Supporting enterprise performance management with organization-specific indicators

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***Abstract*—The high complexity of the enterprise architecture (EA) management calls for decision support by organization-specific indicators for performance measurement. Many EA management frameworks and approaches were presented in last few years to support enterprise architects with the development of their EA management. Some of these approaches became well-accepted and defacto-standards in this field over the years. Nevertheless, enterprise architects still lack decision support by relevant KPIs for performance measurement in these frameworks. In this article, we outline the research questions arising, when organization-specific KPIs for concrete EA management goals are to be defined. We further sketch a possible solution for this problem as firstly outlining a development of a practice-proven KPI catalog for the measurement of EA management goals. Secondly, a so-called performance indicator definition language (PIDL), representing practice-proven computations, is introduced and concrete performance indicator definitions (PIDs) are derived from the developed KPI collection. These PIDs are then finally integrated with the building blocks for enterprise architecture management solutions approach of Buckl et al. to support the definition of organization-specific performance measurement.**

***Keywords*-Enterprise Architecture (EA), EA management, organization-specific indicator, metrics, measurement, key performance indicator (KPI), performance indicator definition language (PIDL), performance indicator definition (PID)**

I. Motivation

In the last decade, Enterprise Architecture (EA) and its management have received considerable attention from academics, practitioners, consultants and tool vendors. EA management targets the enterprise in an embracing manner and seeks to evolve the enterprise to facilitate the alignment of business and of information technology (IT). Therefore, EA management provides individual EA products - enterprise architectures. These architectures describe *"the fundamental organization of [the enterprise] embodied in its components, their relationships to each other, and to the environment"* [9].

Being a management discipline itself, EA management defines and pursues goals. Buckl et al. present in [3] a list of the key EA management goals, e. g., *reduce operating costs*, *ensure compliance*, *increase homogeneity* identified in a literature review in this field. Goals take an important role in the existing EA management frameworks (cf. Section II). For example, according to BEAMS [3], the development of an organization-specific EA management function requires concrete EA management goals as part of the input for this approach. In TOGAF [17], goals are also an important part of the required input for the ADM phases A and B. However, a link to related indicators or measures for the measurement of the achievement of EA management goals is missing in the existing frameworks (cf. Section II). This thesis is supported by the findings of Lucke et al. in [14].

According to many practitioners, the ability to measure the achievement of defined goals is becoming more and more important for existing EA management initiatives. The practitioners lack KPIs for a successful EA management. In particular, following two aspects are very important for the practitioners:

- Enterprise architects are currently taking decisions instinctively regarding the question how to ensure the achievement of their EA management goals.
- Involved stakeholder require clear defined, easy to understand and well-proven KPIs for communicating the performance, the current status and the future development of EA management initiatives.

In related management fields, e.g. IT project management (cf. [2], [11], [12]), IT risk management (cf. [11], [12], [13], [15]), practice-proven KPIs for common goals are well-known and widely accepted. Future EA management has to provide better information regarding the measurement of EA management goal achievement. Following research question question is to be answered:

RQ: How to support enterprise performance management with organization-specific indicators?

To ensure, that the complexity of the main research question remains manageable, following five sub research question are to be answered:

- *rq1:* What are best-practice KPIs for common EA management goals?
- *rq2:* What mathematical functions are used for computing these KPIs?
- *rq3:* Which data is required for these computations?
- *rq4:* How to ensure that required data is available?
- *rq5:* How to link KPIs with concrete EA management tasks?

Thus, the answer of research question RQ depends on the solutions of the five sub research question, i.e.,

$$RQ = rq1 + rq2 + rq3 + rq4 + rq5.$$

The reminder of this article is structured as follows. Section II outlines related frameworks and approaches in the fields of EA management and IT control. Section III provides an insight in our ongoing research activities regarding the aforementioned research questions. The last section IV concludes the paper with a short discussion and an outlook.

II. Related work

In the last ten years, many different EA management frameworks and approaches were developed and presented. Starting in 1987, John Zachman was one of the first to understand the "*bigger whole*" in which information system architecture and its development is embedded. His work, "*A framework for information systems architecture*" (cf. [20]), is the probably most well-known framework for EA (the Zachman Framework). However, the question "*How EA management goals are to be measured?*" is not explicitly treated by this framework.

The EA management approach developed at KTH Stockholm (cf. [7]) aims at providing decision support for IT management in enterprises, in particular for the CIO (chief information officer), as key responsible for the strategic IT-related decisions. In the first step of this approach, relevant business and IT goals for EA management are selected, and are linked in the second step to relevant stakeholders. In the third step appropriate viewpoints for the EA management function are selected and are linked then to the underlying information model. This approach provides a couple of concrete measurement for some of the related EA management goals, however a complete indicator catalog for the measurement of all relevant EA management goals is not provided by the framework.

At the university of St. Gallen, Winter and Fischer discuss in [19] a layered framework for the EA. In their understanding EA seeks to provide a "*cross-layer view of aggregate artifacts*" in order to address challenges that are not confined to a single layer. In particular, following three main aims of EA management are described by the authors: support business/IT alignment, support business development and support maintenance. In [16], Schelp and Stutz show how the balanced scorecard mechanism can be adopted in this framework to support the measurement of related EA management goals. However, no concrete KPIs or measurements are suggested by this framework.

Buckl et al. present in [3] a building block approach for enterprise architecture management solutions (BEAMS) for the development of an organization-specific EA management function. In particular, they elicit a PDCA-like structure that an EA management function typically commits to, defining four phases - describe, implement, analyze, and adapt. EA management goals play an important role during the describe phase in BEAMS. However no information regarding the measurement of these goals is provided by the framework.

The Open Group is a vendor and technology-neutral consortium published the current version 9.0 of their TOGAF framework for EA management in October 2009 [17]. TOGAF is based on the terminology introduced in the ISO Standard 42010 [10] and provides a method and supporting models and techniques for the development of enterprise architectures. This framework is well-known and widely-used in practice. The probably most-known part of TOGAF is the ADM, which describes an iterative process consisting of eight phases, which are complemented by a preliminary preparation phase and the central activity of requirements management. However no additional information is provided by this framework regarding the question "*How defined EA management goals are to be measured?*".

The CobiT framework [11] from the IT Governance Institute is a well-known IT governance framework in the practice. CobiT focuses on the controlling of IT processes. For every IT process defined in this framework, a link to related stakeholders is created. Then concrete goals are presented and corresponding metrics for their measurement are provided by this framework. In particular, CobiT distinguishes between three types of goals – activity goals, process goals and IT goals. However, a link to EA management as well as a link between the suggested metrics and the required data in the underlying information model for the computation of these metrics is missing.

Basili et al. present in [1] the Goal Question Metric (GQM) approach as a mechanism for defining software measurements. The GQM introduces a measurement model on following three levels:

- *Conceptual level (goal):* a goal is defined for a concrete object due to variety of reasons, with respect to various models of quality, from various points of view and relative to a particular environment. Examples for objects of measurement are products, processes, resources, etc.
- *Operational level (question):* a set of questions is used to define models of the measured object and then focuses on that object to characterize the assessment or achievement of a specific goal.
- *Quantitative level (metric):* a set of metrics, based on the developed models, is associated with every defined question to provide measurable answers.

This approach can be easily adopted in the field of EA management enabling the enterprise architects to define organization-specific performance measurements (cf. [5]). However, currently no concrete KPIs are provided by this approach. Furthermore, no link between metrics and related data, stakeholders and task is provided.

This literature review on the fields of EA management and IT controlling supports our finding, that enterprise architects receive insufficient support for the measurement of their goals from the existing frameworks and approaches. It further shows that promising approaches exist in related disciplines.

III. Solution

In this section we describe our current research stream in the field of the development of organization-specific indicators for enterprise performance measurement. Firstly, we outline our current progress in the development of a practice-proven

KPI catalog for the measurement of concrete EA management goals. Then we introduce the concept of a performance indicator definition language (PIDL), which allows the development of concrete performance indicator definitions (PIDs) representing the practice-proven knowledge collected in the KPI catalog. Finally, we sketch how these PIDs are integrated in the BEAMS approach by Buckl et al [3].

A. Development of a practice-proven KPI catalog for EA management goal measurement

Originating from social science, Grounded Theory (GT) is an approach to evaluate primarily qualitative data (e.g. interview transcripts or observation minutes) to generate theories. According to Glaser and Strauss [8], socalled grounded theories relating to a certain phenomenon can be discovered, elaborated, and preliminarily confirmed by systematical collection and evaluation of data. Furthermore, both researchers propose theoretical sampling as a method for comparative analysis. The idea is to analyze a collection of independent pieces of information by selecting a set of cases according to their potential to reveal new insights and findings, while a representative character has less priority. In our research, we followed a structured approach consisting of three sequential steps: literature study, expert interviews, and data evaluation.

To address the problem of missing KPIs for BEAMS, we are currently working in the first step on an initial version of a corresponding KPI catalog for the measurement of EA management goals. Therefore we are performing a literature review to identify concrete KPIs in related literature (cf. section II). This review is structured and performed according to the approach of [18]. In addition, based on our finding, we seek to link these KPIs to concrete EA management goals, tasks and roles as long as such information is available. For example, the CobiT framework provides over 200 concrete metrics for the different type of goals defined by this framework.

After creating the initial version of the KPI catalog, we plan in the second step of our approach to perform a series of semi-structured interviews with enterprise architects from different industry sectors to evaluate our KPI collection. We hope to improve existing KPIs and to identify new KPIs for our catalog based on the input of the participating practitioners.

During the third step, the collected data will be analyzed and consolidated. The information regarding the used mathematical functions and required data for the computation will be documented in an uniform manner. This catalog will provide the answers to the research questions rq1, rq2 and rq3 (cf. Section I).

B. Performance indicator definition language

Applying the idea of patterns to the context of EA management Buckl et al. [4] introduced a new way to structure the domain of EA management. Based on this idea, the authors present in [3] a building block approach for enterprise architecture management solutions (BEAMS). The framework provides following types of building blocks:

- *method building block (MBB):* describing who has to perform which tasks in order to address a problem in a situated context, and
- *language building block (LBB)* referring to which EA-related information is necessary to perform the tasks and how it can be visualized. BEAMS actually differentiates between two subtypes of the LBBs - information model building blocks (IBBs) and viewpoint building blocks (VBBs). An IBB is used to define the syntax and semantics of the EA description language, and a VBB is used to describe the language's notation, i.e., the way the EA-related information is visualized.

Figure 1 illustrates the conceptual framework of an EA according to BEAMS. This conceptual model contains architectural layers, abstraction layers and cross-cutting aspects, which are defined as follows:

- *Architectural layer:* an architectural layer mirrors the overall business-to-infrastructure structure of the organizations's EA ranging from logic concepts on the business and organization level, which are independent of the technical realization, over application level concepts that describe the IT realization of these logic concepts, down to infrastructure, i.e. hardware-related facilities.
- *Abstraction layer:* each abstraction layer complements an architectural layer with a customer-oriented perspective. Hence, an abstraction layer describes the EA concepts on the corresponding architectural layer in an abstract way focused on the provided functionalities, whereas details of the actual realization of the functionalities are suppressed.
- *Cross-cutting aspect:* a cross-cutting aspect covers concepts that are not directly part of the static EA structure but may be linked to any element in a layer.

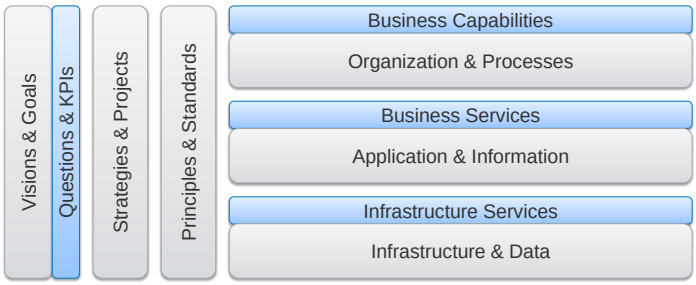

Fig. 1. Architectural layers, abstraction layers, and cross-cutting aspects

According to BEAMS, complementing the aspect of visions & goals, the aspect questions & KPIs establishes means to quantify aspects of importance. Most preferably, a measure or KPI is introduced to quantify the fulfillment of an objective and is hence added to the architectural concept that this objective aims at. However, the framework does not provide any concrete KPIs or measurements for relevant EA management goals. Thus, the research questions rq1-rq5 remain unanswered by BEAMS so far.

To close this gap, we introduce the concept of a *performance indicator definition language (PIDL)*. The PIDL language is used to define concrete *performance indicator definitions (PIDs)*, e.g., sum, product, median. The PIDL is similar to the object constraint language OCL (cf. [6]), and is in particular:

- recursive,
- set-oriented,
- functional, and
- structured.

An example of a concrete PID is provided in section III-C.

The concept of PIDs, representing the practice-proven knowledge collected in our KPI catalog, can be integrated in the existing BEAMS approach. This allows us to link PIDs to concrete EA information models and EA management tasks. Firstly, every PID has to be linked to concrete information models to ensure, that the data required for the computation is available in the underlying information model. Secondly, every PID requires a link to a concrete information model in order to store the computed data (using derived attributes). Linking PIDs to concrete methods provides information about related EA management tasks and actors for the measurement.

According to Figure 1, PIDs can be applied on all three architectural layers – organization & processes, application & information, and infrastructure & data. Furthermore, PIDs can be used to enable aggregation of measurement results from one architectural layer to another. For example, the costs of used hardware resources on infrastructure & data layer can be propagated to the using business applications on the application & information layer. The costs of used business applications on the application & information (containing the aggregated cost from the layer infrastructure & data) can be propagated to the supported business process on the organization & processes layer.

Using this understanding of EA management indicators, enterprise architects will be able to easily recognize dependencies between different EA management task and goals. Concrete EA management task can be then linked to concrete roles or actors and personnel goals with corresponding measurements can be defined. In this way, the enterprise performance measurement can be made more transparent to the interested stakeholders and can help to identify performance bottlenecks in the architecture.

By extending BEAMS with practice-proven PIDs, we combine well established answers for research questions rq1-rq3 (KPI catalog) with an established method targeting research questions rq4-rq5 (BEAMS). In the next section III-C an example for a PID is provided.

C. Example

For the measurement of the EA management goal *reduce operating cost*, following calculation is performed. As defined by the underlying information model (cf. Figure 1), a platform service is supported by many physical technology components.

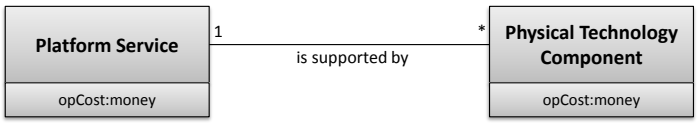

Fig. 2. An information model

Every physical technology component, as well as every platform service has fixed operational costs – *opCost*. According to this information model, a platform service derives its operational cost from the physical technology components used. This value is computed as the sum of the operational costs from all used physical technology components and stored in the derived attribute *derivedOpCost*. The total operation costs are computed as the sum of the derived costs from the used platform components and the fixed cost of the platform service. The result is stored thereafter within the derived attribute *totalOpCost*.

Thinking in PIDs, we identify the PID *sum* in these measurements. This PID computes the sum of a set of attribute values and presents the result of this computation as the value of a derived attribute as shown in Figure 3. In our example, the PID sum is used twice for computing the given KPI.

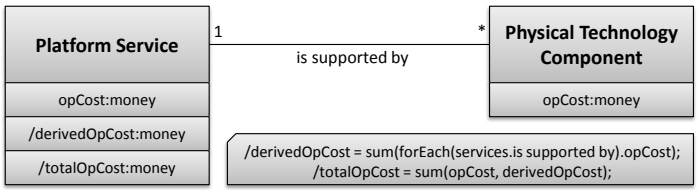

Fig. 3. Interplay between the PID *sum* and a concrete information model

This short example illustrates how PIDs can be identified from practice-proven KPIs and how PIDs can be embedded into concrete information models. The example also illustrates how PIDs can be interlinked to support more complex computations.

IV. Conclusion and outlook

In this article following two ideas for the field of EA management are presented:

1) A best-practice KPI catalog for the measurement of EA management goals.
2) Extension of the BEAMS approach by Buckl et al. [3] by the concept of performance indicator definition (PID) and a corresponding performance indicator definition language (PIDS) to support organization-specific measurement of EA management goals based on best-practice measurements.

After evaluating the developed KPI catalog in workshops with practitioners, computation building block have to be identified and defined in a first step. Then, the developed CBBs are to be refined and integrated in the existing MBBs and IBBs

of BEAMS. Finally, the extended BEAMS approach is applied and evaluated in practice. Last but not least a future research challenge in the context of software engineering will be the implementation of this approach in a corresponding tool.

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