizational results (Van de Wetering, 2021).

Networks in which organizations, partners, suppliers and customers together create and share value between participants is considered as business ecosystems (Hedges & Furda, 2019). Continuous IT innovations create opportunities for organizations to intensify collaboration. Business ecosystems establish cross organizational value streams in which companies use products or services from different providers (Ehrensperger et al., 2020). The concept of investigating enterprise architecture in cross organizational value streams is defined as inter-enterprise architecture (IEA) (Vargas et al., 2016). The degree to which organizations are connected together can be identified into five stages based on the focus (Drews & Schirmer, 2014). These stages are described in Table 2.

Stage	(Extended) Focus
Enterprise Architecture (EA)	Describing EA and EAM within a single organization only
Extended Enterprise Architecture (EEA)	EA + additional actors like customers, partners, suppliers modeled and managed as an actor of the enterprise
Federated or Collaborative Network Architecture (FA / CNA)	EEA + all involved actors agree and align on parts of their architecture (boundary architecture) based on common interest
Focused Business Ecosystem Architecture (FBEA)	FA / CNA + EA of identified customers, partners, suppliers etc. But each actor is an isolated actor and is analyzed and modelled by one delegate representing the actor
Business Ecosystem Architecture (BEA)	FBEA + one central actors identifies and creates an overview of the whole ecosystem where the whole ecosystem is mapped into one overview and no boundaries based on actors are left over

Table 2 - Stages from EA to Business Ecosystem Architecture (Drews & Schirmer, 2014)

The stages from EA to business ecosystems architecture as outlined in Table 2 typically define key characteristics of business ecosystems and its architecture compared to EA. The characterization of these stages provide an answer to the first sub-question of this research. Enterprises are increasingly more connected to other organizations. Hence, they operate in business ecosystems with collaborative networks (Drews & Schirmer, 2014).

Similar to individual organizations, business ecosystems need to be agile and adaptable, and act upon expected and unexpected digital transformations. Regarding the second sub-question of this study, being future ready as an organization, be agile and adaptable to expected and unexpected digital transformations are key challenges for organizations within business ecosystems. According to Wieringa, Engelsman, Gordijn, and Ionita (2019), to align business and IT in cross organization value streams it is essential to accurately indicate the value viewpoint within value streams, for example in digital platforms.

Digital platforms have become a trending concept that materializes business ecosystems where organizations gather to create value (Van de Wetering & Dijkman, 2021). Digital platforms are shaping business ecosystems and cause (digital) transformations how organizations create advantage in markets. To retrieve value from digital platforms, organizations have to enhance the digital platform capabilities (DPC) (Van de Wetering & Dijkman, 2021).

Considering the increasing relevance and adoption of digital platforms and business ecosystems and the acknowledgement of EA as a key to success for enterprise, current literature lacks scientific knowledge about the applicability of existing EA artifacts in cross organizational business ecosystems, as questioned in sub-question three. Although the added value of EA artifacts within organizations have been acknowledged, there is no evidence on how EA artifacts help with endeavors that transcend organizational boundaries. This study intends to diminish this knowledge gap.

2.4. Objective of the follow-up research

The objective of this study is closing the knowledge gap about the application of EA artifacts in business ecosystems. The proven added value of EA and the increasing growth of business ecosystems emphasize the relevance of closing this knowledge gap on scientific knowledge perspective as well as practical application. Studying relevant existing literature and the synthesis in chapter 2.3 has provided answers to two sub-questions.

The aimed outcome of this study is scientific knowledge on how EA acts within business ecosystems and if existing EA artifacts are applicable in business ecosystem as well. Finally, this study aims to result in suggestions for follow-up studies about the topic to continuously enlarge the scientific knowledge about this increasingly relevant topic.

3. Methodology

This chapter describes research methods that have been used to collect data in a methodological manner and how it yields results. First, a description of the conceptual design is explained. Second, the technical design is presented, to explain how data was retrieved and collected. Third, it is explained how the collected data is analysed in a systematic manner. Finally, chapter 3.4 explains why the data and the analysis are reliable, valid and ethical issues are discussed.

3.1. Conceptual design: select the research method

Collecting data from sources and analysing data in a systematic way is described by the research design. The collected data eventually formulates answers to the researches questions, including relevant ethical issues an limitations (Saunders et al., 2019).

Data is retrieved primarily via semi-structured interviews and document analysis. The semi-structured interviews have been transcribed into words. Words derived from data collections are very suitable to use for research (Saunders et al., 2019). Words can be guided by illustrations, pictures or diagrams when that is relevant. Participants for research are selected relevant professionals that work in an organizational context where EA plays a meaningful part that ties into the theoretical framework of this study.

As this study aims to get scientific understanding about something yet unknown, this is an exploratory study, using a qualitative research method to develop new scientific knowledge. By combining semi-structured interviews and corresponding analytical procedures this study applies a multi-method qualitative study which fits into the purpose of developing new knowledge. The inductive research design approach suits for studies to explore a topic and develop a theoretical explanation when little is known (Saunders et al., 2019).

3.2. Technical design: elaboration of the method

The technical research strategy design is an case study approach. Case study strategy fits good into exploratory studies (Saunders et al., 2019). Complementary to the case study, document research is carried out since this combines very well with case study strategies as it enlarges the access to relevant information about the topic.

A case study strategy generates insights from in-depth research to study a phenomenon in its real-life context (Saunders et al., 2019). Physical documents and transcribed audiotapes into words from conducted interviews delivered data to describe results.

Documentary research as research strategy analyses existing documents that contain information that is related to the research topic. Since the original creation of the source was not for research, this literature is considered secondary literature. Though great care has been applied by selecting secondary literature, it can gain access to sufficient suitable documents (Saunders et al., 2019). Documents considered as relevant EA documents by participants or by EA stakeholders, for example EA principles and solution designs, have been selected.

Primary data has been collected by semi-structured interviews, also referred to as ‘qualitative research interviews’. Based on a pre-defined list of themes and key questions to guide the interview, while knowledge is retrieved from the context of the participant that differs per participant, data has been collected. This approach enables the interviewer to retrieve more information depending the context of the participant (Saunders et al., 2019).

The selected stakeholders have been selected based on their role, typically roles like business architects, solution architects, EA consultants, CIO, senior IT leads, since these roles are involved deeply into the EA within an enterprise. In some cases other roles close to EA have been involved in the study, for example Product Owners or Product Managers depending the context of their product or task differentiation.

3.3. Interview design

To conduct the research the first step has been setting up the interview design. This entailed defining the questions to ask during the interview to the participant. Based on the theoretical framework questions have been defined to collect data. The first questions were basic questions, that were easy to answer. Starting with basic questions created an easy start of the interview, made the participant feel comfortable and the participant slowly dived deeper into the research topic while talking about it.

The questions were open questions in order to avoid interview bias. Using open questions enabled participants to define or describe any situation. It encouraged participants to extensively answer the question that led to more data. Open questions typically start with 'what', 'how' or 'why'.

To encourage the participant to talk and explore his response during the interviews, probing questions have been asked to focus the participant in the right direction. Using prompts helped participants to get them go talking. At the end of each interview the participant has been asked if there is anything else he would like to say about the research topic to collect all the relevant data available for this research.

Before the official interviews were conducted a draft interview plan was conducted as a trial with a colleague to test the questions, to time box the full interview and see if the questions were logically ordered. The finalized interview plan including the questions can be found in appendix three.

3.4. Participants selection

Participants have been selected, starting searching in professional network of colleagues and former colleagues. Prerequisite for a participant to be selected was a significant background and responsibility on enterprise architecture and relevant experience on architecture beyond single organizations. Additionally, participants should not work together closely in one team. Initially a long list of names was created, followed by listing the most wanted participants. These were contacted and asked to participate in the research. One potential participant that was contacted did not reply to the invite. All the other invites were accepted.

The amount of participants initially was set to six to eight participants. This amount seemed to be feasible within the time limits of the research and should be enough to gain input to answer the research questions. While conducting the interviews the pre-liminary results were good enough to process and answer the research questions. Hence, after conducting six interviews no new participants have been invited to participate.

3.5. Conducting the interviews

Before the interview took place, all participants have been informed about the scope and purpose of the research. Though, the exact questions that would be asked during the interview have not been shared with any participants before the interviews were conducted. The interview invite contained context about the research, the goal of the research and an explanation of the process of data collection. The invite can be found in appendix 2.

3.6. Data analysis

First, the collected data has been prepared for analysis. The audio-recording of the conducted interviews has been transcribed. To make sure the transcribed data is accurate after transcribing, minimal data cleaning is done to correct transcription errors. Transcriptions have been sent to the participant for final checking and approval. The transcriptions also describe the way participants have given their answers or when there was a long silence between two words. Writing down non-verbal communication as well can give insights in how the data should be interpreted (Saunders et al., 2019). For document research, internal documents from one organization have been used for data analysis.

Once the transcriptions were ready for analysis, thematic analysis has been applied. Thematic analysis is a systematic but flexible and accessible approach to analyse qualitative data (Saunders et al., 2019). All the data is studied first, to become familiar with the data. Studying the data means reading transcriptions and trying to understand high level patterns. Some understanding of the data already took place while transcribing the data. Becoming familiar with the data is essential to be capable of finding accurate codes for data coding. Coding the data is used to categorize data with similar meanings. It involved labelling units of data with a code that describes or represents the meaning of the data item (Saunders et al., 2019). Coding data has been done with MS Word and MS Excel.

After coding was done, the data was categorised based on similar codes. Initially, this resulted in codes that had to be refined. When coding the data was completed, the data was examined looking for themes and relationships. Finally, refining themes and testing propositions finalized initial defined themes to eventually reveal patterns and relationships that resulted in propositions. The entire procedure of thematic analysis is shown in Figure 4.

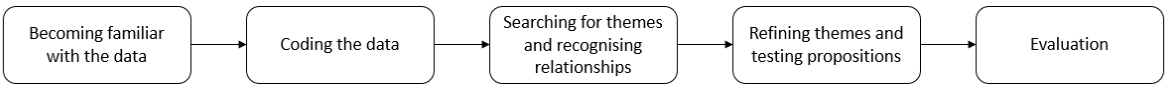

Figure 4 - Thematic Analysis procedure

3.7. Reflection w.r.t. validity, reliability and ethical aspects

The collection of primary data is reflected to credibility, external validity, reliability and ethical aspects.

3.7.1. Credibility

Credibility represents the internal validity as this study is an explorative research. Credibility is ensured by conducting a multi-method research and consequently, not relying on one single method. Credibility from the semi-structured interviews is ensured by collecting sufficient data from six participants. Selected participants had a variety of roles that enlarged the variety of data. Participants were not informed about answers from other participants and questions were not based on answer provided in earlier interviews. Each interview has been conducted as if it was the first interview conducted. A fellow researcher have reflected the results to assess the credibility.

3.7.2. External validity

Transparency about context, research questions, findings and interpretations strengths judgment to what extend the results and conclusions are transferable (Saunders et al., 2019). The more an organization differs from the organization used in this case study, the less transferable the results are. This holds for organization characteristics like type of industry, size of the company, amount of employees or net profit. Organizations with similar characteristics can take over results taking into account the context of the case. In this case study all organisations act in the Dutch financial industry as a bank, mortgage supplier or critical IT supplier.

3.7.3. Reliability

To ensure reliability, the interview transcriptions based on audio recording have been sent to interviewees for approval. Interpretations about spoken words could be reviewed. Defining a pre-defined set of questions for the semi-structured interviews made sure that all the interviews followed a similar path and similar structure (Saunders et al., 2019). Each interview has been conducted as if it was the first conducted interview.

3.7.4. Ethics

Research ethics form norms and values of the behaviour of the researcher and how to approach participants and other people involved in the research (Saunders et al., 2019). Confidential information has remained and treated confidentially at all times. The report must never lead to potential leaks of confidential company information, personal information or personal views. While conducting the research, ethical guidelines of the case company and the university have been respected. Nobody was forced or put under pressure to participate in the research. Participants will be informed once the report is completed.

4. Results

This chapter describes the research results. The first section of this chapter provides an overview of the interviews conducted. Followed by identification of themes based on thematic analysis of the collected data. The third sections explains identified themes and relationships, including quotes from interviews. The fourth section explains executed documented research applying the same thematic analysis.

4.1. Interview overview

For this research six interviews have been conducted with participants working in three different companies, all working in the financial sector in the Netherlands. Participants were selected based on their role, being either solution architect, business architect, enterprise architect or head of architecture with a minimal of three years of experience in the domain of enterprise architecture. Each interview has been conducted with one participant and each participant has only been interviewed once. An overview can be found in Table 3.

Interview	Participant	Organization	Rol	Experience in years	Duration
1	P1	O1	Solution Architect	3	00:50:15
2	P2	O2	Business Architect	8	00:36:13
3	P3	O1	Business Architect	12	00:53:32
4	P4	O1	Business Architect	7	00:45:31
5	P5	O1	Corporate Head of Architecture	18	00:36:54
6	P6	O3	Solution Architect	6	00:50:45

Table 3 - Participants interviews overview

While conducting the research the preliminary results showed an overlap in answers. Complementary to the overlap, all the data seemed to give an accurate answer to the research questions and align with the goal of the research. Hence, the results from these six interviews have been taken as data set to find themes and recognise relationships between the data to eventually draw conclusions.

4.2. Identification of themes

When the interviews were completed and the transcriptions were written and reviewed by participants, the data was studied once again to become familiar with the data. Reading transcriptions and making small notes, summaries or quotes initiated data analysis.

To find similarities in the data, the data was coded based on similarities and categories with similar meanings. Each code always links to a unit of data. Codes can be created in several ways. They can be derived from the raw data such as interview transcriptions by the researcher or by actual terms used by participants. Additionally, codes can be derived from literature in the theoretical framework, so called 'a priori' codes (Saunders et al., 2019), see Figure 5.

The codes have been generated in three to four iterations. While reading transcriptions, units of data were selected and summarized based on the unit of data. When coding the transcriptions was completed, the codes have been revised to see similarities that represent the same similarities but just slightly different defined. These codes were merged into one code. Eventually, this resulted in a decrease of initially 34 codes to eventually 16 codes that represent subthemes. These subthemes could eventually be assigned to identified themes.

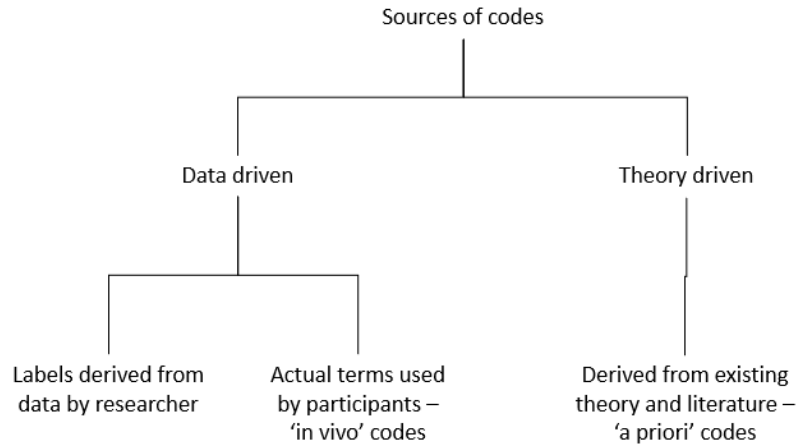

Figure 5 - Sources and types of codes (Saunders et al., 2019)

A theme is a category representing several codes that apparently have a similar meaning or a strong relationship with all the codes and that it has an important role in the research question (Saunders et al., 2019).

Eventually, identification of themes is done subjectively by the researcher based on overlap of labels or meaning of codes of the initial coding. This has been a careful process with continues refinement of themes and testing propositions. Defining themes based on codes involved understanding the key concepts of the codes, understand recurring codes and the meaning the recurrence. Also, trying to understand the essence of each apparent theme, the relationship between themes and identifying themes and subthemes. The relevance of each theme is based on the amount of code occurrences per theme.

4.3. Themes and relationships

This section describes the result of the conducted research. To be able to describe the results, thematic analysis has been applied to the data. Hence, the results are structured by the identified themes. When results refer to specific participants it has been specified by referring to a participant ID from table 3.

4.3.1. Theme 1: EA artifacts in ecosystems

The first theme identified based on the analysis is EA artifacts in ecosystems. The units of data all refer to descriptions of EA artifacts and how they apply in ecosystems. The codes were derived from data by the researcher, terms used by participants and derived from theory. The theme can be divided into categories, as shown in Figure 6.

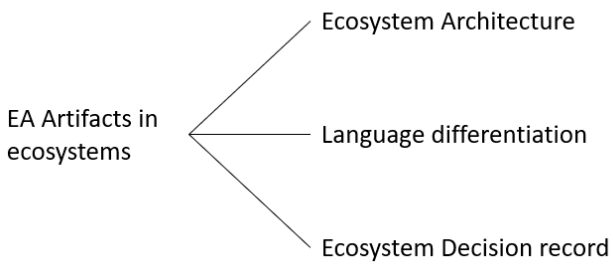

Figure 6 - Theme EA artifacts and categories

All participants have stated that existing EA artifacts used by organizations to outline the complexity of their business and IT for internal organizations can be used to describe complexity within ecosystems where multiple organizations are involved as well. All the participants have stated that the methods and drawings they are used to for EA within a single organizations, are applied in cross organizational ecosystems as well (P1,P2,P3,P4,P5,P6).

A participant said:

> *"When I'm standing at a whiteboard with an architect of a other organization, we'll draw the process diagram, we'll design the data model, maybe the infrastructure, draw the diagrams. Either if we do it internally or cross organizational… The drawings are actually the same. I draw the chain, the data, data flows, the users, the steps. Basically it's the same artifacts"*

Another participant said:

> *"While identifying and visualizing the complexity of the ecosystem we have flawlessly used existing techniques and tools. We didn't use anything extra. Before we started we had agreed on which artifacts we needed. And that if we would agree and those artifacts, we would agree on the direction."*

Another category that resulted from coding the transcriptions is language differentiation. Definitions and terms can have different meanings cross different enterprises. EA artifacts in ecosystems used in different organizations can have different understandings of the same terms(P3,P6). Someone said:

> *"Their language may be different from our language. Whatever they call a customer, we may call a relation. They may use different visualizations for Enterprise Architecture. EA is for 80% marketing. That maybe a bit exorbitant but there is truth inside it. The things we as architects design have to be understood by the Product Owner and Delivery Managers as well."*

While architects and stakeholders talk and decide on decisions that apply to the whole ecosystem, these decisions and their context have to be saved to make sure in a later stage all involved experts have insights in the decisions on the EA in the ecosystem and the context of the decision. If the context has changed, it may be that the decision made is no longer a good decision. Hence, participants plead for Ecosystem Decision Records (P1,P2,P3,P4,P5,P6). A participant said:

> *"You may want to record certain decisions or ideas on dedicated locations to save the knowledge and rational behind decisions. Similar to Architecture Decision Records we use internally."*

Specifically writing down context behind decisions can be very helpful. Multiple participants mentioned the importance of decision records and it's context(P1,P2,P4,P5,P6). According to another participant it helps to reconsider decisions in the future:

> *"One of the most important lessons of Architecture Decision Records is to denote the context. Why did you decide this on that moment. And what were alternatives and why didn't you choose for it? It helps if you can view these records. And then see the context, the pros and cons of the decision."*

4.3.2. Theme 2: EAM in ecosystems

The second theme identified based on the codes is EAM in ecosystems. Several units of data refer to the management of EA in ecosystems where multiple organizations are involved. In this theme three categories are identified, see Figure 7.

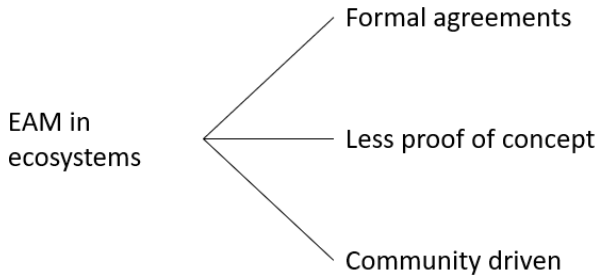

Figure 7 - Theme EAM in ecosystem and categories

All participants outline independently that formal agreements are needed in case there is collaboration between multiple organizations within an ecosystem. Though, things seem to be more fluid or informal internally. Agreements are written down more often and formally approved by selected stakeholders from each company in the ecosystem (P1,P2,P3,P4,P5,P6), according to the following participants' statements:

> *"When you make agreements between organisations, it are much more formal agreements that require some sort of stamp. And these formalities are much less involved if you look only internally in a single organisation."*

Additionally to formal agreements, several participants mentioned less room to experiment (P1,P4) or pragmatical thinking. This participant explains:

> *"The biggest difference is in documentation that is much more formal, and describes more details. There is less space to experiment or pragmatical thinking. You'll have to work faster to an end-state."*

When organizations collaborate within ecosystems, responsibilities come together within an ecosystem and architecture. These responsibilities must be located at the right place (at the right organization), multiple participants say (P3,P4,P5,P6). One participants explains:

> *"When organizations work together within an ecosystem the most important thing, which is also the essence of EA, is to make sure the responsibilities are located at the right place."*

The results show that EAM in ecosystems is different as EAM internally within one enterprise. At the same time the data shows that it is helpful if stakeholders cross organizations are easily approachable as informally as possible(P2,P3,P5,P6). This participant says:

> *"I think the value is much more in communities. Something that really helps us is having short communication lines to the Tribe Architect at the other firm. Officially this department isn't really involved in our project or operations. But because of the knowledge and expertise, it's very convenient to brainstorm about certain topics. Specifically the informal characteristics of communities bring added value."*

4.3.3. Theme 3: Standardisation

The third theme that results from thematic analysis is standardisation. For standardization two categories are defined, as displayed in Figure 8.

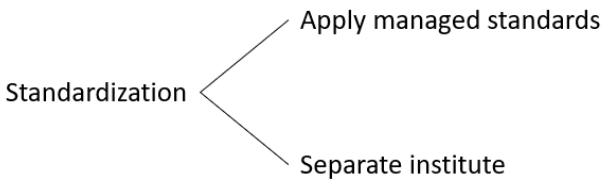

Figure 8 - Theme Standardization and categories

In all the interviews standardization have been mentioned as an key element for future-proof architecture in ecosystems. Participants indicated that customized solutions case by case cause severe challenges whenever organizations have to connect to each other, where each organization have their own API, their own interface specification and more custom solutions. Participants explained that when organizations in ecosystems apply managed standards it is easier to connect and the ecosystems scales more(P1,P2,P3,P4,P5,P6). One participant explains:

> *"If you want to connect quickly within an ecosystem, you'll need standards. Exactly this is what's going wrong with PSD2, there are no standards. Each bank has their own API, their own specification, their own interface. So to connect to each bank in Europe is a very hard job. There's no way doing it. That created a new market of PSD2 aggregators. It would be much nicer, if there would be a standard of how a transaction API should look like. Strictly defined and where everyone sticks to. In that case it's much easier to connect to each other. Consequently, the ecosystem will grow much faster."*

Results show that third parties can be involved that manages these standards (P4,P5). These third parties sometimes already exist or will be established for specifically these purposes. This happens when many enterprises collaborate with many other enterprises, a so called many-to-many relationship.

> *"As soon as there is a many-to-many-relationship, you'll have to standardize."*

It turned out that this has happened in the Dutch mortgages market already before(P5). Someone explains:

> *"As soon as there is a many-to-many relationship in an ecosystem, for example with mortgages, where there are several intermediary companies and multiple mortgages supplies, it becomes very helpful if there is an agreement about a standard interface and standard messaging. When that happens mostly a new organization arises, or the enterprises in the ecosystem establish it, that defines this interface and documents it."*

Another aspect about standardization that has been mentioned in interviews is costs. Custom made software is considered as expensive, similar to customized infrastructure. Hence, organizations want to write everything down as much and as accurate as possible(P4). It has been said that in the past each department could have had their own server configured and installed, that was costly to maintain, develop and scale. This has changed when standard IT infrastructure was introduced when organizations could just install and delete virtual machines at any time.

Standardization of software may bring the same benefits to enterprises(P1,P3,P4). Somebody indicates:

> *"Software these days is expensive because a lot of engineers are thinking about the best possible architecture, functional requirements, non-functional requirements, etc. But if future software just would be based on test cases, define what it should do, give all sorts of conditions and the software is just generated. Just like we do currently with infrastructure as code for servers. Whenever testcases change, just change code or delete the entire software and generate new software. That would make software much cheaper."*

Any relevant business event within an organization may impact, influence or trigger an event somewhere else in the organization or ecosystem as well. Standardizing this avoids multiple departments reinventing the wheel again and again. Standardizing this is possible only if all the departments or enterprises in ecosystems can use the same business events that are openly available (P1,P2,P3,P4,P5,P6). Examples of business events that were given were when customers become eighteen years old, when customers die, a transaction take place or similar events.

> *"In my opinion you'll have to make sure business events within an organization and functionalities, the capabilities that an organization has, must be available and published in the open. There is one catalog of all the capabilities, and functionalities. And I'm sure that in that case open minded people outside organizations, will create new business propositions that don't occur in the minds of people internally. But you'll have to have these building blocks openly available."*

According to the results these standards can be defined and maintained by third parties (P4,P5). For mortgages there is a standard defined by a party called BIAN: Banking Industry Architects Network. This third party have defined standard for the ecosystem for all the parties involved in the mortgages industry. A next step could be that this third party provides labels that approve the compliancy of these standards. A participants elaborates:

> *"Third parties could define such a standard and provide licenses. In the banking industry that could be the Banking Industry Architects Network (BIAN). I've never seen before but it would be very nice to see enterprise to be officially BIAN-licensed."*

4.3.4. Theme 4: Decoupling

Results show that decoupling business capabilities in ecosystems is key to have a future-proof EA in ecosystems. All the participants strongly explain and elaborate the importance of decoupling for future-proof architecture. The theme decoupling can be separated in three sub-themes as described in Figure 9.

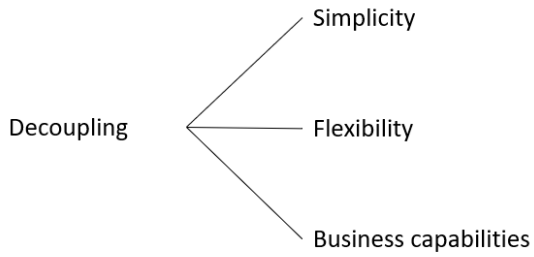

Figure 9 - Theme decoupling and categories

Results show that participants unanimously agree that decoupling is key for future-proof architecture, and that it starts with decoupling enterprise capabilities. A key item that has been mentioned by many is simplicity. Simplicity makes it more easy for enterprise to adapt to change (P1,P2,P3,P4,P5,P6). Someone said:

> *"In my opinion we continuously have to think what's the most simple solution that we can develop so that every party involved is satisfied. The less you have, the simpler the solution, the less software you have to adapt whenever you want to adapt to any change"*

It has been indicated that when an organization is not structured well, the IT landscape will adapt to it. A participant refers to Conway's law(P1). It said:

> *"There is a theory called Conway's law. That theory claims that the enterprise architecture eventually follows the enterprise structure. A good IT Architecture begins with structuring the enterprise because eventually the IT Architecture will follow"*

All the participants indicate intertwinement of systems as a key issue in being adapter for future changes, several times (P1,P2,P3,P4,P5,P6). Someone refers to current challenges in legacy systems that are hard to replace in the banking industry:

> *"If I look to big legacy transitions that big enterprises currently have to go through, something went wrong there. There is always complexity, and always a lot of IT, and a lot to take into account over time. But it is mainly the intertwinement between systems that makes it difficult. It's not thought through, that if a component should have to be replaced to adapt to change, how easy would that be."*

Decoupling architecture creates flexibility in the IT landscape that enables organizations to adapt to change (P2,P3,P4,P5,P6). Flexibility can be created by defining the scope of each application based on functions and capabilities (P1,P2,P3,P4,P5,P6). Someone explains:

> *"You'll have to make your application landscape very modular, and well thought through, what are the scope limits of this function or capabilities? And am I not putting capabilities or functions from other capabilities together? Assign very clear responsibilities, and then demarcate scope of applications. That gives flexibility in the landscape."*

All participants describe in detail how to decouple the IT landscape. According to the interview results, organizations have to define business capabilities and business functionalities first, before designing the IT Architecture and its applications(P1,P2,P3,P4,P5,P6). Someone claims that to be the main role of an architect:

> *"What we do as architects, we always think in business capabilities. A business capability can be seen as a piece of functionality, regardless how you've organized it."*

Decoupling enterprises based on business capabilities creates an IT landscape that connect business functions again and again with new technology (P1,P2,P3,P4,P5,P6). Someone says:

> *"As architects we look at the functions we are considering. Because the business functions are stable. And we demarcate our IT Applications on these functions. Eventually you'll get a sort of pieces of lego in your IT landscape, that you can connect again in new ways."*

4.3.5. Theme 5: Enterprise purpose differentiations

When in ecosystems multiple enterprises get together they may have different reasons to be in the ecosystem. According to the interview results this may influence the architecture within the ecosystem. Enterprises within the same ecosystems can have different purposes that effect the EA in the ecosystem. This theme is not categorized in subthemes.

Differentiations in motivations and purposes for enterprises to be in an ecosystem may influence the decision on architecture level (P1,P4). Hence, it is indicated as valuable to make explicit and capture the context and reasons for organizations to be part of the ecosystem. Someone explains:

> *"It is really a balancing act. Because when you develop many small pieces it's hardly maintainable. There is continuously a balancing act between the different non-functionals, but that's what architects do. So if there is any loans administrations application I'm not going to make a 100.000 small applications of it. Because it's just one functionality. And here is consistency of data very important. and stability is very important."*

At the same time, a shared vision in the ecosystem positively impacts the dedication of organizations to collaborate (P1,P6), according to this person:

> *"When there is a shared vision in the entire ecosystem, you feel much more willingness to collaborate from that starting point and much more commitment to reach the goals."*

Also, when a transition is forced by business propositions or mandatory by law could impact to maturity of the solution (P1,P3).

> *"The EA within a single organisation is mostly for the same shared goal. But for example looking at PSD2 API's, which are forced by law, the question is how willing enterprises really are."*

4.4. Document research analysis

Documents from one organisation that participated in this case study provided architectural documents in ecosystems for research. Advised by participants and searching the organisations internal archive on architectural documents resulted in four documents that have been analysed by the same thematic analysis and codes, used in section 4.2. Each analysed document belonged to a project were multiple organizations were involved, confirmed by the owner of the document. The documents are confidential and not public available. The overview of all documents is described in Table 4.

Document	Type	Organization	Context
D1	Domain Architecture	O1	Insurances
D2	Project Start Architecture	O1	Payments
D3	High Level Solution	O1	Payment information
D4	High Level Solution	O1	Payments

Table 4 – Analysed Documents overview

All the documents start with the description of the complexity of the business and the initial reason for the document. These sections were called “introduction” or “project objectives”.

Document D1 explicitly illustrates the entire enterprise domain model with the domains effected by the project. The logos of other companies involved are drawn into the domain model as well, to illustrate where other organisations are involved in the domain model. Later, the document describes a “current application landscape” with eight lanes representing business capabilities, for example “customer onboarding”, “advice and selection” or “life events”. Each lane contains blocks that represent an IT system and the colour of the block indicates to which organisation in the ecosystem the roles and responsibilities of that IT system belong. Later, a section named “Information and Data Architecture” starts with a paragraph called “Business Object Model” explaining the business capabilities of the enterprise before explaining the IT systems.

Document D2 describes the goals and objectives to achieve, followed by an overview of the entire enterprise IT architecture principles to adhere to. Later, a document section describes “Information Architecture Decisions”. Each decision is described extensively by describing the following attributes in a table: summary, decision, rationale, related IT-principle, consequences, alternatives, architectural fit and mitigations.

Document D3 explains in detail how to sign bulk payments using a technical standard provided in the industry (pain.001). Later, a solution called “Single payments flow” visualises one block called “PSD2 endpoints”, explaining end points outside the organisation displaying as decoupled black box. Another solution overview differentiates processes in the chain mapped to “API Platform” or “API channel”, expressing scope in which the system acts to decouple systems and functions.

Document D4 contains a section called “Ecosystem overview” that describes with text and visualization the role of all organizations in the applicable ecosystem. Later, the document displays user flow designs for an online shopping payment, by user interface designs with multiple parties involved to clarify the flow and how each party is involved in detail.

Not any document introduced new artifact methods yet unknown and specifically tailored to ecosystems. All the documents describe details extensively and contain a logfile to keep track of changes. All the documents extensively describe in text and visualisation the business context, capabilities and scope of the IT solution involved.

5. Discussion, conclusions and recommendations

This section outlines interpretation of the results as presented in the previous chapter. First, in the discussion the relation of the findings to the research questions and objectives discussed in the introduction will be stated. Strengths, weaknesses and limitations of the study will be discussed. In the next paragraph conclusions are made, including answering the research questions. Finally, this sections describes recommendations for practice as well as recommendations for further research.

5.1. Discussion – reflection

The results indicate that existing EA artifacts and practises are certainly used and applied by EA cases in business ecosystems. Experts claim overlap in applicability and purposes of EA artifacts in organisations internally and in business ecosystems. The essence of the bigger picture that has emerged, is that existing methods and EA artifacts can be and are being used in EA ecosystem cases as well. Not any participant stated that existing EA artifacts cannot be used in any case in cross organizational situations, although the degree to which they can be applied depends on the context.

The applicability of existing artifacts, among other things, depends on the size of the ecosystem and the amount of the enterprises involved. All participants have mentioned extra challenges for EA in ecosystems that may not be captured using only the existing EA artifacts. The complexity and agility of the ecosystem can be impacted negatively by the commonly formal way of working and agreements in ecosystems, while in single organisations alignment can be informally. Furthermore, a large variety of solutions and interfacing in organisations in the ecosystem makes it complex as well. Hence, the use of managed standardized services and solutions is crucially important to develop a future-proof ecosystem. Janssen (2009) indicates that EA entails disclosing the coherence of technology to the business and managing dependencies between IT systems. In conclusion, existing EA artifacts do not provide sufficient grip on the technology in ecosystems to establish coherence.

Unambiguous ownership assignment of systems and capabilities that impacts the entire ecosystem is, among others, one aspect that existing EA artifacts do not specify accurately. Suggestions of introducing third parties to the ecosystem to take care of managing the standards indicate that shared ownership is similar to a lack of ownership that should be assigned to someone. The importance of managed standardized services is strengthened by the examples in the results, where the existence of standards help ecosystems to grow and the lack of standards complicate the rise of new business models in ecosystems due to too much complexity. EA in single organizations do not have this challenge as much as ecosystems since they eventually follow a single enterprise strategy and decision making process, unlike ecosystems where multiple organisations may have differences in objectives and reasons to participate in the ecosystem. Clarification on ownership relates to the fundaments of EA as defined by Zachman (1987) that emphasise to manage the complexity of organizations, in this case ecosystems, first before effectively pursue information systems.

Nevertheless, the results outline the complications of intertwinement of business capabilities in IT systems in ecosystems, corresponding to Hazen et al. (2017) who indicated that IT landscapes where cohesion is not ensured can result in performance disruptions and organisation disturbances.

The results demonstrate the importance of ownership, responsibilities and scope demarcation of applications as a prerequisite to successfully decouple the IT landscape. Ownership of business capabilities within a single organization may be defined informally or organically and eventually always belong to the same enterprise strategy. However, in cross organizational value streams there is a risk of conflict of interest on ownership of data or capabilities in the ecosystem. For example data ownership of specific type of data could be valuable for each organizations while only one organization initiates data in the ecosystem and may not willing to share this data ownership for legal reasons. Hence, putting responsibilities at the right place is essential.

According to Hazen et al. (2017) alignment of each IT system, including ownership, with a strategy for integrating, standardizing and leveraging the IT systems and its capabilities is a prerequisite to utilize the benefits of IT among several business units. At this moment, there is no existence of standardized EA artifacts that unambiguously clarifies responsibilities and ownership on data or capabilities in cross organization value streams.

Currently, architects apply agreements created by involved architects that require a formal approval from all parties involved. This results in a formal time-consuming approach, since all stakeholders have to agree with the formal agreements on alignment, responsibilities and ownership. Managing EA already have become largely important within single enterprise to align business & IT (Gampfer et al., 2018). The trend of business ecosystems that entails more complexity in EAM will increase the importance of EAM even more.

Additionally, innovations and changing business are increasing and they come with higher pace (Shanks et al., 2018). This yields organizations no choice to be more flexible and adaptable. Flexibility can be created by defining the scope of each application based on functions and capabilities, transform to an extremely modular application landscape, assign clear responsibilities and demarcate scope of applications.

Although EA artifacts are ecosystem proof to a certain extent, there is a clear necessity for more formal agreements that describe architectural decisions in the ecosystem including their context. These formal agreements have to be written down in a consequential manner that all ecosystem enterprises involved acknowledge. To describe the business complexity in the ecosystem and the EA decisions made on any moment appears to be very much context related. Hence, EA artifacts should guide enterprises to accurately denote the context of EA decisions in order to evaluate any decision at any moment in time again. As such, ecosystem architecture decision records can overcome this lack of knowledge by officially stating the decision, its context, the experts involved and the date.

Strictly decoupling business capabilities and business functions and reducing the intertwinement of applications and enterprises to an absolute minimum can minimize these challenges. Building an ecosystem where each business capability or business function is represented by a single application interface (API) is much easier to modernize in case a new innovation or player enters the industry and ecosystem. In particular, ecosystems with many-to-many-relationships require industry standards for these interfaces since mutual agreements are impractical and unfeasible.

The document research analysis confirmed that existing artifacts are applied and can be applied in the context of business ecosystem. Moreover, additional information artifacts are added that are not based on any existing EA artifact from literature, for example ecosystem overview. Document research confirmed the results from the interviews.

Decoupling each business capability and business function and publish as a service to consume, enables the entire ecosystem to use it for any purpose and replace it at any time. Dedicated communities regarding these interfaces enables consumers to provide feedback for updates and upgrades. Consequently, enterprises can make their own judgement on which API to use depending their purpose and their reason to be part of the ecosystem. API providers can decide on costs, functionality and information that is processed and offer it as a take it or leave it business function to service consumers, which resolves the ownership issue.

This chapter earlier mentioned the suggestions on introducing third parties to the ecosystem to take care of managing the standards. Decoupling the entire ecosystem together with introducing a third party to manage ecosystem standards would result in an Business Ecosystem Architecture (BEA). Drews and Schirmer (2014) define a BEA as a Focused Business Ecosystem Architecture where one central actors identifies and creates an overview of the whole ecosystem and where the whole ecosystem is mapped into one overview and no boundaries based on actors are left over.

Strengths, weaknesses and limitations

The multi-method qualitative study approach by conducting semi-structured interviews combined with document analysis strengthen this research. It enabled validation of results from two research methods combined, which increases the reliability of the results. Participants work for several different companies in the same industry. Consequently, conclusions are applicable across the industry which leads to higher external validity.

However, from three enterprises that together have over 80% market share in the industry, only one enterprise was represented. This decreases external validity and less generalisable to the entire industry since two enterprises with a big market share were not involved. All interviews are conducted by one researcher over a timespan of a few weeks, that unintentionally could result in observer drift where the researcher redefines similar observations or interpretations while conducting interviews. Without rigour immersion in the context for each interview, observer drift could jeopardize the reliability and validity of the results. The field of industry is well known by the researcher that potentially lead to observer bias, where the researcher as observer use his own subjective view or disposition to interpret events in the setting. This risk has been mitigated by sharing the interview results with the participants for review.

Some limitations in this research are important to indicate, first of all the amount of participants. More relevant participants could have led to more varied results that could have given a larger perspective on the research question. Also, participants were selected based on experts in the industry in the network of the researcher or the network of experts well known by the researcher. Participants from the same network might have similar backgrounds and as a consequence might give similar answers. That reduces the external validity and the generalisability of conclusions.

Although the roles of the participants varied, results may be limited to the role of the participants and on what level they work. More variety on roles may gain more insights in the phenomena from more viewpoints. The time available to conduct the research and collect the results was limited. More time could have resulted in selecting more participants and collecting more data. Consequently, more varied data and more generalisable results could be generated. Also, more time for focus groups where multiple experts participate in the same interview could lead to a more complete answer to the research questions, which leads to higher credibility. Within focus groups experts may be tended to complete answers from others or correct false statements.

5.2. Conclusions

The results and discussions together gain new insights about the role of EA in business ecosystems in order to design a future-proof architecture, reaching the objective of the research.

Business ecosystems can be characterized by networks of organizations where organizations, partners, suppliers and customers together create and share value between participants. Hence, ecosystem architecture is more compatible to fit into architecture of other enterprises or organisations as well. EA is more internally focussed and can be customized towards specific organizational cases that are less flexible or scalable for external parties. Internally focussed EA has resulted in huge monolith systems that are stable, secure and less costly until changes are indispensable. Considering the expected continuous innovations and changes in the future, monolith systems are not future-proof. Thereby, an accurate answer to research question one has been formulated.

Furthermore, for organizations in ecosystems to be future ready and adapt to digital transformation, decoupling the IT landscape and applying managed standards create much more flexibility and agility. Legacy IT with significant intertwinement of the application interfaces results in low agility for organizations. The lack of standards in industry results in many formal conversations and agreements between organisations how to communicate and share information messaging digitally between enterprises. Decoupling every business capability and business functions into APIs and using standards that are respected by the industry are a proven solution to simplify solutions. Also, it makes ecosystems scalable and adaptable to digital transformations, answering sub question 2 of this research.

Existing EA artifacts appear to be compatible in describing the situation and complexity of a system, solution or state of the ecosystems similar to describing current situation of an enterprise. Additionally to existing EA artifacts, ecosystem decision records are required to not only formally describe the decision, but also the context, the background, the people involved and the data. EA decisions are very much context dependent and organizations have different interests, so EA artifacts should describe formal agreements about EA in ecosystems.

Concluding the research question, EA can guide organizations to decouple every business capabilities and business functions into interfaces that can be replaced at any time at any place by new solutions. Existing EA artifacts elucidates the complexity of the entire ecosystem and its architecture. Associating value streams beyond organizational boundaries are easier to manage using standards that are generally respected by the industry. Industry standards can be defined and maintained by a dedicated organisation representing the standards per industry.

Applying managed standardized services and decoupling every business capability ensures ecosystems to be future-proof. Enabling adaptation to new innovation or technology at any time in order to be able to transform technology for new innovations that are ahead of time and yet unknown.

5.3. Recommendations for practice

Concluding the results and discussion, recommendations are defined for organizations and professional experts working in the discipline of IT Architecture.

Decouple everything

Digitalization enables enterprises to create new value streams beyond organizational boundaries. Connecting IT landscapes from different enterprises is highly complicated in case there are many intertwined systems within a single enterprise. Organizations are advised to **decouple their entire IT landscape into building blocks** based on business capabilities and business functions. Doing so the building blocks that represent a business function can be replaced or enriched by similar services from collaborative partners in the ecosystem when desired. Consequently, enterprises become future ready being able to leverage from third party excellence and to excel in their own value proposition. Reusing existing services from service providers may gain focus to the initial value proposition of the enterprise and take advantage of expertise and innovation capacity of service providers.

Standardize

Standardizing IT reduces complexity of entire IT landscapes. Using standards ease the creation of cross organizational value streams since enterprises are using same techniques for communication, messaging and more. Using standards reduces the amount of customized software that is required to effectively connect enterprises together. Organizations are advised to **use standards in any IT component to simplify the IT landscape** and be more future-proof. Using standards ensures companies continuous growth and market competitiveness. An example of available market standard is the Berlin Group, a European Standards Initiative that designed a standard for PSD2 APIs. Another example is Banking Industry Architecture Network (BIAN) that creates standards for the banking industry.

5.4. Recommendations for further research

This section defines recommendations for further scientific research.

Considering more enterprises becoming part of ecosystems, standardizations becomes more important to enable connections between enterprises within ecosystems. As long as standards are not available or not used each and every individual connection between organisations may have to be customized. For example with PSD2 API's there is no standard on the API specification, resulting in each bank in Europe having their own API and API specification. The growth of PSD2 aggregators prove the need for standardization to connect many other organizations using a single interface. The problem with standards though is that there are so many of them. Recommendation for further research would be how managed standards can be introduced in an industry and be respected by all enterprises within an ecosystem.

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Appendix 1

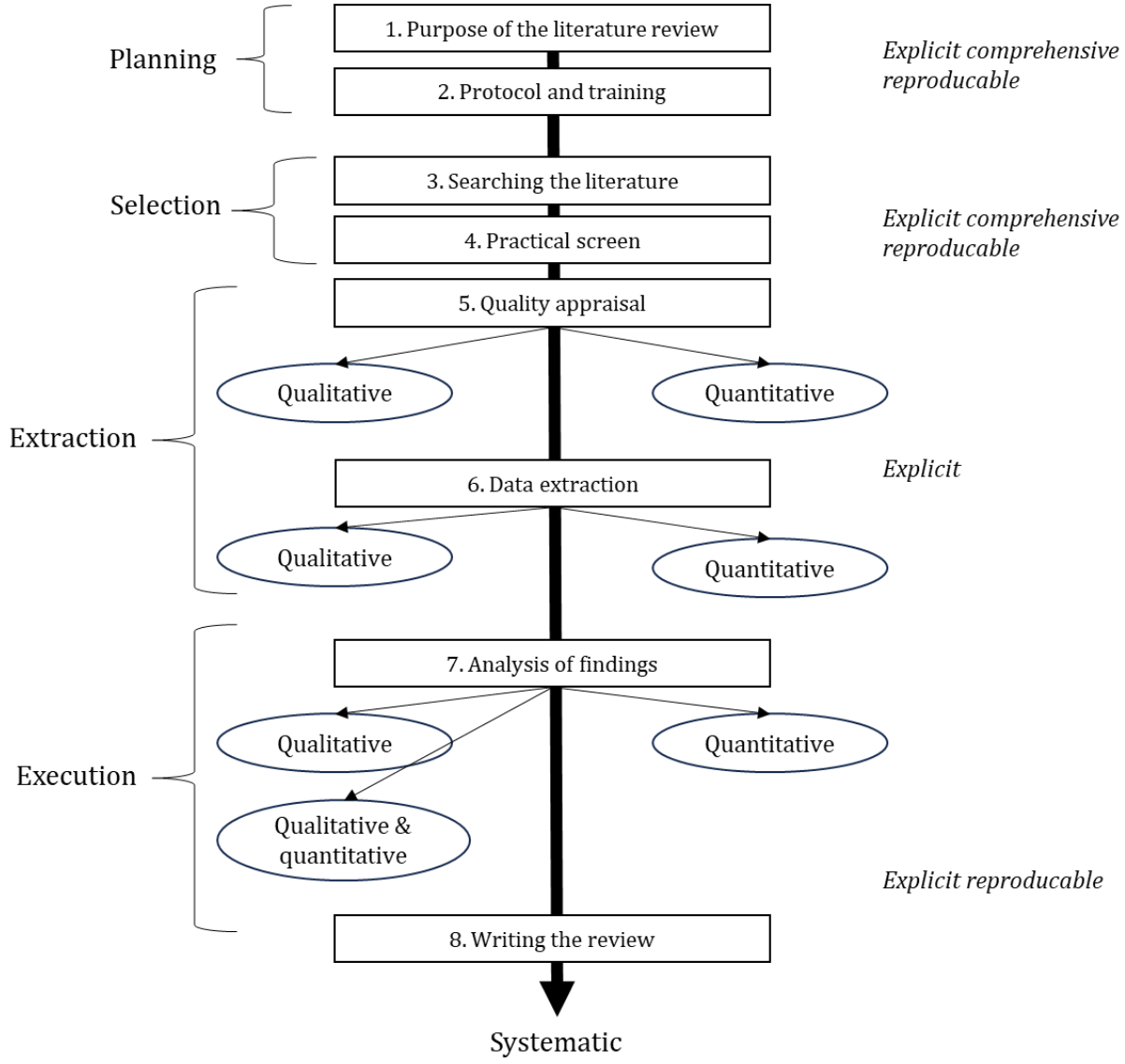

Figure 10 - A systematic guide to literature development (Okoli & Schabram, 2010)

Appendix 2

Hi <name>,

You will participate in the case study research about future-proof Enterprise Architecture in Business Ecosystems. This research is conduct regarding the study Business Process Management & IT, at the Open University. This introduction aims to provide some context information.

The research is about Enterprise Architecture. Enterprise Architecture as we know it today mainly focusses on Architecture within a single enterprise. Caused by digitalization organizations are more and more connected to each other and collaborate more with each other. Optimizing the collaboration between organizations results in the creation of business ecosystems. Enterprise Architecture also plays a significant role in such a business ecosystem.

In principle EA helps with understanding the complexity of an organization and it's IT landscape. EA does this by providing several EA artifacts, documents that describe the organizations business & IT from a particular perspective (high level or detailed). Examples are architecture principles, business capability models, roadmaps, solution overviews, solution designs, etcetera. The question is, how can Enterprise Architecture support in business ecosystems in order to develop future-proof IT?

The goal of this research is to gain more knowledge about how EA can contribute to future-proof IT in business ecosystems. The current theoretical knowledge that is available limits itself to the added value of EA in single enterprises. The central research question in this research is: *"How can EA help organizations in business ecosystems and associating value streams beyond organizational boundaries to establish a future-proof ecosystem?"*

The interview will be recorded and transcribed. The transcription will be used for thematic analysis. Your are not obliged to participate to the research. The interview will take approximately 40 – 60 minutes.

I'm looking forward to our interview.

Best regards,

Maarten

Appendix 3

Interview | Onderzoek naar Enterprise Architecture in business ecosystems

Consent 5 mins

1. U doet mee aan een onderzoek naar future-proof Enterprise Architecture in cross organizational business ecosystems in the financial sector in the Netherlands.
   Bent u, geheel vrijwillig, bereid daaraan mee te werken?
2. Gaat u akkoord als het interview wordt opgenomen?
3. Het interview zal worden getranscribeerd. De verzamelde data zal worden gebruikt voor thematische tekst analyse waarbij tekst wordt gelabeld of gecategoriseerd.
4. Het interview duurt tussen de 40 en 60 minuten.

Introductie 5 mins

Het onderzoek gaat over Enterprise Architectuur in zogenaamde ecosystemen die ontstaan doordat organisaties steeds meer met elkaar verbonden zijn door digitalisering. Enterprise Architectuur helpt bij het in kaart brengen van de complexiteit van een organisatie en het IT-landschap. Daarvoor biedt EA onder andere verschillende EA artifacten, documenten die vanuit een bepaald perspectief (hoog of laag detail niveau) de business&IT van de organisatie beschrijft. De vraag is, hoe kan Enterprise Architectuur ondersteunen in business ecosystems voor toekomstbestendige IT binnen ecosystemen?

Het doel van het onderzoek is om meer kennis te verzamelen over hoe EA kan bijdragen toekomst bestendige IT in ecosystemen. De huidige literatuur over EA beperkt zich tot de meerwaarde van EA in individuele organisaties. De centrale onderzoeksvraag in dit onderzoek luidt: *"How can EA help organizations in business ecosystems and associating value streams beyond organizational boundaries to establish a future-proof ecosystem?"*

1. Wat is uw rol en/of uw functie?
2. Hoeveel jaar ervaring heeft u in uw huidige vakgebied?
3. Welke rol of functie had je bij het project?

Steeds meer organisaties zijn met elkaar verbonden door digitaliseren en groeiende digitale mogelijkheden.

4. Hebt u kennis of ervaring met het ontwikkelen van producten of diensten waarbij informatie (bijv. rekeninginformatie) digitaal wordt uitgewisseld met derde partijen? Zo ja, kunt u uw ervaring delen en de toelichten hoe Enterprise Architectuur een rol speelde hierbij?

Toelichting definitie EA + vraag 5 en 6 | 10 mins

Enterprise Architectuur heeft de afgelopen decennia een steeds belangrijkere rol gespeeld in het succesvol toepassen van IT oplossingen in bedrijfsprocessen en organisaties. Onder andere doordat EA bijdraagt aan het dichten van de kloof tussen business & IT. Uit literatuur volgt dat bij het succesvol ontwikkelen en toepassen van digitale producten of diensten in een organisatie Enterprise Architectuur veel aandacht verdiend.

5. Hoe wordt volgens u Enterprise Architectuur toegepast bij ontwikkeling en toepassing van digitale producten of diensten in organisaties?
6. Enterprise Architectural artifacts zijn documenten die een systeem of oplossing weergeven/visualiseren of de huidige situatie van een organisatie beschrijven. Bent u

bekend met Enterprise Architecture Artifacts? Voorbeelden van EA artifacts zijn (Technical) Solution Designs, Roadmaps, Technology reference models, EA princples, Solution overviews etc.
Zo ja, op welke manier bent u ermee bekend en hoe heeft u ze gelezen, gebruikt, gemaakt of toegepast?

Business Ecosystems + vraag 7 | 5 mins
Business ecosystemen ontstaan doordat organisaties steeds meer met elkaar verbonden zijn door digitalisering. Oorspronkelijk richt Enterprise Architectuur zich vooral op de interne organisatie. De beschikbare literatuur geeft weinig inzicht in Enterprise Architectuur in business ecosystems.

7. Wat is het verschil in het toepassen van Enterprise Architectuur binnen een zelfstandige organisatie en Enterprise Architectuur in een casus waarbij meerdere organisaties betrokken zijn? Zo ja, wat zijn dan die verschillen?
8. Hoe werden architectuur documenten opgesteld tussen verschillende organisaties? Hoe zag de samenwerking er uit tussen architecten tussen verschillende organisaties?

De vernieuwingen gaan razendsnel + vraag 8 | 10 mins
In de afgelopen 20 jaar zijn de digitale vernieuwingen razendsnel gegaan. Organisaties lijken zich te moeten klaarmaken om ook de komende 20 jaar klaar te zijn voor een als maar sneller veranderende wereld, zonder te weten wat de verandering zal zijn.

9. Hoe kunnen EA methodes worden aangepast en ingezet voor het ontwerpen van toekomst bestendig Business Ecosystem architectuur?

EA tussen verschillende organisaties + vraag 9 | 15 mins

Wanneer organisaties samen werken aan digitalisering moeten organisaties kunnen profiteren van het nieuwe product, moeten organisaties relatief eenvoudig kunnen mee doen, en moet het product zélf optimaal renderen.

10. Op welke manier, en met behulp van wat voor artifacten, kan Enterprise Architectuur worden effectief worden toegepast in een business ecosystem? Zijn er specifieke artifacten ingezet voor cross organisatie EA? Zodat alle partijen profiteren, organisaties zelf er niet aan ten onder gaan en het product tot zijn recht komt.