A Practical Approach to EA Planning and Development: the EA Management Grid

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Abstract

Enterprise Architecture is gaining interest as a managerial tool for managing corporate ICT assets and their interplay. Our prior studies indicate that an ICT provider's viewpoint on EA consulting, planning and development seems to be lacking in the proposed methodologies. Considering both literature and practical EA cases, we suggest an approach that supports restricted assignments in EA management. We present an EA Grid for the management of EA descriptions, requirements, constraints, as well as project tasks and deliverables, task preliminaries and dependencies in EA consulting and development.

1. Introduction

The starting point for the present study were the problems perceived within TietoEnator (TE), a full service ICT company that provides both management and ICT architecture consulting and design and implementation of information systems. Within TE, the fourth largest European ICT provider, there was a need, but no consistent method, for information exchange between the sections responsible for the different areas of activity. We set out to investigate methods available for different project types, and the possibilities to cover all activities with a consistent methodology. Although modeling methods used in software design are also suggested for consulting activities (Hay 2003), a gap was found between management consulting and software development methods (Buchanan and Soley 2002, Zachman 2003). Requirements for a method to bridge this gap have been elicited by Hirvonen et al. (2003). The next step was to examine the methodological approaches available for the enterprise architecture (EA) consulting, planning and development, which are perceived as an area interfacing with management consulting on one hand, and software development on the other. In this study, we present the results of these explorations with a suggestion for an enterprise architecture consulting and development methodology approach.

First, we take a look at the enterprise architecture at a conceptual level. We take the meta-model of enterprise developed by Rood (1994), and break it down to a set of viewpoints that enable the comprehensive management of the ICT assets in an organization. The set is kept simple for obvious reasons: not only is it easier for the ICT experts to handle, but the communication between various managerial levels in the end-user organization is also better facilitated with a limited set of viewpoints. To these viewpoints, we add three levels of abstraction, related to levels of decision making: top management, operative management and IT management.

This results in an EA Grid which is the core of the suggested methodology, a practice related framework for EA management. In discrete EA consulting or development assignments, the dimensions, and the levels of abstraction related to decision making levels, help to manage requirements and constraints and support the project and quality management. The tasks, their dependencies, preliminaries and deliverables can be captured within the Grid. In this result, we have incorporated the EA methodology requirements from Hirvonen et al (2003):

- The methodology should cover the gap between pure business consulting and information systems development without leaving further gaps. This means that it takes into account aspects of both business consulting and software development to make the transitions between levels of abstraction smooth.
- The targeted user group of the method are IT consultants and IT architects working with EA projects, and their clients.
- The clients of EA projects have different levels of organizational maturity, and their experience with formal methods varies. The method has to be simple enough to be easily learnt and introduced.
- The method should be flexible, and take into account the wide range of different project types varying in size, scope and focus: they must be able to cover any set of viewpoints and / or levels within the EA area.

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- Flexibility also means support for creativity. The method should not lead to repetition of old solutions without creative thinking. The set of deliverables is evolving.

We validate the constructed method framework with our case study within TietoEnator. The suggested EA Grid is tested against nine real EA cases conducted at TE in the period 1999-2002. In our study, we do not go into the details of the deliverables (e.g. modeling languages), but develop a common framework of reference for the groups of professionals involved. It constitutes a schema for understanding the single work steps and task deliverables, their interdependencies, and is also a project and quality management tool. Within the scope of this study, it is impossible to present the implications for the EA planning and development process (for this, a further publication is planned).

The structure of the paper is as follows:
Section 1 introduces the study area and scope
Section 2 discusses some literature background
Section 3 presents the EA Grid starting with its theoretical foundations
Section 4 validates the Grid against empirical data
Section 5 analyses the results of our study
Section 6 summarises the main points and presents further areas of study.

2. Background

Since the 80's, as computer networking emerged and diverse telecommunication technologies evolved, questions of large architectures have been on the research agenda (Ives and Jarvenpaa 1991, DeMichelis et al. 1998, Braa and Rolland 2000). Information systems methods have been further developed (e.g. Sommerville 1998) to cope with software of increasing complexity. Additionally, the need to capture multiple systems within one organization in a comprehensive enterprise architecture (Zachman 1987, Sowa and Zachman 1992, Spewak 1992) has been recognized. Effort has been put into developing software architecture methods (Shaw and Garlan 1998, Bass et al. 1998), and an enterprise viewpoint is included in approaches for large scale systems (Putman 2001) as well as systems integration (Fowler 2002, Linthicum 2000). From the business and strategic planning viewpoint, consulting oriented enterprise architecture planning approaches have been put forward (Spewak 1992, Armour et al 1999a and 1999b, Heffner 2002, Buchanan and Soley 2002).

Thus there are two directions from which to look at the Enterprise architecture concept:
- First, it is the abstraction of a large organizational entity, the enterprise: a corporation, concern, or public sector organization, or any defined unit of these (Spewak 1992, The Open Group 2002)
- Second, it is the general architecture of a large scale information system, be they so-called enterprise systems like E/MRP, CRM, SCM, work flow or data mining system, or any distributed system (Linthicum 2002, Putman 2001)

These aspects are brought together in comprehensive frameworks (see Whitman et al. 2001 for a summary), that seek to combine the activities of strategic planning and information systems design (Henderson and Venkatraman 1999, Buchanan and Soley 2002). With the advances in technology that enable intra- and extra-organizational information sharing, inter-organizational supply chains, new business models (e.g. e- and m-commerce), and value added information, the business and IT strategy planning are no more isolated areas, but are merging (Hackney et al. 2000, Seltsikas 2000). This raises the need for enterprise architecture planning, development and management. EA serves as a master plan for managing the business, the information, the applications and the ICT infrastructure.

Architectures and architecting are tools for higher-order planning, looking at the planning target from a distance for a holistic view, and considering all elements and their interdependencies contributing to the entirety (Rechtin 1992 and 1997).

Management ICT consulting on EA issues means a new challenge to ICT providers. EA related commissions may deal with any subset of the dimensions of the EA or all of them (Hirvonen and Pulkkinen 2003). For EA management, an organizational management process has been suggested (Spewak 1992, Armour et al. 1999a, The Open Group 2002, Finneran 2003). For an ICT provider delivering discrete consulting and development projects, a modular method is needed with a loosely defined process to support knowledge work (Ramesh 2002), an idea that is supported also by the revision of method thinking (Truex et al. 2000).

3. The Dimensions and Levels of Enterprise Architecture

Rood (1994) gives a comprehensive account of the factors in an enterprise: people, organizational structure, technology, information, processes, tasks, strategy, corporate culture, and the relationships between these, as well as the external environment giving inputs into the enterprise and receiving outputs from it (Figure 1).

Rood's model draws on theories of organization, and is thus not restricted by any IS modeling conventions, but keeps open the possibility of choosing the ways to describe the enterprise and its constituent elements. This seems to be significant when dealing with enterprise

questions with different groups of people, including non-IT professionals.

EA makes the factors that influence the performance of the organization, and each component of it, transparent, and facilitates the reshaping of an organization for its better performance. EA development means planning the implementation of strategies, and part of an EA consulting project can also be the review or creation of the strategies.

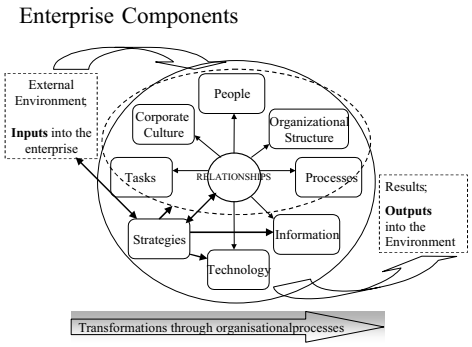

Figure 1 Enterprise Components (adapted from Rood 1994)

To be able to tackle enterprise architecture consulting and development assignments, we need a categorization of the different aspects of EA. First, we look at four architectural dimensions.

Four viewpoints of Enterprise architecture: EA dimensions. A lot of the current discussion on the EA field is conducted around the Zachman (1987) framework. However, the application of this comprehensive framework seems to be mostly as a philosophical meta-framework that joins different approaches in the large. For practical approaches, a limited set of architectural dimensions is widely adopted (NIST 1989, Armour et al. 1999a, Hasselbring 2000, The Open Group 2002, Buchanan and Soley 2002, Heffner 2002). The set commonly consists of the following concepts (see also Table 1), although the terms used may vary:

1. Business/Processes Architecture
2. Information/Data Architecture
3. Logical (Systems / Applications) Architecture
4. Technology Architecture (Application technology and infrastructure)

Although this set is generally found usable and useful, no academic argumentation was found for the choice of these dimensions. We started with the generic model of the enterprise (Rood 1994), that was created for systems engineering. In EA projects that also deal with higher abstraction level issues, we need to cover an area that exceeds the scope of systems engineering. For the EA scope, we take the enterprise components (Figure 1) and assign them to the four suggested architectural dimensions: Business, Information, Information systems (or applications), and Technology, thus defining these four vertical dimensions of EA. In the following, we lay out the grouping of the enterprise components.

Business architecture: Corporate culture, People, Organizational structure, Processes and Tasks

Business architecture (BA) is an account of the basic components of the enterprise, illustrating their organization and interconnections: the elements that exist in an enterprise even without any digital information processing devices. From the point of view of information and communication technology planning, BA is the basic foundation, on which the actual planning and design will be based.

However, changes in business also take place due to technology implementation. The essence of EA planning is to plan and manage the change that can be triggered by technology (recent examples are networks and e-business models), throughout the entire enterprise or in any part of it.

Information architecture: Information

As pointed out by Walsh and Ungson (1991), information resides in organizations in all the elements that the business architecture of an enterprise consists of. Information architecture (IA) focuses on information within the business, as related to the items in business architecture. Information can be required in a business process; it can be processed or stored in units of the business structure, or needed for a task performed by a role. IA also exists independent of any technology, but it is greatly affected and enhanced by technology solutions.

Information is treated as a value-adding asset in today's businesses. Consulting projects that deal with leveraging enterprise information and knowledge management focus on information architecture questions: information flows, business intelligence and optimized storaging, retrieval and mining of data.

Systems / Applications architecture: The logical view of technology solutions, ICT support for tasks and processes

Systems architecture (SA, also: AA; see Table 1) represents the logical structures of information systems and their interconnections, represented on the background of business architecture. Information architecture also serves as a basis for SA planning.

Technology architecture: Technology

Technology architecture (TA) deals with technological solutions used to implement the logical structures represented in Information architecture and Systems architecture: application technology, infrastructure, also hardware architecture and deployment as well as data communications connections. Technology provides the information processing facilities for the components of business architecture: People, culture, processes and tasks organized in a business structure.

Enterprise architecture: Strategy

All four dimensions, BA, IA, SA and TA together constitute the Enterprise Architecture (EA, Table 1). From the components listed by Rood (1994), **strategy** is an issue related to each of the four. Strategies are "transformers" that translate environment inputs (changes) into managerial directions for all enterprise components.

The four architectural dimensions are intertwined. There are interrelationships between all of them (Rood 1994), and it takes an analytical effort to differentiate between them. This is needed for EA development projects, to see what needs to be changed in the EA to achieve the desired results in the enterprise's performance.

The assignment of the consultant may range from any one of these dimensions to covering all of them. Yet the dimensions are not a sufficient tool for parsing the EA area. Figure 2 shows a rough typology of assignments or task areas that an ICT services provider may be commissioned to deal with in an enterprise: management or business consulting, EA consulting, and finally solution design and development (Hirvonen and Pulkkinen 2003, Hirvonen et al. 2003). In the next section, we parse the EA area further to facilitate an analytical approach to EA planning and development. For the four dimensions, we define three levels of abstraction that can be found in enterprise architecting work.

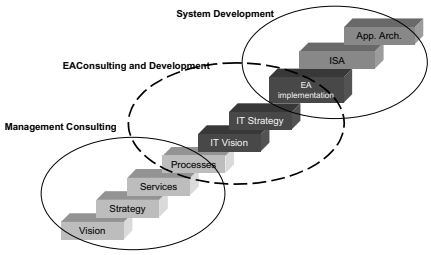

Figure 2 Services of an ICT provider on different levels

Table 1 Four Dimensions of Enterprise Architecture

ENTERPRISE ARCHITECTURE DIMENSIONS			
Business architecture (BA) Underlying (organizational) structures of the business, business functions, business processes, service structures.	**Information architecture (IA)** Information used, created and stored in any defined BA or part of it. E.g. within function(s), within process(es); information capture, creation and retention; information flows, data storages	**Logical EA: (Systems Applications Architecture, SA/AA)** Logical structures of information systems and their interconnections. Can be represented as mapped to a BA (E.g. systems / applications map), also as an application portfolio	**Technology architecture (TA)** Technology of information processing solutions, defined within a BA and a logical EA (IA or Systems / Applications architecture). E.g. Standards and reference models, application technology and infrastructure, platforms, data communications

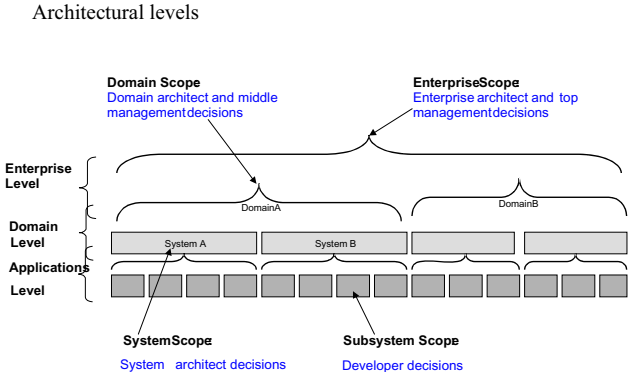

Figure 3 Architecture levels (adapted from Malan and Bredemeyer 2002)

The layered structure of EA management has been seen as a hierarchy of architectures (NIST 1989, Heffner 2002), or output descriptions at different levels (The Open Group 2002). To manage the architecture decisions made at different levels for any of the dimensions, we need to look at the area at different levels of abstraction. Malan and Bredemeyer (2002) have outlined decision making levels for software architecture. They illustrate well the role of the architect (Figure 3) as described by Rechtin (1992), and the decision scope. Rechtin (1997) also underlines the priority of synthesis: first should come the high level overview, before deciding on the details of a design. We have found these discoveries relevant to enterprise architecture: The vision and mission of an enterprise should be the highest level view taken prior to starting with strategic planning, application portfolio review or any ICT development (Spewak 1992, Buchanan and Soley 2002). This is what "business driven" basically means.

For well-informed EA planning, it is necessary not only to understand the dimensions of EA, but also the levels of abstraction that relate to decision making levels. The basic idea behind the five viewpoints (rows) of the Zachman (1987) framework demonstrate this. For a more coarse-grained but practical approach, we suggest three horizontal levels: enterprise, domain and systems level.

The notion of decision making is essential to enterprise architecture assignments. The highest level of decision making power lies with the top management. Here they define the mission and vision of the enterprise, draw the outline of the enterprise structures, and makes strategic decisions. The middle management executes these decisions, but uses its own decision making power for e.g. business unit level issues. Systems level decisions are made by IT management, or as part of the EA planning as applications architecture and technology guidelines, policies and the like.

The EA management Grid is a combination of the four architectural dimensions, and the three levels of abstraction. This 4x3 matrix partitions the enterprise architecture consulting, planning and development work into manageable portions, and illustrates the interdependencies of these (Table 2). It is a tool for managing several aspects of the work:

- The requirements
- The preliminaries for a task
- The deliverables of different project types (management consulting, EA consulting, EA development, software development
- Different tasks in a project, and their dependencies on further tasks
- The constraints for any development effort
- The technology dependent strategic planning
- The transparency of decision making

Table 2 The EA management Grid

Dimensions -> ========== Levels of abstraction	Business Architecture	Logical design: Information Architecture	Logical design: Systems / Applications Architecture	Technology Architecture
Enterprise level				
Domain level				
Systems level				

In the next section, we study real EA cases to validate the suggested framework, the EA Grid, against projects that are considered typical in the EA area (Figure 2, Hirvonen and Pulkkinen 2003).

4. The EA Cases

We surveyed projects conducted at TietoEnator and interviewed senior architecture consultants of the three main business areas in a previous study. Collected and analyzed data was discussed and commented on by consultants. (Hirvonen and Pulkkinen 2003, Hirvonen et al. 2003).

We found that both the scope and the target of the EA consulting cases vary widely, as end-user organizations develop and maintain their entire EA in a continuous process.

These studies were a part of TE's Enterprise Architecture methodology development. We started with the assumption that successful customer cases and their results would be a practice proven starting point for the method development. For the method development, we have explored the development targets of EA projects. These are described in Table 3 (below) with the main characteristics of the projects. Table 4 (below) shows the project results presented in the Grid (cf. Table 2 above).

Table 3 The EA projects and their characteristics

Case	Targets	No. of Client Representatives In the Project	No. of Consul-tants in the Case	No. of Work-shops	Length in Months
P1	–Phased IT architecture development plan –Clearly documented IT architecture with principles and guidelines – Shared understanding –Focus is in applications. Infrastructure and IT technology issues were not covered in the work.	4	3	6	6
P2	–Identifying and anticipating the strategic business requirements for information harmonization and integration –Identify and describe the required information integration architecture –Develop the technology architecture principles (although it was decided in the beginning of the work that technical details will not be covered) –Design the high level development roadmap	8	3	N/A	4
P3	–Evaluate the integration needs in current and future	11	3	N/A	5

	application portfolio –Suggest integration tools & technologies to be used –Produce guidelines for using these technologies –Prepare rough development program for integration roll-outs & support processes –It was not included in this project's assignment to design message content & format				
P4	–Produce new information system architecture –Produce new technology architecture –Produce common application architecture principles –Transition plan (from existing architecture to new architecture) –Enterprise development plan –Current system structure is monolithic (one was huge) and it doesn't fulfill business needs. Also maintenance is difficult and too expensive, so new structure of system is needed (demanded).	7	9	30	11
P5	–Integration architecture with principles and guidelines –Enterprise development plan fitted into product roadmap–One core system is replaced by packet software and packet software was selected as core component of the whole enterprise –In the future, another systems will be replaced and these systems are based on the same package software	2	2	16	4
P6	–New product line is established and product line architecture is needed (lifetime 5-15 years) -Selections of core technologies and maturity analysis -Planning of Architecture roadmap (it is different than product roadmap)	12	3	12	5
P7	–Flexible and independent systems for business processes –Clearly documented System and Technology Architectures with principles and guidelines –Long-life technology Architecture –Focus is on systems, infrastructure and IT technology issues.	1	3	N/A	7
P8	–Technology alternatives and recommendation for new application generation	2	2	6	2
P9	–High level evaluation of current technological environment and recommendation for development targets	1	1	3	1

Table 4 Project outcomes presented in the EA Grid

Dimension **Level of Abstraction**	**Business Archi-Tecture**	**Information Architecture**	**Systems /Applications Architecture**	**Technology Architecture**	**Other results**
Enterprise level	P3: Aggregated business requirements from enterprise perspective. P4: Business requirements from each business line/ department	P2: Common information structures.	P1: High level application architecture, Application – Processes summary P4: System map of the whole organization.	P2: EAI Architecture roadmap principles. P3: Messaging architecture alternatives, Technical principles P4: Technology/solution alternatives and choices	P1: Phased roadmap. P2: Harmonization strategy principles, Internal integration analysis, EAI development roadmap, summary. P3: EAI development roadmap. P4: Enterprise

	(business line owners were involved in IS architecture design).			P6: Core technology selection and maturity analysis	development plan P6: EA roadmap.
Domain level	P7: Business requirements P3: Aggregated business requirements from BU perspective	-	P1: Application map/each application domain P7: Information system architecture.	P5: Integration architecture. P7: Technology Architecture, Application Architecture. P6: Product line architecture P8: Technology alternatives and choices. P9: Technology alternatives and choices	P3: Implementation example of recommended architecture to one BU. P5: Projects' roadmap P7: Phased roadmap.
System level				P4: Application architecture principles and patterns	P2: Application harmonization roadmaps

The most common consultancy area in the projects was technology architecture (cases 2-9) focusing on technology evaluation, cross organizational solutions, standards and principles. Other areas were systems architecture (cases 1, 3, 4 and 7) focusing on application portfolio development and information architecture planning (cases 2 and 3), or focusing on organization wide strategic key data identification and planning.

Business architecture played a minor role (cases 3, 4, 7) in limited areas: business requirements. The reason was the roles and responsibilities at TE: Management consultants are involved in strategic consulting, business process development and other business development related tasks.

The method development effort focuses on enterprise architecture consulting and development. Accordingly, the data was collected from EA consultants and architects. They work in co-operation with management consultants, and are involved in architecture planning in other areas than business architecture. Systems development typically follows EA planning and uses EA planning results. The EA planning method thus needs to have an interface to management consulting and systems development.

Our studies indicated that the relations between the architectural dimensions had not been explicitly defined for the EA work. This is natural, since there was no method to support this type of work. The problem was, that the constraints, dependencies and all necessary preliminaries were identified case by case which meant extra work. On the other hand, the cases varied greatly in size and scope, so without a common scheme these recurrent issues were not easily identified.

5. Analysis

The EA management Grid (Table 2 and Table 4), is suggested as a common framework of reference for enterprise architecture management, planning and development.

We found that EA cases may have varying planning target areas in the client organization (Table 3): the whole enterprise level, domain level including ICT plans for one or various organizational units in the business domain under development, and also systems level issues.

The EA Grid is designed to help to tackle the EA consulting and development assignments and their interfaces to other activities, and to eliminate the perceived problems in information exchange between roles in different activities. For the variegated cases, the Grid provides a map of project tasks, their dependencies, preliminaries as well as deliverables for the tasks. Sources for requirements and constraints can be anticipated and identified with it. A persistent method with fixed phases would not allow for the needed flexibility for these types of commissions. The method process will be discussed in another paper.

Table 5 illustrates an example of dependencies definition between levels of abstraction and the dimensions:

- The requirements coming from an upper level in the Grid must always be taken into consideration.
- Business architecture and the requirements set by it are always the starting point

- If the task focus is on designing a technology solution, the business requirements (BA), and either the information or logical viewpoints, or both of them, are needed as preliminaries.
- Also: if the task focus is on the logical structures (IA or AA), the technology constraints should be checked

The deliverables follow the main dimension, but with a decreasing level of abstraction towards the lowest level. (Within one cell of the Grid we can have descriptions with varying levels of detail). It is noteworthy, that the Grid includes all four dimensions at the enterprise level. This is different from other hierarchical EA models.

This level is in question when the top management are discussing strategic choices, designing the business structures and processes, deciding on business models etc.: that is, re-designing the Business Architecture, with considerations of business information, and systems to manage it, as well as the enabling technology alternatives.

The Technology Architecture, in many models only present at the lowest levels (e.g. NIST), is in the Grid as a dimension already at the top level. In our view, the company management that makes decisions on major technology investments should see the interconnections between all dimensions. Any well-informed manager today takes part in considerations of ICT, since several new ways to do business, both within the enterprise and with external stakeholders, do not come about without the enabling technology.

The well know Zachman Framework suggests a far more detailed set of views to EA, combining architectural dimensions and decision making on the rows of the framework, and presenting detailed aspects in the columns (Zachman 1987). Yet for consulting practices, a feasible way to analyse the enterprise and its components was sought, workable in practice according to the EA methodology requirements (Hirvonen et al 2003, see also Section 1).

In Table 4, we see that not all outcomes of the EA projects could be included in the Grid ("Other results"). Two major areas of planning issues were identified that need consideration in all dimensions and at all levels: integration and security. This leads us to think that, for special EA cases, the Grid needs to be extended with further layers in the 3rd dimension, thus forming an EA Cube. A two-dimensional layer is the basic EA tool. Further layers are dedicated to e.g. integration or security projects, which also start with strategic considerations at the enterprise level. The planning goes on at the lower, more concrete levels. For EA projects dealing with e.g. security, or integration, with data and system harmonization, the Cube would provide a means to manage these issues with the rest of the EA at all necessary levels and in all dimensions.

Table 5 Example of requirements and task dependencies

Dimensions/ Architectures / Levels	Business Architecture	Logical design/ Information Architecture	Logical design / Systems Architecture	Technology Architecture; Infrastructure
Enterprise level	Strategic decisions and choices concerning the dimensions are taken as requirements / constraints for the planning and decisions on lower levels			
Domain level (with example items)	Defined business requirements	Information architecture	ISA	Infrastructure; Choice of application technology
Systems level				

6. Conclusions

Methodological support for ICT consulting is very limited in current EA methods. We have presented an EA planning and management Grid as a backbone for modular EA planning and development methodology that also supports consultancy requirements. The Grid defines four dimensions of EA: business, information, systems and technology; and three levels of abstraction corresponding to decision making levels: enterprise, domain and systems. The Grid was tested against actual consultancy cases conducted at TietoEnator. For variegated consultancy cases, it provides a map for requirements management, constraints identification and a project management tool for task preliminaries and deliverables. Tasks dependencies and constraints can be anticipated and identified with it also.

Within the scope of this paper, it is impossible to deal with all possible uses of the Grid. As we did with the results (Table 3), the project targets can also be put into the Grid to support project management and planning, requirements (Table 4) and constraints identification. As a scheme for organizing EA project deliverables, the Grid is implemented in the EA consulting methodology. The Grid can also be a starting point in managing EA and the related information in a user organization. The current EA can be investigated and described using the Grid as a scheme, to make targeted plans for improvement. The Grid unifies and clarifies hierarchical views to EA, and meets the present need to merge business and technology planning.

Our study was conducted within only one ICT provider, with a limited number of cases. This limits the generalization of the results. At the case company, the results so far have been encouraging enough to complete the development of the EA methodology based on the Grid. Since the suggested framework is supported by a widely used set of architecture dimensions, we believe that the Grid is worth testing in further cases, both by ICT providers and end user organizations. For further research, we suggest the following issues:

- Evaluation of the Grid with a larger number of cases also within other companies for further validation and verification of the Grid
- Developing an EA process model based on the Grid, suitable for incremental EA development and discrete EA projects
- Exploring the modeling languages and conventions for descriptions of different dimensions and levels
- Further elaboration of the suggested EA Grid and the EA Cube for special EA cases.

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