Dealing with Enterprise-IT and Product-IT in a manufacturing enterprise – towards integration in Enterprise Architecture Management

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Abstract. This paper presents an idea for doctoral thesis in the area of Enterprise Architecture Management (EAM). The aim of the thesis is to come up with an integrated way to deal with enterprise-IT and product-IT within EAM practice and investigate the role of participative Enterprise Modeling (EM) in this context.

Key words: Enterprise Architecture Management, Business and IT Alignment, Enterprise Modeling, Enterprise-IT, Product-IT

1 Introduction

IT is a key facilitator for a successful functioning of the today's enterprises. Through IT companies are able to change the way they organize business processes, communicate with their customers and deliver their services (Silvius, 2009). The quest of finding efficient IT support that satisfies business needs has been addressed in the literature as Business and IT Alignment (BITA) (Luftman, 2003; Chan and Reich, 2007). If BITA is to be achieved, stakeholders need to have a clear and up-to-date representation of the various focal areas of the enterprise (Engelsman et al., 2011; Jonkers et al., 2004). These focal areas can include organizational structure, business processes, information systems, infrastructure, which together form an Enterprise Architecture (EA).

A discipline that helps to design and develop EA in a systematic manner according to organizations' strategic objectives and vision is Enterprise Architecture Management (EAM) (Ahlemann et al., 2012). To guide EA's structured development the unambiguous description of EA components and their relationships is required, which calls for coherent modelling language and makes Enterprise Modeling (EM) a helpful

practice (Jonkers et al. 2004; Ahlemann et al., 2012). AS-IS models describing the current EA state and TO-BE models describing the future EA state (target architecture) need to be created and analyzed. Models can cover one or several layers of the EA.

In this relation, Enterprise Modeling (EM) is often addressed as an adjacent concept of EA that is able to describe various focal areas of an enterprise and EA to allow specifying and implementing the systems (Chen et al., 2008). However, a coherent modeling language cannot guarantee to achieve BITA (Jonkers et al., 2004). The problem of BITA is complicated by a numerous stakeholders having multitude of interests and agendas, which cannot always be captured by means of a modelling approach (ibid.). Existence of different, often contradicting, interests of the stakeholders, strengthen the need for active communication between them when it comes to enterprise transformation initiatives aiming to close the gap between business and IT. Here the benefits of participative Enterprise Modeling (EM) become noticeable. According to Barjis (2011), 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 models.

The overall structure of the enterprise is composed of its business and IT structures, such as stakeholders, strategy, business capabilities, domains and functions, business and IT processes, business products, business services, IT services, IT applications, and technologies. When it comes to models representing these areas, the quality and completeness of information often decreases when going from top to bottom (Schmidt et al., 2014). The top layers of architecture models contain more complete and up-to-date information. For lower levels information such as concrete IT services and applications, which will be further addressed as ***enterprise-IT***, is often difficult to collect and keep up-to-date. In addition, more and more data on lower levels of today enterprises originates from usage of Cyber Physical Systems (CPS) and Internet of Things (IoT). Within CPS and IoT, data is produced by numerous communicating entities. These entities are usually IT-components built into the products, which will be further addressed as ***product-IT***. Seamless and real-time integration of physical systems and IT creates a lot of new opportunities for manufacturing industries and other sectors. Data generated by product-IT needs to be managed in convenient and efficient manner for further analysis. Use of this data for enterprise architecture analytics has been a challenge due to shortcomings of information technology possibilities (limits in volume, variety and speed of data collection), and by the fact that product-IT has mostly been considered separately from EA. Advancement in the area of Big Data helped to overcome the first challenge (Schmidt et al., 2014), whereas overcoming the second challenge still requires finding a way to deal with enterprise-IT and product-IT in an integrated manner. Even though the areas of EA, EAM, and product-IT have attracted a lot of research interest during the last 10 years not much work has been done on their integration, i.e. positioning product-IT into EAM consideration. Therefore, there is a clear need for new mechanisms to deal with product IT and enterprise-IT in an integrative way. Therefore, the research question that I would like to answer in my doctoral thesis is the following:

How can participative EM help to achieve BITA when integrating product-IT and enterprise-IT?

The remainder of this doctoral consortium paper is structured in the following way: Section 2 describes the planned research approach. In section 3 the relevant theories are

described, which come from BITA, EAM and EM areas. The results derived so far are presented and discussed in Section 4.

2 Research Approach

In the first part of my doctoral studies I have investigated the role of participative EM in BITA. Starting from answering the research question *"How can EM contribute to BITA?"* in my licentiate thesis, I generated a framework that includes a number of challenges and recommendations for practitioners for using participative EM when dealing with BITA issues. However, the research question has been modified after presenting the licentiate thesis. It became obvious that the original research question should be narrowed down to make more focused investigation possible. The domain of EM application has to be taken into account, which brought current misconnection of enterprise-IT and product-IT into play.

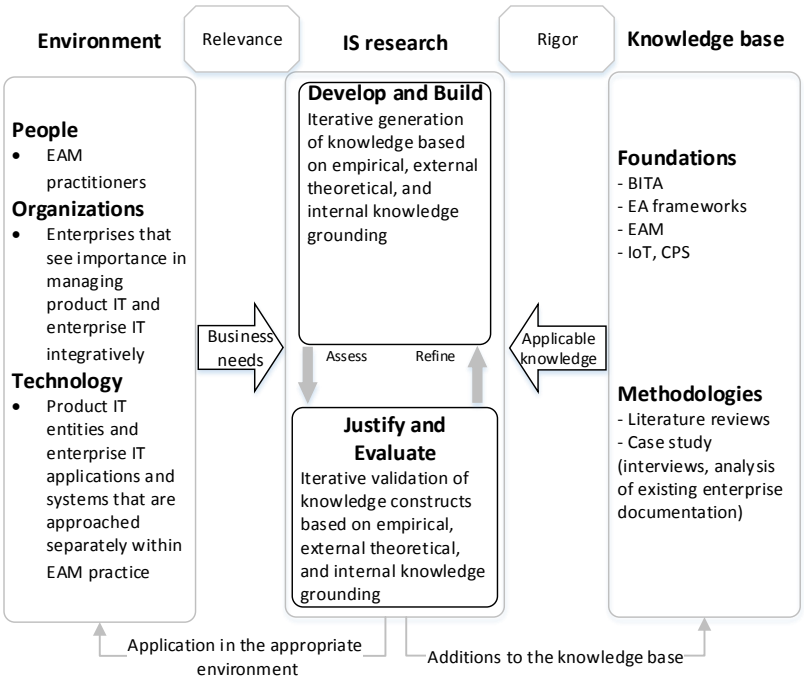

Fig. 1. Design science research approach aimed to answer the main research question

In order to answer the research question introduced in Section 1 this study will follow iterative research approach based on design science paradigm (Figure 1). Design science is used in IS research to acquire knowledge and seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts (Hevner et al., 2004). This study aims to come up with an integrated way for dealing with product-IT and enterprise-IT through designing a new artifact – a framework, which will be addressed as the central artifact of this study. Artifacts are constructs,

models, methods and instantiations that are built to address unsolved problems (ibid). The artifacts are supposed to be evaluated regarding the utility provided in solving those problems. Among four types of artifacts that design science deals with, this study had an aim to generate a model that integrates product-IT and enterprise-IT within the frame of EAM. To a certain extent this study also aimed at generating a method, since it will identify a set of prescriptive best practices for EAM.

The need for this study is generated by environment, and the applicable knowledge for carrying out the study is provided by knowledge base (adapted from Hevner et al., 2004). The problem space for IS research is defined by environment, which is composed by people, organizations and technologies (existing or planned). People have different roles and capabilities within organizations. Roles that are considered within the scope of this study are practitioners from IT domain within an enterprise, having various responsibilities within EAM. From the other side IS research is supported by knowledge base, which is composed by foundations and methodologies. Foundations are existing studies in the field, whereas methodologies provide guidelines that can be used in Justify and Evaluate phase. Applying chosen foundations and methodologies enables achieving rigor in research. This study will use both foundations and methodologies. Foundations are existing theories in the domains of EAM, BITA, existing EA frameworks and other related areas such as IoT and CPS. Foundations for this study are briefly described in section 3. Methodologies used during this study are literature review and case study. The case study will employ data collection techniques such as interviews and review of the existing enterprise documentation. Some details regarding the case study are presented in section 2.1.

2.1 Case study

Planned case study can be classified as exploratory, i.e. I would like to explore the phenomenon of product-IT and enterprise-IT in its natural organizational context. The focus of the case study is the product-IT enterprise-IT integration from an architectural and a management perspective. The architectural perspective addresses commonalities in structure and components of product-IT and enterprise architecture. The management perspective concerns procedures for architecture development, implementation and maintenance. So far, provided enterprise documents of the case study company (Husqvarna Group AB) have been analyzed and the first round of interviews have been performed (June 2016). More interviews will follow. The interviews took place during the initial stage of the project "Project-driven Enterprise Architecture Management (PdEAM)", in which Husqvarna Group AB has been involved as an industrial partner. Nine respondents, Husqvarna employees, have been interviewed. Another industrial partner yet to be studies in this project is Skye Consulting AB.

The first industrial enterprise is Husqvarna Group AB. Husqvarna is a producer of outdoor power products including chainsaws, trimmers, robotic lawn mowers, garden tractors, watering products, cutting equipment, and diamond tools for the construction and stone industries. Husqvarna is multinational and offers products and services for both the private and industrial market. Husqvarna is right now in a transformation

process aiming at embracing the emerging trends that's been presented above in order to stay competitive and to deliver improved value to different stakeholders.

3 Relevant Theories from the Problem Domains

In this section some relevant theories from the problem domains are presented. First, general description of the BITA problem and its various dimensions are introduced in sub-section 3.1. After this, theories regarding EA and IoT are presented in sub-section 3.2, and the participative EM – in sub-section 3.3.

3.1 Business and IT alignment and its Dimensions

According to Chan and Reich (2007) there are several dimensions of alignment: strategic, structural, social, and cultural. The strategic refers to the degree to which the business strategy and plans, and the IT strategy and plans, complement each other. The structural dimension refers to the degree of structural fit between IT and the business that is influenced by the location of IT decision-making rights, reporting relationships, decentralization of IT, and the deployment of IT personnel. This dimension also provides understanding about enterprise-IT as such. It is important to consider product-IT when discussing BITA, which in the existing connotation of BITA is still mostly omitted.

The social dimension refers to the state in which business and IT executives within an organizational unit understand and are committed to the business and IT mission, objectives, and plans. The cultural dimension refers to the need of IT planning to be aligned with cultural elements such as the business planning style and top management communication style. Achievement of BITA requires analysis and improvement of all BITA dimensions. On one hand, there is a need for accurate and up-to-date representation of an enterprise from various perspectives, as it enables alignment of the considered perspectives. On the other hand, BITA achievement requires to deal with numerous points of view of involved stakeholders and create a shared understanding between them.

3.2 Enterprise Architecture Management

Ahlemann et al. (2012) define EAM as a management practice that establishes, maintains and uses a coherent set of guidelines, architecture principles and governance styles that provide direction and practical help in the design and development of an EA to achieve enterprise's vision and strategy.

Facing opportunities and challenges derived from the IoT revolution, business leaders need new ways to conduct effective strategic decision towards IoT business (Li et al., 2012). The impact of IoT on enterprise systems in modern manufacturing is discussed by Bi (2014). They claim that IoT infrastructure can support information systems of next-generation manufacturing enterprises effectively. Data acquisition systems are suitable to be applied in collecting and sharing data among manufacturing

resources. However, they claim that the application of IoT in enterprise systems are at its infant stage, more research is required in modularized and semantic integration, standardization, and the development of enabling technologies for safe, reliable, and effective communication and decision-making. Considering the potential gains that IoT has to offer, Chan (2015) has presented a new business model that can be more suitable for organizing business at IoT age. This and other new business models emerging at IoT age have its impact on EAM practice.

Winter et al. (2010) emphasize the lack of research regarding EA management and argue that there is neither a common understanding of the scope and content of the main activities in EA management, nor has a commonly accepted reference method been developed. On the same time, EAM currently concentrates on enterprise-IT side including number of its layers (see Figure 2). Product-IT, i.e. what is built into the products or supporting industrial automation is currently outside of EAM consideration.

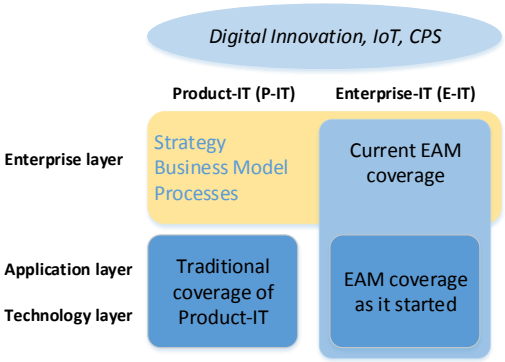

Fig. 2 Roles of enterprise-IT and product-IT in EAM

One potential benefit of such integration can be an ability to conveniently access to the data that a vast number of product-IT instances collect during their operation. Potentially, Enterprise Architecture Management (EAM) can serve as a mean to support both, continuous alignment of business and IT, and the integration of product-IT and enterprise-IT. It motivates the need for new reference models and methods related to EAM.

3.3 Participative Enterprise Modeling

EM is a practice for developing, obtaining, and communicating enterprise knowledge, like strategies, goals and requirements to different stakeholders (Sandkuhl at al., 2014). 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 also increases the validity of models (Sandkuhl et al., 2014; Barjis, 2011). The participative approach also implies involvement of stakeholders in modeling for better understanding of enterprise processes (Sandkuhl et al., 2014). Participative EM has a strong role when it comes to social and cultural dimensions of BITA (Kaidalova, 2015).

4 Preliminary Results

This section will focus on the results of the case study collected so far. The results generated contain number of challenges that practitioners pointed out during the first round of interviews. Several quotations are presented together with discussion below.

Husqvarna produces various products for personal and professional usage. Many of the Husqvarna products for professional customers do not only have built-in electronics or embedded systems but also networking and communication abilities. The built-in IT is in many cases used for controlling the different mechatronic components of the product and for collecting information when the product is in use, either about performance parameters or used product features, or about the environment of the product. The networking features are used for communicating usage statistics, license information or location information (if anti-theft features are activated) to either the product owner or the back-office of the producer. Other functions are software upgrades and functionality add-ons implemented by configuration changes (e.g. for optimizing energy consumption).

Since many of the products offer similar functionality regarding networking and communication, Husqvarna designed and implemented reusable services and components for either the product or the back-office infrastructure which comprise an IT and service architecture for the product-IT. In this context the difference between a license management services - to take one example - for product licenses (in product-IT) and software licenses (in enterprise-IT) has to be discussed. Can both service types be based on the same technical infrastructure and use the same encryption and logging services? If so, why not define common EA elements on application architecture level for product-IT and enterprise-IT?

"Maintenance is a part of Project A today, but maintenance is used in several other projects as well. It is internal maintenance, so we can have a maintenance service. In this way we do not have to implement the maintenance service in Project B anymore."

A core challenge for Husqvarna to handle the integration of product-IT and enterprise-IT is to handle the bimodal dimensions of the IT lifecycle. 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. To handle this Husqvarna is implementing DevOps Teams designed for agility, rapid development and short time to market. Today Husqvarna experience a clear tension between Mode 1 and Mode 2.

"Enterprise architect would like to think ahead of things, which is good. But they have to understand that we at software development side have to focus on a short time, we have to deliver. That is a challenge."

Among other specific challenges in relation to the bimodal dimensions of IT Husqvarna is also facing challenges in: governance and responsibilities between research and development and IT; increasing the speed and finding suitable methods to support agile teams; existing EAM frameworks such as TOGAF do not work in real-life; balancing governance and support between product-IT and enterprise-IT; lack of frameworks to describe IT technology stacks for IoT and Digitization; handling cyber security and data security legislation.

Future work will include continued data collection in the case study. Interviews and workshops with more people from software development side for Husqvarna products and from the enterprise-IT side are planned. Furthermore, a second case study in cooperation with the other industrial partner in the PdEAM project, Skye Consulting, is planned, which will be directed towards turbine manufacturing of one of the world leading companies in this field.

References

1. Ahlemann, F., Stettiner, E., Messerschmidt, M., & Legner, C. (2012) Strategic Enterprise Architecture Management. Berlin Heidelberg: Springer Verlag.
2. Barjis, J. (2011). CPI Modeling: Collaborative, Participative, Interactive Modeling. In: Jain, S., Creasey, R.R., Himmelspach, J., White, K.P., & Fu, M. (Eds.) Proceedings of the 2011 Winter Simulation Conference (pp. 3099-3108). IEEE, Piscataway, NJ.
3. Bi, Z., Xu, L.D., Wang, C. (2014). Internet of Things for Enterprise Systems of Modern Manufacturing. IEEE Transactions on Industrial Informatics, 10(2), 1537-1546.
4. Chan, H.C.Y. (2015). Internet of Things Business Models. Journal of Service Science and Management, 8(4), 552-568.
5. Chan, Y. E., & Reich, B. H. (2007). IT alignment: what have we learned? Journal of In-formation Technology, 22(4), 297–315.
6. Chen, D., Doumeingts, G., Doumeingts, F. (2008). Architectures for enterprise integration and interoperability: Past, present and future. Computers in Industry, 59(7), 647–659.
7. Engelsman, W., Quartel, D., Jonkers, H. & van Sinderen, M. (2011). Extending enterprise architecture modelling with business goals and requirements. Enterprise Information Systems, 5(1), 9-36.
8. Hevner, A.R., March, S.T., Park, J., Ram, S. Design science in information system research. MIS Quarterly, 28(1), 75-105.
9. Jonkers, H., Lankhorst, M., van Buuren, R., Hoppenbrouwers, S., Bonsangue, M., & van der Torre, L. (2004). Concepts for modelling enterprise architectures. International Journal of Cooperative Information Systems, 13(3), 257–287.
10. Kaidalova, J. (2015) Towards a definition of the role of enterprise modeling in the context of business and IT alignment, Informatics. Licentiate Dissertation, ISBN 978-91-981474-6-9
11. Li, Y., Hou, M., Heng Liu, Liu, Y. (2012). Towards a theoretical framework of strategic decision, supporting capability and information sharing under the context of Internet of Things. Information Technology and Management, 13(4), 205-216.
12. Luftman, J. (2003). Assessing IT-Business Alignment. Information Systems Management, 20(4), 9-15.
13. Sandkuhl, K., Stirna, J., Persson, A., & Wissotzki, M. (2014) Enterprise Modeling – Tackling Business challenges with the 4EM method. Berlin Heidelberg: Springer Verlag.
14. Schmidt, R., Möhring, M., Wißotzki, M., Sandkuhl, K., Jugel, D., & Zimmermann, A. (2014). Towards a Framework for Enterprise Architecture Analytics. Proceedings of the 18th IEEE International Enterprise Distributed Object Computing Conference, Workshops (EDOCW).
15. Silvius, A. J. G. (2009). Business and IT Alignment: What We Know and What We Don't Know. The proceedings of International Conference on Information Management and Engineering, 558-563.
16. Winter, K., Buckl, S., Matthes, F., Schweda, C. M. (2010). Investigating the state-of-the art in enterprise architecture management method in literature and practice. The proceedings of the 5th Mediterranean Conference on Information Systems, Paper 90.