Product-IT and Enterprise-IT integration in Enterprise Architecture Management – Methodological Perspective

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Abstract. Enterprise Architecture Management (EAM) is a practice for planning and governance of IT assets in an organization. Today, in the era of digital transformation, new digital opportunities and technological advancements are changing how companies create products and deliver services. Enormous potential for business value generation lies in product-IT – built-in software and digital services enhancing physical products. In this paper we discuss the need to approach product-IT and enterprise-IT in an integrated manner based on the findings from an exploratory case study. Particularly, we outline how to integrate these two in the context of EAM, considering the challenges that traditional EAM is facing in relation to the digital transformation. The main results of the paper are a set of high-level requirements for EAM that would enable product-IT and enterprise-IT integration. These requirements can serve as a basis for future development of methodological support in the outlined context.

Keywords: Product-IT, Enterprise-IT, Enterprise Architecture Management, Internet of Things.

1 Introduction

Information Technology (IT) is changing products. Products have evolved from being solely composed of mechanical and electrical parts to complex systems of hardware, sensors, data storage, microprocessors, software, and connectivity. In [1] these products are addressed as smart, connected products. The integration of sensors and communication technologies serves as the foundation of such technological innovations as Internet of Things (IoT) and Cyber-Physical Systems (CPS) [2, 3]. Smart, connected products are the key actors in these areas – they act as intelligent communicating entities. Smart, connected product have opened a new era of competition and business value creation and capable of generating enormous value. The McKinsey Global Institute estimates that the IoT may have a total economic impact of US $3.9 trillion to US $11.1 trillion a year by 2025 [4].

Three core elements of smart, connected products are (1) physical components, (2) “smart” components, and (3) connectivity components [1]. Physical components in-

clude mechanical and electrical parts. Smart components contain the sensors, microprocessors, data storage, controls, software, an embedded operating system and enhanced user interface. In many products, software replaces some hardware components or enables a single physical device to perform at a variety of levels. Connectivity components include the ports, antennae, and protocols enabling wired or wireless connections with the product. Smart components increase the capabilities and value of the physical components, whereas connectivity increases the capabilities and value of the smart components and enables some of the smart components to exist outside the physical product itself. Particularly, product becomes accessible by various components of Product Cloud: smart product applications for monitoring and control. The data regarding the product operation can be stored and analyzed in Product Data Database to reveal new insights; the application platform enables the rapid creation of smart, connected business applications using data access, visualization, and run-time tools [1]. Together, smart components, connectivity components and product cloud form a product-IT. They give a new, digital character to a physical product, which increase the value of the physical product significantly.

Smart, connected products are developing in all manufacturing sectors, an example describing automotive industry is described in [5]. These products change industry structure and the nature of competition, exposing companies to new competitive opportunities and threats. The shift from traditional (physical) creation and delivery of customer value, including the operational procedures related to this, into the massive use of digital technologies which enhance or replace the traditional product with smart, connected product is usually addressed as IT-driven transformation [1] or digital transformation (DT) [6].

The various aspects of an enterprise possibly affected by DT include organizational structure, business processes, information systems, and infrastructure, which together form an Enterprise Architecture (EA). Enterprise Architecture Management (EAM) is a discipline that seeks to address mutual alignment between these aspects by taking the embracing perspective on the overall EA [7]. Organizations have traditionally deployed EAM to help understand, plan, develop, and control their IT assets, i.e. enterprise-IT [8, 9].

Exploitation and integration of digital technologies, which is pointed out by [6] as the first dimension of DT strategy development, can include digitalizing products (enhancing the physical product with product-IT), or digitalizing business processes, sales channels, supply chains, etc. (enhancing company functioning with a suitable and up-to-date enterprise-IT). Enterprise-IT can include various systems (such as ERP, CRM, PLM) that support organization's functioning. IT strategies are usually providing a general overview of enterprise-IT - the current and the future operational activities, the necessary application systems and infrastructures, together with a suitable organizational and financial framework for providing IT to carry out business operations within a company, however, having a limited impact on driving innovations in business development [10]. To some extent, this restricts the essential product-centric and customer-centric opportunities that arise from new digital technologies, which often cross firms' borders [11]. In addition, IT strategies present system-centric road maps to the future use of technology in a firm, but they do not necessarily

account for the transformation of products, processes, and structural aspects that go along with the integration of technologies. Therefore, in the context of DT and strategical directions in this context, product IT should be considered together with enterprise IT, to enable the company capture and develop product-centric and customer-centric opportunities.

By providing a holistic view of business capability elements and their relationships, EAM facilitates translating strategic objectives into business capabilities and concrete changes in business processes, governance structure, and IT systems that enable those capabilities and, thus, organizational objectives [8, 12-14]. EAM has a broad arsenal of tools and practices to bridge strategy with implementation, which are traditionally applied to realize IT strategy. Example of such tools are EA roadmap and EA principles, which are used for conformity checks and ensures compliance of changed business capabilities [8]. These tools can be also applicable for implementing strategies in the context of DT. However, it is important to keep in mind broader scope of IT strategy that DT calls for – combination of enterprise IT and product IT.

Therefore, the main purpose of this study is to investigate what could be a suitable way for integration of product-IT and enterprise-IT in the context of EAM, which currently lacks suitable methodological support for solving the challenges outlined in [15]. To develop such methodological support in EAM area it is first important to define: *What is important to be considered in the integration of product-IT and enterprise-IT in EAM?*

This research question is the focus of the given paper. To answer this question design science approach is applied (Section 2). A number of issues that EAM will need to address in the outlined context is discussed in Section 3, which is presented as a set of method requirements. The discussion of the generated method requirements in Section 4 includes examples of important aspects and stakeholders that will play a central role in the refined EAM.

2 Research Approach

This section describes how the formulated research question was addressed. This paper describes a part of a design science research [16] aimed at a method generation in the EAM field, which started from outlining the challenges in the described context in [15, 17]. The central artifact of the study is a method that would allow to address enterprise-IT and product-IT in an integrated manner within EAM practice, at the organization that are going through digital transformation. In this paper we present high-level requirements for such a method and discuss how those method requirements can be addressed in terms of specific method components [18]. The method development would need further research and will be investigated in our future work.

Knowledge base for this study is composed by foundations - existing studies in the field, and methodologies - guidelines for justifying and evaluating the method. Foundations are existing studies in the domains of EAM, BITA, existing EA frameworks and other related areas such as IoT and CPS. During the analysis of existing literature, we observed that there is not much work on the integration of product-IT into EA,

however we could clearly see that the interest in this integration is growing. There are several relevant studies available, published mostly between 2014 and 2017, such as [19-21].

The enterprise investigated in the case study is Husqvarna Group AB. Husqvarna is a world-leading producer of outdoor power products including chainsaws, trimmers, robotic lawn mowers, garden tractors, watering systems, cutting equipment, and diamond tools for the construction and stone industries. Husqvarna is right now in a transformation process where they need to embrace the digitalization trends to stay competitive and to deliver improved value to their customers and other stakeholders. Many of the Husqvarna products for professional customers do not only have smart components but also connectivity components.

Empirical material was collected during an exploratory case study, i.e. the phenomenon of product-IT and enterprise-IT is explored in its natural organizational context. Data was collected via interviews, meetings and investigation of the internal company documents. The first round of semi-structured interviews has been performed in summer 2016, where nine respondents have been interviewed. The respondents were chosen from various positions, such as architecture and digital solutions manager, project managers, product owners, EAM practitioners, squad leaders. The second round of in-depth interviews took place in the fall 2017, where four respondents have been interviewed. This round of interviews focused on potential requirements for the existing EAM practice originating from the product-IT development and maintenance projects. The respondents were chosen based on their experience in ad-hoc inclusion of product-IT concerns into the existing EAM practice: EAM practitioner dealing with EA representation and EA documentation, EAM practitioner dealing with IT governance, digital expectation manager, project manager for digital customer support.

3 Method Requirements

The main goal of this paper is to present what is important for product-IT and enterprise-IT integration in EAM, i.e. what kind of issues refined EAM should be able to address. In this section we introduce several high-level requirements for EAM, each of them is discussed and supported both empirically and theoretically.

1. Product-IT should be included into consideration during strategy, operational and technology development.

The market-changing potential of digital technologies is currently wider than transforming products, business processes, sales channels or supply chains—entire business models are being reshaped and overturned [6, 22]. Aiming at competitive advantage companies need to address operational effectiveness (OE) [1]. OE requires embracing best practices across the value chain, including up to date product technologies, the latest production equipment, and state-of-the-art sales force methods, IT solutions, and supply chain management approaches. The boundaries between IT supporting business functioning, digital services that increase the value of the products and automation of manufacturing become blur, as they all act as parts of the digi-

tal assets of an enterprise and need to be considered in a structured and coherent manner both in terms of strategical and operational choices. This motivates the importance of formulating a digital strategy that would allow to not only achievement of OE (doing things well), but to create positioning that would allow strategic differentiation (doing things differently) [1]. The practice of EAM has a broad range of frameworks and tools for translating strategy into implementation and therefore can be used for developing and implementing digital strategy, where product-IT will be considered as a crucial part.

2. The co-existence of different working modes, ranging from traditional waterfall-like to agile, should be considered and orchestrated.

A challenge that is apparent today in the digital transformation is the to handle the bimodal dimensions of the IT lifecycle [23]. The enterprise-IT dimension (Mode1), designed for stability, efficiency, and low cost, which is closely related to traditional EAM. Product-IT on the other hand (Mode 2) is constituted by development projects that help to innovate or differentiate the business. This requires a high degree of business involvement, fast turnaround, and frequent update, the so-called rapid path to transform business ideas into applications.

[21] stated that there is a need to handle *"A two speed architecture for the digital enterprise"*. For digitally native enterprises and startups such as for example Netflix this is not a problem, since they have had the benefit of starting with a "clean slate" and think "digital" and take the advantage of this from the beginning without considering any legacy. This does however not work for more established enterprises. They have many years of delivered technology, architectures, governance, decisions structures and financing mechanisms. The central objective of the two-speed method is to differentiate the systems, architectures, and structures that must be flexible and agile (often on product-IT side) from those that have to be more reliable and deliver the highest quality (often on enterprise-IT side) [21].

3. Enabling analysis and representation of several architectural domains, paying substantial attention to strategy.

The new EAM method will have to cut through the different layers: not only the technology architecture (technology stack proposed by [1]), but organizational architecture, process architecture, strategy and others. A new EAM method's need to enable collaborative support for knowledge representation across different layers and domains and navigating through them easily. This need has been confirmed in the interview with a digital expectations manager, who pointed out the lack of representational capabilities in the existing EA documentation approaches and their strong technical focus, which often made it useless in a dialog with customers and marketing stakeholders focusing on a value of digital services.

This need to cut through several layers and navigate through them is related to the concept of multi-level dynamic is also discussed by [21]. They argue that the enterprise architect would need to understand the differentiating attributes of different levels and place enterprise activities within each level. The constituent activities of any process could be moved across level boundaries however the resulting implications of this would need to be traced.

The traditional EAM division into business, application and technology architectural domains, can remain valid, however should include both product-IT and enterprise-IT. Several interviewees emphasized the need to pay significant attention to strategy formulation and implementation that would necessarily involve product-IT concerns. Within the architectural domains of TOGAF [24], strategy can be positioned as a part of business architectural domain.

4. Common architecture and capturing, structuring, analysis and access to the data needs to be introduced.

The importance to develop products and services in a data-intensive way became obvious for today companies. Business models being reshaped via data exploitation. Data-driven sensing and acting described in [21] suggests that enterprise change is being influenced by both the internal adoption of technologies and the general pervasiveness of digital technologies in the environment that they operate in. This kind of data-driven sense-and-respond loops for ongoing enterprise transformation already exist in multiple industries and often are realized by the mechanisms of Big Data analysis. Interviews with digital expectation manager and the product owner show that analysis of the usage data of the apps features help to optimize product features and facilitate further product improvement, which in the long run increase a value of the product for a customer. The products for which usage data is analyzed continuously throughout the development are leading to better customer satisfaction than for products that do not use data analysis.

According to [21], one specific need that originates from this for enterprise architects is a need for methods for sketching out linear paths or cyclic loops as they exist in any enterprise, the various levels and timescales that they transition through, the interactions that the paths may have with other paths or enterprise objects, the sensory inputs to the sensing part and the corresponding balance that the responding part should bring.

5. The method should enable and support stakeholders' collaboration and interaction.

There is a need to facilitate the collaboration between various groups of stakeholders with varied organizational belonging. The need for representational, collaboration and interaction mechanisms that can be used to support a dialog between stakeholders with various backgrounds (squad leaders, product owners, marketing specialists, graphical designers and others) becomes apparent and crucial to address. For example, [1] point out the need for close collaboration between IT and Research & Development and continuous customer success management.

According to [21] the particular issue for an enterprise architects need to be able to depict actor autonomy, actor objectives and goals, boundaries of actor influence, multiple levels at which these objectives and influences span and interactions between actors. Also, it will be important to show any alignment (or misalignment) of actor objectives with the enterprise-level objectives.

4 Discussion and Conclusions

Described method requirements are representing high-level needs for a new methodological support to address the identified challenges of EAM in digitalization age. These requirements are related to different aspects: what is a suitable way to represent EA, what are the working procedures that EAM needs to follow, what are the concepts that are important to be addressed in product-inclusive EAM, who are the important stakeholders that need to interact in this context, what is the suitable interaction procedure and others. All these aspects can be connected to a method theory described by [18]. [18] state that the core of a method is an implicit or explicit perspective (philosophy). A perspective includes values, principles and categories. Together with perspective, a method can include other parts: (1) *perspective* – what is important? (2) *cooperation and collection principles* – Who puts questions? Who answers questions? How to put questions? How to collect answers? (3) *framework* – How are questions related? (4) *procedure* – what question to ask? (5) *concepts* – what to talk about? (6) *notation* – how to express answers?

Each method requirement presented in section 3 can be addressed by in connection to method theory presented by [18].

1. Product-IT should be included into consideration during strategy, operational and technology development. This requirement entails the perspective of the method – the core philosophy of the new EAM method. It indicates two important parts - Enterprise-IT and Product-IT, that the new method should define and connect as two sides of one coin.

2. The co-existence of different working modes, ranging from traditional waterfall-like to agile, should be considered and orchestrated. This requirement can be addressed with a procedure method component, where a set of working procedures would be defined to ensure the bimodal way of working required for orchestrated management of P-IT and E-IT. It would also call for defining the key concepts in the given domain and might require introducing new elements to the existing notations for representing EA.

3. Enabling analysis and representation of several architectural domains, paying substantial attention to strategy. Addressing this requirement would require defining the key concepts in the given area – not only in terms of architectural domains, but also in terms of specific elements that each of the defined architectural domains will need to include. For example, in [25] Strategy, Organisation and Information System are defined as key architectural domains. The architectural domains defined by TOGAF are business, data, application, technical architecture[26]. Defining strategy into a separate architectural domain is reasonable, taking into account the importance of product-IT for value generation, shaping company's business model and differentiating the company from the competitors.

An example of an important aspect that needs to be represented and analyzed in this respect is customer journey. The journey model (map) describes the journey of a customer (user) by representing the different touchpoints that characterize his interaction with the service. It can include the following: who – Persona; what – to be examined; phases of the journey; actions to take; thoughts; emotional experiences; oppor-

tunities to focus on going forward; who owns it internally. Another example of specific aspect that needs to be analyzed is business moment scenario. A business moment exploits the connection of people, business and things and allow companies to innovate for entirely new scenarios. This method of representation can play a very important role in outlining new strategical directions, which are based on new technological solutions and digital services.

4. Common architecture and capturing, structuring, analysis and access to the data needs to be introduced. Common mechanisms for data analysis and ownership can be defined by developing a suitable procedure. In addition, new mechanisms for data ownership and analysis call for defining roles and responsibilities that are important in this context, and therefore can be manifested in cooperation and collection principles.

5. The method should enable and support stakeholders' collaboration and interaction. This requirement can be addressed by introducing principles and approaches that would define who are the key stakeholders that need to collaborate in the context of product inclusive EAM, what are their responsibilities and what are the suitable ways of the collaboration.

A set of roles that is representing product-IT and enterprise-IT cooperation is represented below in Figure 1. The interaction was observed during the case study in one of the development projects for smart, connected products. The figure shows the key actors and interaction objects in this development.

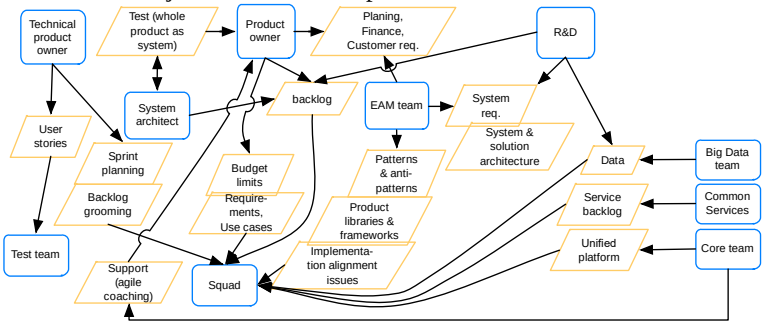

Fig. 1 Interaction model for an app development project

When it comes to a suitable way for stakeholders to interact, participative enterprise modelling (EM) can be applicable in the described context. EM is a practice for developing, obtaining, and communicating enterprise knowledge, like strategies, goals, information systems requirements to internal and external stakeholders [27, 28]. Particularly, participative or collaborative EM, where modeling sessions in groups are led by an EM practitioner and which been established as a practical approach to deal with organizational design problems, can facilitate collaboration between the stakeholders in the described context. Collaboration, participation, and interaction among a large group of stakeholders is highly beneficial in the practice of modeling, as it enables more effective and efficient model derivation and it increases the validity of created models [29], enables more efficient data acquisition and better understanding of enterprise processes [30].

Formulated requirements originate from an explorative case study with a manufacturing company, which is going through digital transformation process. The identified requirements can serve as a basis for future development of methodological support in EAM domain. Linked to method development theory presented by [18] the new methodological support can include one or several parts, such as cooperation and collection principles, concepts, notation, procedures, framework and perspective. The investigated issue requires further research, particularly, broader empirical base from other case companies facing similar challenges would be beneficial.

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