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Enterprise architecture artifacts as boundary objects: An empirical analysis

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ABSTRACT

Context: Enterprise architecture (EA) is a collection of artifacts describing various aspects of an organization from an integrated business and IT perspective. EA artifacts intend to bridge the communication gap between business and IT stakeholders to improve business and IT alignment in organizations and, therefore, can be considered as boundary objects between diverse business and IT communities. However, an intentional analysis of EA artifacts as boundary objects in the current EA literature has been rather shallow and insufficient.
Objective: This study aims to explore how exactly EA artifacts as boundary objects facilitate communication between different professional communities. Specifically, it intends to identify what types of EA artifacts represent boundary objects, analyze their properties and usage scenarios, as well as the differences between them.
Method: This study is based on an in-depth case study of an organization with an established EA practice. Data collection procedures include both interviews with various participants of its EA practice and comprehensive scrutiny of its EA documentation.
Results: We identify five specific types of EA artifacts used in the organization as boundary objects and analyze them in detail. In particular, we analyze their informational contents and usage scenarios, their target audiences and value for cross-community collaboration, as well as their syntactic, semantic and pragmatic boundary-spanning capacity. Moreover, we also introduce the notion of duality as a characteristic of interpretive flexibility of EA artifacts and distinguish two different types of duality leveraging somewhat different boundary-spanning mechanisms: implicit duality and explicit duality.
Conclusions: This paper provides arguably the first inductive qualitative analysis of EA artifacts as boundary objects available in the existing EA literature. It contributes to our understanding of their boundary-spanning properties, distinctive features and general roles in an EA practice. Also, the concepts of implicit and explicit duality that we introduce further advance the theory of boundary objects.

1. Introduction

Due to the critical importance of information systems for the business, achieving close business and IT alignment has been long recognized as an imperative for modern organizations [1] and is still identified among the top issues for IT executives [2]. Enterprise architecture (EA) is a collection of special documents, typically called artifacts, describing various aspects of an organization from an integrated business and IT perspective [3,4].[1] EA intends to bridge the communication gap between business and IT stakeholders, facilitate information systems planning and thereby improve business and IT alignment [5–7].

Boundary objects are special objects that facilitate communication, cooperation and productive teamwork between different social communities with disparate knowledge, interests and perceptions of reality [8,9]. As instruments of communication and collaborative decision-making, EA artifacts can potentially be viewed as boundary

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[1] Numerous diverse and inconsistent definitions of EA are circulating in the literature [22]. As [116] put it, “a common denominator of EA research seems to be the absence of a commonly and generally agreed definition for EA”. The narrow definition of EA adopted in this article (1) has a concrete and perceptible practical meaning, (2) aligns with the original understanding of this term [24,25] and, most importantly, (3) directly refers to the primary subject of this study — EA artifacts as material documents fulfilling the function of boundary objects. Importantly, EA artifacts in this article are also viewed rather narrowly as specific documents relevant to describing business and IT landscapes including, for example, architecture principles, technical standards, business capability maps, landscape diagrams and data models. These and some other terminological issues are discussed in greater detail later in the literature review section.

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objects between diverse professional communities involved in strategic decision-making and implementation of IT systems in organizations [10–12].

Since communication and partnership between business and IT stakeholders have been widely acknowledged as being among the core enablers of business and IT alignment [13–16], understanding the role of EA artifacts as tools for effective communication can be considered as a critical theoretical and practical goal for the entire EA discipline. In particular, from a theoretical viewpoint, this understanding is key to realizing exactly how the alignment of interests of business and IT representatives is achieved in organizations. From a practical perspective, this understanding is necessary for avoiding numerous widely reported problems with unusable EA artifacts [17–19] and, thus, succeeding with EA practices.

However, despite its evident importance, deliberate analysis of EA artifacts as boundary objects in the existing EA literature has been rather scarce and essentially limited only to certain deductive propositions and their subsequent quantitative verification [10,20,21]. Although this deductive quantitative analysis clarifies some properties of EA artifacts as boundary objects, it arguably fails to reflect the full richness of empirical realities around EA artifacts and their usage in organizations, as well as to distinguish the different types of EA artifacts that may be used in EA practices [3,4]. For this reason, our current understanding of EA artifacts as boundary objects between different communities involved in business and IT alignment processes still seems to be insufficient.

To address this gap, this study explores how EA artifacts as boundary objects facilitate communication between different occupational communities in an organization. This paper intends to improve our theoretical understanding of EA artifacts and analyze in detail their features as boundary objects. Unlike the previous studies of EA artifacts as boundary objects [10,20,21], this study adopts an inductive and qualitative case study approach to accurately reflect the practical reality of using EA artifacts as it is, i.e. undistorted by the suggestions of the available literature on boundary objects unrelated specifically to EA.

This paper continues as follows: (1) we discuss EA with its artifacts, boundary objects, EA artifacts as boundary objects and then formulate our research question, (2) we describe the research design, data collection and analysis procedures, (3) we thoroughly analyze various properties, qualities and features of EA artifacts as boundary objects, (4) we discuss our findings in light of the existing literature and (5) we conclude the paper.

2. Literature review

In this section, we discuss EA, EA artifacts, the concept of boundary objects, EA artifacts as potential boundary objects and finally the reasons and research question of this study.

2.1. Enterprise architecture

Although the term “enterprise architecture” today is notoriously difficult to define [22,23], traditionally it referred to some descriptions of enterprises covering their business and IT facets [24,25]. In this vein, for the purposes of this study, EA can be defined specifically as a collection of special documents which describe various aspects of an organization from an integrated business and IT perspective, facilitate communication between business and IT representatives and improve IT-related decision-making [3,4,26]. As Niemi [[27], p. 1] points out, “in brief, EA can be seen as a collection of all models needed in managing and developing an organization”.

In this light, an EA practice can be understood as an organizational practice of using EA for improving communication between business and IT stakeholders, facilitating information systems planning and improving business and IT alignment [28,29]. EA practices include all the necessary documents, software tools, processes, actors and their interactions [28,29].

2.2. Enterprise architecture artifacts

The domain of IT is associated with multifarious artifacts, such as hardware, software, algorithms, models and system development projects [30,31]. Some IT artifacts belong specifically to the domain of EA as they get produced and used as part of EA practices in organizations. These EA-related artifacts include, among others, diagrams, documents, templates, checklists and architectural repositories [28,29].

From the standpoint of the purpose of an EA practice (i.e. improving business and IT alignment), all EA-related artifacts can be separated into primary and supporting ones. Primary EA-related artifacts are those artifacts that directly contribute to business and IT alignment by providing descriptions relevant to the landscape structure. These artifacts are represented by various paper and electronic documents that offer helpful views of organizations from different viewpoints conducive to their planning, evolution and transformation [4,10,17]. By contrast, supporting EA-related artifacts are those artifacts that do not contribute to alignment directly, but facilitate the usage of primary artifacts or other aspects of an EA practice. These artifacts include, for example, standardized templates, modeling tools, architectural portals and specialized repositories that help create, store and manage primary artifacts [28,29].

This study concentrates specifically on analyzing primary EA-related artifacts and considers supporting artifacts out of scope. Therefore, we will understand “EA artifacts” to be exclusively primary artifacts, i.e. documents relevant to describing the business and IT landscape. For this reason, in the context of this study, an EA artifact can be defined narrowly as “a descriptive document providing a specific view of an organization from the perspective of its business and IT” ([3], p. 103), which also corresponds to the regular use of this term widely adopted in the existing EA literature [4,10,32–36]. Importantly, individual diagrams, models and visualizations are normally *not* regarded in the literature as separate EA artifacts, but only as constituting components of full-fledged EA artifacts.

According to the adopted understanding of EA artifacts, many diverse documents of graphical, textual and mixed formats fall within the realm of our interest [29,36,37]. For example, typical graphical documents relevant to our study include, but are not limited to, business capability models [38,39], core diagrams [40,41], target states [7] and enterprise data models [42]. Popular textual documents also considered as EA artifacts include, most importantly, architecture principles [24,43–45], maxims [46,47] and standards [48,49]. Relevant mixed-format documents include, among others, architecture patterns [50,51] and project-start architectures [52]. Hence, EA artifacts in this study encompass a rather broad spectrum of documents.

2.3. Boundary objects

Boundary objects are special material objects that help diverse social communities cooperate, collaborate and successfully pursue shared goals despite their different expertise, concerns and backgrounds [8,9]. Boundary objects are “both adaptable to different viewpoints and robust enough to maintain identity across them” ([9], p. 387). They exist in multiple social worlds and have different identities in each of these worlds. Boundary objects provide different information to representatives of different social groups they intend to connect. They “both inhabit several intersecting social worlds […] *and* satisfy the informational requirements of each of them” ([9], p. 393).

Boundary objects help represent and transform knowledge on the boundaries between different professional communities and enable their productive collaboration [53,54]. For that purpose, they should offer three boundary-spanning capacities: shared language, shared meaning and shared tools [53]. Effective boundary objects are also tangible, concrete, accessible and up-to-date [55]. Sapsed and Salter [56] notice that the use of boundary objects requires an opportunity for direct face-to-face interaction. Wenger [57] explains that *both* boundary objects and personal conversations are necessary for bridging the communication gaps between different communities of practice.

A somewhat special type of boundary objects is conscription devices [58,59]. Essentially, conscription devices are specific boundary objects that must be created collaboratively by cohesive groups of people to fulfill their purpose. Conscription devices "are receptacles for knowledge created and adjusted through group interaction aimed toward a common goal" ([58], p. 456). They "enlist the participation of those who would employ them [...], since users must engage in the generation, editing, and correction of [these objects] during their construction if the [object] is to serve its intended function" ([58], p. 452). Conscription devices organize and constrain group participation in their development [58,59]. While boundary objects are structured simply to enable mutual understanding between different communities, conscription devices are more sophisticated objects intended specifically to be *co-created* by representatives of different communities [59].

Boundary objects are naturally developed in the process of collaboration, when groups of people from heterogeneous communities work together [60]. Examples of boundary objects used in various areas of human activity include engineering sketches [58], assembly drawings [53], technical specifications [59], modeling tools [54], 3D architectural models [61], ubiquitous Gantt charts [62], designs of information systems [63] and aerospace systems [64].

2.4. Enterprise architecture artifacts as boundary objects

Many or even most EA artifacts described in the literature are used by business and IT stakeholders for communication purposes and, thus, represent boundary objects between these communities. For example, principles and maxims are used by senior business and IT executives to discuss and articulate the most fundamental imperatives guiding the use of IT in an organization [44,47]. Core diagrams are used by business and IT executives to express and agree on the essential process standardization and integration requirements of the adopted operating model [41]. Business capability models are used by senior business and IT leaders to identify and highlight the priorities for future IT investments aligned to strategic business goals [65,66].

These observations on the roles of specific EA artifacts are also confirmed by the broader empirical studies of the practical usage of EA artifacts in organizations [3,4]. For example, Niemi and Pekkola [4] describe 15 different situations where EA artifacts are used and nine of them (e.g. support strategic planning, review project architecture and execute solutions acquisition) involve more than one group of stakeholders, most typically EA teams, project teams and business managers. Likewise, Kotusev [3] identifies 24 different types of EA artifacts adopted in the industry and 15 of them (e.g. value chains, roadmaps, solution overviews and options assessments) imply collaborative usage by architects, business leaders and project teams.

Since most EA artifacts are used collaboratively by various business and IT stakeholders, as demonstrated above, these EA artifacts represent evident boundary objects between different professional communities of business and IT actors in organizations. Basically, EA artifacts can be considered as boundary objects providing communication "interfaces" for heterogeneous business and IT communities allowing them to cooperate and pursue shared corporate goals despite their different responsibilities.

2.5. Research motivation and question

A deeper understanding of the role of EA artifacts as boundary objects between business and IT communities has rather obvious significance for the EA discipline from a theoretical standpoint. Namely, it is this mechanism of cross-community collaboration enabled by boundary objects that underpins EA practices and drives business and IT alignment in organizations. As an EA practice purports to improve business and IT alignment, and improving alignment, in turn, requires intensifying communication between business and IT representatives [13–16,67,68], boundary objects, being a powerful means of communication, offer a natural instrument conducive to reaching this goal. In short, by virtue of its central relevance to the problem of aligning the interests of disparate business and IT communities, the idea of creating and using boundary objects arguably lies at the heart of the very EA discipline.

At the same time, an insufficient understanding of EA artifacts as boundary objects has rather strong practical and even financial consequences for organizations. For instance, EA initiatives are infamously known for their frequent failures [69–72] and many of these failures can be clearly attributed to the inability of EA artifacts to provide the anticipated boundary-spanning effects [17,18]. One of the underlying reasons for the inability of EA artifacts to serve as effective boundary objects is their excessive complexity: "Creating and reading most EA products require special skill sets, not commonly held throughout the enterprise. Consequently, the information captured in EA products cannot be conveyed quickly, especially to executive-level decision-makers" ([19], p. 40). Another possible reason for this problem is the unsuitable presentation of information: "The problem is EA information often is unintelligible. The necessary data might be there, but the presentation is so poor that the decision-maker's ability to use it is impaired" ([73], p. 63). Other reasons explaining the inadequacy of EA artifacts as boundary objects include their irrelevant informational contents, wrong level of detail and overly conceptual nature [18,74]. Generally, the unsatisfactory quality of EA documentation has been reported as a major challenge for their EA practices by 55% of organizations [75]. Unsurprisingly, problems with unusable EA artifacts sometimes end up in dramatic monetary wastes for organizations: "Even though [the U.S. Department of Defense] has spent more than 10 years and at least $379 million on its business enterprise architecture, its ability to use the architecture to guide and constrain investments has been limited" ([76], p. ii). For this reason, the properties of EA artifacts as boundary objects are not only interesting from a theoretical point of view, but are actually of immediate practical importance.

However, a systematic investigation of EA artifacts as boundary objects and their boundary-spanning properties in the current EA literature is missing. Although some analysis of EA artifacts as boundary objects has been undertaken [10,20,21,77], this analysis is driven largely by deductive theoretical propositions derived from the existing sociological literature, rather than by inductive observations of real-world EA practices. For this reason, these previous studies arguably do not reflect rich empirical realities of using EA artifacts in organizations in their full complexity, e.g. actual usage scenarios of EA artifacts, stakeholders involved in their usage and other subtleties of the unique EA context. Moreover, the earlier studies also focused on EA artifacts or architecture models in general, but they did not distinguish different types of EA artifacts that can be used as part of EA practices for significantly different purposes, e.g. principles [24], business capability models [66] and options assessments [3].

To address this gap and understand EA artifacts as boundary objects in greater detail, this paper aims to thoroughly study the usage of EA artifacts in an organization and analyze their properties as boundary objects. Therefore, the research question of this study can be formulated as follows:

> *"How do EA artifacts as boundary objects facilitate communication between different communities as part of an EA practice?"*

Answering this question requires clarifying (1) what types of EA artifacts are used as boundary objects, (2) what diverse professional communities they connect, (3) what information relevant to these communities they provide, (4) how this information helps align the interests of respective communities, (5) what boundary-spanning capacity they provide, (6) what qualities of boundary objects they possess and (7) other more subtle aspects of their usage as boundary objects.

3. Research design

This research is exploratory, qualitative and inductive in nature since our research question is understudied in the existing EA literature and requires obtaining purely qualitative answers highly specific to the unique EA context, which cannot be hypothesized based on the earlier findings of other more "general" literature, e.g. literature on sociology and organizational behavior. Accordingly, we chose the case study method as the most appropriate approach for studying qualitatively an unexplored phenomenon in its full complexity [78–81], i.e. decided to undertake an empirical investigation of a contemporary phenomenon with rather unclear boundaries in its real-life context using multiple sources of evidence [82]. We focused specifically on a single case study because this approach is consistent with our research question and more suitable for a detailed exploratory analysis, where depth is more important than breadth [81,83,84].

3.1. Case organization

To provide appropriate settings for this research, a case organization should (1) be large, complex and heavily dependent on IT to require a full-fledged EA practice, (2) employ a permanent EA team, (3) follow consistent EA-related processes and (4) practice EA for a prolonged period of time. To satisfy these criteria, as a case organization for our study we have chosen a large university that enjoys a reputation as an advanced IT adopter and has practiced EA for several years.

The case organization is one of the largest Australian teaching and research universities providing various educational services to local and international students across a broad spectrum of specialties. It has several academic campuses in Australia and overseas serving tens of thousands of undergraduate, postgraduate and vocational students from different countries resulting in annual revenues exceeding one billion dollars. The organization has a centralized IT department that employs more than 500 IT staff. Its IT landscape consists of more than 200 applications, varieties of technologies and infrastructure. The organization invests tens of millions of dollars in new IT projects yearly. The organization practices EA systematically since 2012, but is still evolving towards greater maturity. Its architecture team consists of 20 architects, including four enterprise architects and 16 solution architects, managed by the director of architecture.

3.2. Data collection

As mentioned above, answering the research question of this study requires addressing a number of diverse sub-questions, some of which are purely factual (e.g. what EA artifacts are used as boundary objects), while others represent mostly a matter of theoretical interpretation of basic facts (e.g. what boundary-spanning capacity they provide). To be able to answer all these sub-questions, the following foundational facts should be firmly established: (1) what specific EA artifacts are used in the organization, (2) how exactly they are used to support communication and (3) what their informational contents are. These facts directly answer purely factual questions about EA artifacts and, at the same time, also provide the foundation for theoretical interpretation necessary for answering the remaining theoretical questions.

Hence, our data collection efforts were concentrated on gathering a sound factual base on the use of EA artifacts and their informational contents to be later subjected to theoretical analysis. Specifically, data in this study was collected from two independent sources: interviews and documentation analysis [81,83–85]. On the one hand, the interviews gathered relevant "dynamic" facts on the use of EA artifacts by organizational actors. On the other hand, the documentation analysis gathered complementary "static" facts on their internal informational contents. This approach allowed us to collect the necessary factual basis sufficient for answering both factual and theoretical sub-questions of this study.

3.2.1. Interviews

As part of our interviewing efforts, we took nine face-to-face, semi-structured interviews with the representatives of all direct participants of the EA practice in the organization. The formal section of each interview lasted about one hour, but most interviews also included some informal, off-the-record parts. The profiles of interviewees participating in our study are presented in Appendix A.

Our interviews progressed as follows: (1) we conducted two initial interviews with the director of architecture to understand how the EA practice is organized, what EA artifacts are utilized in the EA practice, who participates in EA-related activities and uses these artifacts, (2) we interviewed the representatives of all the professional communities participating in the EA practice mentioned earlier by the director of architecture, including one solution architect, two solution consultants, one engagement manager, one project manager, one business analyst and one technical subject-matter expert, thereby clarifying the perspective of each participating party, and finally (3) we conducted a concluding interview with the director of architecture to double-check the resulting picture and ensure the consistency of our understanding of the studied EA practice, its EA artifacts and their roles in routine inter-community interactions.

Following this approach, we were able to both (1) satisfy theoretical sampling considerations [85–87] and involve interviewees that are likely to provide new, interesting and unique perspectives on the EA practice and (2) verify the usage scenarios of all EA artifacts utilized in the organization based on the evidence provided by at least two independent respondents and accordingly reach the theoretical saturation [85,87,88] on the use of EA artifacts for communication purposes in the studied organization.

To achieve better consistency in data collection, all the interviews were guided by standardized interview protocols prepared in advance. However, due to the central place of architects in an EA practice and substantial differences between the roles of architects and other participants of EA-related activities [28, 29,89], two different protocols intended for architects and non-architects (see Table 11 in Appendix A) were developed. First, the interview protocols for architecture-side participants, besides general contextual questions, implied discussing EA artifacts, their informational contents, key stakeholders, typical usage scenarios and decision-making processes established around them, as well as other relevant questions. Second, the interview protocols for non-architecture participants implied discussing their roles in the EA practice, their usage of EA artifacts, their benefits from using EA artifacts and their communication with other participants of the EA practice, as well as other relevant questions. Before the first interview, the protocols were pretested with a knowledgeable IS scholar. The two interview protocols used in this study are provided in Appendix B.

However, because all the interviews were intentionally semi-structured, the formal protocols prepared for these interviews were used merely to guide the course of the respective conversations, rather than to dictate it [88,90–92]. Ample additional, clarifying and context-specific questions were also asked. Each interview leveraged the existing knowledge on the EA practice gained from the previous interviews and intended to confirm, refine or refute it when possible. For example, after the interviewed engagement manager reported that conceptual architectures were developed for new IT solutions at their early stages, solution consultants, who immediately participated in their development, were asked to confirm and provide more details on this process. All the interviews were recorded with the permission of the interviewees and transcribed verbatim for further analysis.

3.2.2. Documentation analysis

In the case organization, all EA artifacts representing the subject of our study (i.e. primary EA artifacts relevant to describing the business and IT landscape, as discussed earlier) were stored in a centralized architectural repository based on Google Drive (which itself represents a supporting EA artifact out of the scope of our study). The repository

Table 1
Examples of the applied coding procedures.

Original quotes from the transcripts	Identified concepts and categories
"Engagement managers [1] speak directly with the business [2] to understand the demand for projects [3] we have coming in. They will be engaged with a solution consulting team [4], […], and the solution consulting team internally engages the architecture team [5]. Typically, within the architecture engagement what happens is, first, we take the captured requirements and turn those into the conceptualarchitecture [6]. That is basically enough, so we can size up the piece of work, decide roughly where the solution space is, figure out how big it is and give the business stakeholders an idea of how much they need to invest in order to get this [7]" (Director of architecture)	[1] Engagement Managers (Community) [2] Business Leaders (Community) [3] Identify Needs (Processes) [4] Solution Consultants (Community) [5] Solution Architects (Community) [6] Conceptual Architectures (Artifacts) [7] Estimate Projects (Processes)
"There are a number of different prioritization aspects [1] that occur. […] Stuff like maxims [2] fit is an input into that process. […] We have certain custody of projects where they are prioritized. Essentially, what happens is we decide what gets above the line, what gets done [3]. That goes to senior stakeholders within the university, and there is a governance process that goes up to the ICT steering committee [4] and they approve what projects will go ahead [5]" (Director of architecture)	[1] Prioritize Projects (Processes) [2] Maxims (Artifacts) [3] Prioritize Projects (Processes) [4] ICT Steering Committee (Entity) [5] Prioritize Projects (Processes)

organized the contained EA artifacts into a certain logical structure and provided a common point of access to these artifacts to all architects and other members of the organization.

For our documentation analysis, we were granted full access to this architectural repository to be able to download and analyze all EA artifacts stored there. As a result, we studied the samples of all types of EA artifacts found in the repository, more than 200 instances of EA artifacts in total. Unrestricted access to the repository also allowed us to revisit all EA artifacts mentioned by the interviewees in a timely manner to immediately triangulate the descriptive accounts provided by the interviewees with the "physical" evidence contained in EA artifacts. Thereby, all types of EA artifacts used in the organization have been studied, analyzed and cross-checked against their regular usage.

During our documentation analysis, we also paid considerable attention specifically to the informational content of different types of EA artifacts, their volume, format and representation that may help better understand their properties and features as boundary objects in the context of the studied EA practice. Schematic samples of some exemplary types of EA artifacts demonstrating their informational content, logical structure and presentation format are provided in Appendix C.

As access to the architectural repository had been granted after the first interview with the director of architecture, the entire corpus of utilized EA artifacts was available to us during all the subsequent interviews. Accordingly, after every interview, we studied the samples of all the EA artifacts mentioned by the interviewee to compare their physical copies with the provided descriptions and match these EA artifacts against their typical usage scenarios described by the interviewee to ensure consistency and triangulate the findings. This approach allowed validating the observations from two independent sources and asking appropriate clarifying questions during the subsequent interviews in case of inconsistency. Overall, our data collection process represented a continuous interlacement of interviewing and documentation studying, where one part constantly informed the other.

3.3. Data analysis

As discussed earlier, the central intent of our research is to analyze EA artifacts as boundary objects and their properties as such. Due to the theoretical nature of our research question, it cannot be answered by the collected raw data (i.e. interview transcripts and EA documents) directly, but requires a systematic, theoretically informed interpretation of this data by the researchers. Neither the interviewers nor the interviewees used any theoretical terms like "boundary object" and "boundary-spanning capacity" in their conversations. The same reasoning also applies to the studied EA artifacts. Thus, the collected data itself does not provide immediate answers to our research questions, but these answers can be derived from the data via its theoretical interpretation. For this reason, the data analysis in this study was conducted in two subsequent steps: (1) construction of a consistent and comprehensive descriptive model of the studied EA practice and then (2) analysis of this descriptive model through the lens of boundary objects theory.

Table 2
Communities participating in EA-related processes, their members and interests.

Community	Typical members	Responsibilities and interests
Architects	Enterprise architects, solution architects and the director of architecture	Architects are responsible for planning the evolution of the entire IT landscape according to the organizational business needs and interested in finding IT-related planning decisions optimal from an organization-wide perspective
Business analysts	Regular business analysts and solution consultants (essentially senior business analysts)	Business analysts are responsible for eliciting, collecting and capturing business requirements for new IT solutions from their business sponsors and users and interested in adequately reflecting these requirements in the respective solution designs
Business leaders	C-level business executives, heads of business units and other senior managers either individually or together in the ICT steering committee, as well as engagement managers acting as their representatives	Business leaders are responsible for identifying local and global business needs corresponding to the business strategy and interested in getting these needs addressed with IT in a timely, optimal and efficient manner
IT specialists	All rank-and-file IT specialists and subject-matter experts, e.g. technical designers, software developers and infrastructure engineers	IT specialists are responsible for the actual implementation of new IT systems according to their designs and interested in meeting specified delivery targets, milestones and deadlines
Project managers	Managers of IT projects	Project managers are responsible for managing all project implementation activities and interested in achieving local project objectives in terms of business goals, budgets and timelines

3.3.1. Step one: creation of a descriptive model

The creation of a sound descriptive model of the studied EA practice has been accomplished via applying the proven grounded theory-based coding techniques [86,87]. Specifically, to construct a descriptive model of the EA practice, we followed the essential steps of the Straussian grounded theory method (GTM): open coding, axial coding and selective coding [87,93]. Examples of the coding procedures applied as part of the first step of our data analysis are provided in Table 1.

3.3.2. Descriptive model of the studied EA practice

The first step of our data analysis described above (see Table 1) resulted in a sound descriptive view of the studied organization and its EA practice suitable for further theoretical analysis. This view introduces and defines the main entities that constitute the basis of subsequent theoretical interpretations, most importantly different occupational communities participating in the EA practice and different types of EA artifacts used in the EA practice (the full descriptive account

Table 3
EA artifacts used in the organization, their informational contents and practical usage.

EA artifacts	Informational contents	Practical usage
Business capability model	The business capability model is a large one-page graphical MS Visio drawing. It provides a holistic view of the whole organization from the perspective of its business capabilities and their hierarchy. It also shows strategic goals, customers, suppliers, partners and stakeholders in a simple structured manner	The business capability model is updated collaboratively by enterprise architects and business executives. It is used during the portfolio shaping processes primarily for project prioritization purposes
Conceptual architectures	Conceptual architectures are MS Word documents of 20–30 pages long with mixed textual and graphical contents. They describe goals, objectives, high-level technical structures and, in some cases, major design options for separate IT initiatives detailed enough to estimate their value, size, time and cost	Conceptual architectures are developed for IT initiatives collaboratively by solution architects and senior business analysts and then agreed with their business sponsors. They are used by business executives to approve the implementation of the respective initiatives and then "consumed" by business analysts to be elaborated in greater detail
Maxims	Maxims are formulated as brief written statements with more detailed textual clarifications in a single MS Word document of a few pages long. They provide very abstract global business and IT imperatives influencing all IT-related planning decisions and applicable to all IT projects	Maxims are updated collaboratively by enterprise architects and business executives. They are used during the portfolio shaping processes for project prioritization purposes and also by solution architects for developing conceptual architectures and solution designs
One-page diagrams	One-page diagrams are one-page graphical MS Visio drawings. They show the relationship and interaction between various information systems and cover different parts of the organizational IT landscape in their current states and sometimes in their planned future states	One-page diagrams are maintained by enterprise architects and solution architects and used primarily by solution architects for developing conceptual architectures and solution designs for new IT solutions
Principles	Principles are stored in multiple MS Word and PowerPoint documents related to different technical areas. Principles describe brief implementation-level guidelines applicable to broad categories of IT projects. The definition of each principle usually includes its statement, rationale and implications	Principles are developed by enterprise architects and solution architects and used primarily by solution architects for developing conceptual architectures and solution designs for new IT solutions
Roadmaps	Roadmaps are one-page graphical MS Visio drawings related to different business units or areas. They depict all planned IT initiatives or systems in the respective business areas with their expected commencement and completion dates. Often, they also show currently used information systems	Roadmaps are maintained primarily by enterprise architects and used for communication with business leaders for the identification of necessary IT initiatives in the respective business areas and their subsequent prioritization
Solution designs	Solution designs are MS Word documents of 30–60 pages long with mixed textual and graphical contents. They describe rather detailed business requirements for new IT projects as well as their technical structures and system components actionable for project teams	Solution designs are developed for IT projects collaboratively by solution architects, business analysts and some other members of project teams. They are used by project managers and other IT specialists to implement the respective IT systems
Standards	Standards are stored in multiple MS Word and PowerPoint documents related to different technical areas. Standards provide low-level reusable technical approaches, components and patterns applicable to specific narrow problems and situations. The definition of each standard often includes its description, applicability, rationale and structure	Standards are developed by enterprise architects and solution architects and used primarily by solution architects for developing conceptual architectures and solution designs for new IT solutions
Technology reference model	The technology reference model is a large one-page graphical MS Visio drawing. It provides a holistic structured view of all the technologies used in the organization including programming languages, application servers, operating systems, database management systems, integration buses and many other technologies	The technology reference model is maintained by enterprise architects and solution architects and used primarily by solution architects for developing conceptual architectures and solution designs for new IT solutions

of the studied EA practice is provided by Kotusev [94]).

Specifically, EA-related decision-making processes in the studied organization involve representatives of five broad occupational

Table 4
The flow of the analytical process from data to theory.

Source data	Descriptive accounts	Theoretical interpretations
"Something has to bridge the gap between what we as the organization want to do and how we implement that in technology, and this is [the business capability model]. Capabilities is a common point that we can discuss [with business leaders], where we can connect technology to the business outcomes" (Director of architecture)	The business capability model is used for communication purposes by business leaders and architects, where the concept of capability is meaningful to both parties, and helps align IT efforts with the organizational goals	The business capability model represents a boundary object between the communities of business leaders and architects, which provides a shared language for bridging the syntactic boundary as well as a shared meaning for bridging the semantic boundary
<Visual examination of multiple copies of roadmaps>	Roadmaps are simple and intuitive drawings depicting all planned IT initiatives or systems with their business implications, expected start and end dates in a way understandable even to non-IT-savvy people	Roadmaps provide a shared language and meaning for bridging the syntactic and semantic boundaries between the communities of business leaders and architects (as it is evident from the descriptions of their usage), the community of business leaders interprets them as planned business needs and the community of architects interprets them as planned information systems

communities. Members of all the five communities directly participate in some EA-related processes to protect their essential interests and align these interests with the interests of other communities. These communities with the descriptions of their typical members, responsibilities and interests are listed in alphabetical order in Table 2.

The EA practice in the organization is based on nine core types of EA artifacts. All the nine types of EA artifacts support certain EA-related processes and are actively used for decision-making purposes by the members of one or more professional communities listed in Table 2. These EA artifacts under their original (often peculiar) titles adopted in the organization with the descriptions of their informational contents and practical usage are listed in alphabetical order in Table 3 (more detailed descriptions of these EA artifacts, their informational contents and usage in the studied EA practice, as well as their schematic samples, are provided by Kotusev [94]).

3.3.3. Step two: theoretical analysis of the descriptive model

After the consistent atheoretical descriptive model of the studied EA practice with its participating communities (see Table 2) and utilized EA artifacts (see Table 3) has been constructed, it was subjected to a thorough theoretical analysis from the perspective of boundary objects in order to provide an exhaustive answer to the research question of this study. Specifically, our analysis was guided by the core concepts and ideas of boundary objects theory, e.g. boundary objects themselves and their properties [8,9,57], conscription devices [58,59] and different boundaries and boundary-spanning capacities [53,54]. The flow of the entire analytical process from the source data (including both interview transcripts and real EA artifacts) to the constructed descriptive accounts and finally to their theoretical interpretation is demonstrated in Table 4.

Following the chain of analysis from the raw data to the descriptive accounts and then to their theoretical interpretations, as described above (see Table 4), we constructed a comprehensive theoretical view of EA artifacts in the studied organization as boundary objects between diverse communities of business and IT stakeholders presented in great detail in the subsequent section.

4. Research findings

In this section, we provide a thorough analysis of EA artifacts used in the organization (see Table 3) as boundary objects. We start with discussing whether EA artifacts actually represent boundary objects as hypothesized, and then focus specifically on their properties, qualities and features.

4.1. Are EA artifacts boundary objects?

The analysis of key EA artifacts used in the organization and their typical usage scenarios (see Table 3) suggests that most of these EA artifacts actually represent boundary objects, while others cannot be considered as boundary objects. On the one hand, the business capability model, conceptual architectures, maxims, roadmaps and solution designs are EA artifacts supporting communication and collaboration between different professional communities within the organization and, therefore, represent classical boundary objects. All these EA artifacts fulfill the role of boundary objects in routine decision-making processes established in the organization as part of its EA practice and their usage as boundary objects within these processes has been confirmed by more than one interviewee, as noted earlier (though some of these EA artifacts also have specific use cases that do not involve representatives of multiple communities).

"Something has to bridge the gap between what we as the organization want to do and how we implement that in technology, and this is [the business capability model]. Capabilities is a common point that we can discuss [with business leaders], where we can connect technology to the business outcomes" (Director of architecture)

[Roadmaps] are our living and breathing working documents. They are never static, they are always changing. They are the tools that we use to work with the business and keep the discussions flying in terms of what they are trying to do and what they need" (Engagement manager)

"[A solution design] forms the basis for what we are actually doing, because otherwise everyone would not know what they are all working on to deliver. [...] When doing that solution design, the architect works with all other technical people. [...] All the right conversations happen, so that we can agree on what needs to be delivered" (Project manager)

The business capability model, conceptual architectures, maxims, roadmaps and solution designs all facilitate the translation of knowledge on the boundaries between different professional communities and, thereby, allow this knowledge to occupy multiple social worlds simultaneously having unique manifestations in each of them [53,54]. These EA artifacts represent certain material reifications of conceptual concerns of different groups of stakeholders, often conflicting ones. They supplement face-to-face communication processes by means of providing durable representations of "congealed reality", though not substituting for these processes [56,57]. At the same time, all these EA artifacts possess considerable interpretive flexibility that allows them to reflect internal cognitive structures of diverse actors and, thus, be endowed with the status of boundary objects [8,9].

On the other hand, one-page diagrams, principles, standards and the technology reference model are used predominantly within a homogeneous community of architects and, therefore, are not boundary objects (unless we consider enterprise architects and solution architects as two separate occupational communities, which is arguably difficult to justify). These EA artifacts exist only in one social world, do not travel beyond its boundaries to other cognitive territories and do not accomplish any cross-community knowledge augmentation or transmogrification [95]. Hence, of nine EA artifacts used in the organization, five EA artifacts can be clearly interpreted as boundary objects.

4.2. Properties of EA artifacts as boundary objects

Boundary objects are characterized, first of all, by their appeal to different social communities and their ability to satisfy the information needs of these communities [8,9]. For this reason, it should be possible to specify (1) what communities each boundary object is relevant to, (2) what pertinent information it provides to the representatives of these communities and (3) how exactly this information is valuable to them.

For example, the business capability model is a prominent EA artifact that is used in the studied organization as a boundary object. One of the occupational communities it appeals to is business executives. To this community, the business capability model provides various business-related information including the organizational mission, strategic goals and objectives, suppliers, customers and partners, activities of the value chain and, most importantly, all organizational business capabilities (see Fig. 1 in Appendix C). Moreover, this EA artifact allows business executives to establish traceable mental connections between the strategic goals and objectives and relevant business capabilities that need to be uplifted in the future to achieve the intended goals and objectives. Another professional community interacting with the business capability model is architects. To this community, the business capability model also provides information on business capabilities which, due to the high interpretive flexibility of this EA artifact, is understood by architects mostly from an IT point of view, largely as IT investments or systems necessary to improve the business capabilities required for strategy execution. Thereby, the business capability model enables the transfer of knowledge between the disparate social worlds of business executives and architects, the transformation of this knowledge on the boundary between these worlds (i.e. from high-level business plans to lower-level IT actions) through its explicit reification into a persistent material form and the mutual alignment of interests of "inhabitants" of these social worlds in spite of their different worldviews [53,54].

Table 5
Properties of EA artifacts as boundary objects.

EA artifacts	Communities	Relevant information	How this information helps
Business capability model	Architects and business executives	To architects: Classes of IT resources required in the future to execute the business strategy To business executives: Business capabilities required in the future to execute the business strategy	Allows business executives and architects to discuss the execution of business strategy and formulate priorities for future IT investments optimal from both the business and IT perspectives
Conceptual architectures	Architects, business analysts and business leaders	To architects: High-level technical structures of new IT solutions To business analysts: Functional capabilities of new IT solutions To business leaders: Business value of new IT solutions	Allows architects, business analysts and business leaders to discuss possible solution implementation options and select the most optimal ones from the technical, functional and value perspectives
Maxims	Architects and business executives	To architects: Overarching conceptual requirements to all IT plans and solutions aligned with the business strategy To business executives: Fundamental rules defining how the business needs to work aligned with the business strategy	Allows business executives and architects to discuss the execution of business strategy and formulate core imperatives for using IT in the organization optimal from both the business and IT perspectives
Roadmaps	Architects and business leaders	To architects: Planned information systems that should be implemented in the future to match business needs To business leaders: Planned capability improvements that should be delivered in the future to match business needs	Allows business leaders and architects to discuss anticipated business needs and develop future system delivery schedules optimal from both the business and IT perspectives
Solution designs	Architects, business analysts, project managers and IT specialists	To architects: Detailed technical structures of new IT systems To business analysts: Detailed business requirements for new IT systems To project managers: Implementation plans for new IT systems To IT specialists: Specifications of what IT systems should be implemented	Allows architects, business analysts, project managers and IT specialists to discuss detailed system implementation options and select the most optimal ones from the perspective of their technical fit, business functionality, delivery timelines and practical feasibility

Similarly, solution designs are important EA artifacts that serve as boundary objects in the studied EA practice. Solution designs appeal to four distinct professional communities simultaneously: architects, project managers, business analysts and IT specialists (see Table 2). To the community of architects, solution designs offer rather detailed technical structures of new IT systems and information on how these systems fit into the existing IT environment, including the technologies they utilize and their integration with other information systems. To the community of business analysts, solution designs provide rather concrete explanations of how exactly the functional and non-functional business requirements will be addressed in new IT systems. To the community of project managers, solution designs offer high-level implementation plans of new IT systems that inform them about the required human and financial resources, major delivery milestones, their approximate timelines and potential project risks. Finally, to the community of IT specialists, solution designs provide rather detailed specifications of what IT systems should be implemented that essentially drive their daily efforts. By means of resolving the contradictory interests of all the four parties involved in project implementation activities and reifying these interests into a congealed tangible form, solution designs help surpass the knowledge boundaries existing between the respective communities of actors [53] and collectively develop optimal project implementation plans despite their differing concerns, priorities and competences. Solution designs traverse across multiple social worlds and actually act as cornerstones that lay at the intersection of all these worlds, are attended to by all their inhabitants and allow these inhabitants to align their concerns [9,57].

The detailed analysis of all the five EA artifacts representing boundary objects from the perspective of their key properties (i.e. what professional communities they connect, what relevant information they provide and how this information helps align the interests of different communities) is summarized in Table 5.

The analysis provided in Table 5 shows that all the five types of EA artifacts exhibit evident signs of boundary objects [8,9], i.e. they (1) are used for communication between diverse social communities, (2) provide information relevant to representatives of different communities and (3) enable productive collaboration across these communities. Specifically, the business capability model, conceptual architectures, maxims and roadmaps represent boundary objects primarily between the disparate professional communities of senior business managers and architects, while solution designs represent boundary objects primarily between the communities of architects and project team members.

4.3. Boundary-Spanning capacity of EA artifacts

Establishing full-fledged collaboration between diverse communities requires overcoming three different knowledge boundaries: syntactic, semantic and pragmatic [53,54]. In order to span these boundaries, effective boundary objects should provide respectively a shared language for individuals to communicate across the boundary, a shared meaning to specify cross-boundary dependencies and shared tools to facilitate collaboration processes at the boundary between communities [53]. For every boundary object, it should be possible to describe its boundary-spanning mechanisms for each of the three different knowledge boundaries.

For example, roadmaps, as prominent EA artifacts serving as boundary objects, clearly provide a shared language, shared meaning and shared tools for bridging the knowledge boundaries between business leaders and architects. First, syntactically, roadmaps operate primarily with initiatives and their timelines. These terms and notions are not IT-specific at all and familiar essentially to everyone, including both non-IT-literate business leaders and architects possessing expert knowledge of IT. Second, semantically, the meaning of initiatives included in roadmaps is also easily understandable to both business leaders and architects, though their meaning differs significantly for these parties. On the one hand, to business leaders, initiatives denote specific business improvements, e.g. general capability increments, provision of requested functionality or satisfaction of some other business needs. On the other hand, to architects, planned initiatives represent specific types of IT investments, information systems or simply

Table 6
The boundary-spanning capacity of EA artifacts.

EA artifacts	Shared language for the syntactic boundary	Shared meaning for the semantic boundary	Shared tools for the pragmatic boundary
Business capability model	Business capabilities are understandable to both architects and business executives	Business capabilities represent the components of strategy execution for business leaders and underlying IT resources for architects and, therefore, specify the dependence between the business strategy and information systems	The business capability model provides a tool for the collective definition of future investment priorities employed as part of the global strategic planning and portfolio management processes
Conceptual architectures	Goals, objectives and high-level structures of IT solutions are understandable to all initiative stakeholders	Elements of conceptual architectures represent solution structures for architects, functional capabilities for business analysts and expected value for business leaders and, therefore, specify the dependence between the structure, functionality and value of IT solutions	Conceptual architectures provide tools for the collective definition of abstract solution structures employed at the early initiation stages of the initiative delivery processes
Maxims	Imperatives formulated in plain technology-neutral language are understandable to both architects and business executives	Imperatives represent the rules of strategy execution for business leaders and requirements to IT for architects and, therefore, specify the dependence between the business strategy and information systems	Maxims provide tools for the collective definition of fundamental considerations regarding business and IT employed as part of the global strategic planning process
Roadmaps	Initiatives and their timelines are understandable to both architects and business leaders	Initiatives represent capability improvements for business leaders and information systems for architects and, therefore, specify the dependence between business needs and IT plans	Roadmaps provide tools for the collective definition of necessary IT initiatives employed as part of the local business unit-specific planning processes
Solution designs	Business requirements, technical structures and components of IT systems are understandable to all project participants	Elements of solution designs represent system structures for architects, business requirements for business analysts, implementation plans for project managers and system specifications for IT specialists and, therefore, specify the dependence between the structure, functions, timelines and feasibility of IT systems	Solution designs provide tools for the collective definition of detailed system structures employed at the later implementation stages of the initiative delivery processes

some IT-enabled functionality that need to be implemented by the IT department in the future. Third, instrumentally, roadmaps are physical tools of collaboration that are used in specific situations and at specific time moments as part of established EA-related decision-making processes in the organization. For instance, roadmaps are used during regular conversations with business leaders to capture their demand for IT work as well as during the investment prioritization meetings taking place between business and IT leaders on a periodical basis. This analysis indicates that roadmaps offer the necessary language, meaning and tools for transferring, translating and transforming knowledge across the boundaries between the disparate professional communities of business leaders and architects [53,54].

Similarly, maxims also offer a shared language, shared meaning and shared tools for facilitating the cross-community interactions of business executives and architects. First, syntactically, all maxims are formulated in "normal", technology-agnostic language easily understandable to both architects, as IT experts, and business executives, as laymen. Second, semantically, all imperatives included in maxims have rather clear implications for both business executives and architects. To business executives, these implications relate to the rules of strategy execution or "the way we do business here", while to architects they provide overarching business requirements relevant to all IT systems. Third, instrumentally, maxims have a very clear "place" in the institutionalized decision-making processes constituting the EA practice. Specifically, maxims are reviewed and revised at the yearly meeting of senior business and IT leaders, where the fundamental considerations regarding the relationship between business and IT are discussed. Maxims are also used as a benchmark for judging about the suitability of proposed projects during the respective prioritization processes. Hence, maxims provide a shared language, shared meaning and shared tools for bridging syntactic, semantic and pragmatic knowledge boundaries between the disparate social worlds of business executives and architects [53,54].

The detailed analysis of the five EA artifacts representing boundary objects (see Table 5) from the perspective of the three boundary-spanning capacities is provided in Table 6.

The analysis summarized in Table 6 shows that all the five types of EA artifacts provide the three capacities of effective boundary objects identified by Carlile [53], i.e. they offer (1) a shared vocabulary and language for communication, (2) a shared meaning for negotiation and (3) shared tools for collaboration.

4.4. Qualities of EA artifacts as boundary objects

Previously, Abraham [10] identified deductively 12 hypothetical qualities of boundary objects that might be necessary for EA artifacts to become effective boundary objects: abstraction, accessibility, annotation, concreteness, malleability, modularity, participation, shared syntax, stability, up-to-dateness, versioning and visualization. An inductive analysis of the five EA artifacts representing boundary objects (see Table 5) conducted as part of this study allows confirming, refining or questioning these qualities based on tangible instances of specific EA artifacts and their actual usage patterns.

For example, the quality of stability of EA artifacts [10] was completely confirmed by our analysis. EA artifacts indeed do not change spontaneously for their stakeholders. Normally, all changes to EA artifacts are negotiated between the representatives of the relevant professional communities, e.g. all modifications of roadmaps result from the meetings taking place between business leaders and architects, while all changes to solution designs ensue from the group discussions of project implementation plans among their participants.

As another example, the quality of malleability of EA artifacts [10] was generally confirmed, but also refined by our analysis. On the one hand, all EA artifacts serving as boundary objects are not static, but rather continuously evolve through their lifecycles being shaped by the interests of various communities involved in their development and usage. On the other hand, different types of EA artifacts are malleable to different extents and range in their modifiability from very informal "lightweight" processes to formal "heavyweight" governance procedures. Specifically, such EA artifacts as conceptual architectures and solution designs can be easily modified by the actors collaborating on their development (i.e. are very malleable), while such EA artifacts as maxims cannot be modified directly, but require following official governance procedures where the proposed changes are approved by senior decision-makers (i.e. are less malleable).

At the same time, some hypothetical qualities of EA artifacts as boundary objects have not been confirmed by our analysis or even questioned. Among these qualities is, for example, annotation [10]. Even though the existing literature suggests that boundary objects can often be enriched with additional, community-specific information to

Table 7
Qualities of EA artifacts as boundary objects.

Quality	Status	Explanation
Abstraction	Refined	Each EA artifact representing a boundary object indeed offers a certain level of abstraction. However, these abstraction levels are highly artifact-specific, vary significantly depending on the target audience and can be considered as "lowest common denominators" for the representatives of relevant communities. For example, the business capability model and maxims provide adequate abstractions for executive-level stakeholders, while solution designs provide adequate abstractions for project-level stakeholders
Accessibility	Refined	All EA artifacts representing boundary objects are stored in a centralized architectural repository freely accessible to all potential stakeholders and use only standard MS Office formats (Word, Visio and PowerPoint, see Table 3). However, these EA artifacts are still more often provided to their stakeholders by architects, rather than retrieved by stakeholders directly
Annotation	Questioned	No local, community-specific annotations are observed in EA artifacts representing boundary objects. In most cases, EA artifacts have only a single current working copy intended for all relevant communities
Concreteness	Confirmed	All EA artifacts representing boundary objects indeed have concrete meaning for the representatives of different professional communities (see Table 6) addressing their community-specific concerns (see Table 5)
Malleability	Refined	Each EA artifact representing a boundary object indeed offers a certain degree of malleability to enable its joint modification. However, the malleability of different EA artifacts significantly varies. For example, conceptual architectures and solution designs can be modified rather easily directly by their stakeholders, while all modifications of the business capability model and roadmaps are usually administered and performed only by architects
Modularity	Refined	Some EA artifacts representing boundary objects are indeed structured in a modular manner into multiple semi-independent sections intended for different stakeholder groups. However, their modular structure should arguably be attributed to their low interpretive flexibility, rather than to their independent attendance by different communities (see the discussion of the implicit and explicit duality of EA artifacts provided later and specifically Table 10)
Participation	Refined	All EA artifacts representing boundary objects indeed involve the representatives of relevant communities in the processes of their creation and maintenance (see Table 3), though specific patterns of this involvement differ for different types of EA artifacts (see the discussion of EA artifacts as conscription devices provided later and specifically Table 8)
Shared syntax	Confirmed	All EA artifacts representing boundary objects indeed offer some shared syntax understandable to the representatives of relevant occupational communities (see Table 6)
Stability	Confirmed	All EA artifacts representing boundary objects are indeed rather stable and do not get modified spontaneously without a preliminary conversation and agreement between their stakeholders
Up-to-dateness	Confirmed	All EA artifacts representing boundary objects are indeed maintained up-to-date to stay current and relevant
Versioning	Questioned	Some EA artifacts representing boundary objects are indeed stored physically in a versioned manner. However, their previous versions are arguably regarded mostly as emergency backups, rather than as full-fledged "versions" in a way similar to the ones used in software engineering for change management and traceability purposes
Visualization	Questioned	Different EA artifacts representing boundary objects use different information presentation formats (see Table 3). Specifically, the business capability model and roadmaps are purely graphical, conceptual architectures and solution designs use mixed graphical and textual formats, while maxims are purely textual. As discussed later, different EA artifacts have different interpretive flexibility and follow different approaches for satisfying stakeholder information needs (see Table 10)

facilitate their use by the respective professional community [59,62], no such annotations have been noticed during our analysis of the repository of EA artifacts. EA artifacts normally had single current working copies identical for all communities; none of the examined EA artifacts had multiple versions with local annotations intended only for the members of a particular community.

The detailed analysis of the 12 desirable qualities of EA artifacts identified by Abraham [10] from the perspective of the observed qualities of real EA artifacts is provided in Table 7.

The analysis summarized in Table 7 shows that many of the qualities of EA artifacts as boundary objects predicted earlier by Abraham [10] are indeed observed in practice. However, some of these qualities found no confirmation in the studied organization or can be confirmed only with important clarifications and refinements. This divergence can be explained by the fact that the work of Abraham [[10], p. 10] is "predominantly conceptual, having collected boundary object properties primarily from literature".

4.5. EA artifacts as conscription devices

The analysis of EA artifacts representing boundary objects (see Table 5) and their typical usage scenarios in the organization (see Table 3) suggests that some of these EA artifacts can be actually considered as conscription devices, i.e. as special boundary objects that must be created collaboratively by specific people to serve their function [58,59] (though a strict distinction between "classical" boundary objects and conscription devices cannot always be made).

Namely, conceptual architectures and solution designs are intended specifically to be co-created, rather than just used, by the representatives of different professional communities. For these EA artifacts, their creation and usage are heavily intertwined, they can hardly be separated one from another or viewed as independent processes. It is specifically during their development when the interests of different conscripted communities get weighted against each other and mutually aligned to form an optimal solution structure, i.e. to a large extent, their creation *is* their usage. By contributing to conceptual architectures and solution designs, members of different occupational communities essentially "export" their knowledge outside of their own communities to be transferred to other communities, though members of these communities may not necessarily integrate it into their worldviews [58,59]. Moreover, specific instances of both these types of EA artifacts are relevant to a rather narrow and constant circle of solution stakeholders and tend to form consistent and tightly coupled working groups or full-time project teams around them, i.e. they enlist and constrain participation of people in their development as conscription devices [58, 59]. Basically, conceptual architectures and solution designs are the paraphernalia of their creators. These EA artifacts "belong" to concrete projects teams and are closely associated with individual architects, project managers and other specialists who contributed to their development.

Table 8
EA artifacts as conscription devices.

EA artifacts	Conscription device?	Explanation
Business capability model	No (can be used by a broad circle of stakeholders)	The business capability model is a long-living EA artifact that was developed for the whole organization some time ago and since then gets refined and updated. It is used by many people, but exists largely independently of them
Conceptual architectures	Yes (must be co-created by specific groups of stakeholders)	Conceptual architectures are co-created together by assigned solution architects, business analysts and business sponsors, who interact and contribute their knowledge to find rational IT solutions for addressing business needs
Maxims	No (can be used by a broad circle of stakeholders)	Maxims were initially formulated for the whole organization some time ago and are periodically reviewed to stay relevant. They influence the decision-making of multiple people, but do not belong to any of them
Roadmaps	Largely no (can be used by a rather broad circle of stakeholders)	Roadmaps get periodically updated and evolve together with the corresponding business units or areas. They may have a number of relevant stakeholders, but tend to "outlive" specific people
Solution designs	Yes (must be co-created by specific groups of stakeholders)	Solution designs are co-created together by designated solution architects, business analysts, project managers and IT specialists, who interact and contribute their knowledge to define optimal IT systems for meeting business requirements

"An architect would be engaged through a project manager to work within a project. [He or she] would work closely together with [business analysts] within the project team and also with developers and at times testers to understand the requirements. They would use the understanding of a particular problem the project is trying to solve to build the solution design" (Project manager)

On the contrary, the business capability model, maxims and roadmaps are created essentially only once and then get periodically updated and maintained to stay current. For these EA artifacts, their creation and usage processes are relatively independent and temporarily separated, i.e. first these EA artifacts are developed and then used, though during their usage they are normally updated as well. Also, unlike conceptual architectures and solution designs, all these EA artifacts do not have constant lists of stakeholders or users able to shape durable teams. Instead, each of these EA artifacts has a rather blurred, broad and varying circle of stakeholders, who collaborate pretty loosely on a part-time basis to make specific IT-related planning decisions, e.g. determine priorities for future IT investments. These stakeholders may not meet very often and some of these stakeholders may occasionally come and go. Unlike conscription devices, which essentially belong to the teams of their developers, these EA artifacts are, for the most part, uncoupled from concrete personalities, not owned by any particular individuals or teams, exist separately from specific people and tend to "outlive" their creators. For these reasons, the business capability model, maxims and roadmaps arguably cannot be interpreted as conscription devices.

A more detailed analysis of EA artifacts as conscription devices is provided in Table 8.

The analysis summarized in Table 8 shows that EA artifacts used in the organization as boundary objects differ significantly from the perspective of collaborative co-creation and enlisting participation, and some of them can be clearly viewed as conscription devices.

4.6. Implicit and explicit duality of EA artifacts

The detailed analysis of the five EA artifacts representing boundary objects (see Table 5) suggests that these EA artifacts are rather different from the perspective of their information presentation formats and associated interpretive flexibility [8]. These properties determine their boundary-spanning capacity and their ability to bridge the communication gaps between different occupational communities, which we refer to in this paper as *duality* (for the lack of any established or better terms to represent this notion).[2] For the purposes of further discussions, the duality of boundary objects can be defined as the ability of these boundary objects to satisfy the information needs of different communities using them. Our analysis of EA artifacts utilized as boundary objects in the studied organization shows that they actually apply rather different approaches to satisfying the information needs of relevant audiences, i.e. implement different types of duality.

On the one hand, some EA artifacts intended for different audiences provide the same physical views (e.g. the same diagrams or models) to each of these audiences, but because of their high interpretive flexibility, these views allow broad interpretations and convey significantly different meaning to the representatives of different audiences. For example, the business capability model (see Fig. 1 in Appendix C) is a monolithic EA artifact that offers exactly the same structured graphical view of the organization from the perspective of its business capabilities to both architects and business executives. However, by virtue of its high interpretive flexibility, this view is interpreted very differently by architects and business leaders. Architects interpret required business capabilities largely as IT resources enabling these capabilities, while business executives consider business capabilities as the components of strategy execution and the means of achieving organizational goals (see Table 6).

"[Business capability model is] aligned to the university goals and it shows all the different capabilities that we need to have to enable these goals. […] Rather than getting into a discussion of what particular software, hardware or infrastructure service we need to achieve these goals, we say: What capabilities do we need to have in place and what systems do we need to create these capabilities?" (Director of architecture)

"Capabilities [in business capability model] are the binding point between technology on the one side, which then goes down into the systems that support [these capabilities], and business on the other side, which then talks about processes and organizational structure supporting these processes" (Business architect cited by the director of architecture)

Thereby, the business capability model addresses the interests and concerns of both audiences in a single view. The ability of such EA artifacts to address the information needs of different communities can be called *implicit* duality.

On the other hand, some EA artifacts intended for different audiences are physically structured into multiple separate sections aimed at specific audiences, but because of their low interpretive flexibility, these sections allow only pretty narrow interpretation and are less meaningful to other audiences. For example, solution designs (see Fig. 2 in Appendix C) are modular EA artifacts consisting of multiple different sections that may include the statement of a business problem, concrete business requirements, high-level solution overview, overall architectural alignment and detailed descriptions of different "layers" of system architecture, e.g. data, applications, technology and security. Importantly, though these sections are closely interrelated and any one of

[2] The term "duality" that we use in this article has absolutely no relationship to the term "duality" widely used in the structuration theory [117] and associated publications (e.g. [118]), i.e. duality of agency and structure

Table 9
Implicit and explicit duality of EA artifacts.

Duality	Implicit	Explicit
Interpretive flexibility	High, i.e. allows broad interpretations	Low, i.e. allows only narrow interpretations
Physical structure	Monolithic, e.g. single large diagram (see, for example, Fig. 1 in Appendix C)	Modular, e.g. multiple separate sections (see, for example, Fig. 2 in Appendix C)
Audience focus	The same views for different audiences	Different sections for different audiences
Conceptual basis	Different interpretations of the same views	Unequivocal interpretation of different sections

Table 10
Duality of EA artifacts as boundary objects.

EA artifacts	Duality	Explanation
Business capability model	Implicit (single comprehensive graphical diagram relevant to both architects and business executives)	The same "boxes" (business capabilities) are interpreted as the means of strategy execution by business leaders and as required IT resources by architects
Conceptual architectures	Explicit (mixed documents with separate sections for architects and business stakeholders)	Sections describing business goals, requirements and benefits are more relevant to business stakeholders, while sections defining solution structures are more relevant to architects
Maxims	Somewhat explicit (single textual document with two sections for business and IT leaders)	The section defining business maxims is more relevant to business executives, while the section defining IT maxims is more relevant to architects
Roadmaps	Implicit (one-page graphical diagrams relevant to both architects and business leaders)	The same "rectangles" (scheduled initiatives) are interpreted as anticipated capability improvements by business leaders and as planned information systems by architects
Solution designs	Explicit (mixed documents with separate sections for architects and other members of project teams)	Sections stipulating business requirements are more relevant to business analysts, sections defining solution structures — to project managers, sections describing solution components — to IT specialists, while sections addressing architectural alignment — to architects

them generally cannot be changed without affecting the others, none of these sections can be interpreted broadly by different communities involved in the solution delivery process to satisfy all their information needs. Moreover, certain thought processes are necessary to coordinate the contents of these sections and their modifications. For example, the system architecture of the IT solution is potentially derived from its business requirements, but business requirements cannot be interpreted directly as system architecture by IT specialists since additional mental work is required to specify system architecture. Likewise, the business functionality of the IT solution is potentially derivable from its system architecture, but system architecture cannot be interpreted directly as business functionality by business analysts. For this reason, solution designs always include different sections with explicit descriptions of various aspects of IT solutions intended for different professional communities. For instance, the business requirements section is immediately relevant and absolutely critical to business analysts, but it is only of secondary importance to other communities, e.g. IT specialists seeking some actionable prescriptions for solution implementation. Similarly, the architectural alignment section is relevant and critical to architects, but may be essentially irrelevant to other communities, e.g. project managers incompetent in architectural matters.

> "Things that are really important to me [in solution designs] is the solution overview. This is what the solution looks like, the end-user experience. […] There is a section [in solution designs] on enterprise architecture alignment. To be honest, it is more interesting for architects and this is what they have to do, I do not really care much about that. […] There is also the actual technical view of what we are doing. I do not really use those" *(Project manager)*

Contrary to the case of the business capability model discussed earlier, where different interpretations easily follow from the same description, in the case of solution designs different interpretations do not follow from the same descriptions in a straightforward manner, i.e. different communities need different sections intended specifically for them to satisfy their essential interests. Put it simply, solution designs as a whole address the concerns of all involved communities, but concerns of different communities are addressed by different sections of solution designs. The ability of such EA artifacts to fulfill the information demands of different communities can be called *explicit* duality.

Although implicit and explicit duality represent somewhat different information presentation approaches and underlying mental mechanisms, both types of duality help span knowledge boundaries between different communities and turn the respective EA artifacts into boundary objects facilitating collaboration between these communities. The comparison between the implicit and explicit duality of EA artifacts from the perspective of their interpretive flexibility, physical structure, audience focus and conceptual basis is summarized in Table 9.

The notion of duality and its two different types, implicit and explicit (see Table 9), can be used to analyze EA artifacts and better understand their proprieties as boundary objects. The detailed analysis of the five EA artifacts representing boundary objects from the perspective of their duality is provided in Table 10.

The analysis provided in Table 10 shows that the five types of EA artifacts serving as boundary objects follow different approaches to satisfying the information needs of relevant audiences.

5. Discussion of findings

In this section, we reflect on the value of boundary objects theory for understanding how EA works, the usage of EA artifacts as boundary objects, different types of their duality and the diversity of EA artifacts used in practice.

5.1. The value of boundary objects theory for understanding EA

Effective communication, mutual understanding and partnership between business and IT stakeholders have been long recognized as one of the most significant factors enabling business and IT alignment, if not as the single most critical enabler [13–16,67,68,96–104]. However, the existing EA literature barely explains the relationship between EA and communication, e.g. why the use of EA artifacts helps improve communication and what conceptual mechanisms underpin their ability to facilitate mutual understanding between business and IT stakeholders. For example, mainstream EA publications recommend developing tens of EA artifacts [25,105–107], but provide little or no suggestions as to how exactly all these EA artifacts are expected to boost collaboration between people. Hence, the social aspects of practicing EA and achieving business and IT alignment in organizations currently remain largely unclear.

Looking at EA artifacts through the lens of boundary objects theory leveraged in this study allows clarifying these and other related questions regarding the relationship between EA and communication. Specifically, viewing EA artifacts as boundary objects between different professional communities involved in strategic decision-making and implementation of IT systems helps explain the role of EA artifacts in aligning the interests of these communities (see Table 5). This explanation is arguably critical for understanding how EA practices work, why they work and what underlying theoretical constructs make it possible. For this reason, the theory of boundary objects might be considered as one of the core theories for the entire EA discipline.

5.2. Properties of EA artifacts as boundary objects

The observed usage scenarios of EA artifacts for the purposes of information systems planning in the organization highly correlate with the use of boundary objects in other areas of human activity thoroughly described in the literature, e.g. engineering sketches [58], system designs [63], assembly drawings [53] and Gantt charts [62]. For example, many EA artifacts help transform knowledge on the boundaries between different communities of business and IT stakeholders approximately as explained by Carlile [53]. Many EA artifacts can be considered as non-human intermediaries and inscriptions in actor-networks as discussed by Gasson [63]. EA artifacts as boundary objects are seemingly effective only when they are used to supplement face-to-face interactions as noticed by Wenger [57] and Sapsed and Salter [56].

Collaborative creation of conceptual architectures closely resembles the distributed cognition processes observed during the creation of engineering objects and described in detail by Henderson [58]. Likewise, the use of roadmaps for prioritization of proposed IT initiatives clearly fulfills the three general functions of Gantt charts identified earlier by Yakura [62]: scheduling, synchronization and resource allocation (roadmaps essentially represent Gantt charts adapted specifically for the EA-related purposes and highly resemble them visually). These observations suggest that numerous conclusions regarding boundary objects made earlier in the extensive organizational and sociological literature are directly relevant to EA artifacts representing boundary objects and used for collaboration between different communities as part of an EA practice. All these conclusions can be leveraged by EA researchers in their future studies to better understand the social meaning of EA artifacts in the context of an EA practice.

Arguably the most important of these conclusions, especially from a practical point of view, is an understanding of different types of knowledge boundaries and the appropriate ways of overcoming them [53,54]. On the one hand, this understanding offers powerful analytical lenses for assessing EA artifacts for their ability to bridge the communication gaps between specific communities. Namely, it can be asked whether an EA artifact uses the language that can be understood by the representatives of these communities, whether an EA artifact operates with the notions meaningful to each of these communities and whether an EA artifact can be used as a practical tool in the hands of these communities. On the one hand, this understanding has considerable prescriptive potential and can be leveraged in design science studies [108,109], for example, to formulate practical guidelines for creating EA artifacts that can fulfill the role of boundary objects between the specified occupational communities.

5.3. Different types of duality of EA artifacts

One of the novel and noteworthy findings of this study is the identification of two distinct types of duality of EA artifacts corresponding to different approaches to satisfying the information needs of diverse communities and reflecting different degrees of their interpretive flexibility: implicit duality and explicit duality (see Table 9). These types of duality require different physical structures, have different audience focus and leverage different conceptual mechanisms. Distinguishing implicit and explicit duality of EA artifacts helps better understand the specifics of their informational contents, presentation formats and usage scenarios, as well as associated stakeholder mental representations and cognition processes (see Table 10).

To the best of the authors' knowledge, the distinction analogous to the one made in this paper between implicit and explicit duality has not been made earlier under any titles in the existing body of literature on boundary objects, though the quality of modularity somewhat resembling explicit duality had been mentioned earlier by Abraham [10] (see Table 7). We believe that an understanding of the difference between implicit and explicit duality is a valuable contribution to the boundary objects theory that deepens our knowledge of how exactly boundary objects satisfy the information requirements of different social communities. The available sociological literature only explains that boundary objects address the informational requirements of different intersecting social worlds, but it fails to explain what specific mechanisms can be used to address them, how these mechanisms work and how they differ from each other.

5.4. Diversity of EA artifacts and their purposes

The existing EA literature often discusses EA as a collection of multiple different artifacts [5,110–113], but rather rarely focuses on specific EA artifacts and their unique features [3,4]. However, the detailed analysis of EA artifacts and their properties conducted in this study shows that different types of EA artifacts are very diverse and deserve separate scrutiny.

For instance, EA artifacts are obviously very different from the perspective of their informational contents and usage scenarios (see Table 3). While some EA artifacts cannot be considered as boundary objects, most EA artifacts clearly represent boundary objects. Moreover, as boundary objects, these EA artifacts also differ from the perspective of their target audience, relevant information and its value for communication across different communities (see Table 5), their syntactic, semantic and pragmatic boundary-spanning capacity (see Table 6), their qualities (see Table 7), stakeholder involvement patterns (see Table 8) and approaches that they use for satisfying the information needs of different audiences (see Table 10). These observations suggest that in most contexts, EA scholars cannot discuss simply unspecified "EA artifacts" due to the evident diversity of their possible informational contents, usage scenarios and other critical properties. In other words, different types of EA artifacts may, in fact, have not much in common.

6. Conclusion

In this study, we investigated how EA artifacts as boundary objects facilitate communication between different professional communities as part of an EA practice and provided a comprehensive analysis of their properties. Although our findings are based on a single case study, they can be generalized analytically to other cases [81,114,115] because of the evident "similarity between causal drivers in the sample and those likely to exist in other settings" ([115], p. 13). Specifically, all our conclusions on EA artifacts as boundary objects are likely to apply to other organizations utilizing the same or similar EA artifacts (or some of these artifacts) for facilitating communication between the same or similar occupational communities, which arguably rather accurately reflects the general situation with the usage of EA artifacts observed across the industry [3]. Our study contributes to both EA theory and practice.

6.1. Contribution of this study

Due to its novel theoretical interpretations and the relevancy of its findings to real-world practical problems with EA practices, our study offers both theoretical and practical contributions to the EA literature. On the one hand, this paper provides arguably the first inductive qualitative analysis of EA artifacts as boundary objects available in the existing EA literature, though some deductive analysis supported by quantitative validation has been conducted earlier [10,20,21]. Our study confirms the roles of most, but not all, EA artifacts as boundary objects between different communities and analyzes in detail many of their relevant properties (see Table 3, Table 5, Table 6, Table 7, Table 8 and Table 10). Thereby, this paper contributes to an in-depth understanding of EA artifacts, their boundary-spanning roles and underlying mechanisms of EA practices in general. Furthermore, this study identifies two different types of duality of EA artifacts, i.e. two different approaches to satisfying the information needs of different communities of their users. To the best of our knowledge, these approaches have never been distinguished previously in the literature.

On the other hand, our study provides specific answers to some of the commonly reported practical problems with EA practice. As noted earlier, EA practices often face considerable practical challenges related to the fact that EA artifacts, for some reason or another, are unable to bridge the communication gaps between different communities and improve collaboration [17–19,73,74] or, in other words, EA artifacts fail to become effective boundary objects. This study offers a basic set of insights as to what properties EA artifacts should possess to serve as potent boundary objects, most importantly their informational contents (see Table 5), syntax, semantics and instrumental capabilities (see Table 6).

6.2. Limitations of this study

This paper is based on a single case study and, therefore, analyzes only EA artifacts used in one particular organization, though these artifacts seem to be among the most widely used EA artifacts in the industry [3,37]. This focus on a limited number of organization-specific EA artifacts may affect the generalizability of our findings and, thus, represents an evident limitation of this study.

Furthermore, since different EA sources relate different documents to "EA artifacts" [25,29,105–107], it is discussable which documents should be and should not be considered as EA artifacts for the purposes of this study. For example, the portfolio of IT projects for the upcoming financial year actively used in the studied organization for communication between business and IT communities (titled as the program of work, see Kotusev [94]) has been excluded from the analysis as a non-architectural document. This uncertainty around what exactly can be viewed as an EA artifact also represents a limitation of this study.

6.3. Direction for further research

The boundary objects theory leveraged in this study proved to be a helpful theoretical lens for analyzing EA artifacts of immediate relevance to their practical roles and essential properties. However, as cornerstones and distinctive instruments of EA practices, EA artifacts arguably deserve a more extensive analysis as boundary objects in the organizational context and many of their desirable properties in an EA practice remain largely unclear.

For example, what is the influence of different information presentation formats on the boundary-spanning capacity of EA artifacts? How does the use of various formal EA modeling languages and notations affect their boundary-spanning capacity? Or, what other notions can provide a shared meaning for bridging the sematic boundary between different occupational communities? All these questions still remain unexplored and have no meaningful answers. For this reason, we call for further research on EA artifacts, their boundary-spanning properties, qualities and capacities.

CRediT authorship contribution statement

Svyatoslav Kotusev: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Sherah Kurnia:** Writing – original draft, Writing – review & editing. **Rod Dilnutt:** Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

We understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. We confirm that we have provided a current, correct email address which is accessible by the Corresponding Author.

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Sherah Kurnia
Rod Dilnutt

Data availability

The data that has been used is confidential.

Appendix A: Profiles of Interviewees

This appendix contains the profiles of interviewees taking part in our study with their formal positions, types of their positions (architects or non-architects), tenure in the organization and the number of interviews they participated in. The profiles of all our interviewees are summarized in Table 11.

Table 11
Profiles of the interviewees participating in our study.

Position	Type	Tenure in the organization	Number of interviews
Director of architecture	Architect	13 years	3
Project manager	Non-architect	2 years	1
Engagement manager	Non-architect	2.5 years	1
Solution architect	Architect	9 years	1
Business analyst	Non-architect	1 year	1
Solution consultant	Non-architect	7 months	1
Solution consultant	Non-architect	15 months	1
Technical expert	Non-architect	5 years	1

Appendix B: Interview Protocols

This appendix contains two interview protocols used in this study. The first protocol was developed specifically for interviewing architects. The second protocol was developed for interviewing other participants of EA-related activities. However, because of the semi-structured nature of the conducted interviews, both the protocols were used more as general guidance for conversations.

The Interview Protocol for Architects

The following protocol was used during the interviews with architects.

Respondent Background (Context)

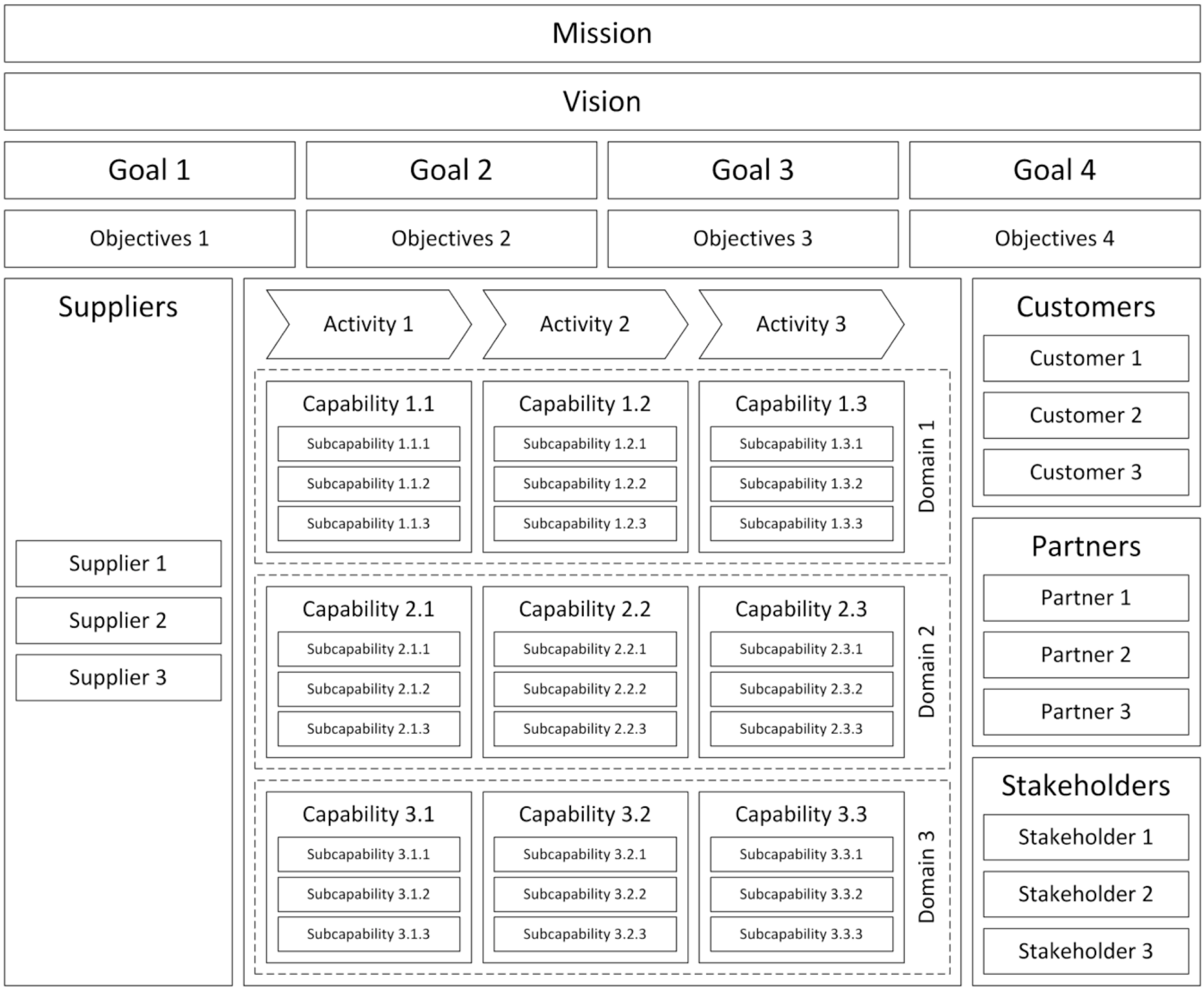

Fig. 1. Schematic graphical structure of the business capability model.

1) What is your position in the organization?
2) How long have you been working in the organization?
3) Could you briefly describe your responsibilities?

Company Background (Context)

1) How many people does your organization employ?
2) How many IT staff does your organization employ?
3) What is the high-level structure of your organization?

Enterprise Architecture Function (Context)

1) How long has your organization been practicing EA?
2) What types of architects does your organization employ?
3) How does your EA function fit into the organizational structure?
4) Does your organization employ any EA methodology or framework to organize its EA practice?

Enterprise Architecture Artifacts (Main)

1) What are the main types of EA artifacts used in your organization?
2) Could you briefly describe these types of EA artifacts?
3) What information do these types of EA artifacts contain?
4) What is the typical volume of EA artifacts of each type (number of pages, diagrams, etc.)?
5) Which architects develop each of these types of EA artifacts?
6) What stakeholders work with these types of EA artifacts?
7) How do these stakeholders use EA artifacts?
8) What information do these stakeholders seek in EA artifacts?
9) What is the purpose of these types of EA artifacts?
10) What role do these EA artifacts play in communication between architects and stakeholders?
11) Could you describe how business decisions translate into specific IT projects through these EA artifacts?

Other Questions (Additional)

1) What tools are used in your organization to develop, store and distribute EA artifacts (MS Office, MS Visio, ARIS, Troux, Casewise, Mega, alphabet, etc.)?
2) What modeling languages are used in your organization for creating EA artifacts (ArchiMate, UML, ARIS, BPMN, IDEF0, etc.)?

The Interview Protocol for Other Participants

The following protocol was used during the interviews with non-architects.

Respondent Background (Context)

Project 1 Solution Design

1. Document Control	1.1. Document author 1.2. Document revision history 1.3. Authorisation	1.4. Document distribution 1.5. Referenced documents
2. Introduction	2.1. Purpose 2.2. Audience	2.3. Overview 2.4. Glossary
3. Business Problem	3.1. Scope 3.2. Problem overview	
4. Solution Overview	4.1. Application overview 4.2. Products and services 4.3. Data and interfaces overview	4.4. Infrastructure overview 4.5. Security overview
5. Enterprise Architecture Alignment	5.1. Architecture maxims 5.2. Architecture principles 5.3. Architecture standards 5.4. Constraints	5.5. Risks 5.6. Issues 5.7. Key architecture decisions
6. Business Architecture	6.1. End-user experience 6.2. Capability model alignment 6.3. Organisational impact	
7. Data and Integration Architecture	7.1. Key information domains 7.2. Business glossary and key terms 7.3. Data entity/function matrix 7.4. Logical data diagram 7.5. Data security overview 7.6. Data migration	7.7. Data lifecycle 7.8. Logical integration architecture 7.9. Logical component architecture 7.10. Real time interfaces 7.11. Batch interfaces 7.12. Message and file formats
8. Application Architecture	8.1. System components 8.2. Support requirements	8.3. Business continuity and DR 8.4. Application security
9. Technology Architecture	9.1. Logical architecture 9.2. Physical architecture 9.3. Storage 9.4. Network architecture	9.5. Networking infrastructure 9.6. Infrastructure architecture 9.7. Licencing 9.8. Infrastructure security
10. Security	10.1. Information classification 10.2. Threat management 10.3. Security assurance	

Fig. 2. Schematic document structure of a solution design.

1) What is your position in the organization?
2) How long have you been working in the organization?
3) Could you briefly describe your responsibilities?
4) When and how often do you interact with architects?

Enterprise Architecture Artifacts (Usage)

1) What EA artifacts do you use personally?
2) Which of your responsibilities are supported by these EA artifacts?
3) How do these EA artifacts help you fulfill your responsibilities?
4) How do you work with these EA artifacts?
5) How exactly do you use these EA artifacts and how often?
6) Which of your responsibilities are the most dependent on EA artifacts and why?
7) How do EA artifacts support your communication with other people?

Enterprise Architecture Artifacts (Information)

1) What specific information do you get from EA artifacts to fulfill your responsibilities?
2) How is this information helpful to you and why?
3) How is this information presented and structured (text, lists, tables, models, diagrams, maps, etc.)?
4) Which EA artifacts are the most important for you and why?
5) Which information from EA artifacts is the most important for you and why?

Other Questions (Additional)

1) How do you obtain and access EA artifacts?
2) In what form do you use EA artifacts (paper, electronic, web-based, etc.)?

Appendix C: Schematic Samples of EA Artifacts

This appendix contains schematic samples of two different types of EA artifacts studied, among many other types, as part of the documentation analysis: the business capability model and solution designs. Due to the strict confidentiality requirements, real copies of EA artifacts cannot be provided. Schematic structures of the business capability model and solution design are shown in Fig. 1 and Fig. 2 respectively.

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