

Correlating Architecture Maturity and Enterprise Systems Usage Maturity to Improve Business/IT Alignment

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Abstract

This paper compares concepts of maturity models in the areas of Enterprise Architecture and Enterprise Systems Usage. We investigate whether these concepts correlate, overlap and explain each other. The two maturity models are applied in a case study. We conclude that although it is possible to fully relate constructs from both kinds of models, having a mature architecture function in a company does not imply a high Enterprise Systems Usage maturity.

1. Introduction

Current markets are highly competitive, making it very important to rapidly respond to changing business circumstances [14]. By optimizing business processes, the efficiency and effectiveness of a company can be increased. In today's companies, transactions have to be made in real-time, while communicating with customers and suppliers. To do this, the information systems in any company should have the latest data available, and therefore should also be integrated with each other.

Different approaches to integrating information systems and/or business processes have emerged, like data warehouses, applications of Enterprise Application Integration technology, and information systems supporting the entirety of business processes in a company. The latter are called Enterprise Resource Planning (ERP) Systems and were first specialized for manufacturing companies. Nowadays, these systems can support businesses in almost all sectors and are often referred to as Enterprise Systems (ES) [6, 19].

Improving enterprise integration with these solutions is a difficult task as it brings along many changes in a company at both organizational and IT infrastructure levels. Many ES implementations are not finished in time and within budget and, often, the desired business benefits are not realized [16]. Therefore, implementation of ES is an important field of study in which a lot of methods are now being proposed to improve current practice. In this paper, we contribute to this field by investigating the

relationship between maturity models for ES usage and enterprise architecture. We have chosen to look at ES usage in relation with enterprise architecture because experiences from more and more companies indicate that an ES perspective alone is not enough [12]. When all major companies in a market adopt ESs, or even the same vendor's ES, the competitive gain resulting from using an enterprise system for one company is low [6]. Moreover, some business processes are just not suitable to fit in with an ES. Consequently, companies need to integrate, but also need to differentiate in their systems. Apart from an ES, companies also have legacy systems that add up to a complex ES implementation.

We use the term 'enterprise architecture' to refer to the constituents of an enterprise at both the social level (roles, organizational units, processes, etc.) as well as the technical level (information technology and related technology), and the synergetic relations between these constituents. Thus, enterprise architecture explains how the constituents of an enterprise are related and how these relations jointly create added value.

Capability maturity models (CMMs) provide a method to gain control over IT processes and improve them. The benefits of these models lie in the systematic use of practices to identify weaknesses, strengths, and improvement activities in IT-processes [13]. The models also assist in managing improvements by providing assessment standards that help express the maturity of the organisation in a scale of five maturity levels [15]. In the architecture field, different maturity models have been developed, called Architecture Capability Maturity Models (ACMMs) [7, 10, 23]. These models specify key components of productive enterprise architecture processes and pay very little attention to the possible integration solutions.

Furthermore, in the field of ES implementation, empirical research efforts by Holland and Light [12] as well as Markus et al. [16] have yielded staged maturity models for ERP systems use. Their value is in providing roadmaps for understanding the evolution of ERP systems in adopting organizations. Such a model is divided in stages of maturity in the use of an ES and illustrates the

different challenges organizations cope with while and after implementing an ES. These models do not focus on IT processes as a whole, but on the ES implementation and use only.

When combining ERP usage maturity models with the ACMMs, a framework can be created to assess how well business processes and systems are aligned in ERP adopting organizations. Such a framework can also serve as a vehicle to integrate formal business case analysis into the process of engineering the requirements for ESs as it would help organizations focus on the business value they expect to achieve from the ESs and associated business changes [6]. Business cases specify real-life problems that ERP-adopters confront and the types of process, competitive, or financial capabilities they will have when implementation is over. Carrying out a business case analysis is recognized as a vital prerequisite for a successful ERP RE process [4] and is a common practice in organizations that were successful in aligning their ESs to business strategy [1]. Specifically, our efforts in combining ACMMs and ES usage maturity models are aimed at answering the following research question: In what way is architecture maturity linked to ES usage maturity? To uncover the interplay between these two classes of maturity models, we first compare their assessment dimensions and then contrast them by using real-life experiences.

The remainder of this paper is organized as follows: Section 2 places the topic of architecture and ES usage maturity in the broader context of enterprise integration (EI) and discusses the role of ES in it. Section 3 describes our research approach. Section 4 and Section 5 provide background information on the concepts of architecture maturity and ES usage maturity, respectively. Specific instances of each of the two model classes are discussed as well. In Section 6, relations between these two classes of models are identified. Then, an ACMM and an ES Usage Model are applied in a case study in Section 7. Section 8 outlines our conclusions and future research plans.

2. Background

The literature of today [14, 17, 19] reports on three approaches for systems integration: data warehousing, ES, and Enterprise Application Integration middleware. The data warehousing approach implies that the data of all systems in an organization are integrated in one 'warehouse' that makes it possible for systems to share data and do a variety of data analyses. The systems themselves are not supposed to be changed [17]. In contrast, ERP systems were the first, in which business functions were integrated to streamline data flows across business functions such as logistics, accounting, and human resources [14]. In the second half of the 90s these systems were extended with applications that supported

business processes beyond the borders of one organisation. This was necessitated by the urge many companies had to optimize processes with suppliers and customers. Cross-organizational integration was further streamlined with the availability of the Internet. Also, today's cross-organizational ESs offer a combination of internal and external integration capabilities and make it possible for ERP adopters to seamlessly participate in virtual networks in which Enterprise Application Integration is used to let the ESs of different companies communicate with each other and with other systems [19].

Enterprise Application Integration is a business computing term for the plans, methods, and tools aimed at modernizing, consolidating, and coordinating the computer applications in an enterprise [24]. It is not a piece of software which is installed to work directly out of the box, but it is a useful method for planning how to integrate systems. It aims at bringing together business processes, applications, data, and platforms [9] in order to produce a flexible and agile information architecture, which permits rapid responses to new business opportunities [14]. Integration is achieved by using middleware and by applying different topologies. Typical business benefits of Enterprise Application Integration are cycle time and cost reductions as well as cost containment.

Intra- and inter-organizational integration through ESs is a very complex task, and case studies suggest that approximately 90% of the businesses did not completely succeed in this [2]. Common failure patterns that ES adopters indicate are (i) failure to meet project goals within specified time and budget and (ii) misalignments between organization's processes and data flows and the ones embedded in the ES. Therefore, for many companies it is also important to have a technology, for example Enterprise Application Integration middleware, which makes it possible to integrate both ES and legacy applications with each other. The ultimate objective of such integration is to ensure a relationship between business and IT decision making processes so that IT and business functions adapt their strategies together [15]. For companies to be able to assess where they are in business/IT alignment and what they can do to improve it, comprehensive vehicles in the form of maturity models should be available for architects to use. In the scope of our research, we cover two classes of models that are good candidates to serve as such vehicles, namely Architecture Maturity Models and ES Usage Maturity Models. Our choice of these models is dictated by our research context, namely the use of ES as enabler for intra- and inter-organizational integration.

3. Research Method

The goal of our study is to collect information that would help us assess the interplay of architecture maturity and ERP usage maturity in an ERP adopting organization. Since research studies in architecture maturity and studies in ERP usage maturity have been done in isolation from each other and research has been focused either on organization-specific architecture or ERP aspects, there is a distinct challenge to develop a research model that adopts the most appropriate constructs from prior research and integrate them with constructs that are most suitable for our context. Given the lack of research on the phenomenon we are interested in and the fact that the boundaries between phenomenon and context are not clearly evident, it seems appropriate to apply a qualitative approach to our research question. Specifically, we chose to use an approach based on the positivist case study research method [8, 26]. We have chosen this method for several reasons: (i) it was found particularly well-suited to IS research situations in which an in-depth investigation is needed, but in which the phenomenon in question can not be studied outside the context in which it occurs, (ii) it offers a great deal of flexibility in terms of research perspectives to be adopted and qualitative data collection methods, and (iii) case studies open up opportunities to get the subtle data we need to increase our understanding of complex IS phenomena such as ERP adoption and architecture.

Our analytical approach had three main objectives, namely: (i) to identify how existing architecture frameworks and ES usage models stand to each other, (ii) to assess the possible mappings among their assessment criteria, and (iii) to examine if the mappings between architecture maturity assessment criteria and the ERP usage maturity criteria can be used to judge the ERP usage maturity in an ERP adopting organization, provided architecture maturity of this organization is known.

The research approach involved five stages:

1. Literature survey and mapping assessment criteria of existing architecture maturity models.
2. Literature survey of existing ERP usage maturity models.
3. Identification of assessment criteria for architecture and ERP usage maturity that seem (i) to overlap, (ii) to correlate, and (iii) to explain each other.
4. Selection and application of two specific maturity models to real-life organizational settings.
5. Post-application analysis to understand the relationships between the two maturity models.

We discuss each of these stages in more detail in the sections that follow.

For the purpose of our research, the unit of analysis [26] is the ERP-adopting organization. We investigate

two aspect of the ERP adopter: (i) the maturity of their architecture function and (ii) the maturity of the ERP usage. Our approach involves the use of qualitative architecture assessments and ERP usage assessments, architecture deliverables, ERP requirements documents, and project team members' observation data, to explore, understand, and explain the relationship between maturity in architecture and maturity in ERP usage.

4. Architecture Maturity

The notion of maturity was first introduced by IBM and, in early 90s, was extended and elaborated in terms of capability maturity models (CMMs) that are formal ways to gain control over and improve IT-related processes as well as to assess organization's development competence [20]. Today's ACMMs follow in structure and logics the original CMM. One of the first ACMMs is the IT ACMM of the Department of Commerce (DoC) of the USA. The goal of this model is to optimize architecture-related processes by identifying weak areas and providing an improvement path [7]. Furthermore, there are models linked to the Balanced Score Card concept [10] and models for extended-enterprise-architects [23]. All these models have five or six levels of maturity that vary from initial to optimized or measured. The extent to which these models pay attention to business issues varies widely. When we compared the different ACMMs to each other (see Figure 1), the Information Technology Balanced Score Card (IT BSC) maturity model was chosen as our point of reference. We chose it because this model rests on four viewpoints that make it possible to jointly consider both business and IT issues in organizations. As the two main reasons for failures in ES-implementations are organizational resistance to change and lack of top management commitment [27], we felt that it was important to use as a reference point a model giving enough attention to business issues. The four viewpoints in the IT BSC model are defined as follows: 'Customer Orientation' is about how the IT should appear to the internal questions, 'Corporate Contribution' is the contribution that IT can have to company's success, 'Operational Excellence' tells which services and processes should be supported by IT, and 'Future Orientation' focuses on the ability to change and improve the IT to better add up to the company's success [10]. The IT BSC maturity model includes five stages, in which these four areas should be better managed and optimized. We compared the assessment criteria of the IT BSC model to the different architecture criteria as defined in the Department of Commerce IT Architecture Capability Maturity Model (DoC ACMM) [7] and the Extended Enterprise Architecture Maturity Model (E2AMM) [23]. We arrived at the mappings in Figure 1.

IT BSC MM	DoC ACMM	E2AMM
Customer Orientation		Extended Enterprise Involvement
	Operating Unit Participation	Business units involvement
		Enterprise Program Management
Corporate Contribution	Business Linkage	Business & Technology Strategy Alignment
	Senior Management Involvement	Executive Management Involvement
	Governance	Strategic Governance
	IT investment & Acquisition Strategy	Enterprise budget & Procurement strategy
		Holistic Extended Enterprise Architecture
Operational Excellence	Architecture Process	Extended Enterprise Architecture Programme Office
	Architecture Development	Extended Enterprise Architecture Development
	Operating Unit Participation	
	Architecture Communication	Enterprise Program Management
	IT security	
	IT investment & Acquisition Strategy	Enterprise budget & Procurement strategy
		Extended Enterprise Architecture Results
Future Orientation	Architecture Development	Extended Enterprise Architecture Development

Figure 1 ACMMs compared and contrasted

The DoC ACMM is developed to make judgements of IT processes to evaluate the current organization and what the future should bring [7]. The E2AMM ‘provides a path for enterprise architecture and procedural improvements within an organization’ [23, p1]. There exist also other architecture maturity models, for example the IS/ICT Management Capability Maturity Framework [21]. These models work with assessment constructs which are very similar to the ones from the DoC ACMM and therefore we do not discuss them here.

5. ES Usage Maturity

Our review of the ERP literature points out that ES Usage maturity models are meant as theoretical frameworks for analysing, both retrospectively and prospectively, the business value of ES. As system evolution adds the concept of time to these frameworks, they tend to structure ‘ES experiences’ in terms of stages, starting conditions, goals, plans and quality of execution [16]. For example, the model by Markus et al [16] allocates elements of ES success to three different points in time during an organization’s experience: (i) the ‘project phase’ in which the system is configured and rolled out, (ii) the ‘shakedown phase’ in which the organization goes live and integrates the system in their daily routine, and (iii) the ‘onward and upward phase’, in which the organization gets used to the system and is going to implement additions. Success in the shakedown phase and in the onward and upward phase is influenced by ES usage maturity. For example, observations like (i) a

high level of success in improvements in business results, (ii) employees’ willingness to work with the system, and (iii) adopting new releases, are directly related to a high level of ES usage maturity. Next, the staged maturity model by Holland and Light [12] suggests three stages and is based on five theoretical constructs as shown in the Figure 2. The model does not yet pay enough attention to certain determinants of the ES architecture, namely, cost, entropy, complexity, flexibility, and competitiveness. However, because these do not affect the way we approach our research question, we would not discuss them as part of this paper.

6. Relations between architecture maturity and ES Usage maturity

Our hypothesis is that the constructs in the AMM and the ES UMM differ, correlate but do not explain one another. That there is a relationship between architecture maturity and ES usage also becomes evident from the fact that the two types of models use the same factors to assess either maturity or alignment, for example, factors like governance, processes, communication, vision and executive sponsorship. These correlating factors are discussed in the sections that follow. We start with the constructs of the ES Usage Maturity Model (ES UMM) and we link them to the constructs of the IT BSC and DoC AMM. For clarity, the acronyms of the names of these models are given in brackets appended to the name of each construct.

Constructs	Stage 1	Stage 2	Stage 3
Strategic Use of IT	<ul style="list-style-type: none"> - Retention of responsible people - no CIO (anymore) - IS does not support strategic decision-making 	<ul style="list-style-type: none"> - ES is on a low level used for strategic decision-making - IT strategy is regularly reviewed - ES Importance is high 	<ul style="list-style-type: none"> - Strong vision - IT strategy through whole organization - CIO in the senior management team
Organizational Sophistication	<ul style="list-style-type: none"> - no process orientation - very little thought about information flows - no culture change 	<ul style="list-style-type: none"> - significant organizational change - improved transactional efficiency 	<ul style="list-style-type: none"> - process oriented organization - top level support and strong understanding of ERP-implications
Penetration of the ERP System	<ul style="list-style-type: none"> - the system is used by less than 50% of the organization - cost-based issues prohibit the number of users - few formalized training - staff retention 	<ul style="list-style-type: none"> - most business groups / departments are supported - high usage by employees 	<ul style="list-style-type: none"> - truly integrated organization - users find the system easy to use
Drivers & Lessons	<p>Key drivers:</p> <ul style="list-style-type: none"> - priority with management information - costs <p>Lessons:</p> <ul style="list-style-type: none"> - mistakes are hard to correct - high learning curve 	<p>Key drivers:</p> <ul style="list-style-type: none"> - reduction in costs - replacement of legacy systems - integrating all business processes - improved access of management information 	<p>Key drivers:</p> <ul style="list-style-type: none"> - single supply chain - replacement of legacy systems
Vision	<ul style="list-style-type: none"> - no clear vision - simple transaction processing 	<ul style="list-style-type: none"> - performance oriented culture - internal and external benchmarking 	<ul style="list-style-type: none"> - higher level uses are identified - other IT systems can be connected

Figure 2 ES Usage Maturity Model (based on [12])

6.1. Strategic use of IT

The first construct of the ES UMM is called ‘The strategic use of IT’ and deals with the importance of the IT function within a business [12]. This construct corresponds to the constructs ‘Corporate contribution’ (IT BSC MM) and ‘Operational excellence’ (IT BSC MM). Figure 3 shows the characteristics from the other ACMMs that are related to these two areas. ‘Business linkage’ (DoC ACMM) and ‘Business/technology strategy alignment’ (E2AMM) are important factors in this construct as these determine how the strategic goals of business and IT are related.

‘Architecture process and development’ (DoC ACMM) are the ones from ‘Operational excellence’ (IT BSC MM) that are related to this construct. These say how the architecture process is organized and what kind of developments is expected. ‘IT investment and acquisition strategy’ (DoC ACMM) is also a characteristic that falls within this construct.

6.2. Organizational Sophistication

This construct describes how the structure of the organization has changed after the ES implementation.

Change is unavoidable due to the fact that an ES imposes its embedded processes and data management procedures to the ES-adopter. Also, either the business processes in the organization have to be adapted to the embedded processes in the system (the so called ‘best practices’), or the ES has to be customized to the diverse processes of the company [12]. This is consistent with the strategy of the organization and with the ‘Organizational sophistication’ construct. Often, it is less expensive to change the business process to fit the system than the other way around. Customizing the ES can bring along problems with future versions of the software but sometimes an organization decides to change the software because their process is so specific or because of strategic advantages: when every organization uses the same ES, it is hard to compete [6]. The ‘Organizational sophistication’ construct has no specific equal within the ACMMs, but it can be mapped onto what is meant in the constructs of ‘Corporate contribution’ (IT BSC MM) and ‘Architecture communication’ (DoC ACMM) as all of these reflect strategic decisions being made.

6.3. Penetration of ERP

The penetration of the system in the organization can be measured by three indicators: (i) the number of

employees who use routinely the system as part of their daily duties, (ii) the number of functions that are covered, and (iii) the retention of legacy systems [12]. This construct can be partially mapped onto the constructs of ‘Customer orientation’ (IT BSC MM) and ‘Operational excellence’ (IT BSC MM). The factors of ‘Participation of the Employees’ (DoC ACMM) and the ‘Involvement of the senior management’ (DoC ACMM) are important for the use of the system as experiences indicate that many ES-implementations fail due to a lack of senior management involvement [22]. ‘Architecture communication’ (DoC ACMM) also is important for the employees to understand why to use the system. This concept discusses the level of penetration of the architecture documents.

6.4. Vision

The vision defines the strategic potential for the ES and what the use of the system is [12]. This is about the strategy of the organization. In this construct, the factors of ‘Business linkage’ (DoC ACMM) and ‘Business/technology strategy alignment’ (E2AMM) are also important because these describe the relationship between the construct ‘Vision’ and the construct ‘Strategic use of IT’, both of the ES UMM. Based on the above consideration, we can conclude that these two constructs are interrelated. The ‘Vision’ also impacts on the type and the number of standards and rules used within the IT. ‘Governance’ (DoC ACMM) is the characteristic that deals with these standards and rules.

6.5. Drivers & Lessons

This construct deals with the business drivers in the implementation and the lessons learned afterwards [12]. It follows the implementation process and can therefore be compared to the architecture process. There is no dimension in the ACMMs that is exactly the same, but the concept of ‘Architecture process’ (DoC ACMM) may well include analysis of business drivers and use of lessons learnt.

6.6. Evaluation

The ES UMM constructs are in essence all related to the architecture maturity constructs. With exception of ‘Penetration of the ERP’, the ES UMM constructs refer to the strategy of the organization as the ACMM do. Therefore our logical conclusion is that to achieve ES usage maturity, the same constructs can be used as to achieve architecture maturity.

ES UMM construct	Related ACMM constructs
Strategic Use of IT	IT BSC MM:
	<ul style="list-style-type: none"> • Corporate Contribution • Operational Excellence
	DoC ACMM:
	<ul style="list-style-type: none"> • Business Linkage • Architecture Process • Architecture Development • IT investment & Acquisition Strategy
Organizational Sophistication	E2AMM:
	<ul style="list-style-type: none"> • Business & Technology Strategy Alignment • Holistic Extended Enterprise Architecture • Extended Enterprise Architecture Programme Office • Extended Enterprise Architecture Development • Enterprise budget & Procurement strategy
	IT BSC MM:
	<ul style="list-style-type: none"> • Corporate Contribution
Penetration of the ERP	DoC ACMM:
	<ul style="list-style-type: none"> • Architecture Communication
	E2AMM:
	<i>Not covered</i>
Vision	IT BSC MM:
	<ul style="list-style-type: none"> • Customer Orientation
	DoC ACMM:
	<ul style="list-style-type: none"> • Operating Unit Participation • Senior Management Involvement • Architecture Communication
Drivers & Lessons	E2AMM:
	<ul style="list-style-type: none"> • Business units involvement • Executive Management Involvement • Extended Enterprise Involvement
	IT BSC MM:
	<ul style="list-style-type: none"> • Future Orientation
Not Covered	DoC ACMM:
	<ul style="list-style-type: none"> • Business Linkage • Governance
	E2AMM:
	<ul style="list-style-type: none"> • Business & Technology Strategy Alignment • Strategic Governance
Not Covered	IT BSC MM:
	<i>Not covered</i>
	DoC ACMM:
	<ul style="list-style-type: none"> • Architecture Process
Not Covered	E2AMM:
	Extended Enterprise Architecture Results
	DoC ACMM:
	<ul style="list-style-type: none"> • IT Security
Not Covered	E2AMM:
	<ul style="list-style-type: none"> • Enterprise Program Management
	DoC ACMM:

Figure 3 Comparing constructs of the ES UMM with the ACMMs

7. The case study

In this section, the ES UMM and the DOC ACMM are applied to a case study of a company implementing an ES. For this purpose, we use the ERP experiences at Telus Mobility, a Canadian communications company [4, 5]. This company completed 13 ERP projects within five years.

7.1. Architecture maturity

In 2000, after a series of corporate mergers, the company initiated a strategic planning exercise as part of a major business processes and systems alignment program. A key component of the strategic planning effort was the assessment of architecture maturity and the capability of the organization's architecture process. The DoC ACMM was used among other standards as a foundation and an assessment process was devised based on a series of reviews of (i) the architecture deliverables created for small, mid-sized and large projects, (ii) architecture usage scenarios, (iii) architecture roles, (iv) architecture standards, and (v) architecture process documentation. The nine maturity assessment aspects of the DoC ACMM (see the second column in Figure 2) were mapped into the types of architecture deliverables produced and used at the company. The highlights of the assessment are listed below:

- **Operating unit participation:** Since 1996, a business process analyst and a data analyst have been involved in a consistent way in any business (re)-engineering initiative. Process and data modeling were established as functions, they were visible for the business, the business knew about the value the architecture services provided and sought architecture support for their projects. Each core process and each data subject area had a process owner and a data owner. Their sign-off was important for the process of maintaining the repositories of process and data models current.
- **Business linkage:** The architecture deliverables have been completed on behalf of the business, but it was the business who took ownership over these deliverables. The architecture team was the custodian of the resulting architecture deliverables, however, these were maintained and changed based on requests by the business.
- **Senior management involvement / Governance:** All mid-sized and large projects were strategically important, as the telecommunication industry implies a constant change and a dynamic business environment. The projects were seen as business initiatives rather than IT projects and has strong commitment from top management.
- **IT investment and acquisition strategy:** IT was critical to the company's success and market share.

Investments in applications were done as a result of a strategic planning process.

- **Architecture process:** The architecture process was institutionalized as a part of the corporate Project Office. It was documented in terms of key activities and key deliverables. It was supported by means of standards and tools.
- **Architecture development:** All major areas of business, e.g. all core business processes, major portion of the support processes, and all data subject areas were architected according to Martin's methodology [18]. The architecture team has a quite good understanding of which architecture elements were rigid and which were flexible.
- **Architecture communication:** Architecture was communicated by the Project Office Department and by the process owners. The IT team has not been consistently successful in marketing the architecture services. There were ups and downs as poor stakeholder involvement impacted the effectiveness of the architecture team's interventions.
- **IT security:** IT Security was considered as one of the highest corporate priorities. The manager of this function was part of the business, and not of the IT function. He reported directly to Vice-President Business Development.

7.2. ES usage maturity

To assess the ES usage maturity in this case, the ES UMM (Figure 3) is used. Throughout the first three projects, the organization was in the beginning of stage 1 of this model. Before the implementation was executed, little thought was given to how the organization should handle these projects in the long-term. During the first few projects, it became clear to the project implementation team that there was a lot of learning on the job, and this was used to reflect on success and failure experiences [5] and get more insights into the intricacies of the ES implementation. At the time of writing, Telus is extending its SAP portfolio and is currently in stage 2 of the ES UMM. Details on the qualitative assessments of the ES usage maturity with respect to the five constructs are discussed as follows:

- **Strategic use of IT:** The company started with a strong IT vision, the senior managers were highly committed to the projects. The CFO was responsible for the choice for an enterprise system, and therefore, moving to a new ERP platform was a business decision. The company also had their CIO on board. The SAP package was not implemented in all areas because this could have reduced their competitive advantage. As quality of service provisioning and client intimacy were the key priorities for the company, they decided to combine the SAP applications with a business-specific

package (namely AMDOCS) for their competitively important domain of wireless service delivery (including client activations, client care, and rate plan management). This made the choice for SAP a well-considered one. The management team now decided to implement three additional SAP modules and, thus, more and more business processes are covered in the ES.

- **Organizational Sophistication:** Business users wanted to keep processes diverse, however the system pushed them towards process standardization and this led to cultural conflicts. Another challenge was the reluctance to change the organization. Users felt overwhelmed with the new ways of working and, for a while, have kept using both the old applications and the newly installed solution.
- **Penetration of the ERP system:** The level of process owners' involvement in the ES implementation was proportional to the quality level of results. The process owners were committed to reuse their old processes, which led to significant customization efforts. The penetration of the ERP was assessed according to two indicators: the number of people who used it and the number of processes covered. The latter gives a clearer picture of the use, than the first because many employees can be in functions in which they have nothing to do with the ES itself, for example, call centre representatives or field technicians in cell site building. Within the company, 30-40% of the business processes are covered with SAP and they are still extending.
- **Vision:** The organization wanted in a longer-term to achieve a competitive advantage by implementing the SAP solution. ERP was a pricy endeavor; once it was brought in, the users got to live with it. Therefore the focus is now on maximizing the value of ERP and extend it to other non-core activities and back office.
- **Drivers & Lessons:** The company's drivers were: (i) integration of sites and locations, (ii) reducing transaction costs, and (iii) replacement of legacy applications. There was a steep learning curve through the process. Some requirements engineering activities, like requirements prioritization and negotiation went wrong in the first place, but solutions were found later in the RE process. More about the lessons learned in the process can be found in [4].

7.3. Evaluation of the results

This section discusses the links between the two models as observed in our case study: we first start with 'Strategic use of IT' (ES UMM) and 'Vision' (ES UMM). The 'Business linkage' (DoC ACMM) in the architecture

process was high: the business was responsible for the architecture deliverables as well as for the choice of the ES. In addition, the choice for SAP was an architecturally-sound and well-thought-out decision. This indicated a high level on both AMM and ES UMM levels.

Second, the 'Organizational sophistication' (ES UMM) was rated low which was due to insufficient stakeholders participation. This was also a weak point in the architecture process and reflected in a low level of 'Architecture communication' (DoC ACMM).

Third, the organization had process and data owners who were involved in both the architecture process and the ES implementation process. The organization was mature in terms of 'Operating Units Participation' and 'Business Linkages'. However, when assessing 'Penetration of the ERP' (ES UMM), it was found that the level of involvement of these process owners varied widely: some of them who were committed to the architecture process were not enough committed to the ES implementation process. These process owners did effectively negotiate their business requirements and signed-off them without suggestions for improvements at the end of the ERP RE process, but they did not return to the later implementation stages after the initial spirit has worn off. They did not show any enthusiasm for repeating the RE process in future projects and suggested other business representatives take over the remaining project stages [5]. This led us to the conclusion (i) that many factors – beyond maturity of the enterprise architecture in a company, can affect the level of ERP penetration in an organization, and (ii) a mature architecture team alone is not enough to positively impact business users' participation and involvement in implementing an ES.

Fourth, although business drivers were defined for each project, the organization found that some of them were in conflict; indeed, conflicting business drivers led to unnecessary complex SAP customization and needless installation of multiple system versions [4,5]. In the early projects, the organization failed to see the ERP initiative as a learning process as well.

To sum up, high architecture maturity does not necessarily imply coordination in determining ERP priorities and drivers; neither, it can turn an ERP initiative into a systematic learning process.

While the architecture maturity in the beginning of the project was very high, the organization could not set up a smooth implementation process for the first six ERP projects. So, at the start, the ES usage maturity was low (stage 1) although the company was clear on the strategic use of IT and treated the ES implementation projects as business initiatives and not IT projects.

8. Conclusions

In this paper, we examined the linkages between the assessment constructs of two types of maturity models,

namely ACMM and ES UMM. We used one company's experiences in ERP implementations as a case study to get a deeper understanding of how these constructs refer to each other. We found that all ACMM and ES UMM constructs are interrelated. The ES UMM constructs are about the strategy and vision of the company, the penetration and use of the ES. However, although most of the ES UMM constructs correlate to the architecture model's constructs, the interpretation of them in both maturity models can be different. Furthermore, we found that a well-established architecture function in a company would not directly imply that there is support for an ES-implementation. This leads to the conclusion that a high architecture maturity will not automatically lead to a high ES usage maturity.

In our case study, we do not give exact measurements of the models. We used qualitative assessments because measurements are often not as precise as is thought [3]. In complex cases like ES implementation, indeed using one only model for assessment is not enough; information from more sources should be collected.

Finally, architecture maturity is a term used in many models, often related to business/IT alignment [15]. These models are much more elaborated than the ES UMM. Therefore, more research has to be done in the area of ES usage maturity to bring the ES UMM to the level of sophistication that other models offer.

Our future research towards refining ES UMM concepts involves case studies at companies' sites in which we plan to analyze how enterprise architecture is used in managing strategic change [25]. We also plan to investigate how calibration, capability assessments, and maturity advancement [11] are used to achieve business/IT alignment.

9. References

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