Modeling the supply and demand of architectural information on enterprise level

Sabine Buckl
Technische Universität München
Lehrstuhl für Informatik 19 (sebis)
Boltzmannstr. 3, 85748 Garching, Germany
Sabine.Buckl@mytum.de

Andreas Gehlert
Federal Ministry of the Interior
Alt-Moabit 101 D
10559 Berlin
Andreas.Gehlert@bmi.bund.de

Florian Matthes
Technische Universität München
Lehrstuhl für Informatik 19 (sebis)
Boltzmannstr. 3, 85748 Garching, Germany
Matthes@mytum.de

Christopher Schulz
Technische Universität München
Lehrstuhl für Informatik 19 (sebis)
Boltzmannstr. 3, 85748 Garching, Germany
Christopher.Schulz@mytum.de

Christian M. Schweda
Technische Universität München
Lehrstuhl für Informatik 19 (sebis)
Boltzmannstr. 3, 85748 Garching, Germany
Christian.M.Schweda@mytum.de

***Abstract*— Enterprise architecture (EA) management aims at analyzing and improving the enterprise as a whole. A correct and consistent analysis is based on reliable EA data. However, current industrial practice shows that many persons need to collect, prepare, and disseminate EA relevant data while only a small group of persons actually benefits from this information. This state of affairs has a negative impact on the motivation of those who are in charge of gathering EA information. Additionally, the monetary value of this information is often implicit. To overcome this situation, this paper presents an approach to model the supply and demand situation for EA information. The resulting model helps to understand, explain, and ease EA-related information gathering. The applicability of the resulting model is demonstrated with the help of a real world case study from the German federal government.**

Enterprise architecture management, enterprise architecture, information demand modeling, information supply modeling

I. MOTIVATION

Today's globalized and highly competitive business environments lead to an increasing frequency of changes of modern enterprises. These constant changes combined with new laws and regulations result in a high internal complexity of the socio-technical system of these enterprises. Originating from the field of information systems architecture [36], enterprise architecture (EA) management represents a promising and commonly accepted instrument to cope with this complexity and to foster business-IT alignment [17, 25]. According to the ISO Standard 42010, an EA is the "fundamental organization of a system [enterprise] embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" [13]. Given this definition, EA management takes a holistic perspective covering all areas of an enterprise from business and organizational via application and information to infrastructure and data aspects.

Today's EAs are developed and maintained by different stakeholders who in turn rely on sound and up to date architectural information. Such architectural information may contain information on the hosted business applications, operating infrastructure components, business processes, and the relations between these entities. These entities and relations may represent current (as-is), planned (to-be) and target (envioned) states of an architecture [14, 27, 33].

Gathering, maintaining, and disseminating EA information as part of EA management is time-consuming and expensive, because relevant data is usually contained in different data sources (e.g. CMDBs, process modeling tools, excel spreadsheets, and data bases) with varying data quality [4]. In particular initiating EA management entails a high workload since information sources have to be identified and assessed before the data can be collected. Additionally, stakeholders may have no clear understanding of the actual information need or common understanding or relevant concepts.

The discussion with our industry partners revealed that a large enterprise easily has 2000 or more business applications hosted at separated organizational units with different

contact persons. These numbers demonstrate that building a solid information base usually entails a significant amount of work.

Concrete numbers on the return on investment of EA management are mixed. While Niemann speaks of a breake-ven point of three months on average [20], Ross estimates that a company needs two to six years to fully implement the cultural and technical changes caused by the introduction of EA management [24].

Quick-wins and short-term benefits of EA management are difficult to achieve. Therefore, it is challenging to ensure the stringent implementation of an EA management function. One challenge on this path of a stringent implementation of an EA Management functions is to understand the communication flows between the providers and consumers of architectural information. This paper focuses on this challenge.

EA information is typically provided and demanded by different persons. The number of information providers may exceed the number of information consumers and/or the number of information providers is unknown. This may result in a lack of motivation and reluctant behavior on the information providers side since the monetary value of documenting, analyzing, and communicating relevant EA information cannot be made explicit. In addition, the overall provisioning costs for EA information are only transparent to the information provider, who rarely receives consumer's feedback. This situation may be deteriorated when too complex and too abstract EA models are implemented (reflecting the so-called "ivory tower syndrome" as alluded to in [33]).

In sum, the introduction of an EA management function comes with the following challenges:

- distributed information sources;
- high initial expenditures due to identifying relevant data sources;
- high costs for collecting relevant and high-quality data;
- unclear information supply and demand;
- and lack of short term benefits of EA management.

Applying models to illustrate current and future information demand and supply can be helpful to prevent the before-mentioned challenges. In this paper we propose how such a model should be constructed by addressing the following problems:

- How can the demand for and supply of EA information be made transparent in an enterprise?
- How should this information supply and demand be visualized?
- What are possible relationship constellations among stakeholders reflecting the different EA information dependencies?

The paper adheres to a design science research paradigm following the five step approach as proposed by [26], namely: need identification, building, evaluation, learning, and theorizing. The need for modeling the demand and supply situation for EA-related information has been identified from the literature as described above. It was confirmed by several industry partners, and is further backed by Section II where relevant literature in the field of EA management and related disciplines is examined. Section III sketches a model to make the demand and supply situation transparent. Besides a graphical representation this section also suggests several types of information dependencies among the stakeholders. A first step towards an evaluation is performed in Section IV, which demonstrates how the suggested model can be applied in practice in a real-world example from the German federal government. The paper concludes with a critical reflection on the findings including the lessons learnt from the application scenario and a discussion of future areas of research.

II. Related Work

With the growing importance of the topic of EA management in recent years [16] many methods and models have been proposed by researchers, practitioners, and standardization bodies [1, 12, 20, 32]. These approaches typically distinguish between the following activities for EA management: describing the current state of the EA, developing envisioned target states and intermediate planned states (roadmaps), communicating and enacting EA descriptions, and analyzing and evaluating different states [8]. Questions, how to gather the corresponding information, are frequently discussed and different techniques, e.g. for documenting the current state, are provided. However, the proposed approaches do not address the challenge of having multiple information sources and information consumers as the approaches do not analyze the dependencies between information providers and consumers.

Information supply in EA management is closely related to the question of the 'right' level of detail, which has been repeatedly discussed in academia [1, 2, 5, 19]. In [19] the authors present six EA management process patterns for documenting the EA or parts thereof. The authors discuss the need to clearly understand, which parts of the EA have to be documented and who performs which documentation activities. When the patterns are applied in practice, the described tasks are assigned to concrete actors in the enterprise. These approaches describe the information supplier side but the information itself and their consumption are not analyzed.

In [12] a general decentralized approach to EA maintenance is described. The maintenance process consists of ten tasks, which are executed by different actors. The actor 'EA stakeholder' consumes and acknowledges the relevant architectural information, which is supplied by the 'data owner'. The approach highlights that the information consumer should be satisfied with the provided information. However, the approach does not provide mechanisms to specify, which

information is exchanged and does to specialize the general actor role 'data owner' to specific roles for dedicated parts of the EA. Furthermore, the approach assumes a strictly sequential process of information gathering followed by information use. In practice such activities are often iterative and are executed synchronously.

In [15] stakeholders' perceptions of the EA and the importance of stakeholder-specific EA viewpoints are discussed. These viewpoints should be designed to convey the specific EA information that a group of stakeholders requires. In this sense the embracing and comprehensive EA model is separated into relevant parts (areas-of-interest) that are relevant to a limited group of users. Such perspective on EA modeling is helpful to analyze information demands. However, [15] does not discuss the information provision, and hence cannot be used to understand the informational dependencies.

The Open Group Architecture Framework (TOGAF) provides both a method for architecture description – the *architecture development method* (ADM) – and a model – the *content framework* – describing the elements to be documented [32]. In all phases of the ADM certain information is required to create the desired outcomes. TOGAF further proposes a technique dedicated to stakeholder management, which is intended to be used "to win support from others" [32]. The techniques proposed encompass a classification of stakeholders in high, medium, and low priority and a so-called *stakeholder power grid* [32], representing the level of interest on one dimension and the power of the respective stakeholder on the other. The stakeholder power grid is then enhanced to a *stakeholder map*, which lists each stakeholder, her/his organizational position, her/his involvement in the EA management endeavor, viewpoints relevant for her/him, and behavior guidelines (e.g. keep satisfied, keep informed, or key player). TOGAF provides means and methods to deal with stakeholders, whose concerns should be addressed. TOGAF does not explain which stakeholders provide information and which stakeholder consume information.

Besides the different approaches undertaken to address the challenge of *supply and demand* in the context of EA management, related domains, such as goal modeling, knowledge management and general information modeling, have developed their own techniques, which may be helpful here. Selected prevalent approaches are discussed subsequently.

i* and its derivates such as Tropos were explicitly designed to model and analyze stakeholder dependencies [3, 11, 35]. In its current form the i* model consists of two submodels: the *strategic dependency* (SD) and the *strategic rationale* (SR) model. The former describes dependencies between actors in terms of *depender*, *dependee*, and *dependum*, i. e. the (soft) goal, tasks, or resource via which they influence and relate to each other. These dependencies are further explained in the SR model, by detailing on the intentionally desired elements for each of the corresponding actors. The following types of dependencies are supported by i*: Two actors can depend via goals where the depender needs the dependee to get the goal fulfilled; tasks where the depender relies on the dependee for getting a task executed; resources where the depender needs the dependee to provide a certain artifact, or softgoals where the dependee can satisfy a not-measurable goal of the depender. For our context of a supply and demand analyses especially the artifact-related dependencies, i.e. the ones based on the exchange of (informational) resources, are of particular relevance.

To address the supply and demand challenge, a knowledge management (KM) approach might be interesting. The authors of [7] and [31] revisit the topic of EA management based on the KM cycle of [23]. The cycle of [23] consists of several building blocks for KM, reflecting typical activities that are carried out to avoid knowledge problems such as the supply and demand challenge discusses before. The KM cycle encompasses two cycles, namely an outer cycle consisting of goal setting, implementation, and measurement and an inner cycle detailing the implementation activity into identification, acquisition, development, distribution, preservation, and use activities. In the context of the research gap identified in the motivating section, the building blocks *knowledge acquisition* and *knowledge use* are revisited in more depth: *Knowledge acquisition* assumes that an organization is not capable to build up and maintain all needed know-how. Therefore, knowledge is imported over different import channels like stakeholder participation, consulting by experts, and acquisition of external companies holding the respective knowledge. *Knowledge use* forms the actual purpose of KM and refers to the application of knowledge in the production process of an organization. This statement can be reformulated in the EA domain as follows: knowledge use refers to the application of knowledge in a particular process, e. g. a management process, of an organization. Accounting for the explicit distinction between participants in knowledge acquisition and knowledge use, the model proposed in Section 3 uses parts of Probst's KM cycle.

In their book on information modeling, [22] define the term *information demand* as "type, quantity, and quality of information, which is required by a person to complete a specific task in a certain amount of time" (translated from German). Thereby, the authors distinguish between two types of demand: the subjective and objective demand for information. The subjective information demand is the demand of an actor fulfilling his/her individual tasks. Objective information demand denotes all pieces of information to handle the entire task. Going further, [30] compares (subjective/objective) information demand and supply, showing that even if there is an overlap between the subjective and objective type, both sets can be considered as being partially disjoint. The distinctions of the authors when describing information demand and supply provide a good starting for addressing information related questions in the domain of EA management.

The different methods and techniques presented above provide helpful insights into the field of information-related interplay between information consumers and providers. Therefore, we use the following elements of the related work when modeling the information supply and demand for EAM:

- Distinction between information suppliers and information consumers
- Relation between stakeholders and their concerns
- Informational dependencies between information consumers and information suppliers via exchanged information resources
- Influences of goals and softgoals on information exchange

III. APPROACH

We approach EA-induced dependencies between information consumers and providers from a modeling perspective. Firstly, we propose a conceptual model for making the information demands and supplies as annotations to EA information models explicit (the meta-models for creating EA descriptions). Secondly, we describe how annotated models and in particular the described information dependencies can be analyzed. We also discuss a classification of organizational situations derived from particular dependency structures that exemplify possible organizational interventions.

A. *Modeling EA information provision and consumption*

According to the ISO standard 42010 [13] central conceptions in describing and modeling architectures are stakeholders, their concerns, and their relationships. A stakeholder is an information consumer, interested in a particular part of the enterprise. Each concern can be identified with a particular conceptualization of the enterprise [6]. In other words, the concepts that are used to describe the EA should be derived from these concerns. This means that a concern induces concepts like "business application" or "business process" and in turn describes the information of interest to a consumer. The conceptualization is a purely mental construct reflecting how the consumer understands the enterprise.

In addition to that, the concern further specifies not only the concepts to be used but also the part of the enterprise, to which these concepts are applied. For instance, a consumer may be interested in business applications "that are hosted in Germany" instead of being interested in business applications in general. When modeling such concepts, an instance-level filtering is needed to address these before-mentioned concerns.

We subsequently move from the mental construct of the conceptualization to an explicit counterpart, the viewpoint. Following the argumentation of [6] a viewpoint identifies a modeling language, i.e. entails modeling language concept for the corresponding part of the enterprise and denotes the aforementioned filtering on instances. In this sense a discussion on the information demands can rely on viewpoints made explicit via modeling constructs and instance-level filters, e.g. via EA information models and filtering rules. A mechanism for defining filtered viewpoints is discussed in [6]. Therefore, a technique to model information demands must allow linking information consumers to modeling concepts in the information model and allow restricting the consumer's access only to those parts of the corresponding modeling elements in the actual EA description, which are in his/her focus.

A similar argumentation applies for the information providers that can supply information committing to certain modeling concepts in the EA information model, but can restrict their provision only to modeling elements having additional properties. Figure 1 shows the meta-modeling stack behind EA information modeling, and shows the relationships between the information consumers and providers, respectively.

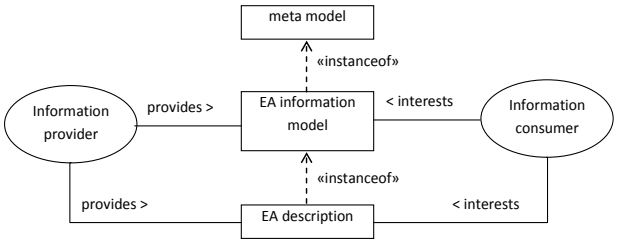

Figure 1. EA meta-modeling stack related to information providers and consumers.

Both information demands and information supplies can be covered on the level of the EA information model using a modeling technique that relates types (classes) to consumers and providers. Such relationship is described in terms of the corresponding meta-model. Figure 2 illustrates the modeling of information consumers' interests.

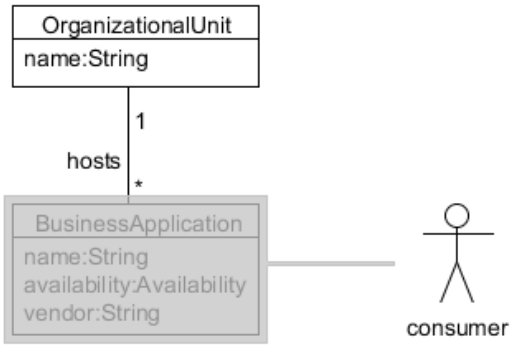

Figure 2. Modeling an information consumer's interest in business applications

While the above model covers the *intention* of information demands and supplies, a similar modeling cannot be achieved on the level of the actual modeling elements (the

instance level). An explicit link starting from a consumer or producer could only be attached to a currently existing instance, whereas the actual demand or supply can pertain to yet not modeled instances. In this sense, link-based techniques are inherently confined to cover the current interests, but cannot make statements on the interests in modeling elements that will be modeled later. Such interests can nevertheless exist and can originate in the nature of the modeling element, i.e. in its underlying concept. To address this issue, we adopt a technique provided by the OMG's Query View Transformation (QVT) specification [21]. In this specification filters are described as *QVT templates*. A provider information supply is in this sense linked to an *ObjectTemplateExpression*, which denotes an instance of a particular class from the information model. The template expression relates one or more *PropertyTemplateItems* that specify the instance level filter. Each *PropertyTemplateItem* relates a particular property of the class to an expression denoting the admissible values. Exemplified along Figure 3 the provider relates to one *ObjectTemplateExpression* of class "BusinessApplication" containing one *PropertyTemplateItem* of property "availability" relating to value "high".

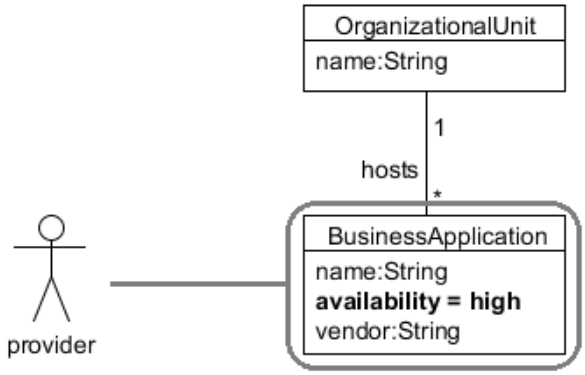

Figure 3. Modeling an information provider's supply of information about business applications

Above we denoted the syntax of a modeling technique that can be applied for the context of describing the information demands and information supply relationships. Such a technique can easily be extended to cover also potential information demands and supplies via specialized relationships.

B. *Graphically analyzing the consumer-producer relationships*

In the preceding section, we established a technique for modeling the relationships between concepts in EA information models (represented via types, attributes, and relationships) and their corresponding information providers as well as consumers, respectively. Based on this technique, we discuss how to visualize the corresponding relationships: Firstly, a more coarse-grained point of view employs concept-level relationships, i.e. those relationships between information model classes and information providers or consumers. Figure 4 displays such visualization backed by a UML-based notation for the information model.

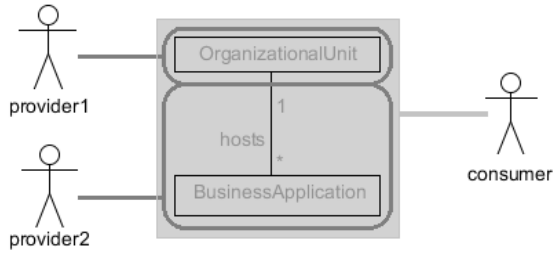

Figure 4. Modeling consumer-producer relationships on model concept level

Secondly, a different form also accounts for instance-level filtering, i.e. depicts the relationship between information providers and consumers based on the providers' consumers' corresponding filters. The relationships are derived from the intention of the demands and the supplies, which means that a relationship holds, when the supply partially or completely covers the demand. On the level of the instance filters, partial coverage entails that one model template is more restricting than another one. Exemplified along the Figure 3, a demand targeting high-availability business applications of vendor "SAP" partially covers the displayed information supply. Figure 5 gives an exemplary visualization for the relationships between information providers and consumers. Building on such visualization, the information-base relationships between different actors in the EA environment can be analyzed. In particular, an *information dependency* is described, denoting which information consumers depend on the input of which information suppliers.

C. *A classification of organizational situations*

Juxtaposing the information dependencies with the organizational control structures in the enterprise allows analyzing, which dependencies are organizationally supported. In particular, the following relations between organizational control and information dependencies can exist, which we use to classify the different organizational situations of an organization:

- "Line-of-control": The information consumer is a (direct) superordinate of the information provider, thus being able to directly demand the information from the corresponding provider. In this case we speak about an alignment of organizational control and information dependencies.
- "Tits-for-tats": The information consumer can exchange information needed for one concern with information provided for another. Such case applies, when circular information dependencies exist, or if such dependencies are mediated over organizational control relationships. In the latter case, an information consumer's subordinates would be respon-

sible for providing information A to the (prospective) provider of the information B.
- "Social competition": The information consumer can raise peer-level competition between the information providers. Such situation exists, if the consumer is in a well-respected but not empowered role, being able to create transparency about information provision by the equally leveled information providers.

Above classification of possible types of organizational situations derived from information dependencies can be used to decide for the most appropriate supportive organizational implementation. Section IV describes how "social competition" can be used to realize information supply. If the analysis of the situation does not reveal one of above types, a different approach to control information dependencies can be taken, e.g. by implementing financial rewards for timely information supply.

IV. EXEMPLARY APPLICATION OF THE APPROACH – A CASE STUDY FROM THE PUBLIC SECTOR

In the following, we present the application of the information provision and consumption approach in a real world case study from the public sector in Germany. In 2007 the German federal government expressed the political intention to enhance the efficiency of their IT and to introduce an active enterprise architecture management (cf. [9, 10]). The German federal government consists of nearly 350 agencies working collaboratively. Due to the great number of agencies and the considerable amount of software systems used today, services were introduced to abstract from this complexity. By services we understand a set of requirements for a software system, which is in turn realized by such a system. The following questions were of particular interest to the project team:

- *Which services are required by the individual public authorities in the future?*
- *Which IT solutions are currently offered to implement these services?*

When tackling these questions the project team was confronted with another specialty of the German government: By constitutional law the government's federal agencies are independent from each other. Due to the lack of a central control and power over these agencies the data collection for the initial enterprise architecture work is challenging. Relevant stakeholders (information consumers) need to be identified and managed. For this purpose four different stakeholder groups were considered relevant:

- *Decision makers* decide in their domain whether an IT solution is required and decide which software product is used.
- *Business responsibles* define the demands from a business perspective and elicit the qualitative requirements for a service, which is implemented via an IT solution.
- *Developers* are responsible for the technical implementation of a service in an IT solution. They realize the requirements from the business departments.
- *Operation responsibles* are accountable for operational service provision and realization.

The individual public authorities are information providers. According to the independent role of the public authorities, the role of information provider is not further detailed to specific roles within the public authorities. Therefore, only one information provider concept can be identified on 'class level' while a multitude of information providers on 'instance level' exist, e.g. the Federal Ministry of the Interior (BMI), Federal Ministry of Finance (BMF). Taking into account the different stakeholders and the information demand, Figure 5 illustrates the resulting consumer-producer relationship.

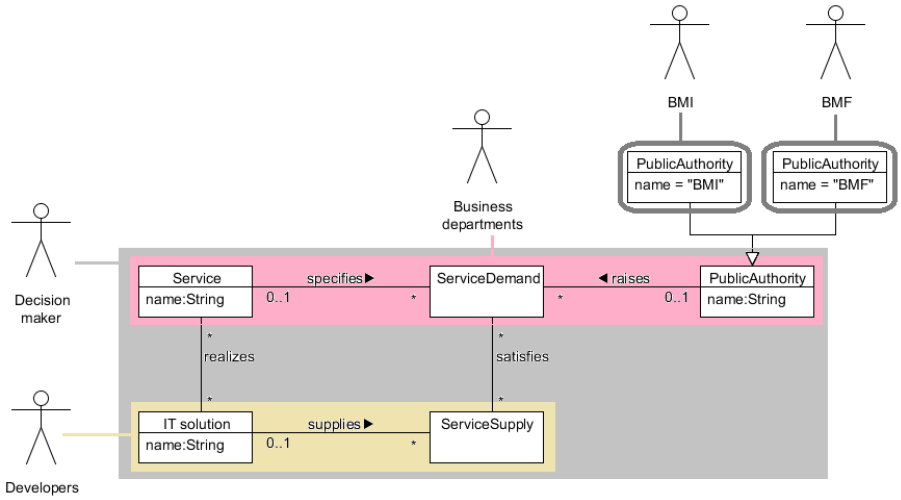

Figure 5. The consumer-producer relationship model of the case study

Comparing the above dependency model with the organizational control structures, it becomes clear that no direct control structures are available or can be established in the case study (due to the independence of the different agencies). Therefore, *social competition* was chosen as enabler, i.e. a public website was set up on which the public authorities could specify their information demand to allow the service provider to offer IT solutions. In addition, the transparency of consumer-producer-relationships enabled on the one hand direct contacts for missing information and on the other hand made the need for that information transparent.

V. Conclusion and Outlook

In this paper we developed a new model for depicting the demand and supply situation for information in EA management. The need for such a model is confirmed by both – current literature in the area of EA management and industrial experience. Based on these demands, we sketched a conceptual model to make the consumer-producer dependencies transparent (Section III). Furthermore, a classification schema for organizational situations is presented, which details different types of relationships among stakeholders and means of ensuring the information supply. The applicability of the approach has been evaluated in a real world case study form the public authorities in Germany described throughout Section IV. This case study served as a valuable example for implementing and evaluating the designed artifact. Since this case provided an introductory view on how the model can be beneficially applied in practice, we aim to encourage scientists to carry out further research especially when it comes to further evaluation and refinement of the model.

As discussed in the motivation section, this paper addresses one important challenge of EAM endeavors, namely the lack of transparency regarding information supply and provision. Future studies could concentrate on the aspect of information quality, by distinguishing for example between the accuracy, reliability, and actuality of a certain information fragment as well as the incorporation of this data within the model. In addition, the question of costs and benefits for providing certain EA information was only briefly discussed in this paper. Introducing and applying an underlying cost and reward model and integrating this information in the model can be considered as a logical consequence for enterprises that are currently struggling with the supply and demand situation for EA-related information. In this vein, we recommend to make costs transparent in the manner that a stakeholder is confronted with the effort producers put into the delivery of certain information. Addressing another EAM challenge, a provider may be motivated to keep on fostering the assigned EA information since the number of consumers as well as the utility and benefits are no longer uncertain.

It is also advisable to further refine the notion of stakeholders and suppliers. On the one hand, this can be achieved by splitting both groups into *current* and *potential* representatives. On the other hand the elaboration of a provider and consumer classification scheme should help to identify relevant stakeholders. Especially for the consumer group current EAM literature may be of great value given that it focuses on the beneficiaries of EA information (e.g. [15, 32]).

The article solely covers the aspect of current stakeholders who possess a specific information demand satisfied by current suppliers. Not treated are the groups of possible or potential producers and consumers who are not involved in the ongoing EA management initiative yet but who could help to either positively contribute to an information base or generate a higher demand for a certain piece of EA information. In particular persons who are simultaneously acting as producer and consumer could objectively assess the work required for such information as well as the benefit they gain through specific EA information. Another distinction can be made on the level of demand and supply as discussed by [30], differentiating between an objective and subjective form.

Furthermore, subsequent research could also take up a market-similar perspective on EA management where the market serves as an arrangement to allow the exchange and trade of EA information (representing the goods) between different participants (represented by EA information provider and consumer) who follow specific market policies which are derived from the organizational context. However, future studies could also cover social aspects among the participants, thus how to incentivize producers to sustainably provide up-to-date information and consumers to appreciate the work which has been carried out to satisfy their information need.

From a more technical viewpoint, the necessary transaction costs to store, update, or retrieve specific EA information should be examined in more detail. As of today, there is a wide selection of tools on the market supporting companies in carrying out their EA management [18]. Among other things, these tools vary in terms of type (e.g. rich client vs. web based), usability, and scope, which in turn may also have an impact on the costs stakeholders and providers may have when consuming or entering EA information.

References

[1] Aier, S.; Kurpjuweit, S.; Schmitz, O.; Schulz, J.; Thomas, A.; and Winter, R. (2008): An Engineering Approach to Enterprise Architecture Design and its Application at a Financial Service Provider. In Modellierung betrieblicher Informationssysteme (MobIS 2008) – Modellierung zwischen SOA und Compliance Management, 27.-28. November 2008 Saarbrücken. pages 115–130.

[2] Aier, S.; Buckl, S.; Franke, U.; Gleichauf, B.; Johnson, P.; Närman, P.; Schweda, C.M.; and Ullberg, J. (2009): A Survival Analysis of Application Life Spans based on Enterprise Architecture Models. In: 3rd International Workshop on Enterprise Modelling and Information Systems Architectures, Ulm, Germany.

[3] Bresciani, P., Perini, A., Giorgini, P., Giunchiglia, F., & Mylopoulos, J. (2004). Tropos: An Agent-Oriented Software Development Methodology. Autonomous Agents and Multi-Agent Systems, 8(3), 203-236.

[4] Buckl, S.; Ernst, A. M.; Lankes, J.; Matthes, F.; Schweda, C.M. (2009a): State of the Art in Enterprise Architecture Management -

2009. Technische Universität München, Chair for Informatics 19 (sebis), München, Germany.

[5] Buckl, S.; Ernst, A.M.; Matthes, F.; and Schweda, C.M. (2009b): How to make your enterprise architecture management endeavor fail!. In: Pattern Languages of Programs 2009 (PLoP 2009), Chicago.

[6] Buckl, S.; Gulden, J.; Schweda, C.M. (2010): Supporting ad hoc Analyses on Enterprise Models. In: 4th International Workshop on Enterprise Modelling and Information Systems Architectures, Karlsruhe.

[7] Buckl, S.; Krell, S.; Schweda, C.M. (2010): A formal approach to Architectural Descriptions - Refining the ISO Standard 42010. In: 6th International Workshop on Cooperation & Interoperability - Architecture & Ontology (CIAO2010), St.Gallen.

[8] Buckl, S.; Matthes, F.; and Schweda, C.M. (2009c): Future Research Topics in Enterprise Architecture Management - A Knowledge Management Perspective. In Workshop Trends in Enterprise Architecture Research (TEAR 2009), Stockholm.

[9] Buckl, S.; Matthes, F.; Schweda, C.M. (2010a): Towards a Method Framework for Enterprise Architecture Management - A Literature Analysis from a Viable System Perspective. In: 5th International Workshop on Business/IT Alignment and Interoperability (BUSITAL 2010), Hammamet.

[10] Bundesministerium des Innern und Bundesministerium der Finanzen (2008a): Das Konzept „IT-Steuerung Bund". http://www.cio.bund.de/cln_102/DE/Grundlagen_IT-Steuerung_Bund/CIO_Konzept/cio_konzept_node.html (cited 2010-12-08)

[11] Bundesministerium des Innern und Bundesministerium der Finanzen (2008b): Umsetzungsplan der IT-Steuerung Bund. http://www.cio.bund.de/cln_102/DE/Grundlagen_IT-Steuerung_Bund/UP_IT-Steuerung_Bund/up_it-rat_node.html (cited 2010-12-08)

[12] Castro, J., Kolp, M., & Mylopoulos, J. (2002). Towards Requirements-Driven Information Systems Engineering: The Tropos Project. Information Systems, 27(6), 365-389

[13] Fischer, R., Aier, S., and Winter, R. (2007): A Federated Approach to Enterprise Architecture Model Maintenance. In: Reichert, M., Strecker, S., and Turowski, K. (eds.). 2nd International Workshop on Enterprise Modelling and Information Systems Architectures – St. Goar/Rhine, Germany, p. 9-22.

[14] International Organization for Standardization (2007): ISO/IEC 42010:2007 Systems and software engineering – recommended practice for architectural description of software-intensive systems.

[15] Johnson, P. and Ekstedt, M. (2007): Enterprise Architecture – Models and Analysis for Information Systems Decision Making. Studentlitteratur, Pozkal, Poland.

[16] Kurpjuweit, S. (2009) Stakeholder-orientierte Modellierung und Analyse der Unternehmensarchitektur. PhD thesis. Universität St.Gallen.

[17] Langenberg, K.; Wegmann, A. (2004): Enterprise Architecture: What Aspect is Current Research Targeting? Technical report. Laboratory of Systemic Modeling, Ecole Polytechnique Fédérale de Lausanne. Lausanne, Switzerland.

[18] Lankhorst, M. (2005): Enterprise Architecture at Work: Modelling, Communication and Analysis. Springer, Berlin, Heidelberg, Germany

[19] Matthes, F., Buckl, S., Leitel, J., & Schweda, C. M. (2008): Enterprise Architecture Management Tool Survey 2008 (p. 278). Munich, Germany.

[20] Moser, C., Junginger, S., Brückmann, M., and Schöne, K.-M. (2009): Some Process Patterns for Enterprise Architecture Management. In: SE 2009 – Workshopband, Workshop on Patterns in Enterprise Architecture Management (PEAM 2009), Kaiserslautern.

[21] Niemann, K. D. (2006): From Enterprise Architecture to IT Governance: Elements of Effective IT Management (1st ed., p. 231). Wiesbaden, Germany: Vieweg Verlag.

[22] Object Management Group (2009): Meta Object Facility (MOF) 2.0 Query/View/Transformation (QVT) Version 1.1 - Beta 2, http://www.omg.org/spec/QVT/1.1/Beta2/PDF (cited 2010-11-29).

[23] Picot, A., Reichwald, R., Wiegand, R. T. (2001): Die grenzenlose Unternehmung - Information, Organisation und Management (4th ed.). Wiesbaden, Germany: Gabler Verlag.

[24] Probst. G. J. B. (1998): Practical knowledge management: A model that works. Arthur D Little PRISM, 1998.

[25] Ross, J. W. (2003): Creating a Strategic IT Architecture Competency: Learning in Stages. Social Science Research, Boston, MA, USA

[26] Ross, J. W., Weill, P., Robertson, D. C. (2006): Enterprise Architecture as Strategy. Harvard Business School Press, Boston, MA.

[27] Rossi, M., & Sein, M. K. (2003): Design Research workshop: A proactive research approach. Presentation delivered at IRIS 26, August 9-12, 2003, http://www.cis.gsu.edu/~emonod/epistemology/Sein%20and%20Rossi%20-%20design%20research%20-%20IRIS.pdf (cited 2010-11-25)

[28] Saat, J., Aier, S., and Gleichauf, B. (2009): Assessing the Complexity of Dynamics in Enterprise Architecture Planning – Lessons from Chaos Theory. In: Proceedings of 15th Americas Conference on Information Systems (AMCIS 2009), San Francisco.

[29] Schekkerman, J. (2005): The Economic Benefits of Enterprise Architecture (p. 296). Victoria, British Columbia: Trafford Publishing.

[30] Steenbergen, M. van and Brinkkemper, S. (2008): Modeling the Contribution of Enterprise Architecture Practice to the Achievement of Business Goals. In: Papadopoulos, G.A. Wojtkowski, W. Wojtkowski, W.G., Wrycza, S., and Zupancici, J.: Proceedings of the 17th International Conference on Information Systems Development (ISD 2008), Springer, New York, USA, p.609-618.

[31] Strauch, B. (2002): Entwicklung einer Methode für die Informationsbedarfsanalyse im Data Warehousing, PhD thesis, Universität Bamberg, Germany

[32] Struck, V.; Buckl, S.; Matthes, F.; and Schweda, C.M. (2010): Enterprise Architecture Management from a knowledge management perspective – Results from an empirical study. In: 5th Mediterranean Conference on Information Systems (MCIS2010), Tel Aviv, 2010.

[33] The Open Group (2009). TOGAF Version 9 – The Open Group Architecture Framework (TOGAF). http://www.togaf.org (last accessed 2010-11-22).

[34] Van der Raadt, B., Schouten, S.,van Vliet, H. (2008): Stakeholder Perception of Enterprise Architecture. Lecture Notes in Computer Science (Vol. 5292, pp. 19-34). Berlin, Heidelberg, Germany: Springer.

[35] Weill, P. & Ross, J. (2004): IT Governance: How Top Performers Manage IT Decision Rights for Superior Results. (1st, Eds.) (p. 269). Harvard Business Press.

[36] Yu, E. (1996): Modelling strategic relationships for process reengineering. PhD thesis, University of Toronto, Toronto, Ont., Canada.

[37] Zachman, J. (1992): Extending and formalising the framework for information systems architecture. IBM Systems Journal 31(3)