Agile Enterprise Architecture by Leveraging Use Cases

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Abstract: Despite benefits Enterprise Architecture (EA) has brought, EA has also been challenged due to its complexity, heavy workload demands, and poor user acceptance. Researchers and practitioners proposed to use EA in an agile and "business outcome-driven" way. This means that EA should not primarily be developed and used according to a pre-defined framework. Instead, EA should be developed and used for specific business purposes and by means of concrete deliverables. By doing so, a more effective and efficient way of EA application could be enabled. However, there is no common agreement on what types of business goals can be expected to be achieved by using EA (The What) and how to achieve these goals through EA solutions (The How). To address these issues, we analysed the information provided by leading EA tool vendors available on their websites to get inspiration. The results showed that Use Cases (UCs) are used generally to motivate potential EA users by focusing on specific business issues. Then, EA solutions to address such business requirements or challenges are scoped and derived accordingly. We expect relevant findings could bring inspiration to agile EA engineering, change the EA "heavy-weight" reputation, and improve the application of EA even among its sceptics.

1 INTRODUCTION

Although Enterprise Architecture (EA) has brought many kinds of benefits, EA was also challenged due to its complexity, heavy workload demand, and poor user acceptance (Guo, Li, and Gao 2019). There is a trend to use EA in a more agile way (Gampfer et al. 2018), such as business outcome-driven EA (Gartner Research 2017). This means that EA should not first be developed and used according to a pre-defined framework. Instead, EA should be developed and used for specific business purposes and by means of concrete deliverables (artifacts) in a more effective and efficient manner. However, there is no consensus on what types of business goals can be expected to be achieved by using EA (The What) and how to achieve these goals through EA solutions (The How).

This research proposes that Use Cases (UCs) could be leveraged as an effective medium to bridge business expectations and EA deliverables. Traditionally in software engineering or system engineering, UCs are used to get requirements by analysing the interaction between users and systems. In the EA domain, we assume it could be leveraged for a similar purpose: to address business issues/requirements and to derive EA solutions.

Interestingly, leveraging UCs to facilitate the agile way of applying EA is hardly reported in the academic literature, while being advocated by many leading EA tool vendors in the industry. In this research, we analyse how these EA tools use UCs. We reviewed and analysed relevant content about 3 different UCs covered by 6 leading EA tool vendors on their websites. The remaining sections of this article are organized as follows. Section 2 briefly introduces some background information. Section 3 introduces the research method. Then in Section 4, we present the results. We discuss the results in Section 5 and conclude the paper in Section 6.

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2 BACKGROUND

2.1 Enterprise Architecture

EA is often referred to as a blueprint for enterprise composition and enterprise operating systems. Despite many kinds of benefits EA might bring (Winter et al. 2010), one main role of EA is to provide the service of understanding and communicating enterprise interaction patterns through abstract and graphical expressions and to facilitate the alignment of business and information systems (Korhonen et al. 2016).

EA usually exists in the form of a set of abstract graphics. They cover the high-level content of the enterprise, across areas such as strategy, business, information, and technology. We call these abstractions **EA artefacts**, **EA documents** (usually in more textual form), or **EA models** (usually in graphical form).

Despite benefits brought by EA, applying EA in practicing is also facing **challenges** (Hinkelmann et al. 2016). One major challenge is its complexity. Traditional approaches of EA Management (EAM) follow formal processes and are separated from other projects. It follows pre-defined frameworks and pursues rigid and extensive upfront planning (Kotusev, Singh, and Storey 2015). This might bring a heavy workload. As changes are happening more and more rapidly nowadays, such prescribed and proactive ways of using EA (Kotusev, Singh, and Storey 2015) could not meet the flexibility requirement well.

To address such issues, relevant theories were investigated, and **agile EA practices** were proposed in academia and industry. *Complexity Theories* were used (Gampfer et al. 2018). *Systems Approaches* (Reynolds and Holwell 2010) were also applied (Nurmi et al. 2018). For instance, according to *Soft System Theory* (Platt and Warwick 1995), for unstructured problem situations, a lens can be utilized to narrow and focus perspective so that the problem can be focused and structured further.

More agile approaches of EAM (Kotusev, Singh, and Storey 2015) were proposed, such as *MIT* (Ross, Weill, and Robertson 2006) and *DYA* (Wagter et al. 2005). Compared with more traditional EAM approaches, they follow informal or no specific process, develop and use EA when needed (business changes severely, for instance) (Kotusev, Singh, and Storey 2015). DYA also advocates "just enough, just in time" architecture and does not design EA until there is a need for it. In the industry, Gartner also proposed *Business Outcome Driven* EA (Gartner Research 2017).

Such efforts conform to the agile framework Dynamic System Development Method (DSDM) also, which believes the philosophy "that any project must be aligned to clearly defined strategic goals and focus upon early delivery of real benefits to the business" (Agile Business Consortium Limited 2021). And among the eight principles of it, the first is "Focus on the business need" (Agile Business Consortium Limited 2021).

2.2 Use Cases

Use cases (UC) originate as a method for capturing the user interaction with a piece of software or the system under development in the field of user-centred software and system engineering. The main idea behind this concept is to obtain requirements by analysing user scenarios and guide subsequent software or system development. UCs are a simple, straightforward, and very powerful way to express the functional requirements/behaviour of a system. UCs have gained wide acceptance as they make requirements less ambiguous by specifying when and under what conditions certain behaviours occur (Bittner and Spence 2003) and help to manage complexity, since they focus on one specific usage aspect at a time (Lee and Xue 1999). As a result, those who effectively employ UCs to model their systems are said to deliver projects on time, within budget, and with fewer defects (Bittner and Spence 2003).

2.3 Use Cases in (Agile) EA Practices

Traditional EA applications are increasingly facing the challenges of complexity and difficulty in adapting to various changes. To address these two challenges, scholars investigated complexity and systems theories to propose more lightweight EA approaches adaptable to dynamic environments. But there is no widely agreed method to implement them or sufficient practical validation yet. Relevant research gaps here include the types of business issues that could potentially be solved/facilitated by EA solutions (The What), and how to solve these business issues through a lightweight EA (The How).

To address these gaps, we suggest exploring UCs as a potential solution to define business goals and derive EA solutions. UCs can be used to define business problems accurately. Basing on the analysis of UC definitions, an EA solution (a process with a set of EA artifacts) could be derived. In industry, this approach of using UCs has been used by several leading EA management tools to promote how these tools can help potential users solve specific and

important business problems and to show what the solutions and EA artifacts to solve these problems are like, with predictable and some kind of predictable workload. But in academia, this method has not been formally raised yet. Some researchers investigated the possibilities to use EA together with use cases (Miranda et al. 2018), but differently from us.

Therefore, this study observes how UCs are leveraged by industrial leading EA tools, aiming to answer two Research Questions (RQs) as below. Here we assume if an EA solution implies a clear process consisting of limited steps, and for each step of the process, the workload is predictable, then the overall workload is predictable.

- RQ1: Can UCs be used to clearly define business issues that can potentially be solved by EA?
- RQ2: Can EA solutions with predictable workloads be derived/outlined to solve business issues that are defined with UCs?

3 METHOD

In this research, we analyse how leading EA tools leverage UCs to address business issues and derive EA solutions. To achieve this goal, we selected relevant content about three UCs from websites of six EA tools. As such, our analysis qualifies as a review of grey data sources. **Grey literature** and sources, such as commercial tools and tool vendors' entries, webinars, and guidelines, have been empirically found to provide substantial benefits in certain areas of research, especially when the evidence they bring is experience- or opinion-based, i.e., outlying the state-of-the-practice (Garousi, Felderer, and Mäntylä 2016). We used **content synthesis** (Cruzes and Dyba 2011) to extract and synthesize the results. In the following, we explain our strategy of choosing UCs and vendors, extracting relevant content, and the synthesis process.

We investigated how UCs are used by leading EA tools. Tools are both instrumental and very important in the EA discipline (Korhonen et al.). Features of such tools were investigated in other scientific papers such as (Nowakowski, Häusler, and Breu 2018). But to the best of our knowledge, there is no comprehensive study about how they utilize UCs in particular. The vendors were selected from the **vendor list** in Gartner's (Forbes Media LLC. 2021) annual report named "Gartner Magic Quadrant for Enterprise Architecture Tools" (Gartner 2020), where long-established manufacturers, as well as insightful new challengers, are included. We believe the fact about how they are applying EA represents the current trend of first-line EA applications. Some other scientific papers also use the report for evaluating EA tools (Nowakowski, Häusler, and Breu 2018).

Among the 16 vendors, we chose 6 **vendors** to be included in our study. The reasons for the selection are: *First*, the included vendors should use the term "use case" explicitly. Some vendors use other relevant terms, such as "solutions" or "features," which turn out to be more diverse and have mixed irrelated information. *Second*, UCs should be used to describe external use scenarios encountered by potential EA users. Some vendors use the term referring to more internal requirements, such as generating EA documents according to some notable EA frameworks. Such scenarios are not in the present research scope. *Third*, there should be sufficient description (relevant texts or figures) explaining how these UCs are implemented. In this way, we could extract information of interests and answer the research questions. As a result, the six vendors we included in this study are Avolution, Mega, Ardoq, Orbus, LeanIX, ValueBlue (See Table 1 for more detailed information).

The six vendors present many UCs. We selected 3 **UCs** for detailed analysis. The main selection criterion is that at least two out of the six vendors should support such UCs in a comparatively similar way. This is to avoid analysing niche UCs that are named from different perspectives and at a different abstraction level due to the nature of grey literature so that it is difficult for us to further extract and synthesize information. The three chosen UCs are Application Portfolio Management (APM), Data Privacy Compliance (DPC) (Rozehnal and Novák 2018), and Strategy Planning (SP). These UCs can be thought as to address typical challenges in different phases of digital transformation (Capgemini Consulting and the MIT Center for Digital Business 2011). They are also related to the three typical parts of EA according to the notable TOGAF framework: application, data, strategy (The Open Group 2020). Thus, we think these three UCs are representative of EA usage scenarios.

To **extract data**, we focus on three types of information for each UC for each tool: 1) textual description about the UC definition or usage scenarios, 2) textual description about the UC implementation, including process, sample EA artifacts and visual representations, 3) figures about the UC implementation. We used textual information and figures in a complementary way. This is because, on the one hand, textual information might not include some implementation details, such as EA data used, which might be derived according to sample

Table 1: Reviewed EA Tool Vendors and The Websites.

Vendor	Tool	Website
Avolution	Abakus	https://www.avolutionsoftware.com/
Mega International	HOPEX Platform	https://www.mega.com/en/
Ardoq AS.	Ardoq	https://www.ardoq.com/
Orbus Software	Orbus	https://www.orbussoftware.com/
LeanIX	LeanIX Enterprise Architecture Suite	https://www.leanix.net/en/
ValueBlue	BlueDolphin	https://valueblue.com/

figures. On the other hand, sample figures with low resolution might look blur sometimes. The textual content could help us to identify and extract important information.

For the extracted data, we **analysed** the commonalities and differences in UC definitions and implementations. For the definitions, we manually compared the keywords in relevant sentences. For the implementations, we identified the process statements or figures and coded the steps for each process. Then we compared the steps to identify commonalities. The results of our analysis are presented in the form of comparison tables. We then summarize the results in Table 3, 5, 7 to answer our RQ1 and Table 4, 6, 8 to answer the RQ2.

4 RESULTS

The three UCs are supported by different vendors. In Table 2, for each UCs, we listed if they are supported by each vendor and the total number of supported vendors (last column). More detailed information for each UC is introduced in the following sub-sections.

Table 2: UCs Supported by Different Vendors.

	Avolution	Mega	Ardoq	Orbus	LeanIX	Value Blue	Tot.
UC1	Y	Y	Y	Y	Y	Y	6
UC2	Y	Y	N	N	N	N	2
UC3	Y	Y	Y	Y	N	Y	5

4.1 UC1: Project Portfolio Management (PPM)

According to Ardoq, PPM is thought to be "The foundation for digital transformation in your organization". Six vendors have similar definitions for this UC, which mainly refers to decisions about whether and to what extend to invest in applications, technologies, or more general projects based on how they support strategic business needs. Among the six vendors, four address "application" while the other two address "IT" or "project/IT". as described by Avolution: "Project Management Office (PMO) practitioners must consider both legacy applications and infrastructure and new technologies including mobile, cloud, IoT and big data." Four vendors propose "portfolio management" while the other two propose "rationalization".

Due to the comparatively clear and limited scope of this UC, the implementation proposed by six vendors are also similar and could be regarded as a 4-step process. The *first* step is to make some preparations, such as setting more specific goals. The s*econd* step is to integrate relevant data required for achieving the goals. Then, the *third* step is to analyse the data for relevant purposes, such as gaining insight about indicators regarding the goals. And the *fourth* step is to benefit from the results by means of various activities such as visualizing and facilitating communication, enabling planning, and answering questions.

Table 3: UC1-Project Portfolio Management (PPM).

	UC1 Name	UC1 Description
Avolution	Project/IT Portfolio Management	"Managers can take control of their inventory and move quickly to rationalize and plan portfolios. They can also calculate how technical investments map over to the company's business strategy."
Mega	IT Rationalization	"IT rationalization is the process by which an organization identifies and assesses the value of business applications to determine which ones to keep, update, or eliminate."
Ardoq	Application Portfolio Management	"Get application overview" "oversee application owners", "control application investment", "run cost savings", "manage business risk."
Orbus	Application Rationalization	"The number, nature and cost of applications should all be focused around the business value they offer."
LeanIX	Application Portfolio Management	"Ensure application support for your business capabilities."
Value Blue	Application Portfolio Management	"Identify the applications that support your business functions — eliminate overlap and decrease complexity."

Table 4: A 4-Step Process to Implement UC1.

		Avo	Mega	Ardoq	Orbus	LeanIX	ValueBlue
1	**Prepare**			Buy in from business	Goals		
				Show output			
2	**Integrate Data**	Integrate data	Inventory	Data	Data	Import	Map data
		Build portfolio inventory		Add in a reference model	Build on data		
				Validate with stakeholders	Assess data		
				More data to answer business			
3	**Analyse Data**	Analyse	Rank	Analyse	Analyse	Application supports business capabilities	Determine
		Align with business					
4	**Benefit from the results (visualize, communicate, plan, answer, act)**	Present and recommend	Plan	Communicate	Visualize	Answer APM questions	Goal and rationalization
				Plan and track execution	Review and present		

Table 5: UC2-Data Privacy Compliance (DPC).

	UC2 Name	**UC2 Description**
Avolution	Data Privacy and Control/ GDPR Compliance	"Gain visibility of, and be proactive about data flows and data-management", "provide up-to-date and end-to-end information about data flows and storage of personal information across departments, processes, and systems", "understand who holds decision rights and accountabilities how that information can be used."
Mega	GDPR Compliance	"To comply with the EU's General Data Protection Regulation (GDPR), companies must rethink the way they capture, manage and process personal data", "have a comprehensive understanding of their compliance level and to efficiently produce regulatory documentation."

To summarize, this UC addresses a comparatively simple, specific, and prevalent business need. Vendors share commonalities when defining the case and designing reference EA solutions. Some exempts from the vendors' websites regarding the use case definition are presented in Table 3. The implementation process used in reference solutions is summarized and normalized in Table 4.

4.2 UC2: Data Privacy Compliance (DPC)

Two vendors explicitly support the UC of DPC, which is about governing data and demonstrating compliance with local and international laws and regulations. As described in Avolution, "Global CIOs and their teams need to think holistically about data governance. Building trust and demonstrating compliance with local and international laws and regulations is becoming a key part of strong enterprise architecture".

The implementation looks similar and can also be looked at as a four-step process. However, the overall scope of relevant data is more diverse in types and tangled than that in PPM. This will probably bring much more overall workload than that of PPM.

To summarize, although the business issue involved in the DPC case is clear and prevalent, the implementation is much more complicated and potentially involves a much heavier workload than that of PPM. Only two vendors explicitly support it. Despite the similar UC definitions, reference solutions exhibit differences in terms of the overall process and EA artifacts involved. Exempts about the definition of this UC are presented in Table 5. And the implementation process could be seen in Table 6.

Table 6: A 4-Step Process to Implement UC2.

		Avolution	**Mega**
1	**Prepare**	Audit information	Build company organigram and roles & responsibilities
2	**Integrate Data**	Model interdependencies and data flows	Document the Record of processing activities
3	**Analyse Data**	Prioritize data by risk and value	Identify compliance gaps & reduce existing risks
		Discover Shadow IT	
4	**Benefit**	Report	Implement remediation actions
		Roadmaps for strong compliance and innovation	

Table 7: UC 3-Strategic Planning (SP).

	UC3 Name	**UC3 Description**
Avolution	Roadmapping change	"Color or 'heatmap' your business capability maps or technology landscapes to show WHAT is changing."
Mega	IT Strategic Planning	"Based on an initial assessment of the IT landscape, and a thorough understanding of the business strategy, IT departments can create an IT roadmap that best supports business initiatives."
Ardoq	Strategic Planning and Execution	"Connect your Strategic Objectives to your Project Portfolio or Capability Map to identify your ability to execute."
Orbus	Application and Technology Roadmapping	"Roadmaps communicate and influence change, earning buy-in from key stakeholders and providing a plan of action to achieve particular goals, or in this case, implement new applications and technology solutions."
Value Blue	Agile Business Transformation	"Enables CIOs and Enterprise Architects to plan and manage their business transformation, combining architectural insights with operational agility," "structure these improvements so that we can reduce the risks, improve the effectiveness and enhance the efficiency of the transformation process."

Table 8: A 5-Step Process to Implement UC3.

		Avolution	**Mega**	**Ardoq**	**Orbus**	**ValueBlue**
1	**Prepare**				Inputs	
					Establish goals	Strategy
2	**Integrate Data (current state)**	Business capabilities			Identify technical components	Capabilities
						Current state
3	**Plan (future state)**	Colour business capabilities	Create IT roadmap	Objectives	Determine the target state	New capabilities
		(Propose change initiatives)				Future state
4	**Analyse Data (the Gap between current and future states)**	(Analyse dependencies)	Define new IT architecture	Impact analysis	Execution	Gap analysis
		(Feasibility and reachability analysis)	Build a portfolio of projects			Projects
5	**Benefit**		***Continuously*** adjust roadmap	Ensure portfolio level alignment	Business outcomes	***Iterate***

4.3 UC3: Strategic Planning (SP)

The SP use case is widely mentioned which is proposed to address the complexity issue when organizations plan strategic (digital) transformation. SP usually consists of strategic planning, roadmapping and execution which involves management of applications, information technologies (IT) or more general technologies. Due to different perspectives on this UC, vendors define it with different names. See Table 7 for more details.

The implementation of SP in general consists of five steps as summarized in Table 8. Different with PPM and DPC use cases, one extra step of "plan"

appears between “Integrate Data” and “Analyse Data”. This is because SP not only integrates existing data (“as is” or “current state” data), but also creates new data (“to be” or “future state” data). Although the data analysis (“gap analysis”) work sounds simple which focuses on comparing the gap between two states, the actual work might be very complex and time-consuming. This is because “states” might imply all aspects of an organization that can be involved at different levels and tangled. Therefore, one vendor, namely Avolution, proposes both a fundamental solution which consists of two steps and other optional steps (presented in brackets in Table 8), which could be included in a more comprehensive solution. In addition, this process can be executed in an iterative way as maintenance is needed. This is partly indicated by ValueBlue and Mega. See italics in Table 8 for details.

To summarize, the roadmap UC has been widely provided due to the trends of global digital transformation. Five vendors explicitly support it. The general solution to this UC is to design and execute projects that are identified based on a gap analysis that stems from a strategy evaluation. Compared with PPM and DPC, SP might indicate a much more complicated and time-consuming process. This also might indicate coupling relations between SP and other UCs such as PPM and DPC. However, there is space for users to choose the appropriate level of implementation according to different vendors’ provision.

5 DISCUSSION

5.1 Feasibility (Answering the RQs)

Our RQs were proposed to address if UCs could be used to clearly characterize relevant business issues (RQ1) and to derive EA solutions with predictable workload (RQ2). In general, we tend to say yes to RQ1 and RQ2. As presented in Section 4, for all three UCs, the four vendors presented clear descriptions of business issues/requirements. Based on the requirements, specific EA solutions with predicable workload were also proposed. This means that a process with limited steps was proposed. And for each step, the tasks are clear and involves a predictable workload.

5.2 Commonality

According to our analysis, we noticed that some common UCs exist which address similar business issues. For example, all the vendors we surveyed support PPM. In contrast, other UCs such as Technical Debt (supported by Avolution) are less standardized and supported by fewer vendors. Therefore, vendors encourage novice users to start with simple and general UCs like PPM and try more advanced, less standardized, and more customized UCs like SP.

Regarding the EA solutions proposed, there seems to be some common overall process (four or five steps as presented in Table 4, 6, 8).

By establishing such connections between business issues and EA solutions, users could be more aware of the available options to use EA in a business outcome-driven way (Gartner Research 2017). As advocated by Ardoq, “Each of Ardoq's use case modules comes with a pre-configured setup with everything you need to get started and the flexibility to expand on this effortlessly in-app.”

5.3 Diversity

Despite the commonalities of UCs that involve common business issues and/or common processes to solve them, we also noticed the space of diversity. Vendors propose diverse UCs. Detailed definitions, perspectives, and requirements for one similar UC might also differ. Even for the simplest UC such as PPM, core deliverables proposed, data to capture, algorithms used to analyse, and the presentation/visualization methods might differ. To summarize, diversity might exist at four below levels.

- Use case. There are different use cases. Detailed perspective for one similar use case might differ. For example, Mega focuses on IT roadmap instead of general roadmaps, which Avolution and Ardoq prefer. While Orbus focuses on applications and technologies roadmap. In addition, some use cases might include other Use cases. For instance, SP often includes PPM.
- EA Implementation process. Vendors suggest implementation processes of different complexity or granularity for one UC. In addition, one vendor might provide such different options for one UC for their users to choose. An example is Avolution, which provides four types of SP solutions.
- EA Deliverables. Core deliverables involved in EA implementation might be different. Auxiliary artifacts are of the same. For SP, the five vendors proposed quite different artifacts when capturing and analysing data.

- EA Visualization. For instance, although all vendors use a similar EA deliverable for one simple UC PPM where the technical fit and business fit of applications are evaluated, vendors choose different ways to visualize it.

5.4 Related Works

There are a few studies that are also related to analysing usage scenarios or use cases and tools in the EA field. However, they are not addressing similar RQs and have employed different methods.

In (Niemi and Pekkola 2017), 15 scenarios to use EA were identified. However, some of them are characterising how EA was used internally. Different from this study, we observe UCs for business goals as this is the key of agile EA. In (Nowakowski, Häusler, and Breu 2018), seven EA tools were surveyed about how they support eight capabilities including analysis of scenarios and planning of scenarios. But the aim of the research is to analyse how these tools support industry 4.0 transformation planning, instead of general use case utilization. (Miranda et al. 2018) also discussed about the relation between EA and UC. However, their proposal is that EA artifacts can be useful to construct UCs for software development.

6 CONCLUSIONS

In this paper, we observe how 3 UCs are leveraged by 6 leading EA tools. The results showed that it is possible to use UC as an approach to define business expectations/issues on one hand and to derive EA solutions on the other hand. We found that there exist some common UCs and a common process to derive EA solutions for UCs. But there is still space for diversities where different UC details, EA artifacts and visualizations could apply. The limitation of the present research is that the observation is not very systematic (although representative). For instance, we have only investigated vendors that Gartner recommends. We plan to review relevant content in a more systematic way and validate the result in the future.

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