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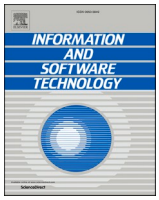

The practical roles of enterprise architecture artifacts: A classification and relationship

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ABSTRACT

Context: Enterprise architecture (EA) is a description of an enterprise from an integrated business and IT perspective. EA is typically defined as a comprehensive blueprint of an organization covering its business, data, applications and technology domains and consisting of diverse EA artifacts. EA has numerous potential stakeholders and usage scenarios in organizations. However, the existing EA literature does not offer any consistent theories explaining the practical roles of individual EA artifacts and fails to explain how exactly different types of EA artifacts are used in practice.

Objective: This study intends to explore the roles of different EA artifacts in organizations and develop a generic descriptive theory explaining these roles. The theory purports to cover various properties of EA artifacts as well as the relationships between them.

Method: The research method of this study follows two consecutive phases: theory construction and theory validation. First, theory construction is based on the qualitative in-depth analysis of five case organizations with established EA practices. Next, theory validation includes confirmatory interviews with ten EA experts.

Results: This study develops a descriptive theory explaining the roles of different EA artifacts in an EA practice. The resulting theory defines six general types of EA artifacts (Considerations, Standards, Visions, Landscapes, Outlines and Designs, CSVLOD) and explains their type-specific practical roles, including their informational contents, typical usage, ensuing organizational benefits and interrelationships with each other.

Conclusions: This study presents the first systematic theory describing the usage of EA artifacts in organizations. Our theory facilitates better theoretical understanding of the concept of EA and also provides evidence-based solutions to the commonly reported practical problems with EA. This study suggests that the EA research community should focus on studying individual EA artifacts instead of studying EA in general and calls for further research on EA artifacts and their usage as part of EA practices.

1. Introduction

The role of IT for modern companies is significant. Companies spend substantial amounts of money investing in IT. However, to realize the full potential value of IT investments, the IT strategy of a company should be aligned with its business strategy [25,47]. Enterprise architecture (EA) is a description of an enterprise from an integrated business and IT perspective intended to bridge the communication gap between business and IT stakeholders. Using EA helps companies improve business and IT alignment and brings a number of other benefits [2,78,103].

EA is typically described as a comprehensive blueprint of an enterprise covering its business, data, applications and technology domains and consisting of individual EA artifacts [9,141]. EA artifacts that can be related to EA range from high-level principles and policies to detailed technical diagrams and models [141,143]. Potential stakeholders of EA range from business executives and middle managers to rank-and-file IT specialists [100,140,144]. EA supports corporate strategic planning [125], helps coordinate organizational transformations [106], facilitates communication between different stakeholders [88], enables informed decision-making [97] and provides actionable guidance for implementing IT systems [9].

However, despite the wide variety of different EA artifacts, EA stakeholders and EA use cases, the available literature does not explain clearly what particular purposes are fulfilled by different types of EA

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Table 1
Proposed dimensions and classification schemes for EA artifacts.

Dimension	Classification	Source(s)
Domains	Business, data, applications and technology	FEAF [40], Pulkkinen [105], Schekkerman [116], Covington and Jahangir [29], van't Wout et al. [143] and TOGAF [141]
	Data, applications, communications and technology	Wardle [147]
	Infrastructure, data, application and organization	PRISM [104]
	Business, data, application, technical environment and type of plan	Connor [27]
	Work organization, information, applications and technology	TAFIM [135]
	Goals & initiatives, products & services, data & information, systems & applications and network & infrastructure	Bernard [9]
Viewpoints	Operational, systems and technical	C4ISR [22] and DoDAF [32]
	All views, strategic, operational, system, technical and acquisition	MODAF [93]
	Concepts, service, logical, physical resource and architecture meta-data	NAF [96]
	Functional, information, organizational and infrastructure	TEAF [138]
States	Current and future	PRISM [104], FEAF [40], TOGAF [141] and Bernard [9]
Horizons	Strategic, tactical and operational	Connor [27]
Perspectives	Planner, owner, designer, builder and subcontractor	Zachman [152], Sowa and Zachman [130] and TEAF [138]
Aspects of concern	Taxonomy, structure, connectivity, processes, states, sequences, information, constraints and roadmap	NAF [96]
Stages	Describe, define, specify, identify and select	EACOE [35]
Interrogatives	What, how, where, who, when and why	Sowa and Zachman [130], Schekkerman [116], van't Wout et al. [143] and EACOE [35]
Abstraction levels	Enterprise, domain and system	Pulkkinen [105]
	Conceptual, logical and design guidelines & boundaries	Wardle [147]
Representations	Catalogs, matrices and diagrams	TOGAF [141]

artifacts for these stakeholders in these use cases, or what specific roles they fulfill in practice. As our literature review indicates [73], no consistent theories explaining the utilization of EA artifacts in organizations have been developed. Although the EA discipline exists for decades [71], the practical usage of EA artifacts surprisingly remains largely unclear [102].

At the same time, the most significant reported practical problems associated with EA can be partly attributed specifically to an insufficient understanding of the roles, purposes and usage of different EA artifacts in EA practices [82].[1] As a case in point, the U.S. Federal Government reportedly invested in total about a billion dollars in developing EA for all agencies, but the artifacts produced were largely unable to improve decision-making [46]. Likewise, the experience with EA in the U.S. Department of Defense (DoD) has been essentially identical: "Even though DoD 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" ([45], p. ii). Therefore, the roles of different types of EA artifacts still remain an unexplored area of the EA discipline of significant theoretical and practical importance.

To address this longstanding gap in the EA literature, in this paper we explore the roles of different EA artifacts in an EA practice.[2] Based on five case studies of established EA practices and subsequent confirmatory interviews with accomplished EA experts, we develop a descriptive theory explaining the practical roles of different types of EA artifacts. Since the term "role" in relation to EA artifacts has no commonly accepted definition, the role of an EA artifact in the context of this paper can be understood as the set of its key properties including its informational contents, regular users, typical use cases and respective organizational benefits. This study is conceptually similar to the previous study of the roles of software architecture by Smolander et al. [128], but focuses specifically on the roles of EA artifacts.

This paper proceeds as follows: (1) we discuss EA, EA artifacts, their stakeholders and usage in organizations, and explain why the practical roles of EA artifacts are insufficiently understood, (2) we describe our research design, data collection and data analysis procedures, (3) we present the resulting theory explaining the roles of different EA artifacts in an EA practice, (4) we discuss our findings in the context of the existing EA literature, (5) we describe the contribution of our study to EA theory and practice, (6) we discuss the threats to validity and limitations of our study and (7) we conclude the paper and outline directions for further research.

2. Background

In this section, we discuss the concept of EA and its artifacts, stakeholders and usage of EA in organizations, and then explain the motivation of this study and formulate its research question.

2.1. Enterprise architecture and its artifacts

The mainstream EA literature views EA essentially as a comprehensive blueprint describing various business and IT aspects of organizations as well as their interrelationships [9,40,141]. EA generally covers business, data, applications and technology domains of organizations [29,131,141]. It is also typically assumed that EA includes the current state, future state and roadmap describing the transition from the current state to the future state [9,39]. An EA practice is a complex set of organizational activities that imply using EA for facilitating IT-related decision-making and improving business and IT alignment [3,38,72,84].

EA is composed of multiple individual documents usually called EA artifacts [77,141,150]. An EA artifact is a distinct document describing a specific narrow aspect of an organization from the perspective of its business and IT [82,102,150]. EA artifacts have several theoretical interpretations and meanings [80]. For instance, they can be viewed as boundary objects between business and IT communities [1], as elements

[1] Of course, there might be numerous other reasons for the failures of EA initiatives, including the lack of top management support or appropriate training [7,30]

[2] Importantly, this study focuses specifically on EA artifacts, not on EA modeling languages that can be used to create these artifacts, e.g. ArchiMate, ARIS, UML and BPMN. On the one hand, there is no clear relationship between EA artifacts and modeling languages as each artifact can be visualized with different modeling languages, or without any languages. On the other hand, formal modeling languages are actually not that widely adopted in the industry [6,23,115,118] and considered unsuitable for creating business-facing EA artifacts prevailing in EA practices [19,149]

of actor-networks into which human interests are inscribed [124] and as instruments of knowledge management [81].

EA artifacts can be very diverse and vary in their informational contents, representation formats and other properties. For example, an incomplete list of EA artifacts that can be used to constitute EA includes context diagrams, principles, policies, standards, guidelines, business process models, business service views, information components, logical data models, data flow diagrams, system integration views, network diagrams, transition plans and roadmaps, as well as a multitude of other artifacts [9,33,77,83,131,141,143].

The EA literature describes multiple ways of classifying EA artifacts based on their properties along different orthogonal dimensions, including domains, viewpoints, states, perspectives, interrogatives, abstraction levels and representations. These dimensions and corresponding classifications of EA artifacts are summarized in Table 1.

2.2. Stakeholders and usage of enterprise architecture

EA has a wide circle of potential users and stakeholders [100,140,141,144]. An incomplete list of EA users and stakeholders includes members of the board, senior business executives, CIOs, middle managers, enterprise architects, software architects, project managers, developers, testers, IT operations staff and other specialists [100,140,144].

EA can be used by IT staff as it provides actionable guidance for implementing necessary information systems and moving an organization closer to the desired target state [9,131,141]. EA can also be used by senior management stakeholders for the purposes of corporate strategic planning [125]. EA can facilitate the coordination of strategic changes and transformations in organizations [106]. Multiple formal analysis techniques can be used to support informed decision-making based on EA including, among others, estimating the costs of system modifications [85], analyzing IT risks and opportunities [129] and estimating service response times [97]. EA also has many other, more advanced applications in organizations, e.g. supporting corporate mergers and acquisitions [34], facilitating regulatory compliance [133] and helping introduce big data [146].

2.3. The motivation and research question of this study

As discussed above, the existing EA literature mentions many EA stakeholders and multiple ways of using EA. At the same time, EA is not a single overarching document or plan, but a collection of diverse artifacts with different properties and informational contents. However, when discussing the use of EA, the literature rarely refers to concrete EA artifacts leaving their practical roles largely unclear. For example, all the sources defining comprehensive sets of EA artifacts [9,33,131,141,143] specify only their informational contents and in what sequence they should be created, but barely explain how exactly each of these artifacts should be used or what particular role it should fulfill in practice, appealing only to obscure generalities, e.g. EA as a whole should inform stakeholders and facilitate decision-making. Moreover, all the proposed classification schemes for EA artifacts (see Table 1), in a similar vein, explain only the differences in their informational contents and representation formats, but none of these classifications explains the differences in the practical roles of different EA artifacts in terms of their stakeholders, use cases or purposes.

Although the existing EA literature provides in-depth role descriptions for a limited number of concrete EA artifacts, including principles [50,52,109], standards [14], business capability models [15,66] and project-start architectures [43], it does not offer any generic theoretical models explaining the roles of all the various types of EA artifacts that can be related to EA. Moreover, different EA artifacts may also be interrelated with each other. For example, local project-start architectures [43] should be compliant with organization-wide standards [14]. However, the available EA literature fails to provide a systematic description of the relationships between different types of EA artifacts.

In summary, despite the existence of a long list of diverse EA artifacts proposed in the literature, the roles of these artifacts in an EA practice, as well as the relationships between them, still remain largely unclear. Interestingly, this knowledge gap is consistently acknowledged by EA researchers [10,82,102,126]. For example, Simonsson et al [[126], p. 2] fairly noticed that "current Enterprise Architecture Frameworks, propose that a plethora of models should be developed and maintained. However, it is rarely evident when and why a particular model is to be preferred over others and what questions they are created to answer". More recently, Bischoff [[10], p. 93] reported that "the review of the state-of-the-art literature reveals the missing use-focus in the existing [...] enterprise architecture body of knowledge despite the fact that a vast amount of [EA] application scenarios exists and is presented in literature". Niemi and Pekkola [[102], p. 327] confirmed that "currently a theoretical model of EA artifact use does not exist". Accordingly, Niemi and Pekkola [[102], p. 326] "call for further research in these respects".

To address this longstanding gap in the EA literature, this study aims to explore the roles of different EA artifacts in an EA practice and the relationships between them. Specifically, the research question of this study can be formulated as follows: *"What are the roles of different artifacts in an EA practice and how are they interrelated?"* Answering this question implies explaining (1) what useful information different types of EA artifacts provide, (2) who uses these artifacts, (3) how exactly these artifacts are used, (4) what organizational benefits ensue from their usage and (5) how their usage relates to other types of EA artifacts.

3. Research design

This research is qualitative, inductive and exploratory in nature because the question under investigation is not described in the existing EA literature well enough to formulate any reasonable deductive propositions or quantitative hypotheses. Since this study intends to build a new inductive theory, the grounded theory method (GTM) has been selected as the key researchstrategy. [28,132] Due to the inherent qualitative nature of this study, case studies have been selected as a subsidiary data collection method to complement the primary grounded theory approach [41,42].

3.1. Data collection

According to the canons of the case studies-based grounded theory [41,42], both the case selection and within-case data collection processes have been driven by theoretical sampling considerations. Therefore, as part of this research, we successively selected and studied five diverse organizations working in different industry sectors (academe, finance, telecommunication, delivery and retail) to achieve better theoretical saturation and eliminate potential industry-specific biases. All the five cases were large organizations having permanent EA teams, consistent EA-related processes and substantial experience with EA. Brief descriptions of the five studied organizations can be found in Appendix A.

Data in the studied organizations was collected predominantly from semi-structured interviews. However, numerous samples of EA artifacts provided by the interviewees were also analyzed and, in one case, full access to the organizational EA repository has been granted. In total, 31 one-hour interviews with direct participants of EA practices in the studied organizations have been taken: 14 with enterprise architects (including principal architects, domain architects and other denominations), nine with solution architects, five with architecture managers and three with other participants of EA practices (project manager, engagement manager and subject-matter expert). A detailed list of participants interviewed as part of data collection can be found in Appendix B.

All the interviews have been taken solely by the first author via organizing face-to-face meetings at the interviewees' offices. During the

interviews, all the participants have been asked to list the main types of EA artifacts used in their organizations and then to describe in detail the informational contents, developers, users, purposes, benefits and other relevant aspects of each of these types of EA artifacts, e.g. temporal lifecycles and software tools used for their creation. The interview questionary used in this study can be found in Appendix B. All the interviews have been recorded with the permission of the interviewees and transcribed verbatim for further analysis.

During the process of data collection, theoretical sampling was used to select interviewees that are likely to be most knowledgeable in different subsets of EA artifacts used in their organizations [36,132]. Specifically, the core intent of within-case theoretical sampling was to interview all the key representatives of architecture functions (e.g. enterprise architects, domain architects, solution architects, etc.) and cover all the relevant levels of planning (e.g. enterprise level, business unit level and project level). The data collection for each organization stopped when a comprehensive list of all EA artifacts used in that organization had been composed, the roles of these artifacts had been unambiguously understood and a theoretical saturation had been achieved [48,132], i.e. when successive interviews did not add new EA artifacts to the list and did not provide substantially new information on the old artifacts.

3.2. Data analysis

Since the research question of this study addresses an insufficiently explored area of the EA discipline, the grounded theory method [48,132] was selected as the most suitable approach to data analysis. During the data analysis, the three essential steps of the grounded theory method have been followed: open coding, axial coding and selective coding [28,132]. The first step, open coding, included reading the recorded text line-by-line and identifying significant concepts and categories relevant in the context of the studied phenomenon. This step resulted in the list of major concepts and categories including artifacts, contents, stakeholders, usage, purpose and benefits. The second step, axial coding, included rereading the recorded text and establishing the relationship between various concepts and categories relevant in the context of the studied phenomenon. This step resulted in the relationship network explaining the connections between all the concepts and categories previously identified during the open coding step. The concluding step, selective coding, included selecting EA artifacts, as the central object and focal point of this study, to be the core category and then unifying all the previously established concepts, categories and relationships around EA artifacts into a consistent logical picture describing the studied phenomenon. This step resulted in an initial theory of the roles of different EA artifacts in an EA practice. All the data analysis has been performed solely by the first author. Detailed examples of the open coding and axial coding procedures can be found in Appendix C.

As suggested by the grounded theory method, the data analysis was intermingled with the data collection and carried out in parallel as soon as new data was available [48,132]. Therefore, the data analysis was iterative and adaptive, and relied on the constant comparison technique. To minimize the potential influence of existing theories on our analysis, we followed the principles of "direct" research advocated by Mintzberg [92]. In particular, we tried to be as purely descriptive as possible, as purely inductive as possible, relied on first-hand data collection methods and formulated questions in "real organizational terms".

3.3. Validation of the findings

After the data collected from the five case organizations had been analyzed and the initial theory had been developed, this theory and the corresponding roles of EA artifacts have then been discussed with ten Australian and international EA experts, including seven active EA practitioners and three EA academics with significant practical experience. A detailed list of the participants interviewed as part of theory validation can be found in Appendix D.

The initial theory that has been subjected to validation distinguished six general types of EA artifacts (titled Designs, Landscapes, Outlines, Principles, Standards and Visions), described their characteristic properties (e.g. informational contents, usage scenarios and general purposes) and explained the relationships between them. As part of theory validation, all the involved EA experts were provided with the printouts containing the brief description of the theory (in a tabular form highly resembling an extended version of Table 3 presented later), including the descriptions of the six general types of EA artifacts in the form of concise statements characterizing their essential features and mutual relationships (e.g. Outlines provide "High-level descriptions of specific IT projects understandable to business leaders" and the purpose of Standards is to "Help achieve technical consistency and homogeneity"). Then, the participants were asked to carefully study the provided descriptions and classify all EA artifacts utilized in their organizations according to these general types. After that, the experts were asked to identify inaccuracies in the theory via matching the theoretical descriptions of the general types of EA artifacts with the actual properties of artifacts used in their organizations. Finally, the participants were asked to provide their general opinion and comments about the developed theory, its completeness and practical utility.

All the conversations with the experts were recorded, their feedback was analyzed and the relevant suggestions were incorporated into the resulting theory and respective descriptions. Key points of the experts' feedback regarding each general type of EA artifacts, as well as the ensuing amendments to the developed theory, are summarized in Appendix D. Apart from "local" issues related to the features of specific types of EA artifacts, the theory has been confirmed and considered valid by the involved experts. Specifically, the participants appreciated the immediate relevance of the proposed classification of EA artifacts to the work of architects and noted its comprehensive coverage of all types of artifacts normally used in EA practices:

> *"This is real architecture, this is what I really do. […] That model describes what I do as an enterprise architect, all of the artifacts I produce. […] This is a good description of the artifacts I produce and where they sit. So, if I am an enterprise architect and I want to know what sorts of documents I need and where they fit, that is really good"* (Expert 5)

> *"I think you are covering all the main areas [of enterprise architecture in your model]. I think you captured all that would go into enterprise architecture or be encompassed by enterprise architecture"* (Expert 6)

Experts 8 and 9, who teach EA courses in universities, opined that the proposed classification can be used to explain the meaning of EA artifacts, as well as of an EA practice in general, to university students. The final descriptive theory of the roles of EA artifacts developed in this study is presented in the next section.

4. Resulting theory of the roles of EA artifacts

Data from the five studied organizations shows that each organization used from ten to 15 different artifacts considered by the interviewees as relevant to EA (61 artifacts in total, 12.2 on average per organization). Brief descriptions of all the 61 identified EA artifacts can be found in Appendix E. The grounded theory analysis shows that all the identified EA artifacts can be classified based on their conceptual

Table 2
Lists of EA artifacts related to the six general types and explanations of their titles.

Type	Related EA artifacts identified in organizations	Explanation
Considerations	Core drivers, data models, maxims, policies, principles (four organizations), strategic papers and strategy papers	All these EA artifacts provide some general *considerations* defining global architectural decision-making
Standards	Data schemas, IT principles, patterns, principles, reference architectures, standards (four organizations) and technology reference model	All these EA artifacts provide some technical *standards* influencing the designs of all information systems
Visions	Blueprints, business capability models (four organizations), business reference architectures, capability model, divisional roadmaps, enterprise investment roadmap, function roadmaps, process model, program of work and roadmaps (three organizations)	All these EA artifacts provide some *visions* of the long-term future agreed by business and IT stakeholders
Landscapes	Asset register, domain roadmaps, inventories (two organizations), one-page diagrams, platform architectures, platform roadmaps, reference architecture model, technical reference architectures, technology blueprints and technology roadmaps	All these EA artifacts provide some views of the organizational IT *landscape* from the technical perspective
Outlines	Blueprints, conceptual architectures, idea briefs, key design decisions of SOs, solution overviews and solutions on a page	All these EA artifacts provide some brief *outlines* of proposed IT initiatives
Designs	Detailed designs, full solution architectures, high-level designs, key design decisions of SAs, preliminary solution architectures, solution architectures (two organizations), solution blueprints and solution designs	All these EA artifacts provide some technical *designs* of proposed IT solutions

differences and similarities into six consistent groups describing their roles in an EA practice. These six general types of EA artifacts have been titled Considerations, Standards, Visions, Landscapes, Outlines and Designs (CSVLOD).[3] The lists of the identified EA artifacts related to these six general types (under their original peculiar labels adopted in organizations[4]), as well as the explanations of their titles, are provided in Table 2.[5]

Each of the six general types of EA artifacts fulfills a specific role in the context of EA practice and combines a unique set of related properties including its typical informational contents, stakeholders, usage and associated benefits. Each of the 61 EA artifacts identified in the studied organizations can be allocated to one and only one of these six general types. The practical roles of the six general types of EA artifacts listed in Table 2 are described in detail in the following subsections.

4.1. Considerations

Considerations (e.g. principles, maxims and policies, see Table 2) describe global conceptual rules and fundamental considerations important for business and relevant for IT. Essentially, they document some significant organization-wide business decisions having a direct impact on IT. Considerations represent the overarching organizational context for information systems planning. They are expressed in simple, intuitive formats, often as brief verbal statements. They are typically either unrelated to specific timeframes or focus on the long-term future.

Considerations are developed collaboratively by senior business leaders and architects and then used to influence all architectural decisions. They represent a certain consensus achieved between senior business and IT stakeholders on the essential questions relevant from the perspective of the relationship between business and IT. The general purpose of Considerations is to help achieve the agreement on basic principles, values, directions and aims. They allow multiple different stakeholders to tune on the same "wavelength" and develop a shared view of what is important for the organization. The proper use of Considerations leads to improved overall conceptual consistency between business and IT. They help architects avoid making inconsistent architectural decisions contradicting the most essential business needs agreed with senior business executives.

The role of Considerations in the context of EA practice is typically described by the interviewees with the following or similar statements:

> *"Maxims are very high-level principles and they are intended to apply to any project. The maxims help see whether on the highest level the project aligns to the business and technical needs. The intent of maxims is to be able to score the project to see what the organizational fit of the project is"* (Director of Architecture, Organization 1)

> *"Every architecture decision has to be evaluated against these architecture principles*" (Lead Architect, Organization 3)

4.2. Standards

Standards (e.g. technology reference models and patterns) describe global technical rules, norms, patterns and best practices relevant for IT systems. Essentially, they define how all IT systems in an organization are implemented from a technical perspective. Standards represent proven reusable means for IT systems implementation. They can be expressed in various formats, often use strict notations. They are typically either unrelated to specific timeframes or focus on the current state.

Standards are developed collaboratively by architects and technical subject-matter experts and then used to influence the architectures of all IT initiatives. They often result from the attempts to document and reuse proven best practices and implementation approaches in new IT projects or, in some cases, are derived from the existing industry standards. The general purpose of Standards is to help achieve technical consistency, technological homogeneity and regulatory compliance. They help architects to select same technologies for similar purposes, implement same solutions to similar problems and follow same prescriptions in

[3] The choice of concrete titles for the six general types of EA artifacts is indubitably subjective and other analysts would probably have chosen some other titles. These titles have been chosen with an intention to (1) reflect the overall meaning of the corresponding EA artifacts and (2) align with the common industry terminology. When these two objectives contradicted each other, we favored the first objective and "invented" new titles that seemed explanatory. The choice of titles, however, does not change the practical meaning of these types of EA artifacts reflected in their detailed descriptions

[4] Since the titles of various EA artifacts are inconsistent across the industry [77], the fact that some artifacts from different organizations with identical titles (e.g. blueprints, principles and reference architectures) actually relate to different general types in Table 2 should not be surprising or confusing. Moreover, as the title of a specific EA artifact adopted in a particular organization can be essentially arbitrary, the practical meaning of an artifact often *cannot* be deduced from its title, but only from its rich descriptive account (see Appendix E)

[5] Here and further in this article, the six general types of EA artifacts are ordered starting from the most "generic" types and ending with the most "specific" types. Although the choice of this ordering scheme is certainly subjective and the presented order itself can be debatable, the objective alternative to it would be only to order the six general types alphabetically. Also, as with the titles of these types, ordering them differently will not change any conclusions of this research

similar cases. The proper use of Standards leads to accelerated initiative delivery, reduced IT-related costs, risks and complexity of the IT landscape. They help organizations consolidate their technology portfolios and avoid "reinventing the wheels".

The role of Standards in the context of EA practice is typically described by the interviewees with the following or similar statements:

> *"We have the technology reference model [TRM] which shows us all the technologies that we have right now. So, everything [all IT projects] we do should line out with the TRM"* (Solution Architect, Organization 1)

> *"For example, my domain is networks and I have standards for networks. If somebody [of solution architects] is doing a project and they need to use the network, then they will use the standards I defined for networks. If they want to divert from the standards, then they have to fill an exemption form"* (Enterprise Architect, Organization 2)

4.3. Visions

Visions (e.g. business capability models and roadmaps) provide high-level conceptual descriptions of the organization from the business perspective. Essentially, they describe in an abstract manner how an organization works or needs to work in the future. Visions represent shared views of the organization and its future agreed by business and IT. They are expressed in brief informal formats, often as simple one-page diagrams. They usually focus on the long-term future up to 3–5 years ahead (though this horizon can be shorter in dynamic organizations and longer in more stable ones) and sometimes also depict the current situation as well.

Visions are developed collaboratively by senior business leaders and architects and then used to guide IT investments, prioritize IT initiatives and initiate IT projects. They represent a certain consensus achieved between senior business executives and architects regarding the desired focus and intensity of future IT investments. The general purpose of Visions is to help achieve the alignment between IT investments and long-term business outcomes. Collaborative discussions of Visions help senior business and IT stakeholders agree on the desired future course of action for IT based on the long-term business objectives. The proper use of Visions leads to improved strategic alignment and effectiveness of IT investments. They help senior business stakeholders ensure the direct connection between planned IT investments and the organizational business strategy.

The role of Visions in the context of EA practice is typically described by the interviewees with the following or similar statements:

> *"The business capability model is used to represent the business of the organization. Its key purpose is to facilitate a conversation around where the business wants to prioritize its investments. In our capability model for the supply chain, there might be around 30 capabilities, but we have only a limited set of resources. So, we recommend that you invest 20% of your IT budget into this capability because this capability is absolutely critical, but currently it is being neglected. It should be a number one priority on the [investment] roadmap. This is how we use our business capability model to facilitate a conversation with our business colleagues"* (Enterprise Architect, Organization 5)

> *"Roadmaps are largely for a senior executive audience in the university to make investment planning decisions"* (Director of Architecture, Organization 1)

4.4. Landscapes

Landscapes (e.g. platform architectures and inventories) provide high-level technical descriptions of the organizational IT landscape. Essentially, they describe what IT assets exist in an organization, how they are related to each other and how they are used. Landscapes represent a knowledge base of reference materials on the IT landscape. They are expressed in strict formats, often as complex one-page diagrams using formal modeling notations. They usually, but not always, focus on describing accurately the current state of an organization.

Landscapes are developed and maintained by architects, or in some cases by IT operations and support teams, and used to rationalize the IT landscape, manage the lifecycle of IT assets and plan new IT initiatives. They often document the existing IT landscape from different perspectives, are updated after completion of new IT projects and provide a baseline for IT planning to architects. The general purpose of Landscapes is to help understand, analyze and modify the structure of the IT landscape. Architects using Landscapes are able to see more easily what IT assets exist in an organization, which IT assets may cause problems in the future and how these IT assets should be reused, decommissioned or modified as part of new IT projects. The proper use of Landscapes leads to increased reuse and reduced duplication of IT assets, improved IT agility and decreased dependency on legacy IT systems. They provide high-level views of the organizational IT landscape helping eliminate inefficiency, complexity and redundancy as well as plan new IT projects more quickly.

The role of Landscapes in the context of EA practice is typically described by the interviewees with the following or similar statements:

> *"Solution architects will use the asset register to understand what systems we have in the company. It also defines which assets we are trying to reuse, which ones we are trying to decommission. If you have to build a blueprint [for a new IT solution], it is a good idea not to build it on the assets we are trying to get rid of. It is all in that repository"* (General Manager for Architecture and Strategy, Organization 2)

> *"The platform architecture document tends to live with the platform describing its current state. Then, when a new project comes along, there will be a new blueprint, and then the changes from that blueprint will be applied to the existing platform architecture. So, the platform architecture will be continually updated with each project*" (Solution Architect, Organization 3)

4.5. Outlines

Outlines (e.g. solution overviews and conceptual architectures) provide high-level descriptions of specific IT initiatives understandable to business leaders. Essentially, they describe what approximately will be implemented as part of particular IT initiatives and what business value is expected from these initiatives. Outlines essentially represent benefit, time and price tags for proposed IT initiatives. They are expressed as a mix of simple diagrams and textual descriptions and detailed enough to evaluate the project. They usually focus on the relatively short-term future up to 1–2 years ahead, in some cases on longer horizons, and evolve along with the corresponding IT projects, but their lifespan is limited to the project initiation phase.

Outlines are developed collaboratively by architects and business leaders and then used to evaluate, approve and fund specific IT initiatives. They represent a certain consensus achieved between project sponsors and architects regarding what should be implemented as part of the IT project and which major implementation options should be preferred. The general purpose of Outlines is to help estimate the overall business impact, size and value of proposed IT initiatives. They help clearly see what business value is delivered with each IT project and for what price. The proper use of Outlines leads to improved efficiency and ROI of IT investments. Via using Outlines, senior business stakeholders are able to make informed IT investment decisions and approve only the IT projects with the maximum expected payoff.

The role of Outlines in the context of EA practice is typically described by the interviewees with the following or similar statements:

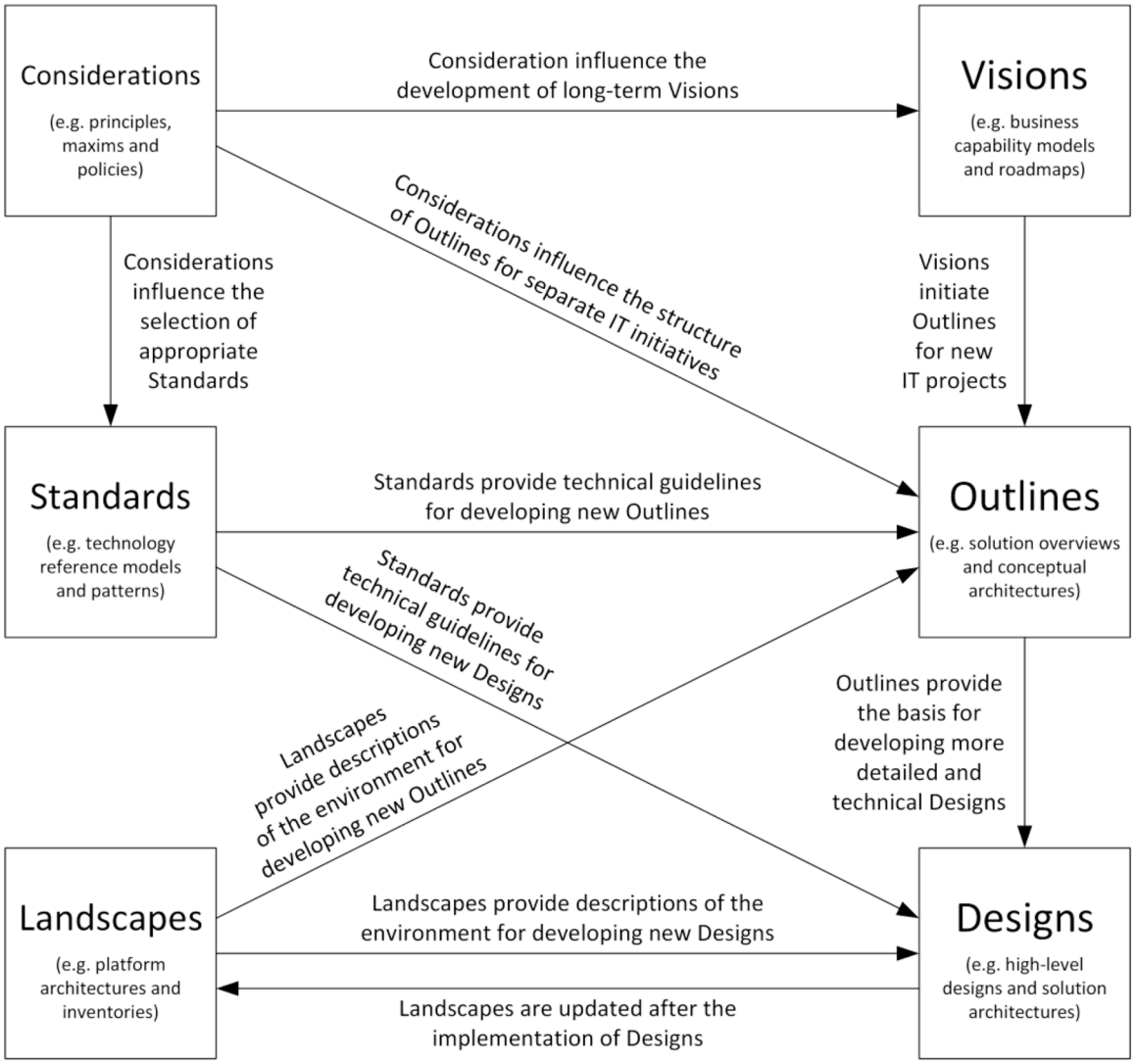

Fig. 1. Relationships between the six roles of EA artifacts.

"An idea brief provides the business information about the initiative: the benefits, the costs, what roughly it is going to deliver and what it is all about" (Enterprise Architect, Organization 4)

"A blueprint explains that if you spend ten million dollars on the project, then these are the benefits you will get. […] So, the blueprint is used to tell them [funding committee] 'we know the solution, we know the steps and these are the benefits'. We present blueprints to the funding committee to justify the spendings" (Enterprise Architect, Organization 2)

4.6. Designs

Designs (e.g. high-level designs and solution architectures) provide detailed technical descriptions of specific IT projects actionable for project teams. Essentially, they describe how exactly particular IT projects should be implemented from a technical perspective. Designs represent communication interfaces between architects and project teams. They are expressed as a mix of complex diagrams, tables and text. They often use formal modeling notations and can be voluminous. They usually focus on the short-term future up to one year ahead, rarely on longer horizons, and evolve along with the corresponding IT projects, but their lifespan is limited to the project implementation phases.

Designs are developed collaboratively by architects, project teams and business representatives and then used by project teams to implement IT projects, possibly via producing even more detailed project documentation. They represent a certain consensus achieved between all project participants regarding how the essential requirements of the IT project will be met. The general purpose of Designs is to help implement approved IT projects according to business and architectural requirements. The use of Designs ensures the connection between local implementation-specific details and global organization-wide implementation standards. The proper use of Designs leads to improved quality of the project delivery. They help diverse project participants agree on the essential design decisions and select the most appropriate, proven and risk-free project implementation approaches.

The role of Designs in the context of EA practice is typically described by the interviewees with the following or similar statements:

"We get it [solution design] developed for the project with all the necessary details, and then for the whole duration of the implementation of the project that document is a key cornerstone document providing guidance for what we [project team] are implementing" (Project Manager, Organization 1)

"Full solution architecture's role is to inform all the downstream design and implementation work. It needs to be complete enough, so that a [technical] designer can say "I know what is intended here, I know what components I need, I know what standards I need"" (Solution Architect, Organization 4)

Table 3
Summary of the six roles of EA artifacts.

Role	Information	Usage	Purpose	Relationships
Considerations	Global conceptual rules and fundamental considerations important for business and relevant for IT	Developed collaboratively by senior business leaders and architects and then used to influence all architectural decisions	Help achieve the agreement on basic principles, values, directions and aims	Influence Standards, Visions and Outlines
Standards	Global technical rules, norms, patterns and best practices relevant for IT systems	Developed collaboratively by architects and technical subject-matter experts and used to shape architectures of all IT initiatives	Help achieve technical consistency, technological homogeneity and regulatory compliance	Shape Outlines and Designs
Visions	High-level conceptual descriptions of an organization from the business perspective	Developed collaboratively by senior business leaders and architects and then used to guide IT investments, identify, prioritize and launch new IT initiatives	Help achieve the alignment between IT investments and long-term business outcomes	Initiate new Outlines
Landscapes	High-level technical descriptions of the organizational IT landscape	Developed and maintained by architects and used to rationalize the IT landscape, manage the lifecycle of IT assets and plan new IT initiatives	Help understand, analyze and modify the structure of the IT landscape	Provide the environment for Outlines and Designs
Outlines	High-level descriptions of specific IT initiatives understandable to business leaders	Developed collaboratively by architects and business leaders and then used to evaluate, approve and fund specific IT initiatives	Help estimate the overall business impact and value of proposed IT initiatives	Provide the basis for Designs
Designs	Detailed technical and functional descriptions of specific IT projects actionable for project teams	Developed collaboratively by architects, project teams and business representatives and then used by project teams to implement IT projects	Help implement approved IT projects according to business and architectural requirements	Cause updates of Landscapes

4.7. Relationships between the six roles of EA artifacts

The analysis of the six roles of EA artifacts described above suggests that these roles are closely linked with each other. Specifically, all types of EA artifacts are related to some other types, thereby creating a complex dynamic system representing an EA practice as a whole. For instance, Considerations provide general conceptual suggestions shaping all major architectural decisions in organizations reflected primarily in Visions (e.g. priorities for future IT investments), Standards (e.g. preferred technologies and vendor products) and Outlines (e.g. high-level solution implementation options).

> *"When a solution architect is defining the solution for any program or any project [i.e. Outlines], it should be aligned with the enterprise architecture principles [i.e. Considerations]. Otherwise, if their solution is not aligned with enterprise architecture principles, then definitely there is a conflict"* (Solution Architect, Organization 2)

Standards provide recommended implementation approaches defining the technical structure of higher-level Outlines (e.g. technologies to be used in new IT solutions) and lower-level Designs (e.g. solution deployment best practices) for all IT initiatives. Similarly, Landscapes provide descriptions of the surrounding IT environment necessary for developing both Outlines (e.g. available IT assets that can be leveraged in new IT solutions) and Designs (e.g. possible integration approaches between new solutions and the existing information systems). Visions provide an overall direction for future IT investments and thereby initiate the development of high-level Outlines for new IT projects (e.g. what types of IT solutions are required).

> *"We have a roadmap [i.e. Visions] that has been signed off by the business and the business has some ownership of it. I work with the business to turn those major steps in the roadmap into initiative proposals [i.e. Outlines] to be able to get started on the build"* (Principal Architect, Organization 4)

Outlines in their turn provide the initial basis for developing more detailed technical Designs (e.g. key solution implementation options agreed with the business sponsors of IT initiatives).

> *"Blueprints [i.e. Outlines] is the one that they [solution architects] take the SADs [solution architecture documents, i.e. Designs] from. They write the SAD based upon the blueprint"* (Technical Architect, Organization 2)

Finally, Designs do not influence any other types of EA artifacts directly, but cause the updates of Landscapes after the respective solutions are implemented and deployed (e.g. addition of newly built IT assets to the organizational IT landscape). The most important relationships between the six general types of EA artifacts with relevant explanations are shown in Fig. 1.

4.8. Summary of the six roles of EA artifacts

An empirical analysis of EA artifacts used in the studied organizations suggests that all these artifacts can be grouped into six general types fulfilling different roles in an EA practice. Moreover, these roles are interrelated with each other and form a dynamic system representing an EA practice.[6] The six roles of EA artifacts identified in this study are summarized in Table 3 (specific EA artifacts fulfilling these roles are summarized in Table 2 and described in detail in Appendix E).

5. Discussion

This paper provides arguably the first available theory explaining the roles of different EA artifacts in an EA practice. The resulting theory represents a full-fledged descriptive theory (or theory for analyzing, or Type I theory, see Gregor [51]) and provides an accurate conceptual depiction of the practical usage of EA artifacts in organizations. As Gregor [[51], p. 623] explains, descriptive theories analyze or summarize "salient attributes of phenomena and relationships among phenomena". Accordingly, our theory identifies relevant phenomena (i.e. six general types of EA artifacts), describes their essential attributes (Sections 4.1–4.6, summarized in Table 3) and explains the relationships between them (see Fig. 1).

5.1. New interpretation of earlier research findings

The existing EA literature, in most cases, refers simply to EA without distinguishing different types of artifacts constituting it [5,16,49,87,101,108,117,123,136]. However, many conclusions of the previous studies regarding EA can actually be related to specific types of artifacts substantially clarifying their meaning.

For instance, the entire sub-stream of EA research on the analysis methods for EA models [60,97–99,107,129] can be related specifically

[6] The fact that the identified EA artifacts, their roles and relationships do not correlate with the suggestions of popular EA frameworks (e.g. Zachman, TOGAF, FEAF and DoDAF) should not be surprising as these frameworks proved impractical long ago and, thus, are either not used at all or used purely symbolically [8,19,38,46,53,75,76,79,90,94,95,127,137]

Table 4
Relationships between the roles of EA artifacts and software architecture.

Type of EA artifacts	Blueprints (implementable specification)	Decisions (choices and rationales)	Language (medium of communication)	Literature (documentation of the current state)
Considerations	No, provide only abstract ideas	Yes, most general decisions	Yes, communication medium between architects and business leaders	No, typically do not show the current state
Standards	No, provide only general guidelines	Yes, general technical decisions	Yes, communication medium among architects	No, often provide "timeless" recommendations
Visions	No, provide only strategic plans	Yes, long-term strategic decisions	Yes, communication medium between architects and business leaders	No, reflect long-term future plans
Landscapes	No, provide only high-level views	No, often describe only what is	Yes, communication medium among architects	Yes, architectural view of the current state
Outlines	No, provide only high-level plans	Yes, key initiative-specific decisions	Yes, communication medium between architects and business leaders	No, represent mid-term future plans
Designs	Yes, provide implementable specifications	Yes, specific project-level decisions	Yes, communication medium between architects and project teams	No, represent short-term future plans

to Landscapes because, of all the six general types of EA artifacts, only Landscapes provide accurate broad-scope descriptions of the IT landscape that can be analyzed with formal methods. Similarly, most publications on EA modeling [44,57,61,69,88,111,149] can be related specifically to Landscapes and Designs as other types of EA artifacts either imply little or no modeling (Considerations and Standards) or require only informal, simplistic and intuitive models easily understandable to business leaders (Visions and Outlines).

The findings of many other EA studies can also be clarified and positioned in the context of relevant EA artifacts. For example, Alaeddini and Salekfard [5] and Alaeddini et al. [4] demonstrate that the use of EA correlates positively with business and IT alignment. However, a detailed understanding of EA artifacts and their practical roles suggests that improved alignment can be attributed mostly to the use of Visions and Outlines, which represent communication devices helping intertwine business and IT plans, while Standards and Landscapes are not used for communication with business stakeholders at all and, thus, simply cannot contribute to better alignment between business and IT. The same reasoning equally applies to the studies of Valorinta [142] and Bradley et al. [16] as well.

5.2. New theoretical view of enterprise architecture

Since the six general types of EA artifacts identified in this study represent complete and non-overlapping categories to which all EA artifacts can be allocated, the entire concept of EA can be viewed as a set of six distinct components: Considerations, Standards, Visions, Landscapes, Outlines and Designs. In line with the earlier calls for reconceptualizing EA [56,59,70,74], we argue that the most common explanation of EA as a set of business, applications, data and technology architectures prevalent in the mainstream EA literature [9,40,141,143] is largely inadequate, overly simplistic and fails to capture many important nuances of an EA practice. Viewing EA from the perspective of its domains, viewpoints or any other facets of its informational contents explains it only from the informational perspective, but does not address any other critical EA-related questions (e.g. who uses EA artifacts, how, when and why) and inhibits more advanced theorizing around EA (e.g. establishing cause-and-effect relationships between specific types of EA artifacts and the respective organizational benefits). A conceptualization of EA as Considerations, Standards, Visions, Landscapes, Outlines and Designs offers arguably a more powerful description of EA, facilitates in-depth analysis of EA practices and enables deeper theorizing on EA-related activities.

5.3. EA artifacts as blueprints, decisions, language and literature

In an earlier study with similar intentions, Smolander et al. [128] identified four general metaphoric roles fulfilled by software architecture: Blueprints, Decisions, Language and Literature. As Smolander et al. [128] demonstrate, Blueprints, as one of the roles of software architecture, provide specifications of IT systems that need to be implemented. Decisions represent different choices and rationales for systems planning. Language provides a shared means of communication enabling mutual understanding. Finally, Literature provides documentation for current and future users and IT specialists.

The studies of Bischoff et al. [11] and Niemi and Pekkola [102] suggest that these four roles can be used to better understand the roles of EA artifacts as well. The theory developed in this study shows that the practical roles of EA artifacts indeed have significant overlaps with the four roles of software architecture identified by Smolander et al. [128], though with appropriate type-specific clarifications reflecting considerable differences between EA artifacts and software architecture. The relationships between the four roles of software architecture identified by Smolander et al. [128] and the six general types of EA artifacts identified in this study are summarized in Table 4.

As shown in Table 4, the roles of EA artifacts are similar in principle to the roles of software architecture identified by Smolander et al. [128]. However, different types of EA artifacts fulfill different roles of software architecture. For example, of the six general types of EA artifacts, only Designs provide implementable specifications (i.e. fulfill the role of Blueprints), while all the other types of artifacts offer only some high-level conceptual suggestions. Likewise, of the six general types, only Landscapes provide a documentation of the current state (i.e. fulfill the role of Literature), while all the other types of artifacts either focus on the future (Designs, Outlines and Visions) or rarely refer to specific points in time (Considerations and Standards).

5.4. Practical problems with enterprise architecture

EA is infamously known for the low success rate of its initiatives [12,46,56,58,65,90,110,153]. EA endeavors often face significant challenges and suffer from a number of typical problems [6,21,26,54,62,67,89,91,114,121,122]. These problems can generally be summarized into three core issues [82,90]: (1) extraordinary efforts are needed to develop and maintain the EA documentation, (2) low quality of the EA documentation undermines its usability and (3) EA-related activities are isolated from the rest of the organization.

These three problems are widely acknowledged in the extant EA literature and perfectly explainable in light of the current situation in the EA discipline, when the practical roles of different EA artifacts are insufficiently understood. At the same time, the findings of this study on the roles of EA artifacts help elucidate how exactly each of these problems is resolved in successful EA practices. For example, the studied organizations used only about 10–15 different EA artifacts (see Appendix E), as opposed to tens of artifacts prescribed in the industry literature [9,141,143]. Further, the informational contents and presentation formats of EA artifacts were adapted to the specific demands of their intended audiences.

Table 5
Typical practical problems with EA, their explanations and resolutions.

Problem	References	Explanation	Resolution
Extraordinary efforts are needed to develop and maintain the EA documentation	Gaver [46], Kim and Everest [67], Lagerstrom et al. [86], Lohe and Legner [90], Roth et al. [114], Segars and Grover [121] and Seppanen et al. [122].	Although the EA literature provides a multitude of diverse artifacts that can be related to EA, it does not explain clearly which of these artifacts play significant roles in an EA practice and, thus, are worth to be developed and maintained	The studied organizations utilized limited numbers of EA artifacts belonging to the six general types and did not develop a comprehensive EA documentation advocated by the mainstream EA methodologies and frameworks
The low quality of the EA documentation undermines its usability	Blumenthal [13], Carvalho and Sousa [24], Gaver [46], Hauder et al. [54], Kappelman [63], Kim and Everest [67], Lohe and Legner [90], Roth et al. [114] and Segars and Grover [121]	Although the EA literature lists various EA artifacts and stakeholders, it does not explain clearly which exactly artifacts are intended for different stakeholders, what information they contain and how this information is presented	All EA artifacts used in the studied organizations were aimed at specific audiences, structured according to their information needs and formated for their convenience
EA-related activities are isolated from the rest of the organization	Ambler [6], Burton [20], Gaver [46], Hauder et al. [54], Hobbs [55], Janssen [59], Levy [89], Lohe and Legner [90], Thomas et al. [139], van der Raadt et al. [144], van der Raadt and van Vliet [145]	Although the EA literature lists various EA artifacts and ways to use EA, it does not explain clearly which exactly artifacts are used for these purposes, how they are used and who uses them	All EA artifacts employed in the studied organizations were integrated into some or the other institutionalized decision-making processes, where they were produced, updated and used

Table 6
Recommendations for overcoming the three typical problems with EA.

Problem with EA	Recommendations for overcoming the problem
Extraordinary efforts are needed to develop and maintain the EA documentation	EA practitioners should focus on mastering a reasonable number (e.g. 10–15) of different EA artifacts fulfilling the purposes of all the six general types instead of producing and maintaining heaps of artifacts to comprehensively describe their organizations
The low quality of the EA documentation undermines its usability	EA practitioners should clearly distinguish between business-focused EA artifacts (Considerations, Visions and Outlines) and IT-focused EA artifacts (Standards, Landscapes and Designs). Business-focused EA artifacts should be represented as simple, intuitive, preferably one-page diagrams convenient for decision-makers. They should present only the most essential information in brief summarized forms consumable even to an executive-level audience. On the contrary, IT-focused EA artifacts should provide detailed and specific information with all the relevant details. They can be represented in any form using any reasonable formats or special modeling notations, e.g. ArchiMate, UML, ARIS or BPMN
EA-related activities are isolated from the rest of the organization	EA practitioners should integrate the processes around Considerations and Visions with regular strategic management and decision-making processes, integrate the processes around Designs and Outlines into the project lifecycle, while the processes around Landscapes and Standards can be carried out largely independently within architecture functions

> *"Roadmaps are geared towards what questions are being asked. We have different lenses across them. […] The financial lens shows the total cost of ownership for the capability. How does this capability affect our profitability? Because there are always going to be questions about that. […] Then, there is another lens which is called the value lens. What is the value of this capability? How is it going to help enrich the customers' life experiences and journeys? […] But we never show [business stakeholders] all the connections and stuff like that, they are not interested in understanding what the interfaces are. […] The roadmap is a document that helps the business make decisions about their IT investment, so it has to be framed that way. Showing the number of connections does not help them understand that" (Enterprise Architect, Organization 5)*

Also, EA artifacts had concrete and well-defined usage scenarios within organizational decision-making processes.

> *"Roadmaps really are controlled by the business on how they want to spend the money. They can prioritize different activities on the roadmap. So, it is all intended to keep the business control and IT react to that"* (Domain Architect, Organization 3)

Typical practical problems with EA, supporting references, relevant explanations and the resolutions of these problems observed in the studied organizations are summarized in Table 5.

6. Contribution

This study contributes to both EA theory and practice. From a theoretical perspective, the resulting theory of the roles of EA artifacts provides an innovative explanatory view of EA. From a practical perspective, the findings of this study help address the most common practical problems associated with EA.

6.1. Theoretical contribution

This study presents arguably the first systematic theory describing the practical roles of EA artifacts, including their informational contents, stakeholders, usage scenarios, anticipated benefits and interrelationships. Moreover, this study also helps better understand the concept of EA itself. Current academic studies usually theorize on the value, benefits and applications of EA, but do not provide any more granular views of EA-related activities [5,16,87,108,117,123,136]. Put it metaphorically, they consider EA largely as a "black box" and do not try to analyze what is "inside" EA (except for various EA viewpoints). This study develops the first theoretical model explaining what is "inside" EA, i.e. what components constitute EA from the perspective of their practical roles. Thus, the resulting theory allows a more accurate interpretation of the previous findings on EA, many of which actually relate only to specific types of EA artifacts. An in-depth understanding of EA offered by this study enables more advanced theorizing on EA distinguishing different elements of EA as separate theoretically significant concepts.

6.2. Practical contribution

From a practical standpoint, the findings of this study on the roles of EA artifacts allow formulating specific recommendations for addressing common problems with EA in organizations. Typical practical problems with EA and the recommendations for addressing them derived from the experience of successful EA practices are summarized in Table 6.

7. Threats to validity and limitations

This study has several limitations that represent potential threats to the validity of our findings and, thus, should be clearly understood. First, the vast majority of the participants of this study were architects of various denominations and architecture managers. For this reason, the findings of this study are based mostly on the views of architects and portray an "architecture side of the story", which may be somewhat different from its business side.

Second, all the five organizations studied as part of this research were Australian companies. Although our findings have then been validated independently with the involvement of EA experts from other countries, the possibility of a certain Australia-centric bias of the resulting findings cannot be excluded. The Australian EA community is relatively small and significantly influenced by the approaches promoted by a limited number of local EA consultancies. This circumstance may potentially reduce the variety of EA artifacts employed in organizations and, thereby, impact the outcomes of our study.

Third, observations from a limited number of cases can be generalized only to theoretical propositions and may require further validation on larger samples [37,151]. For this reason, all the claims regarding EA artifacts made in this article should be regarded only as analytically generalizable and, first of all, generalizable to similar contexts [120]. However, during the theory validation stage, no contradicting evidence has been provided by the involved EA experts from other settings.

8. Conclusion

The EA literature argues that EA consists of multiple different EA artifacts, has many different applications, is used by multiple different stakeholders and brings multifarious benefits to organizations. These claims are completely supported by the findings of our study. However, the resulting theory of the roles of EA artifacts suggests that different types of EA artifacts are used by different stakeholders for different purposes and bring different benefits. Unsurprisingly, different types of EA artifacts have significantly different properties and features.

Some of these differences, and especially differences in their informational contents, are relatively obvious. For example, business-focused EA artifacts (Considerations, Visions and Outlines) are typically brief and use business language to be understandable for the senior business audience, while IT-focused EA artifacts (Standards, Landscapes and Designs) are typically more voluminous and use IT-specific language to be useful for architects and other IT specialists. However, other differences can be more subtle and much less evident. For instance, the value of IT-focused EA artifacts is realized mostly from "having" these artifacts since they are used largely as reference materials for IT planning and implementation. Conversely, the value of business-focused EA artifacts is realized largely during the process of their development since this process implies reaching mutual agreement on strategic questions, achieving a shared understanding of the organizational goals, balancing needs and concerns of various business and IT stakeholders, while the resultant versions of these artifacts only document the decisions that have already been made in the process of their development. In other words, merely developing EA artifacts from the IT-focused category is largely meaningless, but their subsequent usage can bring value, while for EA artifacts from the business-focused category the development process itself can bring more value than their subsequent usage since merely "having" these artifacts does not improve business and IT alignment. In short, for IT-focused EA artifacts documents themselves are important, but for business-focused EA artifacts the discussion of documents is important.

Consequently, EA cannot be conceptualized as a homogeneous description of various aspects of organizations that is developed and then used, but rather as a collection of diverse EA artifacts with their own specific purposes, roles, developers, users and lifecycles. The fact that different EA artifacts have different developers, users and lifecycles suggests that the phrases "developing EA" and "using EA" in most contexts are meaningless and essentially synonymous to "writing a library" and "reading a library". As the results of this study demonstrate, no individuals or groups of individuals develop and use the entire EA, but only separate artifacts or subsets of artifacts constituting EA. Therefore, we argue that all the various types of EA artifacts should not be "lumped" together under the single title of EA, but should be studied separately due to a variety of their roles, purposes and other critical properties.

The extant EA literature generally insufficiently describes the specific features of the six general types of EA artifacts, while some types of artifacts are studied much better than others. For instance, Considerations are well studied [17,18,31,50,52,68,104,109,148], limited type-specific information is available on Visions [64,112,113,119,134], but Standards, Landscapes, Outlines and Designs in the context of EA practice, arguably, have not been given the same scrutiny. Moreover, the inability to recognize the existence of different types of EA artifacts often leads to considerable confusion in the EA discipline. For example, both Ross et al. (2006) and Lankhorst [88] discuss "enterprise architecture", but provide very different descriptions of "enterprise architecture" because Ross et al. (2006), in fact, discuss the usage of Visions, while Lankhorst [88] actually discusses the modeling language suitable mostly for Landscapes and Designs.

To summarize, we argue that the EA research community should refocus from studying the properties of EA in general (as a collection of all artifacts) to studying the properties of individual artifacts constituting EA, including their desired properties, purposes and use cases, since the focus on specific EA artifacts can, arguably, lead to a much better understanding of the notion of EA as well as the essence of an EA practice.

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.

Appendix A. Overview of the Studied Organizations

This appendix provides brief descriptions of the five studied organizations. However, real organization titles, precise numbers and other specific details are not provided due to strict confidentiality requirements.

Organization 1 (Academe)

Organization 1 is one of the largest Australian teaching and research universities providing various educational services to international undergraduate, postgraduate and vocational students across a wide spectrum of specialties. The university has a long history and is consistently included in QS World University Rankings. Currently, it has several academic campuses in Australia serving tens of thousands of students from different countries. Organizationally, the university is structured on several faculties consisting of multiple academic schools. Totally, it employs several thousand people including administrators, permanent academic staff, casual teachers and invited researchers. The university has a central IT department with several hundred IT specialists providing planning, delivery and support services to all faculties and schools. The university practices EA for more than three years. Rhetorically, its EA practice is based on TOGAF, but actually it does not resemble any of its key prescriptions and represents a homegrown, company-specific approach instead.

Organization 2 (Finance)

Organization 2 is a large international bank with multibillion-dollar revenues. It was listed in the Fortune Global 500 and is among the top 100 largest banks in the world. It operates in multiple countries and is a prominent financial services provider in the Asia-Pacific (APAC) region. Products offered by the bank include retail, business and corporate banking, insurance, wealth management and other financial services. It also owns and controls a number of subsidiary companies working under different brands and providing similar services across the globe. Currently, the bank serves several million personal and corporate customers globally and maintains an extensive network of several thousand branch offices and ATMs worldwide. Totally, the bank employs tens of thousands of people including a few thousand IT specialists, although a significant part of its IT delivery function is outsourced to offshore partners. The bank practices EA for at least eight years. Nominally, its EA practice is based on TOGAF, but factually it barely correlates with its main suggestions and represents an authentic homegrown approach instead.

Organization 3 (Telecommunication)

Organization 3 is a well-known Australian telecommunication company. It provides various communication services to millions of customers across Australia. Totally, the company employs several thousand people, including several hundred in-house IT staff. Additionally, it has established partnership networks with a number of IT service providers, vendors and other telecommunication companies. Organizationally, the company is structured into four different complementary functions: construct, operate, customer and enterprise. However, its IT function is centralized and provides various IT services to all the four main corporate functions. The company practices EA for more than six years based on its own homegrown approach.

Organization 4 (Delivery)

Organization 4 is one of the prominent goods delivery companies operating in the Australian market. It provides a wide range of delivery services to individual and corporate customers. Totally, the company employs tens of thousands of people, including several hundred internal IT staff. It has multibillion-dollar revenues and delivers several billion items annually. Organizationally, the company is structured into three lines of business acting largely as independent profit centers. It has a centralized IT function providing various IT services to all the three lines of business. The company practices EA for at least five years based on its own idiosyncratic homegrown approach.

Organization 5 (Retail)

Organization 5 is a prominent Australian fast-moving consumer goods retailer with multibillion-dollar revenues. Currently, it employs tens of thousands of people, including several hundred IT staff and a similar number of outsourced IT personnel. Organizationally, the retailer is split into several lines of business acting largely as independent profit centers. Totally, it operates several hundred retail outlets across Australia. The retailer has a centralized architecture function, although each line of business has its own IT delivery function. It practices EA for more than four years based on its own homegrown approach.

Appendix B. Primary Data Collection

This appendix provides a detailed list of the interviews taken in this study as part of the primary data collection as well as the interview questionary used in these interviews.

Interviews Taken in Organizations

Primary data collection in this study was accomplished via 31 semi-structured one-hour interviews with direct participants of the EA practices in the five studied organizations. In each organization, all relevant levels of planning (i.e. from enterprise-wide to project-level planning) have been covered during the interviews. A detailed list of the interviews taken as part of the primary data collection in each organization is provided in Table 7.

Table 7
List of the interviews taken for primary data collection.

Organization	Interviews taken in the organization
Organization 1 (9 interviews)	Director of architecture (3), solution architect (1), two solution consultants (1), engagement manager (1), project manager (1), business analyst (1) and communication systems engineer (1)
Organization 2 (6 interviews)	General manager for architecture and strategy (1), enterprise architect (2), solution architect (2) and technical architect (1)
Organization 3 (7 interviews)	Enterprise architect (2), domain architect (2), lead architect (2) and solution architect (1)
Organization 4 (5 interviews)	Enterprise architect (1), principal architect (2) and solution architect (2)
Organization 5 (4 interviews)	Manager of architecture (1), enterprise architect (2) and solution architect (1)

Interview Questionary

All the interviews taken in this study were guided by a standardized questionary. However, due to the semi-structured nature of the conducted interviews and the overall exploratory attitude of this research, this questionary has been used more as an overall framework for driving and structuring conversation, than as a verbatim questionary.

Respondent Background

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

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

Enterprise Architecture Function Background

1) How long has your organization been practicing EA?
2) How does your EA function fit into the organizational structure?
3) What types of architects does your organization employ (enterprise, domain, solution, etc.)?
4) Whom does your EA function report to?
5) Does your organization employ any EA methodology or framework to organize its EA practice?

Enterprise Architecture Artifacts (Main Section)

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 is the value of these types of EA artifacts?
11) Could you describe how business decisions get translated into specific IT projects through these EA artifacts?

Additional Questions

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.)?

Appendix C. Examples of Data Analysis Procedures

This appendix provides examples of the application of the grounded theory method [28,132] to the data analysis in this study. Detailed examples of the open, axial and selective coding procedures are demonstrated in Table 8. The interviewee quotes column contains select quotes from the original recorded and transcribed text. The open coding column contains high-level concepts and categories identified in the text in order of their appearance. The axial coding column describes the relationship established between these concepts. Finally, the selective coding column provides the fragments of the resulting "story" around EA artifacts.

Table 8
Detailed examples of the open coding and axial coding procedures.

Interviewee quotes	Open coding	Axial coding	Selective coding
Solution architect: "[I useinventories] during design, I mean when I design something and I need a tool that can do the data integration, should I be using IBM or should I be using Informatica? […] You cannot reuse assets unless you have a list of assets"	Architects (Users), Landscapes (Artifacts), Initiative Planning (Usage), Reuse (Benefits), Landscape Descriptions (Information)	Landscapes provide Landscape Descriptions used by Architects for Initiative Planning to increase Reuse	Landscapes (general type) describe the current IT landscape. They are maintained and used by architects as a baseline for planning new initiatives and allow reusing existing IT assets
Architecture manager: "We have a business capability model, we know that the capabilities that we describe in that model are aligned with the objectives that the university has in its strategic plan and then we decide how to invest to build those particular capabilities. […] The turnaround that we expect from that is the fact that we will be talking to the business about how do we enable a capability rather than talking to them about how do we deploy an application"	Visions (Artifacts), Future Descriptions (Information), Strategic Effectiveness (Benefits), Investments Focusing (Usage), Business Leaders (Users), Strategic Effectiveness (Benefits)	Visions provide Future Descriptions used by Business Leaders for Investments Focusing to improve Strategic Effectiveness	Visions (general type) describe the desired future from the business point of view. They are used collectively by architects and business leaders as part of the strategic dialog and help identify opportunities for effective IT investments
Architecture manager: "Typically within an architecture engagement what happens is first we take the captured requirements [for the project] and turn those into the conceptual architecture. That is basically enough. So, we can size up the piece of work, decide roughly where the solution space is and figure out how big it is to be able to give the business stakeholders an idea of how much you need to invest in order to get all of this. And that then	Initiative Overviews (Information), Outlines (Artifacts), Initiative Shaping (Usage), Business Leaders (Users), Investments Efficiency (Benefits), Initiative Approval (Usage)	Outlines provide Initiative Overviews used by Business Leaders for Initiative Shaping and Approval to improve Investments Efficiency	Outlines (general type) describe proposed initiatives at a high level. They are used by architects and business leaders at the initiative shaping stage to agree on the solution details and ensure its efficiency

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Table 8 (*continued*)

Interviewee quotes	Open coding	Axial coding	Selective coding
causes a notification process for the project, so that gets it passed the first gate"			
Enterprise architect: "Then we go down to the design, we are calling it a high-level design. High-level design is something like a mixture of bits of architecture and bits of design. […] It is how that architecture is going to be implemented, so more getting towards how many boxes, how many wires, more detail"	Designs (Artifacts), Implementation Plans (Information), Project Implementation (Usage), Implementation Plans (Information)	Designs provide Implementation Plans for Project Implementation	Designs (general type) describe detailed system plans. They are developed at the solution delivery stage and then used to guide its technical implementation
Solution architect: "We have the technology reference model which we use to say "this is all of the technologies that we have right now". Everything [all projects] we do should line out with the TRM"	Standards (Artifacts), Implementation Recommendations (Information), Implementation Guidance (Usage)	Standards provide Implementation Recommendations for Implementation Guidance	Standards (general type) describe the adopted system implementation approaches. They apply to all IT solutions to ensure their consistency

Appendix D. Theory Validation

This appendix provides a list of experts involved in theory validation as well as detailed feedback on the theory collected from these experts.

Experts Involved in Theory Validation

Theory validation in this study has been accomplished via discussing the resulting theory with ten Australian and international EA experts, including seven active EA practitioners and three EA academics with practical experience. A detailed list of experts involved in theory validation is provided in Table 9.

Feedback from the Experts

Key points of the experts' feedback regarding each general type of EA artifacts as well as the ensuing amendments to the developed theory are summarized in Table 10.

Table 9
List of experts involved in theory validation.

Expert	Profile	Organization	Country	EA experience
1	EA practitioner	University	Australia	10 years
2	EA practitioner	Road operator	Australia	8 years
3	EA practitioner	Organization 3	Australia	12 years
4	EA practitioner	Superannuation fund	Australia	6 years
5	EA practitioner	Organization 4	Australia	13 years
6	EA practitioner	Insurance provider	Australia	18 years
7	EA practitioner	Food manufacturer	Australia	7 years
8	EA academic with practical experience	University (as EA academic) and government agency (as EA practitioner)	Netherlands	6 years
9	EA academic with practical experience	University (as EA academic) and bank (as EA practitioner)	Netherlands	20 years
10	EA academic with practical experience	University (as EA academic) and government agency (as EA practitioner)	Finland	8 years

Table 10
Experts' feedback on the general types of EA artifacts and the resulting amendments.

Type	Identified issues	Experts	Amendments to the theory
Designs	For large IT projects, Designs can describe time horizons longer than one year	1, 2 and 5	This fact was explicitly reflected in the description of Designs
	Designs are developed in collaboration between architects and project teams	7	This fact was explicitly reflected in the description of Designs
	Business requirements captured in Designs can also be relevant to business stakeholders, who verify them	3 and 5	This fact was explicitly reflected in the description of Designs
	Designs can also provide a basis for developing lower-level technical documentation for IT projects	5	This fact was explicitly reflected in the description of Designs
Landscapes	Some Landscapes, especially those based on configuration management databases (CMBDs), can be maintained and used also by IT operations and support teams	2, 5 and 6	This fact was explicitly reflected in the description of Landscapes
	Landscapes can also provide some information on the future state	1 and 7	This fact was explicitly reflected in the description of Landscapes
	The purpose of Landscapes is also to help analyze the overall "health" of the IT landscape	1 and 3	Analyzing the corporate IT landscape was added to the purposes of Landscapes
Outlines	For large IT initiatives, Outlines can describe timeframes longer than 1–2 years	1, 2 and 5	This fact was explicitly reflected in the description of Outlines
	The purpose of Outlines is also to help constrain the size of IT projects	3	Constraining the project size was added to the purposes of Outlines
Principles	"Principles" is an inadequate title for this general type as it is too narrow, non-inclusive and fails to represent the whole variety of EA artifacts that can be related to this type	2, 3 and 6 2 and 3	"Principles" general type was renamed to "Considerations" (this title was proposed by one of the experts)

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Table 10 (*continued*)

Type	Identified issues	Experts	Amendments to the theory
	EA artifacts related to this type can be either very stable, if not timeless, or refer to the long-term future		This fact was explicitly reflected in the description of this general type
Standards	Standards are often influenced, if not imposed, by external industry bodies, rather than developed inside organizations	2 and 7	This fact was explicitly reflected in the description of Standards
	The purpose of Standards is also to facilitate compliance with industry legislation and regulatory acts	7	Achieving regulatory compliance was added to the purposes of Standards
	Some Standards are used not only by architects, but also directly by project teams implementing IT solutions	6 and 7	This fact was explicitly reflected in the description of Standards
Visions	Different opinions have been voiced regarding the planning horizon appropriate for Visions	1 and 7	The varying horizon of planning was reflected in the description of Visions
	Visions can also focus on describing some elements of the current state	7	This fact was explicitly reflected in the description of Visions
	The purpose of Visions can be better explained as achieving the alignment between IT investments and business outcomes	1	The purpose of Visions has been reformulated accordingly

Appendix E. Overview of the Identified EA Artifacts

This appendix provides brief descriptions of all the 61 EA artifacts identified in the five studied organizations including their titles, contents and usage. In most cases, the provided titles of EA artifacts are the original titles used in the organizations. However, some EA artifacts were widely used, but titled inconsistently by different interviewees or even did not have any formal titles at all. For these artifacts, the most commonly used titles or the most "reasonable" titles are provided.

Organization 1 (Academe)

The EA function in Organization 1 includes enterprise architects working at the enterprise level and solution architects working at the solution level. The description of ten EA artifacts used in Organization 1 is presented in Table 11.

Organization 2 (Finance)

The EA function in Organization 2 includes business architects working at the enterprise level, enterprise architects working in multiple enterprise-wide domains (customer relationship management, payments processing, origination, etc.), program architects and solution architects working at the solution level and technical architects working at the delivery level. The description of 13 EA artifacts used in Organization 2 is presented in Table 12.

Organization 3 (Telecommunication)

The EA function in Organization 3 includes enterprise architects working at the enterprise level, lead architects working in four enterprise-wide functions (construct, operate, customer and enterprise), domain architects working in four enterprise-wide domains (data, security, integration and infrastructure), solution architects working at the solution level and external vendor architects working at the delivery level. The description of 15 EA artifacts used in Organization 3 is presented in Table 13.

Table 11
Description of EA artifacts used in Organization 1.

Type	EA artifacts	Description
Considerations	Maxims	Maxims are global high-level business and IT guidelines relevant to all information systems in the organization. They are updated by enterprise architects and approved by senior business stakeholders after the business strategy is updated. Maxims are used by all architects and influence the design of all IT solutions
Standards	Principles	Principles are brief technical rules relevant to certain broad categories of IT solutions. They are developed collaboratively by enterprise and solution architects. Principles are used by solution architects and influence the design of relevant IT solutions
	Standards	Standards are reusable implementation-level patterns and rules applicable in narrow and specific situations. They are developed by enterprise and solution architects. Standards are used by solution architects to follow unified approaches in all IT solutions
	Technology Reference Model	Technology reference model lists the available technologies that should be used in all IT solutions including programming languages, operating systems, databases and other technologies. It is maintained collaboratively by enterprise and solution architects. The technology reference model is used by solution architects to select standardized technologies for their IT solutions
Visions	Business Capability Model	Business capability model is a simple one-page diagram providing a high-level, holistic view of the whole organization in a structured manner. It shows all the organizational capabilities and sub-capabilities as well as the organizational goals, customers, suppliers, partners and stakeholders. Business capability model is maintained by enterprise architects and used primarily for communicating with senior business stakeholders to direct and prioritize IT investments
	Program of Work	Program of work contains the list of all funded IT projects approved for implementation in the upcoming year. Program of work is developed by senior business and IT stakeholders, including enterprise architects, and used for initiating IT projects
	Roadmaps	Roadmaps are one-page diagrams describing all the current and future information systems relevant to different business units of the organization. For each business unit, they show the systems and technologies that are currently used, being implemented now, approved for implementation in the future and not yet approved for implementation. Roadmaps are developed by enterprise architects and used by business stakeholders to discuss their need for future IT solutions
Landscapes	One-Page Diagrams	One-page diagrams describe the relationship and interaction between various information systems covering different parts of the organizational IT landscape typically in their current states. They are developed and maintained collaboratively by enterprise and solution architects. One-page diagrams are used by solution architects to select optimal implementation options for their IT solutions
Outlines	Conceptual Architectures	Conceptual architectures are high-level documents typically of 20–40 pages long describing goals, objectives, tentative designs and major design options for individual IT projects detailed enough to estimate their size, time and cost. They are developed by solution architects for all IT projects and discussed with relevant business stakeholders. Conceptual architectures provide initial estimates for IT solutions to support decision-making and then serve as a basis for more detailed project planning
Designs	Solution Designs	Solution designs are detailed technical documents typically of 40–80 pages long describing designs of individual IT projects actionable for project teams implementing them. They are developed by solution architects for all IT projects based on their conceptual architectures and used by project teams to deliver IT projects

Table 12
Description of EA artifacts used in Organization 2.

Type	EA artifacts	Description
Considerations	Core Drivers	Core drivers describe several global abstract architectural guidelines relevant to all information systems in the organization. They are maintained and approved by senior business and IT executives as part of the IT strategy. Core drivers are used by all architects and influence all architectural decisions
	Principles	Principles describe various high-level architectural guidelines relevant to specific domains. They are developed by enterprise architects for their domains and approved by relevant business stakeholders, typically on a yearly basis. Principles are used largely by program architects and solution architects and influence the design of all IT solutions in corresponding domains
	Policies	Policies are high-level guidelines regulating certain specific areas, for instance information security or data exchange, and relevant for all information systems in the organization. They are developed collaboratively by relevant business stakeholders and enterprise architects. However, some policies are common industry-wide compliance policies provided by external industry regulators. Policies are used by all architects and influence the design of all IT solutions
Standards	Standards	Standards describe various best practices and technology standards relevant to specific domains. They are developed largely by enterprise architects responsible for corresponding domains and discussed with other architects in architecture forums. Standards are used by program architects, solution architects and technical architects to follow unified approaches in all IT solutions
Visions	Capability Model	The capability model is a large one-page diagram describing business capabilities of the whole organization up to four or five nested levels of abstraction. It is maintained collaboratively by business architects and relevant business stakeholders. Capability model is used by business architects and business stakeholders to focus IT investments on important business capabilities and translate strategy into specific initiatives. However, it is also used by program architects for describing the capability impact of the proposed IT solutions to business stakeholders
	Process Model	The process model is a large one-page diagram describing main business processes and roles of the whole organization up to four nested levels of abstraction. It is maintained collaboratively by business architects and relevant business stakeholders. The process model is used by business architects and business stakeholders to focus IT investments on important business processes and discuss which processes should be modified or added
	Enterprise Investment Roadmap	Enterprise investment roadmap is a global business-focused document describing the allocation of all investment funding decisions in the organization planned for the next financial year. It represents the top-level aggregation, prioritization and sequencing of all investments described in divisional roadmaps. Enterprise investment roadmap is developed and used collaboratively by senior business stakeholders and a subgroup of senior architects for allocating forthcoming investments for the next financial year and initiating projects or programs
	Divisional Roadmaps	Divisional roadmaps are business-oriented documents describing the desired evolution of individual business units on a horizon of 3–5 years. They describe where and when business units need to invest in order to uplift the required business capabilities and outline the necessary projects to be delivered to achieve these business goals. They are developed collaboratively by relevant business stakeholders, business architects and enterprise architects based on platform roadmaps for corresponding domains. Divisional roadmaps used by business stakeholders, business architects and enterprise architects for making decisions on future IT investments and prioritizing them
Landscapes	Platform Roadmaps	Platform roadmaps are technical documents describing the desired evolution of individual domains from the IT perspective on a horizon of 3–5 years. They are developed by enterprise architects responsible for corresponding domains based on the objectives of agility and simplicity. Platform roadmaps are used largely by enterprise architects to inform the development of divisional roadmaps and by program architects to align their projects or programs to these roadmaps
	Asset Register	Asset register is a repository describing all currently available IT assets in the organization. It includes all existing capabilities, processes, applications, infrastructure and technology components. Asset register describes the purposes and lifecycles of these IT assets as well as shows which IT assets are currently changing and which projects are modifying them. It is maintained largely by enterprise architects. Asset register is used by business architects, enterprise architects, program architects and solution architects to reuse appropriate IT assets, for instance assets that are not planned to be decommissioned in the future. Additionally, it is used for project sequencing purposes to ensure that multiple projects do not change one IT asset simultaneously
Outlines	Blueprints	Blueprints are high-level descriptions of individual IT projects or programs in business language typically of 25–50 pages long. They describe the objectives, value, benefits, scope and risks of IT initiatives and provide approximate estimates of their time and cost with 50% precision. They show the current state, future state, tentative solution and the necessary steps to implement it and explain which vendors or partners will be involved. Blueprints are developed by program architects and inform business cases for projects or programs. They are used by business stakeholders to discuss, approve and fund initiatives as well as by solution architects as a basis for developing more detailed solution architectures
Designs	Solution Architectures	Solution architectures are high-level technical documents describing the conceptual implementation of individual IT projects or groups of related projects. They are typically of 50–100 pages long, but may reference more detailed subdocuments. Solution architectures describe functional and non-functional requirements of the solution, logical components of the solution and their relationship from the business, information, application, infrastructure and security perspectives. They are developed by solution architects based on blueprints and used by technical architects for developing more detailed high-level designs
	High-Level Designs	High-level designs are detailed IT-specific descriptions of the physical implementation of individual IT projects. They are voluminous documents describing technical designs of all logical components outlined in solution architectures. High-level designs are developed by technical architects based on solution architectures and used by project teams as a basis for developing more detailed designs and delivering IT projects

Table 13
Description of EA artifacts used in Organization 3.

Type	EA artifacts	Description
Considerations	Principles	Principles describe high-level architectural guidelines or concepts relevant for specific functions (construct, operate, customer and enterprise) or domains (data, security, integration and infrastructure). They are developed by lead or domain architects and approved by relevant business stakeholders. Principles are used largely by solution architects and influence the design of all IT solutions in corresponding functions or domains
	Data Models	Data models are abstract business-oriented descriptions of the main types of data stored in the organization and connections between them, for instance customer, product, service and order. They are developed collaboratively by data domain architects and business stakeholders. Data models are used largely by solution architects and influence the usage and storage of information in all IT solutions
	Strategic Papers	Strategic papers are conceptual documents describing recommended future directions for both business and IT, typically on a horizon of 5–10 years. They are developed by enterprise architects and discussed with business stakeholders, often as a response to specific long-term strategic business needs. Strategic papers are relevant for all architects and influence the design of all roadmaps and IT solutions.
Standards	IT Principles	IT principles describe ten global high-level architectural guidelines relevant to all information systems in the organization. They are developed and maintained by enterprise architects. IT principles are used by all architects and influence all architectural decisions
	Patterns	Patterns describe reusable technical solutions to typical problems relevant to specific domains (data, security, integration and infrastructure). They are developed by domain architects and used by solution architects to follow standardized approaches in all IT solutions
	Data Schemas	Data schemas are detailed technical documents defining standardized formats to store and transfer main data entities on different platforms, for instance SQL definitions and XML schemas. They are developed by data domain architects based on data models and used by solution architects in all IT solutions to achieve a unified representation of information
Visions	Business Capability Models	Business capability models are one-page diagrams describing general business capabilities of the whole organization as well as more specific business capabilities of different organizational functions (construct, operate, customer and enterprise). They are maintained by enterprise and lead architects. Business capability models are used primarily to facilitate a conversation with business stakeholders, prioritize IT investments and serve as a basis for developing function roadmaps. However, they are also used by solution architects for determining the impact of their IT solutions and explaining to business stakeholders which business capabilities will be improved
	Function Roadmaps	Function roadmaps describe tentative lists of IT initiatives to be implemented in different organizational functions (construct, operate, customer and enterprise) in the future up to five years ahead. However, short-term horizons describe more specific IT initiatives approved and funded to be implemented during the next financial year. Function roadmaps are developed and used collaboratively by lead architects and business stakeholders for prioritizing IT investments and initiating IT projects
Landscapes	Reference Architecture Model	Reference architecture model is a one-page diagram showing all business capabilities of the organization and the main information systems supporting these capabilities. It is maintained by enterprise architects and used by different architects for optimizing the IT landscape, reusing systems and managing their lifecycles
	Domain Roadmaps	Domain roadmaps describe the desired progression of different domains (data, security, integration and infrastructure) in the future from the technical or semi-technical perspective. Domain roadmaps are developed by domain architects and used by solution architects, who try to align their IT solutions to domain roadmaps and thereby opportunistically deliver these roadmaps
	Inventories	Inventories are lists of systems, technologies, data entities, platforms and other assets existing in the organization. Each item in an inventory is marked as to-be-decommissioned, current and to-be-implemented. They are maintained by lead and domain architects. Inventories are used mostly by solution architects to properly reuse currently available IT assets in their IT solutions
	Platform Architectures	Platform architectures are detailed technical documents and diagrams describing different parts of the IT landscape (platforms) typically of 60–150 pages long. They are maintained by solution and vendor architects and updated after each release of the projects affecting the platform. Platform architectures are used by solution and vendor architects to facilitate detailed solution planning and manage the complexity of the IT landscape
Outlines	Solutions on a Page	Solutions on a page are one-page diagrams schematically describing individual IT solutions in an abstract manner. They are developed by solution architects in the early stages of IT projects. Solutions on a page are used for communication with business stakeholders, getting initial approvals and estimating projects as small, medium or large
Designs	Solution Blueprints	Solution blueprints are high-level descriptions of individual IT solutions typically of 30–70 pages long. They are developed by solution architects and contain enough detail for reasonably accurate size and cost estimation. Solution blueprints are provided as project requirements to vendor architects to quote the exact price and then deliver the project
	Detailed Designs	Detailed designs are voluminous detailed technical documents up to several hundred pages long describing a number of individual IT solutions relevant to a single platform included in a single release. They are developed by vendor architects, approved by solution architects and then used by vendor IT specialists to deliver the projects included in a release

Organization 4 (Delivery)

The EA function in Organization 4 includes chief architects working largely as architecture managers in three lines of business, principal architects working in three lines of business, enterprise architects working in five enterprise-wide domains (product and pricing, customer, information management, integration and infrastructure) and solution architects working at the solution level. The description of 11 EA artifacts used in Organization 4 is presented in Table 14.

Organization 5 (Retail)

The EA function in Organization 5 includes enterprise architects working at the enterprise level and solution architects working at the solution level. The description of 12 EA artifacts used in Organization 5 is presented in Table 15.

Table 14
Description of EA artifacts used in Organization 4.

Type	EA artifacts	Description
Considerations	Principles	Principles describe high-level architectural guidelines relevant for the whole organization, specific lines of business or domains (product and pricing, customer, information management, integration and infrastructure). Global principles are abstract guidelines for the whole organization, while principles for particular lines of business or domains are more specific versions of these global principles refined to their specific areas. They are developed by the CIO, corresponding principal or enterprise architects and approved by senior business stakeholders. Principles are used by all architects and influence all architectural decisions in corresponding lines of business or domains
Standards	Reference Architectures	Reference architectures describe reusable technical patterns providing solutions to typical problems in specific domains (product and pricing, customer, information management, integration and infrastructure) and sometimes in specific lines of business. They are developed by the corresponding enterprise or principal architects and used by solution architects to follow standardized approaches in all IT solutions
	Standards	Standards are lists of main technologies, tools, products and vendors that should be used in all IT solutions in the organization. They are developed largely by enterprise architects as a result of the technology selection process. Standards are used by solution architects to select standardized technologies or products for their IT solutions
Visions	Business Capability Model	The business capability model is a one-page diagram describing business capabilities of the whole organization up to three or four nested levels of abstraction. It is maintained collaboratively by principal architects and relevant business stakeholders. Business capability model is used by principal architects and business stakeholders to identify strategically important capabilities and manage the portfolio of IT investments. However, it is also used by solution architects for explaining to business stakeholders the capability impact of their IT solutions
	Blueprints	Blueprints are business-oriented descriptions of the desired future states in particular business areas typically up to 3–5 years ahead. They are A3 one-page diagrams showing business drivers, key decisions, architecture overview, customer outcomes, business outcomes and other relevant information. However, each blueprint also includes a more detailed supplementary information pack. The whole organization is covered with ten core blueprints and some additional local blueprints. Blueprints are developed and updated on a yearly basis collaboratively by principal architects and relevant business stakeholders. They are used by principal architects and business stakeholders as a basis for developing roadmaps
	Roadmaps	Roadmaps are business-oriented one-page diagrams describing the progression of IT initiatives necessary to achieve the desired future states envisioned in blueprints. The level of detail on roadmaps is gradually decreasing from short-term time horizons to long-term horizons and the period of the next financial year is described in most detail. Roadmaps are developed and updated on a yearly basis collaboratively by principal architects and relevant business stakeholders. They are used by principal architects and business stakeholders for prioritizing IT investments and initiating IT projects
Landscapes	Technology Blueprints	Technology blueprints are descriptions of the desired future states in particular technology domains typically up to 3–5 years ahead. They are A3 one-page diagrams structured similarly to business-oriented blueprints. However, most of them, especially in integration and infrastructure domains, are largely irrelevant to business stakeholders. The whole organization is covered with five core technology blueprints and some additional local blueprints. Technology blueprints are developed and updated by enterprise architects, approved by the CTO and used by enterprise architects as a basis for developing technology roadmaps
	Technology Roadmaps	Technology roadmaps are one-page diagrams describing the progression of IT initiatives necessary to achieve the desired future states envisioned in technology blueprints. Their format is similar to the format of business-oriented roadmaps, but they are largely irrelevant to business stakeholders. Technology roadmaps are developed and updated by enterprise architects and approved by the CTO. They are used by enterprise architects and other IT stakeholders for prioritizing IT investments and initiating IT projects sponsored by the CIO. However, they are also used by solution architects who try to align their IT solutions to technology roadmaps and thereby opportunistically deliver these roadmaps
Outlines	Idea Briefs	Idea briefs are high-level descriptions of individual IT solutions in business language. They describe the general ideas, goals and benefits of IT projects and provide enough architectural information to estimate their costs with 50% precision. Idea briefs are developed collaboratively by solution architects, principal architects and business stakeholders. They are used by business stakeholders for initial approvals of IT projects and by solution architects as a basis for developing preliminary solution architectures
Designs	Preliminary Solution Architectures	Preliminary solution architectures are high-level technical descriptions of individual IT solutions typically of about 30 pages long. They are detailed enough to estimate the costs and timelines of IT projects with 20% precision and inform their business cases. Preliminary solution architectures are developed by solution architects, provide the estimates for the final approval of IT projects and are then used by solution architects as a basis for developing more detailed full solution architectures
	Full Solution Architectures	Full solution architectures are detailed technical descriptions of individual IT solutions typically of about 50 pages long. They are developed by solution architects based on preliminary solution architectures and used by project teams for producing detailed designs and delivering IT projects

Table 15
Description of EA artifacts used in Organization 5.

Type	EA artifacts	Description
Considerations	Principles	Principles are global abstract architectural guidelines relevant to all information systems in the organization. They are formulated by enterprise architects and approved by senior business stakeholders. Principles are used by all architects and influence the design of all IT solutions
	Strategy Papers	Strategy papers are high-level analytical documents discussing the potential influence and impact of disruptive technology trends on the business of the organization. Essentially, they represent the results of a SWOT (strengths, weaknesses, opportunities and threats) analysis from the technology perspective. They are produced collaboratively by enterprise architects and senior business stakeholders. Strategy papers are communicated to a wide circle of business and IT stakeholders to influence their decision-making
Standards	Standards	Standards are specific technical recommendations relevant for all IT solutions in the organization, for instance that all solutions should be based on the Microsoft .NET platform. They are developed by enterprise and solution architects, typically in a bottom-up manner as a result of a particular project introducing a new technology or specific need. Standards are used by solution architects to select standardized technologies for their IT solutions
Visions	Business Capability Model	The business capability model is a one-page diagram describing business capabilities of the whole organization up to two or three nested levels of abstraction. Business capability model is maintained by enterprise architects and used primarily to facilitate a conversation with business stakeholders and prioritize IT investments. However, it is also used by solution architects and project managers for identifying the stakeholders, impact and potential disruption of an IT solution
	Business Reference Architectures	Business reference architectures describe the desired ideal organization of business processes according to recognized industry best practices in certain important business capabilities. They are developed collaboratively by business stakeholders and enterprise architects. Business reference architectures are used largely by business stakeholders for identifying best opportunities for improvement and IT investments
	Roadmaps	Roadmaps are business-focused documents describing desired future IT investments and their impact in certain important areas for three years ahead. They describe planned IT investments through different "lenses" including financial, value, capability, structure and other lenses. Roadmaps are developed and used collaboratively by enterprise architects and business stakeholders for deciding on future IT investments, prioritizing them and initiating IT projects
Landscapes	Technical Reference Architectures	Technical reference architectures are high-level technical descriptions of the current and sometimes ideal target states of the IT landscapes supporting certain business capabilities. They are developed by enterprise architects and used by solution architects to facilitate detailed project planning by providing a description of the current state as well as a description of the desired state that their projects should be aiming to achieve
	Inventories	Inventories are catalogs of application, infrastructure and information entities currently available in the organization. They are maintained by enterprise and solution architects. Inventories are used mostly as reference materials by solution architects to facilitate detailed project planning and reuse the available IT assets
Outlines	Key Design Decisions of SOs	Key design decisions of SOs (solution overviews) are summary documents describing significant architectural decisions taken for individual IT solutions at the solution overview stage, for instance deviations from principles or roadmaps. They also describe the reasoning behind these decisions, their justifications, pros and cons. Key design decisions of SOs are extracted from solution overviews by solution architects and used by enterprise architects and business stakeholders as main points of discussion and initial approval for all IT solutions
	Solution Overviews	Solution overviews are high-level documents describing individual IT solutions. They are abstract enough to be understandable for business stakeholders, but specific enough for obtaining approximate estimates of time, cost and risk. They are developed by solution architects for all IT solutions. Solution overviews are typically used for communication with business stakeholders, early project discussions and initial approvals. They also provide estimates for informing formal business cases and serve as a basis for more detailed solution architectures
Designs	Key Design Decisions of SAs	Key design decisions of SAs (solution architectures) are summary documents describing significant architectural decisions taken for individual IT solutions at the solution architecture stage, for instance deviations from standards or technical reference architectures. They also describe the reasoning behind these decisions, their justifications, pros and cons. Key design decisions of SAs are extracted from solution architectures by solution architects and used by enterprise architects as main points of discussion and final approval for all IT solutions
	Solution Architectures	Solution architectures are detailed technical descriptions of individual IT solutions actionable for project teams. They are developed by solution architects for all IT solutions based on solution overviews and used by project teams for producing detailed designs and delivering IT projects

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