How does the presentation mode of enterprise architecture artifacts affect their use in decision-making?

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Abstract
This position paper explores the impact of the presentation form of enterprise architecture (EA) artifacts on their utilization in decision-making. While enhanced decision-making is said to be one of the main benefits of EA, previous research highlights the frequent challenges in interpreting complex EA visualizations and models, which can hinder their practical application. There are many lessons to learn from studies of visualization and decision-making for the EA research community. This study hypothesizes that the choice of presentation form significantly affects the value and usability of EA artifacts and argues that more research should be devoted to understanding the best ways to communicate and use complex architectural information in decision-making scenarios.

Keywords
Enterprise Architecture, Decision-making, Visualization

1. Enterprise Architecture in Decision-making

"[Enterprise Architecture] *enhances the enterprise's ability to guide decision-making, to manage change, and to communicate the organization's business goals, objectives and policies up and down its hierarchy and across its functional components*" [9] (p. 142). Improved decision-making and communication between various stakeholders are some of the most often-mentioned benefits of EA [1]. This implies that EA is supposed to produce valuable and usable information for decision-makers. It is argued that EA provides strategic decision-makers with relevant, timely, and high-quality information, thus supporting the business-driven decisions concerning change and standardization of business processes, products, and services. Also, EA can help the decision-making regarding technology and information systems development, procurement, and standardization to become faster and more secure [2].

Although improved decision-making is often attributed to EA artifacts and deliverables, and the information they convey, it is a non-quantifiable feature that is deemed difficult to measure [3]. Consequently, it is difficult to evaluate the information value of (a set of) certain architectural deliverables in the hands of a certain decision-maker working in a

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certain decision-making situation. [4] discuss prior research and conclude with low use of enterprise architecture, and visualizations (i.e., graphical models) in particular, for decision-making in organizations. This may be due to the limited perceived usefulness of EA visualizations, which are often characterized by their complexity, lack of focus, and inappropriate level of abstraction, which inhibits their effective use for decision-making and lead to a low added value perceived by stakeholders [4]. [5] review the prior literature and conclude that it indicates decision-makers favor documents that are understandable, user-friendly, easy to access and visually engaging, can be quickly examined and interpreted, include expert opinions, focus on relevant information, and recommend courses of action. Further, simple, jargon-free language is favored over complex or overly technical expression [5].

Traditionally EA has been a knowledge-intensive and modeling-focused expert profession in which the perceived value of EA comes from "*a comprehensive blueprint of an enterprise covering its business, data, applications and technology domains and consisting of individual EA artifacts*" [6], although the scope and purpose of EA seem to be broadening [7], [8]. These artifacts are regularly different types of models, which are used to convey information to different stakeholder groups for decision-making [10]. The use of these models and the guiding frameworks often results in practical problems, seen from the relatively low success rates of EA [11]. As EA methodologies are regularly adapted and differentiate from de facto methodologies, the usage of EA artifacts in practical situations is still not understood comprehensively.

As discussed by [11], prior research has concluded that companies tend to abandon traditional EA methodologies and frameworks, which are deemed unnecessary, impractical, or even unachievable. As further deliberated by [12], EA artifacts are often regarded to be excessively complex, having irrelevant informational contents, wrong level of detail and overly conceptual nature. [12] quote prior research stating that: "*Creating and reading most EA products require special skill sets, not commonly held throughout the enterprise. Consequently, the information captured in EA products cannot be conveyed quickly, especially to executive-level decision-makers*" [13] and "*The problem is EA information often is unintelligible. The necessary data might be there, but the presentation is so poor that the decision-maker's ability to use it is impaired*" [13][14]. Further, [12] note that different EA artifacts use different presentation formats: business capability maps, core diagrams, data models and target states are graphical. Conceptual architectures, project-start architectures and solution design use mixed formats, and maxims, standards and principles are represented as textual objects. The notion that different architectural artifacts use different presentation formats is in line both with the theory of cognitive fit as well as prior studies from other lines of research [15].

Some prior studies on EA decision-making [4], [10], [16], [17], [18], [19] [20], [21] exist. Further although there is some research on the relationship between the mode of information and the usage of that information in EA decision-making [10], they are scarce, and the studies discussing the effects of visualization and other means of conveying information to decision-making offer mixed and inconclusive results [15]. The need to better understand the connections between decision-making, visualization and EA have been expressed [16], [17], [18]. This paper posits that more research efforts should be

devoted to understanding the best ways to communicate and use complex architectural information in decision-making scenarios and hypothesizes that the choice of presentation form significantly affects the value and usability of EA artifacts in decision-making.

2. Decision-making Processes and Visualization Methods for Effective EA

2.1. Decision-making

Decision-making can be defined as choosing between several alternative courses of action, including evaluation of different attributes of these alternatives, and is an effort which is cognitively demanding and complex when compared to more elementary tasks, such as a choice between options. Strategic decisions typically involve complex information environments, and as one of the critical factors in the effectiveness of strategic decisions is the analysis of relevant information, information visualization may relate to decision quality [15]. According to [23], accurate understanding of data can be considered as a prerequisite for high-level decision-making. While well-designed visualizations of complex and high dimensional data can enable more informed decisions, generating and displaying more data may also come at higher (cognitive) costs.

In the organizational context, decision-making can be roughly divided into the strategic and the operational domains. While the access to relevant and accurate information is critical in any rational decision-making, determining the relevance of information for each different context and situation is complex. Theories of cognitive fit and bounded rationality suggest that visualizations can improve decisions because they leverage human perception skills and cognitive capabilities, and thereby enhance decision-makers' ability to make sense of the available data. Accordingly, the theory of cognitive fit suggests that the efficacy of decision-making is heightened when there is a synergy between the information presentation format and the cognitive style of the decision-maker. For EA related decision-making, the wide range of decision-makers and decision-making scenarios could make the understanding and optimizing of the cognitive fit could beneficial [22]. According to [22], the information presentation formats used in EA artifacts usually correlate with the types of decisions and tasks intended, and in mature EA practices, the presentation formats of EA artifacts are constantly optimized for more effective decision-making.

2.2. Visualization

Verbal and textual communication has restriction, and according to some prior research, visual representations are superior to textual and verbal communication in regards of e.g., speed in processing, noting, and memorizing details and expressing complex ideas and thoughts to others [15]. According to [15], visualizations are visual representations of information or concepts designed to effectively communicate the content or message, improve understanding in the audience, and are associated with clarity, speed, and the understanding of complex concepts, requiring less cognitive effort in interpretation than textual alternatives. The triumph of visual representation seems also to be somewhat true concerning EA artifacts [10]. In contrast, some EA artifacts are considered just the opposite - too sophisticated, either too narrow or wide in scope and abstraction, and not concerning

the information needs of the user, thus not enhancing knowledge transfer [1]. According to [24], groups develop a group-specific verbal and graphic discourse that is not easily understood by outsiders and have a "*tendency to match each other in choice of words, syntax, and semantics during verbal dialogue*" [25] (p. 286), creating language-specific communities of knowing. This might also be true regarding EA and (certain) of its artifacts.

As stated by [24], "*Verbal communication is especially restricted in representing the complex and dynamic systems that strategy work centers around. For example, we cannot easily explain with words alone the details of business relationships, the factors impacting a strategic decision, or economic causalities in business operations*". Besides EA, visual artifacts have been used e.g., in product and business design, organizational work, cross-disciplinary collaboration, and strategy work, although the exact form of visual artifacts is different in traditional EA work compared to most of the other endeavors. Still, at least some EA artifacts can be viewed as cognitive artifacts, which have been studied to enhance human cognitive abilities by being experiential, helping us think, reflect, and perform cognitive tasks. As stated by [24], an example of a cognitive artifact might be "*a diagram or a model* [which] *helps structure information and relationships between elements*'', and "[...] *As such, artifacts may be a vehicle to express things beyond language, a way to extend comprehension, advance thinking, reasoning, and decision-making*".

One of the major benefits of using visual objects is their cognitive effects. Artifacts enable thinkers to offload cognitive work by visualizing knowledge, ideas, and visions, and allow greater input channel capacity. By allowing different cognitive subsystems to hold and process object knowledge and conceptual knowledge, using visual artifacts allows individuals to simultaneously utilize multiple parts of the brain in operating, memorizing, and executing. Using various types of objects together might be effective, as sometimes an artifact on its own will be ineffective, but, in combination with others, it becomes part of a cluster that forms a boundary object. Prior research has concluded that visual artifacts combined with verbal communication, i.e., mixed-modality presentations, are more sensitive to details and articulated linkages between properties than solely verbal and textual communication, can boost memory formation and encoding, and enhance the integration of reasoning, visual representations, motor codes, and haptic perception into integrated memory traces. [24]. A strategy reported as a combination of text and drawing helps recall compared to a strategy that is solely described in text [24].

Although visualizations can be useful in EA practice, empirical studies exploring the role of visualizations are inconclusive, even among EA research [4]. For example, some studies show that visual cues do not improve judgment accuracy over verbal cues in imagery processing and in some contexts verbal information can be better than graphs for comprehension and judgment accuracy. Concerning studies in management and business research, several studies did not find graphs superior over tables in financial judgments or consumer research, and the use of graphs may even lower financial judgment accuracy [15]. For example, [26] note that ineffective visualization can lead to superficial analysis, overgeneralization, and illusion of deeper understanding, "*replacing elaborate, text-based, argumentation with (often implicit) assumptions and inferences (a frequent problem in presentation slides). If the visualization itself is not well explained, presented, and documented, it can lead to ambiguous communication and misunderstandings*".

3. Enterprise Architecture for Decision-making: A Call for Action

Improved decision-making is a key benefit of Enterprise Architecture (EA), as it provides decision-makers with relevant, high-quality information. However, interpreting complex EA visualizations is often challenging, limiting their practical use. Research indicates that due to their complexity and poor focus, EA visualizations are underutilized in decision-making. Decision-makers prefer documents that are understandable, user-friendly, and visually engaging, but traditional EA artifacts are often too complex for practical use. Theories of cognitive fit and bounded rationality suggest that visualizations enhance decision-making by leveraging human perception skills, and effective EA practices should align presentation formats with decision-makers' cognitive styles. Optimizing cognitive fit can improve the usability of EA artifacts. Visual representations frequently outperform textual communication in speed and clarity, which is essential for conveying complex ideas. Nonetheless, overly sophisticated EA artifacts can hinder their effective use.

As [3] points out, "in brief, EA can be seen as a collection of all models needed in managing and developing an organization". Therefore, in this paper, we understand EA artifacts in a broad sense, and argue, that 1) the aim of enterprise architecture is to convey information to decision-making, 2) prior research indicates that the way the information is conveyed (e.g., in textual format, in visual format, with models) has numerous impacts on the decision-maker and the decision made, 3) prior research also indicates that there are numerous practical and theoretical problems with traditional enterprise architecture artifacts, hindering their use in decision-making, thus 4) enterprise architecture should use whatever ways are best for the decision-making, even if this would mean challenging the traditional artifacts of EA. This position paper opens several topics for future research, namely discussing how different EA artifacts are used in decision-making scenarios and whether there is a relationship between the types of artifacts and the types of use of these artifacts. Further topics include the balance between complexity and comprehensibility of EA artefacts, i.e. how to make artifacts that are detailed and useful on multi-objective decision-making yet not so complex that they become inaccessible or overwhelming for decision-makers? Finally, the contextual variability in the utility of the artefacts might be another interesting topic for future research, as the effectiveness of different artifacts could vary depending on specific decision-making scenarios and the decision-maker themselves

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