An Agile Approach for Modeling Enterprise Architectures

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Abstract: Organizations need a holistic view of their information assets in order to lead a digital transformation. Information assets can be obtained from modeling the Enterprise Architecture (EA) of the organization. However, the current EA modeling methods have been criticized for being heavy and rigid. In fact, EA modeling methods present similar problems to those faced by traditional software development (waterfall) methods. We propose that EA modeling could benefit from ideas presented in the Agile Manifesto. Previous research already pointed out the importance of finding the "ideal" boundaries for the intersection between agile software development methods and EA practices. In this paper, we apply the Design Science Research Methodology (DSRM) to propose an Agile Enterprise Architecture Modeling Method based on agile principles and values. The proposal was demonstrated in two organizations, from which we extracted evidence such as continuous deliveries, short interactions (Sprints), proximity to customers, and systematic improvements in the process. We conclude that our proposal can improve EA modeling.

1 INTRODUCTION

One of the biggest challenges faced by Information Technology (IT) managers is to ensure that the technologies used by the organizations are perfectly aligned with the business objectives and the satisfaction of their customers (Ferreira et al., 2017). In this context, the concept of Enterprise Architecture (EA) has gained importance, being established as a fundamental element for the management of information assets of organizations (Hosiaisluoma et al., 2018).

EA methods use many artifacts to represent the information assets of one organization. They are holistic and can be represented from different perspectives or layers, with different (although similar) nomenclatures, which range from the strategy level to the infrastructure one (Ahlemann et al., 2012). The Open Group, for example, presents an EA modeled in four layers: business, applications, data, and technology (Group, 2018). It is not difficult to imagine that, depending on the size of the organization, modeling an EA can be laborious and quite challenging.

More recently, EA methods have been criticized for being heavy and rigid (Hosiaisluoma et al., 2018; Kotusev, 2018; Gill, 2015; Hauder et al., 2014). The most popular EA framework, the Open Group Architecture Framework (TOGAF), for example, is heavily based on processes, tools, and artifacts, similar to what occurs with traditional approaches for developing software that are heavily based on planning and engineering (Group, 2018; Dybå and Dingsøyr, 2008; Nerur et al., 2005).

In response to those criticisms, Agile Software Development (ASD) has been widely applied in the software industry (Ambler, 2013; Hauder et al., 2014) and, more recently, its principles, values, and agile project management practices have been tested in the context of EA (Hensema, 2015; Hosiaisluoma et al., 2018; Rasnacis and Berzisa, 2017). ASD promises flexibility, velocity, lean, learning, and adaptability, characteristics that motivated previous research efforts to implement agile concepts in the EA context (Qumer and Henderson-Sellers, 2008; Dybå and Dingsøyr, 2008).

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Although there is still some confusion about whether EA and Agile can and should be used together, so far, there is no research that may give us the state of the art about the possible interactions between both areas (Canat et al., 2018). Some research efforts are worth citing, such as (Ambler, 2013) that argues EA management has to be business-driven, evolutionary, collaborative, and focused on producing valuable artifacts. Other research efforts focus on applying lean and agile methods in the context of EA (Bente et al., 2012; Hosiaisluoma et al., 2018; Hensema, 2015).

More recently, it has been developed and launched by The Open Group, a Guide to Agile Architecture Modeling using the ArchiMate® Language (Group, 2020). An Agile EA framework has also been already proposed (Rouhani et al., 2008). Other researchers presented agile methods for creating EA deliverables and also for collaboration between architects and developers (Hanschke et al., 2015). There are also some evidence that current EA development follows the same software development problems, so agile principles and values (Fowler et al., 2001) could provide benefits for EA (Hanschke et al., 2015).

Based on these initial research efforts (Ambler, 2013; Hensema, 2015; Canat et al., 2018), we propose to apply Agile to EA modeling in order to generate benefits such as faster deliveries, better artifacts, and alignment to the needs of stakeholders. In particular, considering the scarcity of empirically grounded Agile EA approaches (Hauder et al., 2014) in this paper, we not only propose but also demonstrate an Agile Enterprise Architecture Modeling Method to answer the following research question: *How can we model EA, using Agile principles and values?*

The rest of the paper is organized as follows. In Section 2, we present the main concepts related to EA, agile methods, and the relationship between them. In Section 3, we present the methodology used to conduct this research. In Sections 4 and 5, we propose and demonstrate the artifact. In Section 6 we present the results of evaluating the proposal. We then finally present the lessons learned in Section 7 and conclude the paper in Section 8.

2 BACKGROUND

In this section, we summarize the main concepts needed for this paper about EA, agile, and related work.

2.1 Enterprise Architecture, Layers and Models

According to Kotusev, Singh, and Storey (Kotusev et al., 2015), "EA is a description of an enterprise from an integrated business and IT perspective". However, EA is more inclusive is presented from different perspectives at different layers of abstraction (Ahlemann et al., 2012). According to TOGAF (Group, 2018): "EA is a system formed by four subsystems, namely Business, Data/Information, Application, and Infrastructure (or Technology) Architecture".

The ArchiMate® Framework defines a structure composed of layers and aspects. Its language defines generic elements, and their relationships can be specialized in different ways. Business, Application, and Technology are the layers specified. Active Structure, Behavior, and Passive Structure are the aspects. In this paper, we consider the EA concept covering the four layers: business, information, application, technology (Group, 2019).

Architecture models constitute the core of the EA approach and serve to make the complexities of the real world understandable and manageable (Winter and Fischer, 2006). Considering the previous layers, EA models are used as an abstraction of the enterprise's structure in its current state (AS-IS models). They show possible alignment issues, ease communication and can aid in decision-making, by being used to predict the behavior of future states (TO-BE state models) rather than modifying the systems in the current architecture (Buschle et al., 2010). EA models are tools for planning, communicating, and of course, also for documenting (remembering) (Johnson et al., 2014).

2.2 Agile and Enterprise Architecture

The authors of the "The Agile Manifesto" [1] in 2001 identified a set of frequent problems in the software development's practice. Generally speaking, those problems were related to the excess of focus in processes, methods, documentation, and plans instead of fast delivery of results and the response to changes.

Similar to software development, EA management initiatives face challenges that delay results, complicate the collaboration, and deteriorate the overall work quality (Hauder et al., 2014). The striving for agile principles and values enhancing the efficiency of EA management is mainly found in practitioners' circles. While only a small number of experts emphasize

[1] https://agilemanifesto.org/

the misfit of both disciplines, the majority of the industry consider Agile means being well suited for EA management. A similar position has the interviewees from (Canat et al., 2018).

While in ASD, more tangible methods like SCRUM[2], Extreme Programming[3] and others, in EA, no such proposal has been highlighted among the community so far. As one of the most popular EA approaches, in the Architecture Development Method (ADM)[4] of the TOGAF, the modeling efforts are concentrated along with the phases B (Business Architecture), C (Information Systems Architecture) and D (Technology Architecture), also known as the design cycle of the ADM. Each of those phases is divided into several steps, each of them with its inputs and outputs.

The TOGAF advocates its adaptation to the context, that is, practitioners may tailor the framework (e.g., the breadth of coverage of the enterprise, the level of modeling detail, etc.) according to the organization's specificity. As a generic method, the ADM is intended to be used by enterprises in a wide variety of different geographies and applied in different vertical sectors/industry types. Despite also being iterative, the TOGAF does not explicitly recommend to manage an EA in an Agile style, and does not claim to be an Agile approach (Group, 2018).

According to the Agile alliance[5], Agile software development (ASD) is an umbrella term for a set of frameworks and practices based on the four values and twelve principles expressed in the Manifesto for ASD. Some important features among those practices are quick releases of small versions, lean (focuses on shortening the time and cost and improving quality), responsiveness to expected and unexpected changes, and attentive to learning (emphasizes improvement during and after product development) (Qumer and Henderson-Sellers, 2008).

Agile practices have already been applied to EA, but no method to implement EAM or EA modeling was proposed though (Hensema, 2015). Translated into an EA management context, enterprise architects should strive to ship their deliverables as early as possible, pursue an incremental and iterative approach, and embrace changes regarding their working style and results. Recently, (Canat et al., 2018) interviewed twelve professionals in different roles, such as developers and architects, in five companies about EA and Agile relations. They found out that "all interviewees believe that enterprise architecture and Agile development can be combined, although not at all levels".

In this direction, (Hauder et al., 2014) performed a survey among 105 industry experts working for more than 10 industry sectors across 22 different countries about the agile principles applied to EA management in their organizations. They identified a set of agile principles, such as cross-functional operations, iterative and incremental approach, self-organization, and so on, which were used by practitioners in the industry. Therefore, we can see that the potential of combining EA and Agile is already perceived by practitioners and practiced in several organizations. Although no systematization of those practices is available.

Agile and EA can benefit each other in a two-way relationship. These relations are depicted in Figure 1. At this point, we only talked about the first side of the relation (ASD - EA), which represents the contributions of Agile to the EA context. To the best of our knowledge, the EA community does not have its "EA Agile Manifesto" nor a consolidated "Scrum-like" EA method for modeling purposes. In the second side of the relation, some scenarios were found by (Canat et al., 2018).

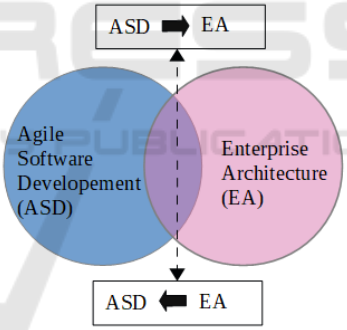

Figure 1: Possibilities of convergence between EA and ASD research and practice.

The first one relates to the reuse of software applications. In this case, the companies are not reusing existing systems or applications and are developing or procuring new ones with the same or similar functionalities. It is obviously costly and ineffective to support all these different applications, and it adds complexity to the architecture. The most common reason the authors found for the reusability issue was the lack of knowledge about existing systems and applications, which is partly caused by not working enough with architecture and not having an excellent overall view of the IT landscape. Without the architecture to guide them, team members and engineers are unaware of what is available and have no other choice but to decide on one ineffective alternative.

[2]https://www.scrum.org/

[3]http://www.extremeprogramming.org/

[4]https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap03.html

[5]https://www.agilealliance.org/agile101/

This quote is particularly interesting: ”To solve these issues, a good architecture that is kept up-to-date is required in order to provide procurement and developers guidance on what is already available to them, and how the systems are connected. The architects also need to show their coworkers the value of reusability and avoid having multiple systems cover the same area of functionality.”(Canat et al., 2018)

Those findings highlight the necessary balance (represented by the intersection in Figure 2) between prioritizing enough architecture documentation and providing software releases quickly. This is architecture helping developers to integrate better and reuse software and, thus, save resources.

2.3 Related work

Few works tried to merge Agile constructs in EA methods or frameworks. The work of (Rouhani et al., 2008) presents a framework for Agile EA with seven models and eleven interactions between them. They believe that their framework is performed in a way that allows the enterprise ”to finish the architecture better, faster, and cheaper and with the complete adhesion of stakeholders”. However, no evidence for those achievements is presented. A specific work describes how to streamline the architecture processes, set up an Agile EA project, and foster collaboration (Bente et al., 2012). Even though their explanations are based on several toy examples, therefore no empirical evidence is provided about the adoption of Agile practices in EA management.

This master thesis presents an Agile EA management method (Agile EAMM) that embodies eight essential elements adapted from lean and agile principles and values (Lumor, 2016). He demonstrates, conceptually, that the Agile EAMM has the propensity to support the agility of the EAM function and the agility of the enterprise as a whole. Similarly, (Hosiaisluoma et al., 2018) introduces a lean EA development (LEAD) method for EA management based on agile principles. The applied lean and agile principles encourage to avoid unnecessary big design up-front and redundant planning activities. In practice, the LEAD operating model organizes capabilities around the value delivery chain. The authors adopted and used the LEAD in a public organization, one of the largest cities in Finland, as a case.

The Open Group, has been development a work as part of a broader set of initiatives focused on the relationships between Agile and EA. The main focus of the work is: ”a) expressing the business intent, to help prioritize epics and features, and to convey the architecture vision to Agile teams; b) fostering enterprise agility, complexity reduction, and managing architectural and technical debt; c) facilitating the communication within, between, and across Agile teams” (Group, 2020). However, the document does not provide many application details.

As in (Hosiaisluoma et al., 2018), this paper focuses on applying Agile principles and values to EA (first side of the Agile-EA relation in Figure 1). Our approach differs from previous works because we focus on EA modeling, one of the phases of the EA management life cycle. Also, we provide practical guidance for experts to build their models using our method and artifacts. Additionally, we perform the method in two public organizations providing empirical evidence of its applicability as described in the next sections.

3 RESEARCH DESIGN

In this section, we present the research question, research method, and data collection and analysis methods.

3.1 Research Classification

This work can be classified as an exploratory, inductive-based, applied and qualitative research (Wohlin and Aurum, 2015). We design an Agile method for EA modeling called Agile Enterprise Architecture Modeling Method (AgEAMM). Then, we demonstrate the application of this method in two organizations, described in the following sections. The goal is to answer the following research question: *How can we model EA, using Agile principles and values?*

3.2 Research Method

As in any research approach, we need to ensure adherence to a method, transparency in the procedures and decisions, and specify clearly the evaluation criteria, in order to enhance our conclusions' validity and artifact's utility. As for research method, we adopted the constructs and the process for the Design Science Research Methodology (DSRM) proposed by Peffers to frame our initiative (Peffers et al., 2007).DSRM is an empirical method (based on evidence) for the systematic creation of innovative solutions (Hevner and Chatterjee, 2010). The central concept in the DSRM is the artifact, that is, solutions to problems materialized in methods, techniques, processes, or tools (Peffers et al., 2007).

The initial motivation to investigate the current research problem (or opportunity) came from our *ad hoc* literature review (Ambler, 2013; Hauder et al., 2014; Hensema, 2015; Canat et al., 2018; Hosiaisluoma et al., 2018) which indicated that the EA Agile field is relatively recent, with the first one published in 2008 (Rouhani et al., 2008). However, more than half the works were published in 2013 or later and confirmed that it still lacks some theoretical foundations. This was an opportunity to propose a method for Agile modeling for EA, our first artifact (problem-centered research).

The purpose of the proposed artifact is to provide an agile way of modeling EA with stakeholders, performing a set of activities that generate benefits aligned with agile values and principles, such as (a) short deliveries/interactions, (b) artifacts aligned with the business, (c) promoting stakeholder engagement, systematically improving the modeling process (d) quick responses to changes for establishing EA modeling. We argue that the two knowledge domains (Agile and EA) could complement each other and provide answers to the criticisms mentioned previously in Section 1.

We used constructs from the theory about agile principles and values (Schwaber, 1997) combined with the concepts from EA domains (TOGAF) (Group, 2018) to deliver the modeling artifact, described in Section 4. Since EA is a robust modeling-based discipline and modeling is one essential part of it, we believe introducing the Agile perspective in an effective modeling method is an important contribution to the EA community.

Following the cycle of (Peffers et al., 2007), after defining the problem, we designed the AgEAMM artifact and demonstrated it at the same public organizations selected by convenience (one researcher is affiliated). The same artifact was instantiated and evaluated in two selected organizations, from September 2019 to February 2020, with a time gap of one month between them.

3.3 Data Collection and Analysis Methods

One commonly used qualitative data collection method in the information system (IS) research is participant observation (Wohlin and Aurum, 2015). Three researchers were part of the artifact's design instantiation team. The AgEAMM artifact and its evaluation are presented in Section 4 and 6, respectively, resulted from the perceptions and discussions among those researchers along with the executed cycles, explained in detail throughout this paper.

The AgEAMM is based on Scrum (Schwaber, 1997) and also has a step called "Sprint Retrospective", which runs at the end of each Sprint. The objective was to collect and evaluate points where the method worked well, or what could be changed, and in that situation, what actions should be taken to improve the method. Notes about insights, bottlenecks, and improvements'suggestions for our method (artifact) were recorded and shared in Google Documents in what we called "EA Diary" (see Figure 3). We also kept and shared the method's outputs, such as BPMN and Archimate models and minutes of each one of the meetings. All those files can be accessed upon request.

The research team performed qualitative analysis over the notes and comments made in the records and produced models. As for the artifact's evaluation (Prat et al., 2014), we consider as a criterion the application of the AgEAMM (**applicability**) and the stakeholder's validation of the produced models (**utility**).

3.4 Selected Organizations

As mentioned early, the artifact (AgEAMM) was demonstrated and evaluated in two organizations - Public Service Consumer (PSC1 and PSC2), with the intermediation of a third organization, a Public Service Provider (PSP). A work plan was established by PSP to be performed as a service for two of its customers, PSC1 and PSC2. The Figure 2 represents the relationship between the organizations.

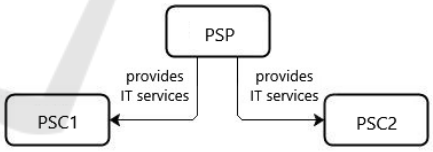

Figure 2: Organizations involved in the study and their relationships.

The PSP is a public, non-profit IT provider with approximately 230 employees. It provides IT services (such as software development, and user technical support, data center, etc.) to the city hall's offices (Health, Education, Infrastructure and so on). The city has around 1.6 million inhabitants. The PSC1 is also a public, non-profit organization, with approximately 700 employees. It is responsible for executing the urban cleaning services for the entire city. The PSC2 is also a public, non-profit organization with approximately 1,200 employees. Its core business is engineering and urban infrastructure services for the entire city. In this particular condition, PSP is providing the EA modeling service to PSC1 and PSC2.

Value/importance for PSC and ease of access were the criteria used to select the organizations for this research.

In PSC1, there are systems implemented in different technologies, although no software development department exists. Its IT function provides only technical support services and manages the infrastructure (internet, servers, printers, etc.). In the PSC1, the business planning unit was our EA modeling client. Seven employees from this department took part in the modeling sessions (see Figure 4).

In PSC2, it has infrastructure similar to PSC1, and there are also systems implemented in different technologies, and there is also no software development department. Its IT function provides only technical support services and manages the infrastructure (internet, servers, printers, etc.). In the instance of PSC2, the "customer service" unit that was our EA modeling customer. Five employees from this department participated in the modeling sessions (see Figure 3).

4 PROPOSAL

In this section, we present the proposed Agile Enterprise Architecture Modeling Method (AgEAMM) research artifact. The method is described below, including the nine activities and eight artifacts.

- **Sensitize CIO and CEO:** The activity of raising awareness on top management (modeling initiative's sponsor), aims to present the fundamental concepts related to EA, its related advantages, and benefits. It is a productive communication activity. In practice, it is a way to convince the main stakeholders to achieve a predisposition for a change within the organization in order to strengthen its business.

  Related Artifact: This activity was aided by an **Executive Presentation** made with simple slides. The topics approached in this presentation were: basic EA concepts; a proposal for the organization; a list of expected outputs, a list of partners involved; an overall explanation of the Agile process used by the team; counterparts and responsibilities of those involved, and an overview of the next steps. We faced our EA modeling initiative as a project and presented its project charter in this step.

- **Define EA Committee:** The committee's idea is to establish a group of people empowered to deliberate, direct, or clarify points of the work in question.

  Related Artifact: We created a document called **EA Committee**, which contained the members of the PSP organizations (its director and the three EA researchers), PSC1 (two IT specialists, and five business specialists) and PSC2 (two IT specialists, one from the human resources sector and two business specialists). This artifact contained the *names* of those stakeholders, the *type of involvement*, the *role* played in the project, their *responsibilities*, and their *contact* details numbers. Regarding the type of involvement, they can be classified as Strategic, EA Technical, Management, and Business). Regarding the role of those involved in the project, the classification used was:

  – **Sponsor:** To sponsor the project, establish priorities, decide strategic issues and select clients for the project;
  – **EA Leader:** To understand and to interpret the requirements for building the models, as well as to refine and validate the models produced, ensuring EA adherence;
  – **EA Consultant:** To provide guidance, best practices, application referrals and technology for the project;
  – **Modeling Team:** To perform EA modeling work (modeling sessions);
  – **Project Manager:** To establish and manage the project;
  – **IT Expert:** The professional on the client-side, responsible for arranging meetings and helping with technical knowledge related to the local applications and
  – **Business Expert:** The specialist in the business to be modeled, responsible for gathering and validating the expected data, and articulating the necessary knowledge for the modeling team to compose the outputs of the corporate architecture.

  These roles were obtained mainly from the Scrum Framework elements and Project Management Body of Knowledge guide (PMI, 2017).

- **Perform EA Diagnosis:** The goal of this activity was to examine the EA artifacts existing in the investigated organizations. The questions are directed towards obtaining answers about the presence or lack of common EA artifacts, as well as discovering the organization's maturity concerning these practices. The questions, together with the answers, guided our study.

  Related Artifact: We artifact called **EA Diagnosis**, which contains a set of guiding questions, as shown in Figure 4. In our situation, the responses were entirely different from "YES". The

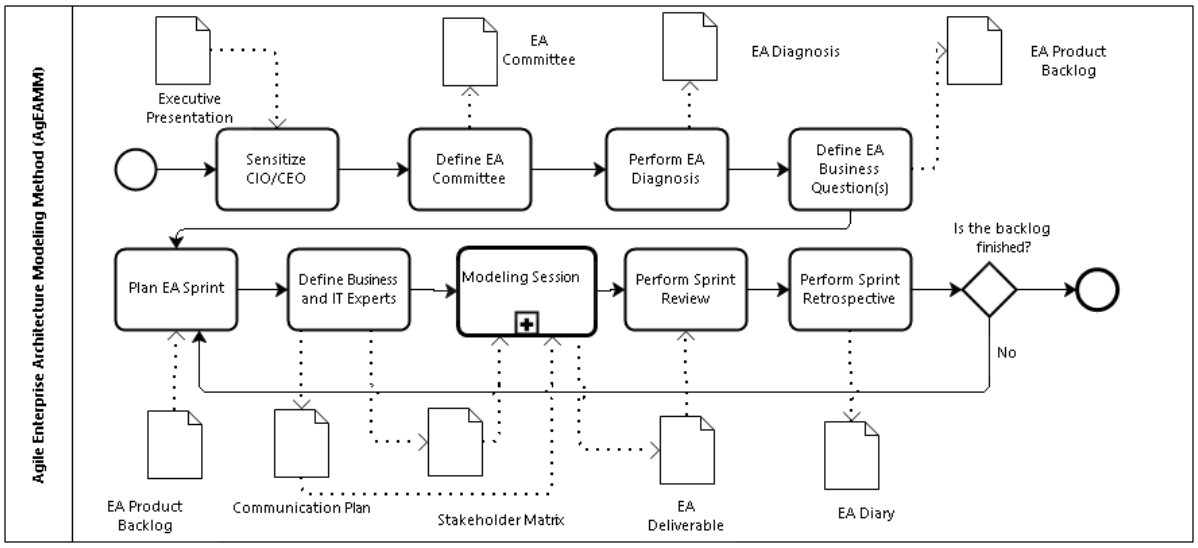

Figure 3: Agile Enterprise Architecture Modeling Method (AgEAMM), in BPMN notation.

complete questionnaire was developed on Google Docs and contained thirteen questions.

ARTIFACT	YES	NO	NOT SURE
Does your organization maintain a diagram or matrix of all systems running, showing how they interact?			
Does your organization maintain a diagram or matrix with all the technologies used in the systems?			
Does your organization have a matrix of stakeholders with the respective technology services that meet their needs?			
Are there organizational data or application silos in the various departments of the organization?			
When your organization starts a new application, do you have minimal documentation (corporate architecture plan) used to align this new application with what already exists?			
If you have any questions or problems related to the systems' architecture, do you know with whom you should seek guidance about it?			
Can you use any technology you want, or is there an official guide with business standards, methods, tools, or technical references?			
Is there a list of the technicians responsible for a particular application?			
Is there a list of those responsible for supporting applications to the end-user?			

Figure 4: EA Diagnosis form.

- **Define EA Business Question(s):** Activity performed right after the diagnosis to prioritize the work, as well as directing it.

  Related Artifact: The organizations' definition business questions came through brainstorming sessions between the Business Expert team and the Modeling Team, considering the EA Diagnosis's content. The business questions defined by the PSC1 and PSC2 organizations are respectively described below:

  - What are the current IT applications, and how they support the organization's business processes?

  - What are the main business processes in the directory, and how are the IT applications supporting them?

  It is essential to notice that although they are similar, the questions differ in scope and orientation. In the first one, the concern was to map the entire IT landscape, while in the second one, the focus was to map critical processes and applications of one specific business unit. Based on the definition of the business question(s), an **EA Product Backlog** (Schwaber, 1997) artifact established and documented on the web tool Trello (https://trello.com/).

- **Plan EA Sprint:** These meetings establish the Sprint goal based on the definition of the scope (increment) of work to be delivered in this timebox.

  Related Artifact: In practice, a piece of the **EA Product Backlog** (input) with activities related to EA modeling was prioritized and delivered during as an **EA Sprint**. Those planning meetings lasted on average of two hours. A planning meeting was arranged to happen every two weeks. The only one input artifact for this activity was the EA Product Backlog, produced by the previous activity, as depicted in Figure 3.

- **Define Business and IT Experts:** Once the workload in each of the two organizations involved several of their sectors/departments, immediately after each Plan EA Sprint, it was necessary to define or update information about the Business and IT Experts that had to be consulted for that EA Sprint.

  Related Artifact: In our experience, this activity proved to be extremely necessary and valuable, as it allowed us to keep those people informed and committed to the work. **A Communication Plan** artifact was established for the project. This document contains a list of stakeholders with their names, roles, type of requested information, frequency, and contact details for communication.

- **Modeling Session:** One of the most important activities, where the Modeling Team participated together *in loco* with the Business Experts, the owners of the knowledge of the business to be modeled.

  Related Artifact: The modeling sections took place in the companies. Four modeling meetings were held in one organization and three in the other. They were weekly meetings, of 2 hours, recorded, documented, and later reflected in Business Process Model and Notation (BPMN) or Archimate diagrams. The beginning of each modeling session was used to validate the increment of the work of the previous modeling section. Useful **EA deliverables** in the form of BPM or Archimate models were produced and validated by the stakeholders.

- **Perform Sprint Review:** In this Activity, the Modeling Team presents the work done during the current Sprint to Business Experts and stakeholders. Then, the Sprint may be validated.

  Related Artifact: This activity does not have any specific artifact. It only has, as input, the EA deliverables produced in the previous activity (Modeling Section). This Sprint review took place in the customer's environment, with the modeling team, IT specialists, and business specialists. The review meeting lasted around one hour.

- **Perform Sprint Retrospective:** Its occurs at the end of a Sprint in order to identify, under the process perspective, what worked well, what can be improved, and what actions will be taken to improve it.

  Related Artifact: We used an **EA Diary** as a way to record the improvement actions identified in the Sprint Retrospective.

The proposed AgEAMM is based on incremental improvements through four cycles of practical use in both organizations (two cycles in each), as explained in Section 3. The first version was only based on the literature. After the first instantiation in PSC1, it was possible to establish an improved version of the AgEAMM with the knowledge obtained from this first experience. In the second version of AgEAMM, new activities were included (Define EA business question (s) and Define business and IT specialists); and also artifacts (Executive presentation, Communication Plan, Matrix of stakeholders, and EA Diary. This final version of the method consists of nine activities and eight artifacts, as depicted in Figure 3.

5 DEMONSTRATION

The AgEAMM artifact proposed in Section 4 and shown in Figure 3 was demonstrated in the two public organizations, described in Section 3.4 from September 2019 to February 2020. The study was conducted through regular meetings with the presence of three professionals profiles: EA Leader, Modeling Team, and Business Expert (see Section IV). While driving the work, the proposed artifacts generated in activities of the AgEAMM were delivered to organizations, through short, iterative and incremental sprints. At the start of each meeting, we validated the EA deliverables from the previous activities.

All AgEAMM activities to be performed on that particular Sprint were planned and monitored with the Trello[6], a free tool that may be easily configured. Our Trello's configuration is depicted in Figure 5. We used four lists: "BACKLOG", representing what we have to do throughout the project; "TO DO", representing what we have to do in the current Sprint; "DOING", representing what we are doing; and "DONE", representing what has already been completed in the current Sprint.

Also, we used some "Trello labels" to systematize the work, such as:

Sprint: Represents a Time Box within which a set of activities must be performed. In our instance, it is numbered to represent the current Sprint (in Figure 5, it is highlighted in red);

Story: Represents a User Story or a simple, light and concise description of a user's need (in Figure 5, it is highlighted in green);

Ceremonies: There were two types of ceremonies (Planning and Retrospective). The first served to record the planning carried out for the Sprint and the other to discuss improvements in the method (in Figure 5, it is highlighted in orange);

[6]https://trello.com/

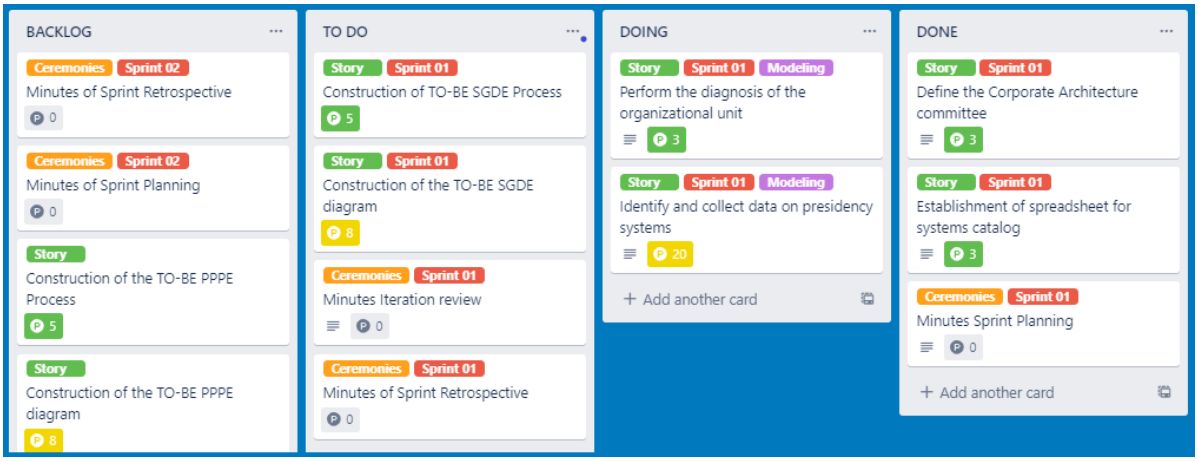

Figure 5: Managing AgEAMM activities with Trello.

Modeling: Used to mark EA's modeling activities (in Figure 5, it is highlighted in purple);

We also used a Trello extension (Agile Tools) that allowed us to estimate the size of the story, following the Fibonacci scale (Boehm et al., 2012).

As mentioned before, all deliverables and documents involved in the AgEAMM instantiation were kept in our Google Drive Repository, which was shared with PSC1 and PSC2.

6 EVALUATION

This section presents an evaluation of AgEAMM (the artifact), following the DSRM, and proposing to answer the established research question.

The evaluation is grounded in the researchers´perspectives and discussions along with the artifact's instantiation, especially at the end of the each Sprint (Sprint Retrospective). First, we applied the applicability criterion to evaluate the AgEAMM artifact. Instantiations help to reason about an artifact's feasibility and applicability at build-time or its usefulness when applied to some reality. Once we executed the artifact and we were able to produce EA deliverables in accordance with agile principles, thus, **we claim the applicability of our artifact**. The second used criterion was "correspondence with another model" (Prat et al., 2014), in this case, the correspondence of the AgEAMM with the Agile Manifesto's ideas (Fowler et al., 2001). Our reasoning is based on the four values and twelve principles of the Agile Manifesto:

- Customer satisfaction can be increased with fast and continuous deliveries of artifacts or small parts of the expected architectural models. We observed that this approach could generate the perception of value delivered and thus, customer satisfaction;
- Welcome changing requirements, even late in development, is what Agile Manifesto describes. The approach used in this work was to establish a macroscope, with the flexibility of changes at any time during the course of the Sprints. In practice, we realize that the continuous delivery of value, in the form of artifacts or models, can help trim possible problems related to changes. Obviously, in environments where more tight or rigid contracts are required, the change may not be precisely welcome;
- The promotion of constant cooperation between people who understand the business (Business Experts) and the Modeling Team is essential for the job. Looking and worrying about how to promote cooperation can save the project. Here, cooperation was promoted through the use of messaging tools (smartphones) and the promotion of less formal environments during meetings;
- Face-to-face meetings, which were frequent and in the client's environment, were determining factors in keeping those involved motivated. It was natural that, in times of absence, the pace of work was hampered due to the unavailability of the client. However, confidence remained high throughout the project;
- Artifacts or architectural models delivered became a measure of the project's progress. However, the idea of delivering components that generate value was the determining factor in progress. For example, when delivering a list of all the organization's systems, as well as other related information, we could realize the idea of delivering value and progress. It is something we rec-

ommend practicing: we thus reinforce that it was crucial to bring early value to the clients.

- The concept of simplicity is often understood as maximizing the amount of work not done. The idea of simplicity was something related to the project, and despite being at the head of the team, we were unable to state exactly the simplicity points applied. As previously mentioned, actions to focus on what was perceived by the modeling team as "delivering value", can be understood with actions to promote simplicity;
- The Agile Manifesto talks about self-organizing teams. In this sense, we were able to apply this concept while maintaining sufficient autonomy and confidence for Modeling Team to decide the best way to carry out its work. This self-organization was deepened a lot by the profiles of the project's professionals and the collaborative relationship;
- Finally, the reflection on how to make the team and the method more effective occurred with each Sprint cycle, starting from the Sprint Retrospective meeting, inspired by the Scrum framework. These meetings served, among other subtle points, to improve AgEAMM in each cycle.

7 LESSONS LEARNED

The method was applied after authorization and formal support by the top management (the sponsor in the organization). This authorization already pointed out the indication of IT experts (as already described, client-side professionals responsible for facilitating meetings with business specialists). The two EA modeling initiatives in both organizations started shortly after the "Sensitize CIO and CEO" meetings which occurred independently.

In each of the organizations were introduced: the goals, the schedule of activities and delivery stages, descriptions of those involved, including the project manager, and his authority. Assumptions, restrictions, and risks were also part of the presentation. Concerning the deliverable, they started to appear according to customers' needs, Sprint after Sprint, as shown in Figure 3.

The relationship between the modeling team and the clients took place in a very collaborative way, following the precepts of the Agile Manifesto "Customer collaboration over contract negotiation"(Fowler et al., 2001). This collaboration was important and made the communication easier during the course of the project, especially during meetings, which always took place at the client. Collaboration, in addition to improving trust between the parties, eliminated unnecessary efforts, and allowed us to focus on actions that could generate value for the work/business. The willing to collaborate was perceived by both organisations. We repute this to their expectations about improving their IT solutions/work conditions.

Difficulties in the application of the method were issues related to a) availability of the participants of the two organizations; b) need to formalize the work, for cultural reasons related to public organizations (agility was hindered for this reason); c) lack of knowledge in some parts of the business and divergence between practical work and existing processes, caused by the existence of organizational silos.

7.1 Recommendations

Below are some critical points present in the AgEAMM that we can mention, and that deserves attention when conducting the EA modeling process:

- It is essential to obtain the support of top management. Understanding and giving the necessary importance to this activity is essential to conduct all the work. For this reason, we explain this step, "Sensitize CIO/CEO", in the proposed method. Many barriers or resistance from those involved can be broken by winning a good sponsor for the project, someone within the organization's command chair. In this work, we start by requesting a meeting with the organization's top management. The objective was to present the concepts of EA, as well as the advantages related to its implementation in the institution. This meeting proved to be very efficient, as it made top management become sponsor the project, supporting the group and promoting the project in organizations;
- Establishing clear roles, appropriate professionals, and a multidisciplinary team is a critical success factor. It is essential to avoid situations where there are delays or failures in EA modeling jobs' quality due to deviations from functions (someone doing someone else's job). Agile methods talk about multidisciplinary teams, but that does not mean that a professional knows or should do everything. For agile methods, the team has to be multidisciplinary. In this work, we propose a set of roles (Sponsor, EA Leader, EA Consultant, Modeling Team, Project Manager, IT Expert, Business Expert), which we recommend. Section 4 presents these roles in more detail;
- To guide the work based on business questions. When the question is specific and clear, it can be

an excellent way to direct the work, promote a focus on the planning and execution of the modeling sections, or even a way to direct the conversation between the modeling team and the business experts. In the two organizations surveyed, the team encouraged customers to formulate questions, to which the answer could generate value for their organization. For example, one of the many questions asked for one of the organizations was: "What are the existing applications in the organization, and how are these applications supporting the organization's business processes and strategy?";

- Communication means making every day, information exchanging, sharing ideas, feelings, experiences, and values through gestures, acts, words, figures, images, symbols, etc. (Cockburn and Highsmith, 2001). Communication is a critical factor in the success of the project, and it was no different for this work. Creating a communication plan associated with a stakeholder matrix can help the EA modeling process. This concern with communication was designed at the beginning of the work and was consolidated throughout the lifecycle of the project. We recommend continuous attention to avoid communication noise.

8 CONCLUSION

In this paper, we present the proposal for a hands-on Agile Enterprise Architecture Modeling Method. The research problem was established from the literature and confirmed during the execution of the study. We used the Design Science Research Methodology as a methodology for proposing an artifact to improve the organization's EA modeling process. We described in detail the AgEAMM and its relation to the twelve principles defined in the Agile Manifesto. The demonstration and evaluation were conducted in two organizations.

Some critical points in the implementation of Agile modeling were: obtaining support from the organization's top management, establish appropriate and clear roles for the project, guide the project through business questions, and do not neglect communication with stakeholders. We also presented lessons learned along with the present research. Our experience and results allow us to conclude that the two concepts, Agile and EA modeling, are convergent and may help us minimize the current challenges in carrying out the modeling of one EA.

8.1 Research Limitations

Although this research has achieved all of its objectives, some limitations must be considered:

- The evaluation presented in this work may have been limited by analysis unit used to validate the AgEAMM. The cultural factors of the organizations surveyed may differ from those obtained in private organizations, for instance;
- A weak point in our research design is that the evaluation of the method was done by specialists who were members of the project. Thus, the opinions of the researchers may produce a bias towards the findings and conclusions;
- TOGAF ADM represents an important approach to EA modeling in the market. Our method does not cover the entire ADM cycle.

8.2 Future Work

As for future works, we can think of suggesting the application of the AgEAMM in private organizations, since the two organizations, PSC1 and PSC2, are in the public sector. The goal would be to understand if there would be necessary to make any adaptation in the AgEAMM. Another point would be to intensify agile practices in the method proposed here, applying and testing adaptations to other techniques well-known in the Agile field, such as Daily Meetings, Pair Programming, Refactoring, Planning Poker, etc. (Fowler et al., 2001). Third, to apply the method associated in association with structured questionnaires that can measure customer satisfaction to minimize analysis bias. Finally, to conduct studies on which could be possible to evolve the AgEAMM and integrate it with the software development process and strategic planning and project portfolio management processes of the organization.

REFERENCES

Ahlemann, F., Stettiner, E., Messerschmidt, M., and Legner, C. (2012). *Strategic enterprise architecture management: challenges, best practices, and future developments*. Springer Science & Business Media.

Ambler, S. W. (2013). Agile enterprise architecture. Accessed: Jan. 04, 2020.

Bente, S., Bombosch, U., and Langade, S. (2012). *Collaborative enterprise architecture: enriching EA with lean, agile, and enterprise 2.0 practices*. Newnes.

Boehm, B., Abts, C., and Chulani, S. (2012). Does the use of fibonacci numbers in planning poker affect effort estimates? In *16th International Conference*

on Evaluation\& Assessment in Software Engineering (EASE 2012), volume 10, pages 177–205. IET.

Buschle, M., Ullberg, J., Franke, U., Lagerström, R., and Sommestad, T. (2010). A tool for enterprise architecture analysis using the prm formalism. In *Forum at the Conference on Advanced Information Systems Engineering (CAiSE)*, pages 108–121. Springer.

Canat, M., Pol Català, N., Jourkovski, A., Petrov, S., Wellme, M., and Lagerström, R. (2018). Enterprise architecture and agile development: Friends or foes? In *2018 IEEE 22nd International Enterprise Distributed Object Computing Workshop (EDOCW)*.

Cockburn, A. and Highsmith, J. (2001). Agile software development, the people factor. *Computer*, 34(11):131–133.

Dybå, T. and Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and software technology*, 50(9-10):833–859.

Ferreira, A. H., Laurindo, F. J. B., and Júnior, J. L. B. (2017). Analysis of information technology sector companies in brazil in the 2013 to 2015 period: A knowledge intensive business services and innovation perspective. In *14th CONTECSI-International Conference on Information Systems and Technology Management*.

Fowler, M., Highsmith, J., et al. (2001). The agile manifesto. *Software Development*.

Gill, A. Q. (2015). Agile enterprise architecture modelling: Evaluating the applicability and integration of six modelling standards. *Information and Software Technology*, 67:196–206.

Group, T. O. (2018). Togaf version 9.2. Available: https://pubs.opengroup.org/architecture/togaf92-doc/arch/. Accessed: Feb. 10, 2021.

Group, T. O. (2019). Archimate 3.1 Specification. Available: https://pubs.opengroup.org/architecture/archimate3-doc/. Accessed: Feb. 21, 2021.

Group, T. O. (2020). Guide to agile architecture modeling using the archimate language. Available: https://publications.opengroup.org/g20e. Accessed: Dec. 19, 2020.

Hanschke, S., Ernsting, J., and Kuchen, H. (2015). Integrating agile software development and enterprise architecture management. In *2015 48th Hawaii International Conference on System Sciences*, pages 4099–4108. IEEE.

Hauder, M., Roth, S., Schulz, C., and Matthes, F. (2014). Agile enterprise architecture management: an analysis on the application of agile principles. In *4th International Symposium on Business Modeling and Software Design*, pages 38–46.

Hensema, M. (2015). Applying agile in enterprise architecture. Master's thesis, University of Twente.

Hevner, A. and Chatterjee, S. (2010). Design science research in information systems. In *Design research in information systems*, pages 9–22. Springer.

Hosiaisluoma, E., Penttinen, K., Mustonen, J., and Heikkilä, J. (2018). Lean enterprise architecture method for value chain based development in public sector. In *ECDG 2018 18th European Conference on Digital Government*, page 86. Academic Conferences and publishing limited.

Johnson, P., Lagerström, R., Ekstedt, M., and Österlind, M. (2014). It management with enterprise architecture. *KTH, Stockholm*.

Kotusev, S. (2018). Togaf-based enterprise architecture practice: An exploratory case study. *Communications of the Association for Information Systems*, 43(1):20.

Kotusev, S., Singh, M., and Storey, I. (2015). Consolidating enterprise architecture management research. In *System Sciences (HICSS), 2015 48th Hawaii International Conference on*, pages 4069–4078. IEEE.

Lumor, T. (2016). Towards the Design of an Agile Enterprise Architecture Management Method. Master's thesis, University of Jyväskylä, Finland.

Nerur, S., Mahapatra, R., and Mangalaraj, G. (2005). Challenges of migrating to agile methodologies. *Communications of the ACM*, 48(5):72–78.

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of management information systems*, 24(3):45–77.

PMI (2017). *A Guide to the Project Management Body of Knowledge (PMBOK®)*. Project Management Institute, Inc.

Prat, N., Comyn-Wattiau, I., and Akoka, J. (2014). Artifact evaluation in information systems design-science research-a holistic view. In *PACIS*.

Qumer, A. and Henderson-Sellers, B. (2008). An evaluation of the degree of agility in six agile methods and its applicability for method engineering. *Information and software technology*, 50(4):280–295.

Rasnacis, A. and Berzisa, S. (2017). Method for adaptation and implementation of agile project management methodology. *Procedia Computer Science*, 104:43–50.

Rouhani, B. D., Shirazi, H., Nezhad, A. F., and Kharazmi, S. (2008). Presenting a framework for agile enterprise architecture. In *2008 1st International Conference on Information Technology*, pages 1–4. IEEE.

Schwaber, K. (1997). Scrum development process. In *Business object design and implementation*, pages 117–134. Springer.

Winter, R. and Fischer, R. (2006). Essential layers, artifacts, and dependencies of enterprise architecture. In *2006 10th IEEE International Enterprise Distributed Object Computing Conference Workshops (EDOCW'06)*, pages 30–30.

Wohlin, C. and Aurum, A. (2015). Towards a decision-making structure for selecting a research design in empirical software engineering. *Empirical Software Engineering*, 20(6):1427–1455.