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IT Architecture Standardization Survey

Alexander W. Schneider, Anna Gschwendtner and Florian Matthes

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October 2015

Software Engineering for Business Information Systems (sebis)
Ernst Denert-Stiftungslehrstuhl
Chair for Informatics 19
Technische Universität München

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Technical Report

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About sebis

sebis is the chair for Software Engineering for Business Information Systems at the Institute for Informatics of the Technische Universität München. sebis has been established in 2002 with funding of the Ernst Denert-Stiftung and is headed by Professor Dr. Florian Matthes. The main research areas of *sebis* are:

- Software Cartography: Development of multi-faceted and formal models that help to manage (plan, build, operate, optimize) complex software application landscapes consisting of hundreds or thousands of information systems.
- Innovative technologies and software architectures for enterprise information and knowledge management (enterprise solutions, groupware and social software).
- Domain-specific and reflective languages and models for families of business applications.

sebis is using software engineering methods (model construction & abstraction, analysis & design, construction & evaluation) and is working in close relationship with industrial partners and with organizations from the public sector.

Professor Matthes puts particular emphasis on the knowledge transfer from academia to industry. For example, he is co-founder of CoreMedia AG, of infoAsset AG, and of 20six Web log services AG, which at present employ a total of approx. 150 employees.

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1 Introduction

Today, organizations rely more and more on the usage of information technology (IT) to support daily business routines. As a result of decades of growth, IT landscapes of modern organizations comprise up to thousands of business applications and tens of thousands of interfaces. Due to uncontrolled evolution, many organizations ended up with an application silo architecture and proliferation (Ross et al., 2006). In this stage, business departments focus on the value of their applications and occasionally complain about high operations costs. The IT department is responsible for systems development, although business departments are usually expected to generate the benefits. However, more mature architectures would provide benefits like an increase of IT efficiency, process optimization and strategic agility. To guide the evolution of application landscapes towards an organization's goals, many organizations introduced enterprise architecture management (EAM) functions. Among others, EAM functions can facilitate organizational alignment, information availability, resource portfolio optimization and resource complementarity (Tamm et al., 2011). A commonly used management approach to coping with the increasing complexity of application landscapes is the usage of IT standards set by enterprise architects (Mueller et al., 2015). Current literature attributes different benefits and drawbacks to IT standardization. For example, decreasing IT costs are mentioned frequently (Boh and Yellin, 2007; Mueller et al., 2015; Richardson et al., 1990) but increasing technology or vendor dependence is also reported (Fürstenau and Kliewer, 2015; Farrell and Klemperer, 2007). However, ambidexterity theory suggests that both, IT standardization as well as differentiation are equally required (Gregory et al., 2015). The reason therefore is that exploitation of existing IT capabilities has to be performed in parallel to exploring new ways of using technologies to support existing or generate new business models (March, 1991). Nevertheless, expected and reported effects of IT standardization are wide-ranging and empirical evidence for various effects of IT standardization is often scarce. To provide an overview on the current state of the practice, an online survey is performed and outlined in this report. The following goals are pursued by the survey described in this report:

1. Identification of benefits and drawbacks of IT standardization observable in practice
2. Identification of means commonly used to manage IT diversity
3. Identification of areas commonly subject to standardization or differentiation

The remainder of this report is structured as follows. In Chapter 2, the applied research methodology is described in detail as well as the background of the experts participating in the online survey. In addition, the hypotheses derived from literature regarding effects of IT standardization and respective results of the questionnaires are presented. Finally, Chapter 4 summarizes the findings of this research and provides suggestions for future research activities.

2 Methodology

To achieve the aforementioned research goals, a common approach consisting of a literature review, an online survey and respective analyses was followed. In addition to the methodology, this chapter provides detailed information about the industry experts participating in this survey.

2.1 Approach

To achieve the aforementioned research goals, the respective research endeavor started by performing a structured literature review since it represents an “essential first step and foundation when undertaking a research project” (Baker, 2000). However, the search process needs to be described in detail (vom Brocke et al., 2009). The literature review used to derive hypotheses for this research has been conducted according to the guidelines by Webster and Watson (2002). To assess the current state of research on IT standardization a number of scientific databases were queried systematically. These include IS journals (AIS senior scholars basket), IS conferences (ICIS, ECIS, AMCIS) and academic databases (IEEE Xplore, ScienceDirect, Web of Science, ACM DL, Google Scholar, SpringerLink, EBSCOhost). The search was performed in April and May 2015 by using combinations of the search terms “Enterprise architecture” OR “Enterprise architecting” AND “IT standard” OR “architectural standard” OR “IT guidelines” limited to titles, abstracts and keywords. To reduce the results to the most relevant, “impact”, “consequence”, “effect” or “influence” have been added to the search string resulting in a set of twelve articles. Separating out duplicates and irrelevant articles limited this set to seven. Given these articles, a forward and backward search was performed to avoid omitting relevant references. The search results were further verified by applying alternative search terms such as “application landscape” and “IT diversity”.

Based on the literature review results, concrete hypotheses about goals of IT standardization, means of IT standardization and effects of IT standardization could be derived. We refrain from providing an extensive list of hypotheses here, because due to missing definitions of relevant concepts and missing access to reliable information or measurements, classical statistical hypothesis test cannot be applied here. Therefore, we shortly outline respective hypotheses and relevant literature when describing the results in Chapter 3. Based on these hypotheses, the online survey used to capture the respective experience of practitioners has been designed. Thereby, the guidelines described by Fowler (2013) and Pfleeger and Kitchenham (2001) have been adhered to. Therefore, closed as well as open questions were included and only questionnaires in which all mandatory questions were answered have been considered. If not all participants provided an answer to an optional question, this is indicated next to the respective result description in in Chapter 3. The complete questionnaire is available for download at https://wwwmatthes.in.tum.de/pages/9higmgku6d4c/.

As next step, invitations to participate in the online survey have been sent via e-mail to 253 industry experts. These experts have previously shown interested in the research activities of our chair or participated in research projects. In addition, about 100 participants of an annual EAM practitioner’s conference have been invited. The participation was anonymously but participants had the chance to leave their email addresses for further queries. In total, 70 industry experts filled out the survey. However, only 47 answered all mandatory questions. The subsequent analysis of the survey results is described in Chapter 3.

2.2 Participant overview

This section provides an overview about the 47 industry experts participating in the online survey and provides details about the companies they currently work for.

An analysis of the roles the participants take within their organization reveals that most of the participants work as an enterprise architect although some of the participants selected more than one role. In addition to the 26 enterprise architects, ten consultants participated in the survey followed by seven IT managers, four software architects, four project managers and one software developer. In addition, many industry sectors are covered by the participating companies including finance (33%), IT/technology (24%) and production (17%). As visualized in Figure 1, of all respondents, 89% were employed by an organization having more than 1.000 employees. Of those, 61% had more than 10.000 employees indicating an over-representation of large companies. Regarding professional experience (see Figure 2), 87% of the participants had more than five years of experience in relevant domains. Although not necessarily representative, the study covers a broad spectrum of industry domains and roles.

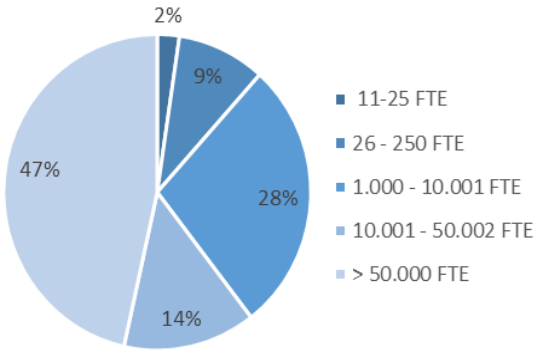

Figure 1: Company size

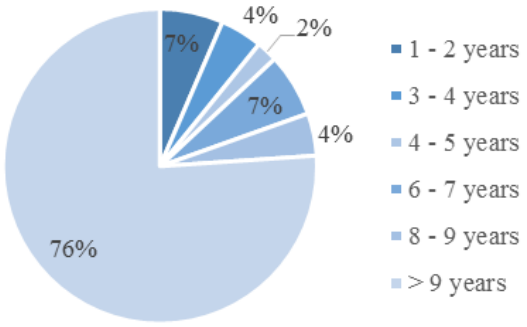

Figure 2: Professional experience

The participating companies differ in terms of EAM maturity, EAM key drivers, current degree of IT standardization as well as the perceived importance to react to a changing environment. As visualized in Figure 3, 24% of the participants perceive the degree of their EAM function's maturity to be high while 50% perceive it to be medium. However, 26% of the participating companies seem to have an immature EAM function. This is reflected by the fact that 76% of the participating companies started their EAM endeavor more than 5 years ago. Regarding the key drivers for EAM within the participating companies, it can be stated that in 51% of the companies the IT department is the main driver which is depicted in Figure 4. Obviously, this impacts the scope of the EAM function in this large portion of the participants. However, in 47% both, business and IT departments are considered as key drivers. Only in 2% of the companies, business departments are the main driver for EAM.

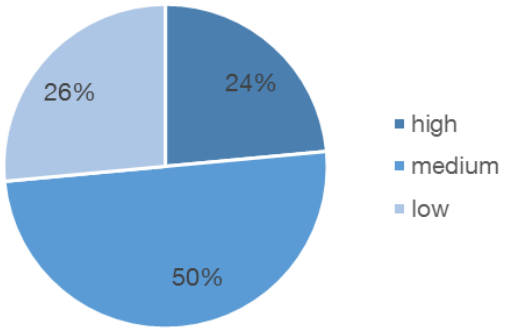

Figure 3: EAM maturity

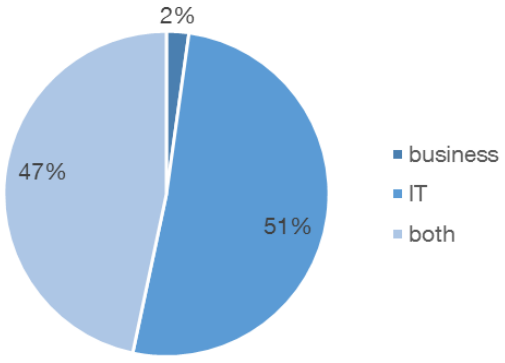

Figure 4: EAM key drivers

Regarding the support of higher management, 89% of the participants confirmed that the EAM team has the required support. While 74% of the participants stated that reacting to a changing environment is important or very important, only 10% stated that it is rather or not important. Concerning the actual EAM methodology, the companies who participated in the survey have chosen different frameworks and scopes. Figure 5 visualizes the distribution of EAM frameworks among the participants (multiple answers possible). Most companies follow the TOGAF framework followed by Archimate and the Zachman framework. However, 15 participants stated that their company does not follow any specific framework.

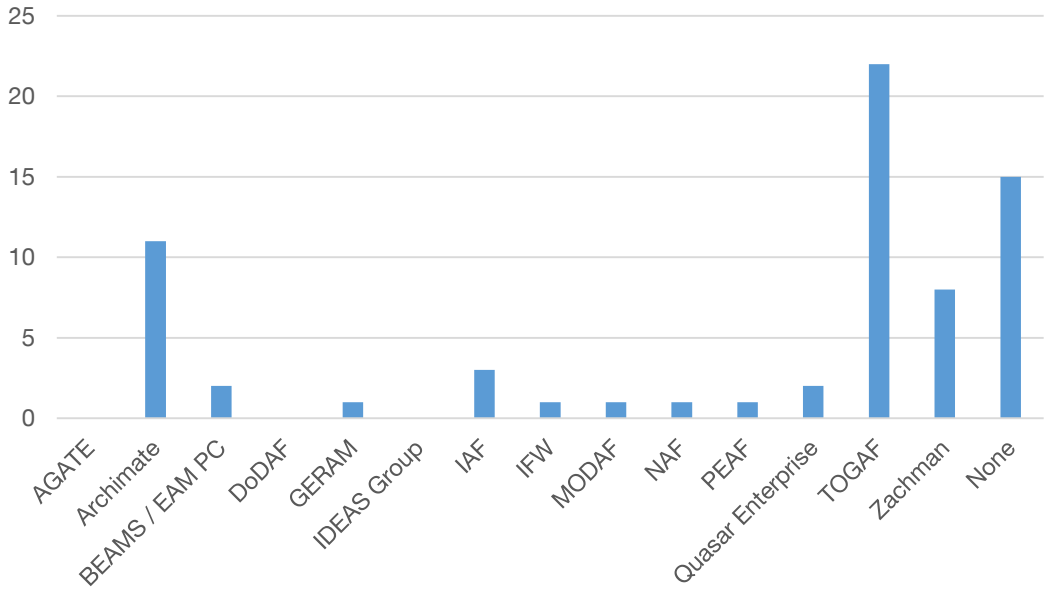

Figure 5: EAM frameworks used by participating companies

As EAM frameworks do not necessarily determine which horizon is used for EA planning, the participants were also asked whether they model the as-is architecture, planned states of the architecture or the to-be architecture. Again, the answers are relatively wide-spread. As indicated in Figure 6, most of the participating companies model the as-is state. Only about one half also models planned states or a to-be state. Interestingly, in three companies modelling is not done at all. One of the participants commented this with “we create slides”. 28% stated that they model all three states of their EA while 11% stated that they model only a to-be state of their enterprise architecture.

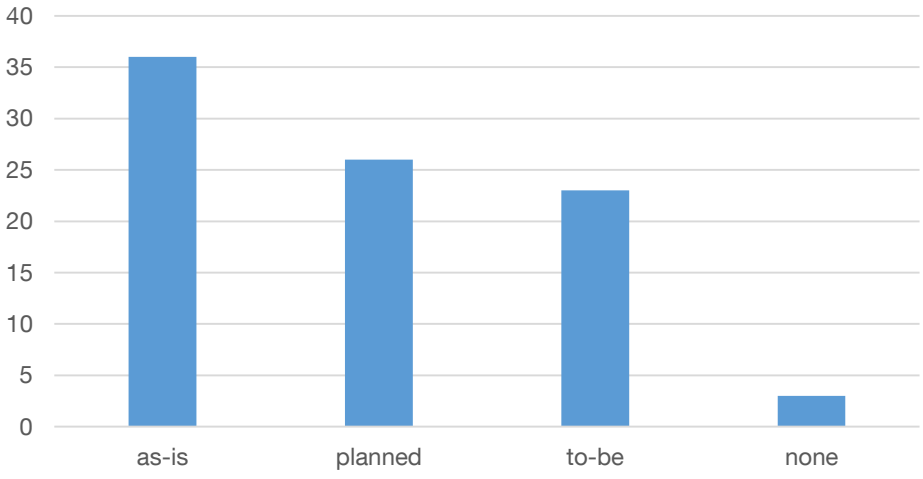

Figure 6: Modelled states of the enterprise architecture

3 Survey results

In this this chapter, the results of the online survey are described in detail.

3.1 Current standardization efforts within enterprises

Both, the current and the planned state of standardization efforts in enterprises are outlined in this chapter. To assess the respective information, the survey participants answered a series of questions, e.g., regarding their enterprises' standardization initiatives or the durance of introducing a new standard.

Standardization is a key challenge

Ross et al. (2006), for example, state that standardizing the IT landscape is the first stage of enterprise architecture maturity. Several case studies describe how difficult it can be to achieve this stage. To assess the easiness of developing and implementing a new IT standard in more detail, the experts were asked whether the development or implementation of IT standards is a key challenge for their enterprise. Of 43 respondents, 83% stated that IT standardization is a key challenge for their enterprise (see Figure 7). The high number of positive replies allows for two conclusions. First, IT standardization seems to be important for enterprises. Second, the procedure for creating and establishing new IT standards is currently not a smooth and easy process in most enterprises which is costly and binds a rather high number of human resources. Concluding, improving the respective standard creation and implementation process could be very beneficial for enterprises.

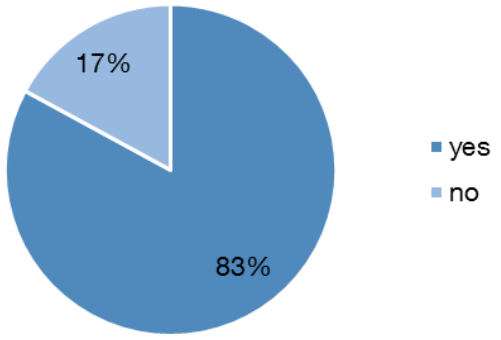

Figure 7: Perception of IT standardization as a key challenge

Timeframe for implementing new IT standards

For the purpose of determining a timeframe currently required for implementing a new IT standard, the experts were asked for the durance of establishing a new standard within their enterprise. One the one hand, of 39 respondents, only 9% stated it would require less than one year establishing a new standard (see Figure 8). In 40% of the cases, on the other hand, introducing IT standards requires three years or more. The remaining 51% estimated a timeframe of one to three years. A long durance of implementing new IT standards, however, may have negative effects on the company in the sense of an increasing number of standard-incompatible products and short-term solutions which have to be subsequently replaced by the standard solution. Thus, this confirms the statement that improving the respective standard creation and implementation process could be very beneficial for enterprises and reduce the standard implementation durance.

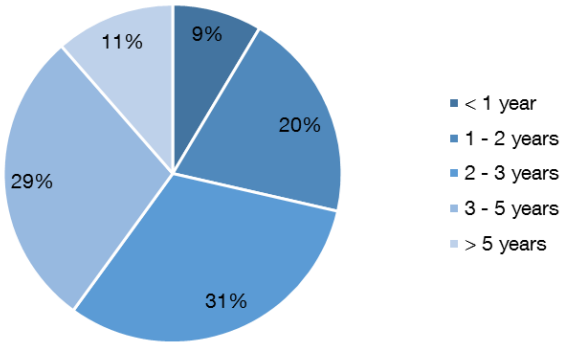

Figure 8: Common timeframe for establishing a new IT standard

Current extent of IT standardization

In the study conducted by Ross et al. (2006), 12% of the companies had not yet matured to the stage of standardized technology. Furthermore, 48% had been in this stage although it remains unclear to which extend. To evaluate the current standardization extent in organizations, the respondents were asked to estimate the IT standardization degree within their enterprise. Of all 47 respondents, 15% rated the standardization degree as “high”. In contrast, about one third (32%) considered their standardization degree as “low”, while the remaining 53% considered it to be “medium”. Thus, in 85% of the cases there would still be a potential for increasing the enterprise’s IT standardization extent – if desired.

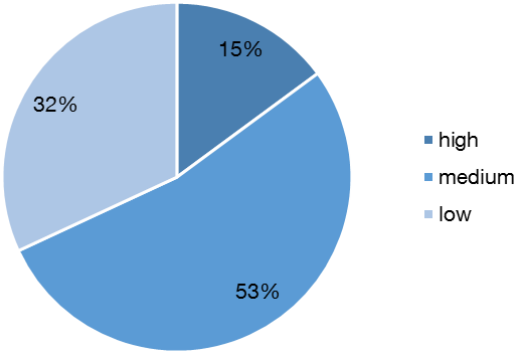

Figure 9: Current degree of IT standardization

Standardization as objective

To assess whether enterprises are willing to increase their IT standardization extent, the experts were asked whether their companies aim at increasing their level of IT standardization. Of all respondents, a small minority (4%) stated that increasing the degree of IT standardization within their company is currently not desired (see ##). The other 96%, on the other hand, stated standardizing was desired indeed: 60% confirmed to aim at increasing standardization in general, while the other 36% intend to standardize in particular domains. All in all, the vast majority of the enterprises addressed within this survey confirmed to be willingly to increase the standardization level. Thus, IT standardization seems to be perceived as, both, beneficial and desirable.

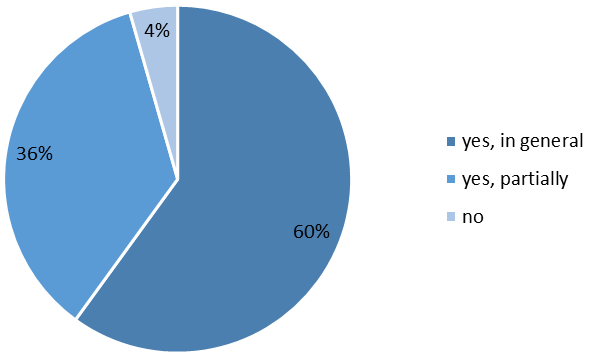

Figure 10: Standardization as current objective of enterprises

Perception of standardization benefits

Complementing the question of whether IT standardization is currently intended, the respondents were asked whether the value of particular IT standards is perceived within their enterprise. About two thirds (62%) of the respondents confirmed that in their enterprise, the standard benefits are recognized (see Figure 11). It is interesting that of all respondents which had confirmed a low standardization degree within their enterprise only 21% confirmed the perception of the standardization benefits – considerably less than those with a higher standardization degree. Further, those respondents answering that the standardization value is perceived within the enterprise also stated to have top management support for their EAM initiatives.

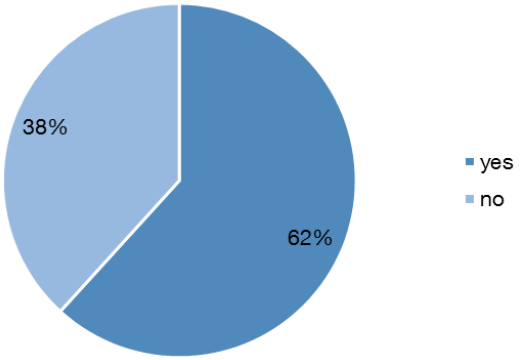

Figure 11: Perception of standardization benefits

3.2 Standardization goals

Although IT standardization seems to be a prevalent objective of today's organizations, the question is why do organizations actually pursue that goal. As visualized in Figure 12, the most prominent reason for standardizing IT components are expected cost savings which has been confirmed by 85% of all respondents. To maintain the control and governance over the application landscape is a reason for IT standardization in 66% of the participating companies. Also in the focus is the improvement of integration and collaboration of IT systems as well as organizational units which has been confirmed by 55% of the respondents. Implementing security guidelines or legal requirements is pursued by 45% and 26% of the companies that participated in this survey.

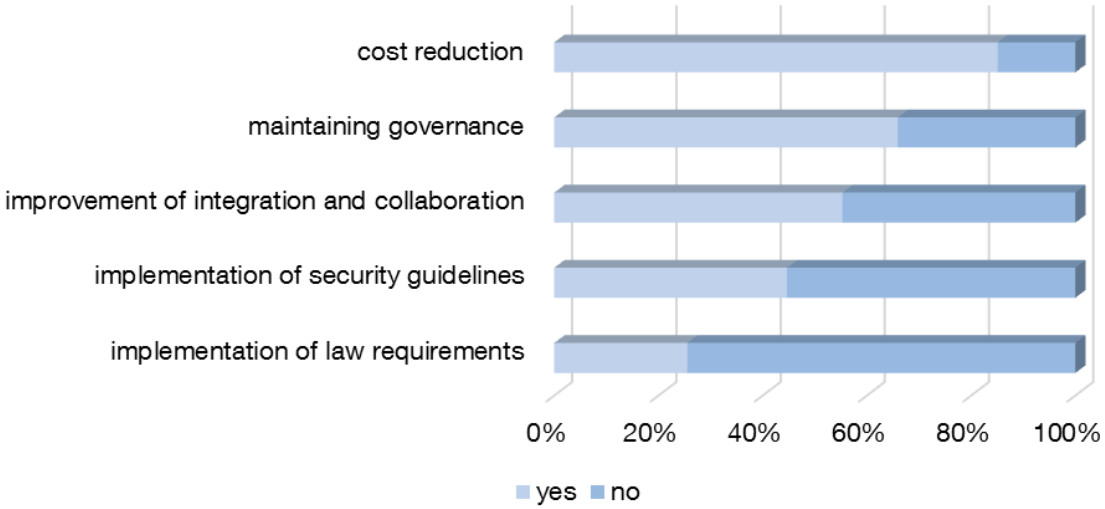

Figure 12: Most frequent incentives for IT standardization

3.3 Standardization means

Because organizations form complex adaptive socio-technical systems, up now it remains unclear how organizations can increase the degree of standardization within their application landscapes. Accordingly, it is of interest which means are currently used by organizations pursuing this goal. As depicted in Figure 13, the pallet of possible means is large.

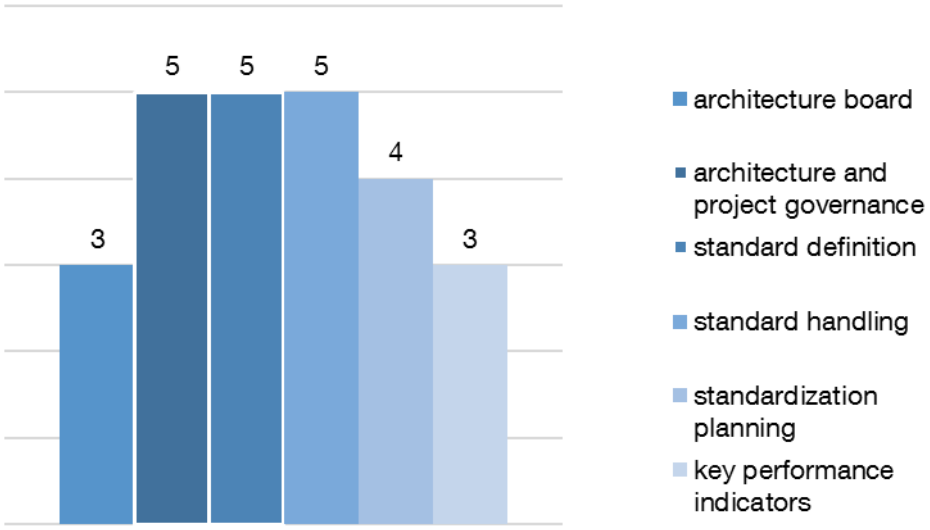

Figure 13: Planned and implemented means to increase standardization

For example, many organizations established a strong architecture- and project-governance. This includes, for example, dedicated release processes for technical components and business applications. This corresponds naturally with the definition of particular standards, sometimes published as a book-of-standards. Within an architecture board, decisions regarding standardization can be made by bringing together different stakeholders and support them with relevant information derived from an EAM tool. If this board has influence on the project portfolio, its influence can be significant. All these observations are in line with previous studies performed, for example, by Ross et al. (2006).

The handling of standards includes not only their definition. Furthermore, a continuous process is established to monitor the adherence to these standards and adapt the set of standard technologies to changing requirements timely.

Many companies (70%) also develop target architecture descriptions which adhere to the given set of standards and guide the future development of the application landscape. Therefore, it is required to document both, the as-is and the to-be state, and derive a transformation path. For technical areas, reference architectures ore technical platforms are provided by 81% of the participating companies. Another 66% define concrete architecture principles.

A considerable amount of organizations uses key performance indicators (KPIs) to measure the progress towards the goal of IT standardization. These include metrics regarding technical variety as well as business requirements coverage. Thereby, risks as well as opportunities should be clearly communicated by these metrics.

If the level of standardization should be decreased, other means are typically used. These include, for example, the definition of an explicit multi-product strategy in 36% of the participating companies. In rare cases (6%), subsidiaries or new business units are founded.

3.4 Influence of EAM/IT department on standardization

Subsequently, the influence of the IT department or enterprise architects on IT standardization is assessed. All respondents were asked to rate the IT department's influence on different EA levels including infrastructure, technical components, business applications, data and business processes. The highest influence was perceived in the context of infrastructure – of the 42 respondents, 87% considered the influence to be "high" or "very high" (see Figure 14). As second highest EA layer, technical components were rated with "high" or "very high" by 86% of the respondents, followed by business applications (83%), data (75 %) and business processes (71%). In summary, the IT department influence of all five domains is perceived as rather high but clearly focused on technologies.

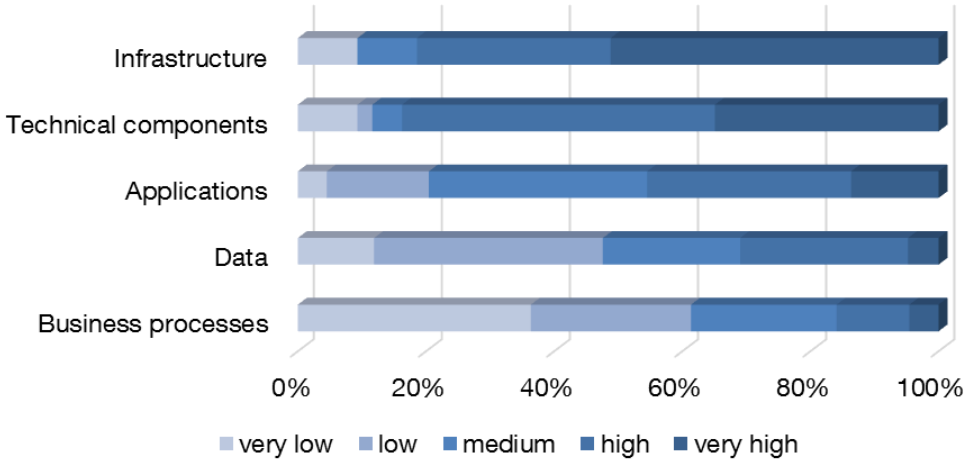

Figure 14: Influence of enterprise architects regarding IT standardization

In addition to the actual influence of enterprise architects on the different EA layers, the survey participants were also asked about their desired influence to reveal the best leverage points for IT standardization. The results are depicted in Figure 15.

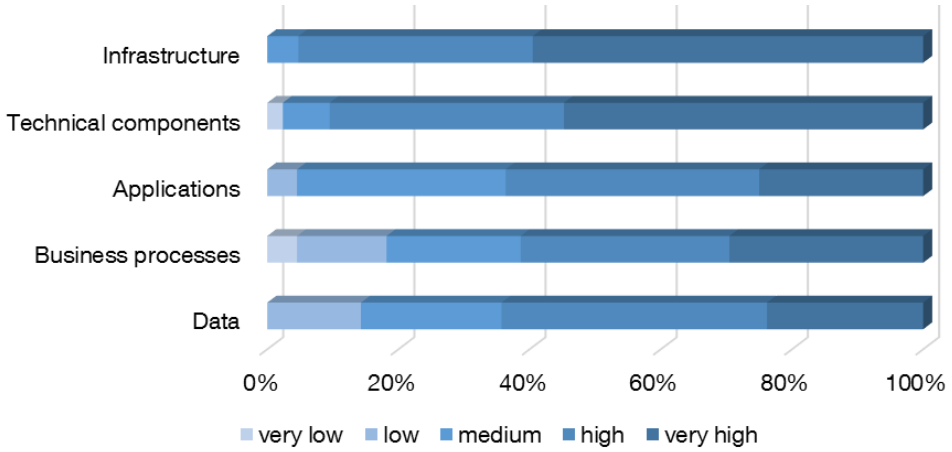

Figure 15: Leverage points of IT standardization

By comparing the desired influence of enterprise architects (see Figure 15) with their actual influence (see Figure 14), two important conclusions can be drawn. First, commonly the enterprise architects do not have influence on the most suitable leverage points to increase IT standardization. For example, business processes have been ranked higher than data but only a few enterprise architects can actually exert influence on them. The influence of the participating experts was mainly technical oriented. Second, the influence of enterprise architects seems to be limited in general. This becomes obvious by the fact that for each layer, a considerable amount of survey participants reported "low" or even "very low" influence. Thus, it would be interesting to see who else could influence the IT standardization in these cases.

Beside the suitability of horizontal EA layers for IT standardization, the survey asked additionally if vertical domains are in the focus of IT standardization. As depicted in Figure 16, 75% of the respondents confirmed that in their organization specific domains are subject to IT standardization while others are not.

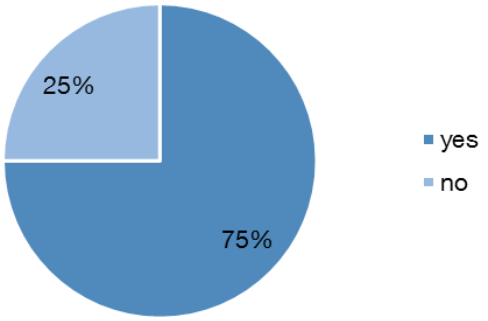

Figure 16: Existence of vertical focus domains for IT standardization

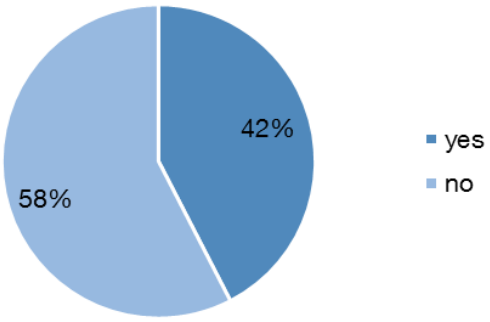

Figure 17: Existence of excluded from IT standardization

The survey participants mentioned several IT standardization focus domains. Frequently mentioned was the financial department which includes financial accounting systems, enterprise resource planning systems and controlling systems. Also frequently mentioned were workplaces including typically used hardware and software. In parallel, 42% of the survey participants confirmed that in their organization particular domains are excluded from IT standardization (see Figure 17). When asked for concrete domains, the experts mentioned frequently logistics systems and HR payroll. Also mentioned frequently are domains requiring differentiation from competitors like research and development and innova-

tion topics, e.g., big data initiatives. Some participants also mentioned top management applications to be excluded from standardization activities.

The collected answers revealed that some organizations try to standardize their core processes and respective IT systems while others standardize only non-core processes because for those differentiation from competitors is not needed.

3.5 Standardization challenges

Implementing organization-wide IT standards has been identified as a major challenge of today's organizations. Therefore, the survey participants have been asked about the particular challenges in this context. Among the wide-spread challenges mentioned by the experts, the following have been mentioned frequently.

The most challenging aspects during IT standard implementation seem to be related to affected people. For example, the users need to change their previous behavior and adapt it to the new system. The "not invented here" syndrome often prevents a fast expansion of an IT standard. In addition, business users might need to attend trainings to learn how to handle a new IT system. Likewise, IT personnel needs to be trained as well to operate standardized IT components.

Another challenging aspect seems to be the distribution of decisional power. If the centralized IT department sets global IT standards, those decisions might not be respected by business units having their own local governance structures.

Among many others, the related costs for implementing an IT standard often hinder organizations in doing so. Replacing legacy systems can require significant investments. However, the perceived business value is often not visible. Therefore, such decisions are often postponed until they are required due to technical aspects. Figure 18 summarizes the most frequently mentioned IT standardization challenges.

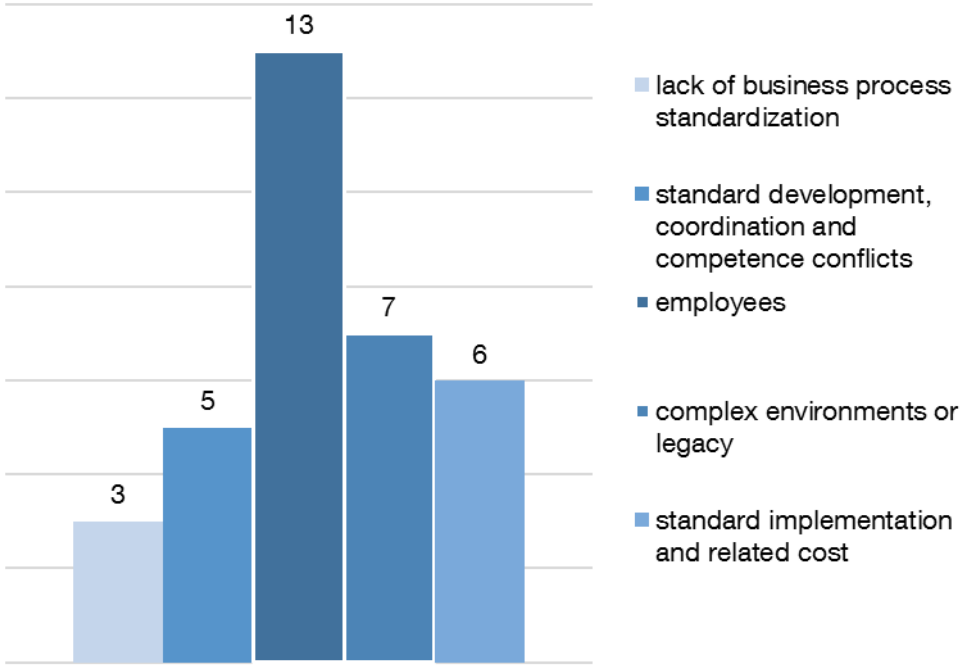

Figure 18: Most frequently mentioned IT standardization challenges

3.6 Standardization and controllability

As outlined in Chapter 3.2, 66% of the respondents confirmed that maintaining IT architecture controllability is a major reason for IT standardization. In accordance with Mueller et al.

(2015), we thus hypothesize that IT standardization fosters IT management and control. Accordingly, survey participants have been asked whether they confirm the statement that “IT standardization eases management and maintenance of control in my organization”. Out of 41 respondents, 38 respondents confirmed this statement. Only three respondents did not confirm the statement. Given the high degree of confirmation, we can conclude that enhanced manageability and control are two common effects of increased IT architecture standardization.

IT standards provide guidelines for IT departments and business units regarding their technical choices and are assumed to hereby affect the creation of local IT objectives (Boh and Yellin, 2007) and sub-optimal business solutions (Ross et al., 2006). In the purpose of verifying this, the interviewees were asked whether they know any concrete case in which the compliance of IT standards has effected suboptimal solutions. Of 38 respondents, 74% knew at least one such case. It seems reasonable that respective experiences, i.e., IT standards effecting suboptimal local solutions, are likely to foster the creation of local objectives as well as to increase the resistance against IT standards. The relevance of the employee resistance against standards has already been outlined in Chapter 3.5, where 13 respondents listed the “employee mindset” as primary challenge of implementing IT standards.

In addition, IT standardization is frequently considered to foster shadow IT due to a misalignment of business demands and provided IT solutions (György et al., 2012). To confirm or neglect this statement, the survey participants were asked whether it is true that “the higher the standardization degree of the applied IT, the higher the danger of generating shadow IT by the business departments”. As visualized in Figure 19, of all 47 respondents, 56% confirmed this statement. 21%, on the other hand, rather disagreed with this statement. As, in summary, the majority confirmed this statement, we assume that a high IT standardization level is likely to foster shadow IT although this effect might be mitigated. Integrating this aspect into considerations on an appropriate level of IT standardization may thus assist at keeping the enterprise shadow-IT more controllable.

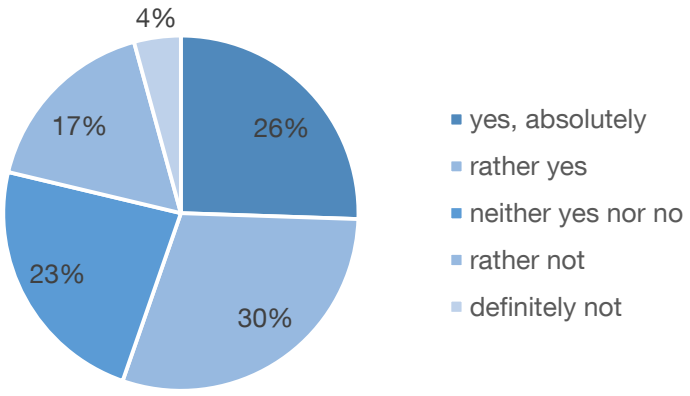

Figure 19: IT standardization causes shadow IT

3.7 Standardization and productivity

According to current IT standardization literature as well as to personal experience, standardization can increase both, the throughput and efficiency, of business units (Ross et al., 2006). Thus, the experts were asked for the number of known cases in which complementing IT standards facilitate synergy effects within their enterprise. Of the 35 respondents, 91% knew at least one such case – 71% knew several cases, i.e., three or more. Thus, in

summary, according to the survey results, IT standardization may indeed effect synergies and hereby have a positive impact on productivity.

To assess the short-term productivity effects of introducing new IT standards, the experts were asked whether they know cases in which the familiarization time required when introducing new IT standards effected a significant short-term productivity loss. Of the 33 respondents, only 6% stated to have never experienced such a case. In contrast, 67% knew at least three cases where significant short-term productivity was observable within their company. Thus, regarding the frequency of short-term productivity losses, this aspect should be regarded when considering the introduction of a new standard and be weighted against the potential long-term standard productivity advantages.

A factor influencing the department productivity is also the fit of solutions to the departmental needs. In the context of IT standardization, it is frequently stated that, by restricting business units, IT standards often effect less optimal local solutions (Ross et al., 2006; Farwick et al., 2010). To verify this claim, the practitioners were asked whether they know at least one case where the compliancy to an IT standard resulted in a less optimal local solution. In total, of 38 responses, 74% of the survey participants answered with “yes”.
To assess the impact of IT standards on local solutions in more detail, the experts were further asked to rate the frequency of IT standard-based restrictions effecting less optimal local solutions. Of 28 replies, 78% stated that this was at least sometimes the case, i.e., three times or more. Of these, 39% saw even a frequent (i.e., five cases or more) occurrence of IT standard-caused restrictions resulting in non-optimal local solutions.

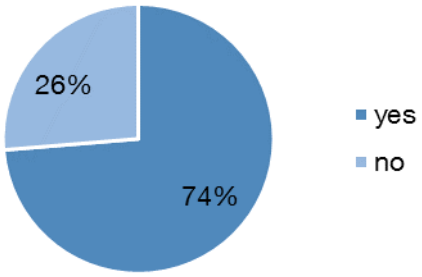

Figure 20: IT standardization causes less optimal business solutions

This aspect is of particular relevance when considering the increasing likeliness of affected business departments counteracting against the particular standards (and eventually further ones) with an augmenting number of restrictions perceived as unnecessary. Moreover, the more the departments counteract against IT standards, the more heterogeneous and the more difficult the management of the application landscape becomes. In this respect, when selecting IT standards, respecting the needs and wants of business units as well as creating a common awareness of the necessity of the particular standards is very important to successfully establish IT standards. Considering the business units’ perspective will thus increase the general IT standard acceptance and increase the departmental understanding in the case of suboptimal local solutions, which reduces the likeliness of departments counteracting against standards. In summary, to increase the general acceptance of IT standards, the effect on business departments in terms of additional restrictions should be of particular relevance when making standardization decisions.

3.8 Standardization and costs

IT standardization is generally assumed to reduce the enterprise´s IT-related cost – both, in literature and by practitioners (Boh and Yellin, 2007). The study conducted by Ross et al. (2006) observed a 15% decrease of IT costs on average due to IT standardization. However, it is frequently disregarded that establishing new IT standards impacts IT costs in multiple

ways – not each of those influences necessarily effects a cost reduction, e.g., the sudden necessity of unexpected changes of adjacent systems. The subsequent section examines such cost influence factors of IT standards in the purpose of providing a more differentiated perspective on the actual impact of IT standards on the enterprise cost.

Unexpected changes of adjacent IT systems

To determine the relevance of IT standards generating the need for implementing sudden changes in adjacent IT systems, the experts were asked to rate the frequency of unexpected changes after establishing an IT standard. All 35 respondents stated that this occurred at least rarely. In more detail, 81% replied that unexpected changes were required at least sometimes. 49% stated that sudden changes are occurring often or very often. The high rate of unexpected changes perceived by the respondents allows for two conclusions. First, the change impact when introducing new IT standards is frequently not properly assessed. Second, the additional costs caused by the required changes may be quite considerable, compared to cost savings due to IT standardization, especially as the requirement for unexpected changes may simultaneously result in productivity declines. It can be doubted that such effects are represented adequately in current IT cost measurements.

Perceived IT cost reduction due to standardization

To assess the perceived impact of IT standardization on IT costs, the experts were asked whether standardization significantly reduces IT costs within their enterprise. Of the 42 responses, 83% confirmed that IT standardization decreases IT cost a little or significantly (see Figure 21). In contrast, only one respondent saw IT standards as effecting a cost increase instead of a cost reduction.

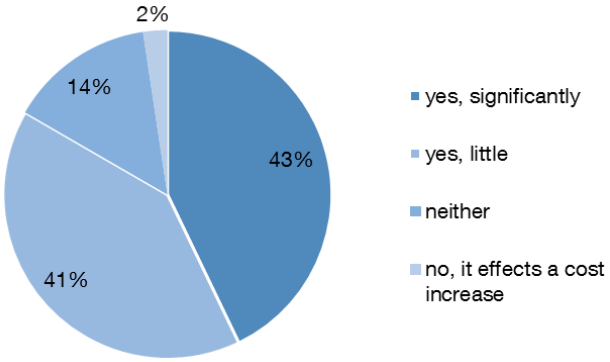

Figure 21: Perceived impact of IT standardization on IT cost

To complement this question, the survey participants were asked whether, in their enterprise, concrete measures regarding the reduction of costs due to IT standardization exist. Of the 37 replies, 41% confirmed to know of such measurements within their enterprise. Regarding the response with IT standards effecting an IT cost increase, the actual IT standardization impact is not measured within the experts' enterprise.

Thus, IT standardization is predominantly perceived to decline the enterprise IT cost. However, less than half of the enterprises addressed within the survey seem to measure the standardization impact on IT cost. In addition, it remains unclear which aspects of costs are currently regarded by those measurement systems.

Estimated IT cost reduction due to IT standardization

In the purpose of determining the average savings due to IT standardization, the interviewees were asked to estimate the savings due to IT standards compared to their total IT budget. In total, 16 experts provided an estimation – of which 75% estimated the total IT

standardization-related savings as higher than 5% of the total IT budget (see). Of those, 44% rated the savings as 10% or higher. In summary, the survey results regarding the estimated cost reduction allows for two conclusions: First, the rather low response rate (less than 50%) supports the statement that many enterprises do not measure the IT standardization impact on cost savings. Second, although the significance of the particular results is limited by the number of replies, the generally estimated cost savings are quite considerable. Thus, IT standardization may indeed be beneficial for enterprises.

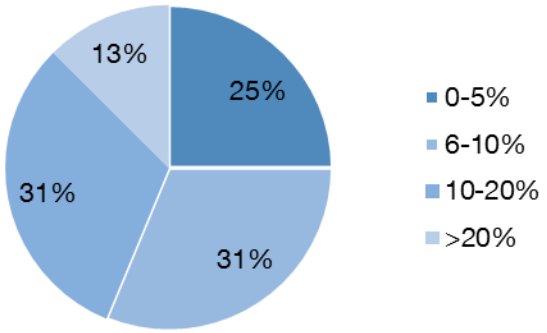

Figure 22: Estimated IT cost savings due to IT standardization based on IT budget

IT cost saving domains

To assess the manner in which IT standardization-related cost savings are generated in enterprises, the survey participants were asked whether IT standardization considerably reduces operational costs, maintenance costs or costs for new developments within their organization. According to 95% of 40 respondents, IT standardization considerably reduces operation costs. Further, 86% out of 37 stated that maintenance costs decreased as well as the costs for new developments (68% out of 31). Therefore, all three cost factors, i.e., operational, maintenance, as well as new development-related ones, may be decreased by introducing IT standards. However, the participation rate of the three types indicates a differing importance of the factors as well as the varying confirmation rates. Concluding, reducing operational costs is either more in the focus of enterprises when thinking of effecting cost reductions via IT standardization – or the perceived cost reduction with operational costs predominates in practice.

Impact of non-compliance to IT standards on IT cost

In the purpose of capturing the impact of non-compliance to IT standards on overall IT costs, the survey participants were asked for their knowledge of cases in which the non-compliancy to standards effects or has effected monetary losses within their enterprise. In total, 37% of 30 respondents stated that they had experienced cases where ignoring a standard has effected monetary losses. Thus, the non-compliance to IT standards may indeed effect additional cost for enterprises. As examples for loss causes, four experts mentioned redundancy, e.g., in the context of redundant infrastructure such as data warehouses, or the development of individual solutions subsequently replaced by standards. Three survey participants listed the non-usage of scale effects, e.g., due to the non-utilization of the full capacity of licenses or infrastructure. Investments to compensate a lack of knowledge were outlined by two respondents. Thus, in summary, non-compliance to IT standards may indeed effect monetary losses, which can significantly reduce the savings generated by standardizing the enterprise IT. Concluding, ensuring standard compliancy should be a priority when planning and governing IT standards.

3.9 Incompatibility of IT standards and system integration

Incompatible standards are frequently considered to encourage the creation of local IT objectives and hinder integration, proliferation and complexity (Boh and Yellin, 2007). Hereby, incompatible standards harden the control of an enterprise`s application landscape. To confirm this statement, the interviewees were asked whether they know cases in which incompatible, coexisting IT standards have hindered the integration of IT systems within their enterprise. 62% of the 32 respondents stated to know of such cases while 32% knew at least three cases. Thus, we assume this hypothesis correct in many organizations. Given the considerable number of known cases, the risk of incompatible standards hindering IT system integration seems rather high. However, future research needs to investigate how this risk can be mitigated.

Generally, the introduction of IT standards is considered to improve the integration if divergent IT systems (Kumbakara, 2008). To verify this statement, the practitioners were asked whether "IT standardization effects a better integration of IT systems in my enterprise". Of the 39 respondents, 67% confirmed this statement. However, only 3 experts stated to use (or plan) measurements of IT standardization impact on the integration of IT systems. Thus, the integration effects are primary statements of personal perception. Being the most frequently mentioned example, eight respondents outlined database systems, e.g., in the context of competing database standards and a security standard hindering the introduction of new IT systems. Further examples listed include collaboration solutions, the usage of multiple infrastructure and cloud platforms as well as multiple middleware layers and product lifecycle management solutions.

It is frequently stated that the more common using a particular standard is, the more likely it is that complementary products for this standard are available (Buxmann et al., 1999). In the purpose of verifying this connection, the experts were asked to select the number of cases of complementary IT products, respectively the number of observed synergy effects of IT standards, within their enterprise. Of 35 respondents, 91% knew at least one case; 71% knew three cases or more. Further, all of the respondents, which knew more than 10 cases (in total 31%) stated to use a particular EA modelling framework. On the other hand, those which could not observe any synergy effects (9%) also declared to not apply particular modelling frameworks. Considering those responses in which few or several cases were observed, particular EA modelling frameworks were applied in some cases.

3.10 Standardization and security/legal aspects

This section examines the effect of standardization efforts on enterprise security. In this respect, the respondents were asked for known security incidents as well as for a prioritization of security considerations within their enterprise. In addition, IT standardization is assessed regarding its suitability to foster legal compliance.

Security incidents due to standardization

Aiming at estimating the likeliness of security-critical incidents in the context of IT standardization, the experts were questioned whether there had been any security incidents due to IT standards. Of 25 respondents, 32% stated to know respective cases (see Figure 23). Thus, a negative impact of IT standards on enterprise security cannot be excluded.

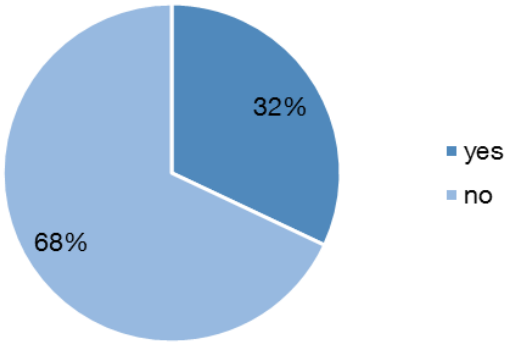

Figure 23: Known security incidents caused by IT standards

Importance of security considerations in standardization decisions

To further assess the prioritization of security considerations when making standardization decisions, the participants were asked how important this aspect is in their company. Of all 43 respondents, 93% stated security considerations were at least “rather important” (see Figure 24). As at least “important” were security aspects considered within three fourths (75%) of the replies. Concluding, standardization decisions seem to be closely connected with their impact on enterprise security. Even further, respective security aspects may influence the applicability of IT standards in enterprises.

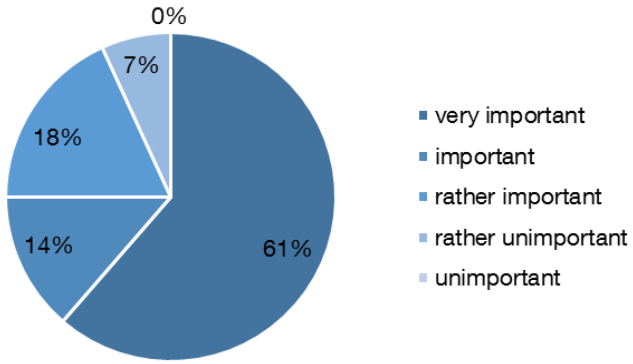

Figure 24: Importance of security aspects when making standardization decisions

Legal compliance

Some IT standards are claimed to be imposed by law. To achieve a better understanding of the impact of law-based requirements on IT standards, the respondents were asked whether they would recommend IT standardization in the purpose of complying to legal requirements. As visualized in Figure 25, 80% of the respondents would rather or fully confirm the standardization recommendation. In contrast, 9% rather declined this statement. Thus, although the perception of legal requirements as general key incentive for standardization is rather low, the vast majority of the respondents sees a positive impact. These results indicate that respective cases in which legal requirements could influence standardization occur far less than, e.g., situations in which enterprises see the possibility to save money due to standardization. Respectively, this aspect is likely to be less present in the responses of the survey participants.

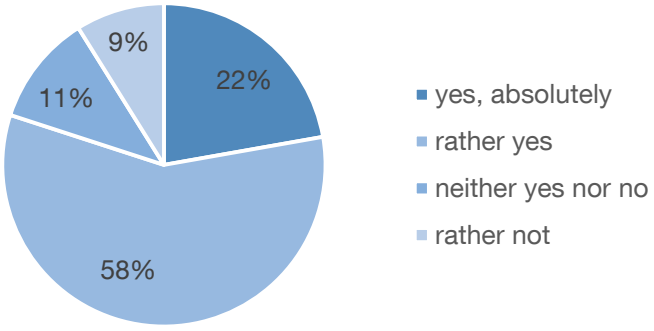

Figure 25: IT standardization fosters legal compliance

3.11 Standardization and agility

Reacting rapidly to a changing environment is important for most enterprises to ensure competitiveness. This is only one reason why enterprises aim at achieving agility, flexibility and uniqueness. The subsequent section examines the influence of IT standardization and IT diversity on those aspects.

Uniqueness

In the literature, it is stated that IT standards may result in a loss of the enterprise's unique features (Buxmann et al., 1999). To verify this assumption, the experts were asked whether they know cases of uniqueness losses due to IT standardization. In total, 13% of the 38 responses knew such cases of which 10% knew several cases. Although this rate is not exceedingly high, the impact of the occurrence of such cases might be enormous. To assess the extent of a uniqueness loss due to IT standardization, the experts were asked to complement their response with examples from personal experience. In this context, one respondent described the required removal of a solution offered on both, the internal and the external market due to IT standardization. Existing contracts were resigned, which effected a noticeable popularity loss as well as a loss of scale economies. Another example outlined was a process (as unique feature) integrated into standard software that was also available for competitors. Further, one expert saw uniqueness losses in platform standardization due to the reduction of industry offers.

Fragility

In the purpose of verifying whether IT standardization significantly influences the enterprise fragility, the experts were asked if they knew cases of IT standard prescriptions increasing the departmental or enterprise fragility. Of the 37 respondents, 49% stated to know of respective cases. Concluding, IT standardization may indeed foster the business department, or respectively the enterprise, fragility. However, this impact does not occur permanently in every enterprise. When further asked whether at least one case of IT standard prescription fostering fragility has resulted in concrete issues and problems, 42% of 31 respondents confirmed a respective experience. Thus, in summary, verifying whether (and eventually how) IT standards affect the enterprise fragility may prove valuable for enterprises either to avoid respective incidents or to prepare countermeasures absorbing the negative consequences as good as possible.

Agility

To examine a potential impact of IT standards on business department agility, the survey participants were queried whether they perceive that IT standardization influenced their department's agility. As visualized in Figure 26, of 38 replies, 63% confirmed respective perceptions.

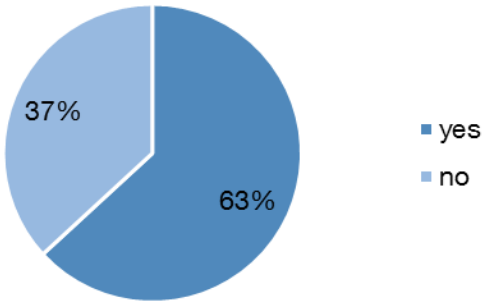

Figure 26: IT standardization affects business department agility

Being asked to outline how IT standardization affects department agility, seven experts listed aspects related to speed and performance increases, e.g., due to a "faster allocation of ready-made services according to a 80/20 rule for standard cases", due to standards enabling a quicker operational readiness or to an "improved understanding of business processes". One expert further saw an improved collaboration as the impact of IT standardization on department agility due to enterprise-wide uniform procedures. On the other hand, the practitioners also outlined negative impact factors of IT standards on agility: The predominant aspect listed hereby were restrictions of the solution space, e.g., perceived as a loss of freedom degrees, as IT standards prescribing suboptimal local solutions or as "restrictions of local and department-internal innovations". IT standards effecting a longer period or an effort increase were addressed by 5 respondents. Examples include the necessity of comprehensive explanations for standard deviations, of "requirements related to new applications based on non-standard components resulting in longer allocation periods" or standards "not covering the full solution, the extensions (occasionally more than 50%) need to be adjusted at every release. Adjustments further result in run-time problems for users". One expert further mentioned cost aspects as negatively influenced by IT standardization affecting agility, as "especially in low cost countries, licenses such as SAP and MS are a relevant cost factor". When further asked whether any measurements regarding the effect of IT standardization on their enterprise's agility existed, of 42 respondents, 5% stated that this was the case.

In summary, the majority of the survey respondents confirmed IT standardization as affecting departmental agility. The perception of ways in which this influence occurs varies enormously. While seven interviewees perceived a speed increase, five respondents, on the other hand, saw a speed decrease as IT standardization effect related to agility. However, predominating influence factor in this context seems to be the additional restrictions of business units due to IT standards. As hardly any enterprises measure the impact of IT standards on agility, the results need to be interpreted as subjective impact perception of the interviewees.

Technological dependence

IT standards are considered to eventually increase technological dependence (Schneider et al., 2015). In the purpose of verifying this connection, the survey participants were asked whether they know cases of IT standardization fostering technological dependency on par-

ticular technologies within their enterprise. Respective knowledge was confirmed by 81% of the 47 respondents. When asked to rate the extent of IT standards fostering technological dependence, 4% of the respondents stated that this does not apply at all. Of the 96% that perceived IT standards as fostering technological dependence, 53% saw a very strong or extremely strong influence in this respect (see Figure 27).

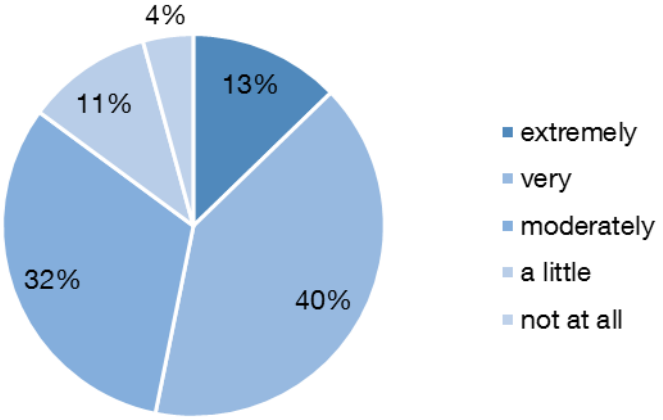

Figure 27: Degree to which IT standards foster technology dependence

In summary, according to the survey results, the dependence of enterprises on particular technologies is fostered significantly. Thus, to prevent complications due to excessive dependence on other enterprises, avoiding or accepting the dependence on particular products should be included into each IT standardization decision.

Flexibility

IT standardization is frequently considered to impact enterprise flexibility. Regarding the impact type, practitioners as well as current literature proposes different interpretations: On one hand, some consider IT standards as increasing IT standardization (Vrancken, 2006; Kumbakara, 2008). Others, on the other hand, support the assumption that IT standards may effect a flexibility decrease (Boh and Yellin, 2007). Thus, multiple questions were designed to verify respective impact assumptions.

In the purpose of verifying whether IT standards may effect a flexibility decrease within enterprises, the interviewees were asked for the number of known cases of IT standardization decreasing flexibility. In 85% of the 46 responses, the experts confirmed to know cases, of which 50% knew at least three cases or more. As examples for such restrictions, the interviewees predominantly outlined aspects related to restrictions and suboptimal local solutions. In total, nine practitioners referred to this effect, e.g., due to “decreasing flexibility in the context of individual features”, the “introduction of a central SAP MM” resulting in central processes hindering local short-term-based actions or the “introduction of a suite solution reducing diversity and flexibility of (best of breed) solutions”. Further, six experts described an increased time/adjustment effort, such as due to SAP ERP for multiple domains which “increases the coordination and test-effort” or a particular phone standard delaying the introduction of new mobile service technology. These results further correspond to the impact of IT standardization on department agility already described. A lack of or a non-functioning of solutions was listed by four respondents, e.g., in the context of “lacking a standard solution for a new product release hinders the use of new technical solutions.” Further aspects described by practitioners were the wrong appliance of the integration layer, capacity overloads, forced collaboration, rising process cost as well as an increase of workarounds and changing basic conditions. Thus, IT standardization may indeed effect a flexibility decrease of business units or enterprises, by, e.g., enforcing suboptimal local solutions or increasing the coordination or adjustment-related efforts of departments.

To verify whether IT standardization can effect a flexibility increase, the interviewees were asked for the number of cases they knew where IT standards increased the department flexibility. Of the 47 respondents, 53% knew at least one respective case. 25% knew three cases or more. As examples for IT standardization fostering the enterprise flexibility, six experts outlined aspects related to integratio. Hereby, a middleware for (enterprise) services was mentioned as well as a "standardized entitlement enabling flexible login to different systems". Examples related to reusability and uniformity were listed by four (e.g., in the context of mini-frame contracts or reusing of online offer functionality), while functionality-enablement was addressed by three respondents – such as the usage of different operating systems enabled by a uniform portal standards. Overall, IT standards may thus indeed foster the flexibility of departments or the enterprise in general, e.g., in the context of improving the integration of IT systems. However, a flexibility increase cannot be achieved by every standard – while some standards effect a flexibility increase, others may contrary effect a flexibility decrease. The identification of respective reasons is subject to future research.

3.12 Standardization and innovation

Current literature frequently indicates that IT standardization affects the technical innovation of an enterprise (Hui et al., 2013; Ross et al., 2006). However, there is no consensus on whether standardization fosters or hinders technical innovation. To verify the impact of IT standardization in this context, the interviewees were asked for their perspective on, both, IT standardization as innovation increasing and as innovation hindering.

To verify whether IT standardization increases technical innovation within the enterprise, the respondents were asked to choose the number of known cases of IT standards fostering technical innovation within their enterprise. 70% of the 37 respondents knew cases in which IT standards promoted technical innovation; 38% knew at least three cases.

Even further, IT standards are occasionally considered as enabling new functionality due to particular restrictions in other domains. In the purpose of verification, the respondents were asked for the number of known cases of IT standard-caused restrictions in specific architectural layers enabling new chances or functionality in upper layers. Out of 47 replies, 70% stated to know of such cases; 43% of those knew three cases or more.

When asked about concrete examples for IT standardization as functionality enabler, 10 experts listed examples related to communication and compatibility, e.g., an enterprise-wide unified communication solution, central management of the technical output or the direct sales with an uninterrupted workflow due to a standardized internal trading system. Four respondents outlined process unification and facilitation-related examples, such as the central management for Java and .NET in-house developments.

Three practitioners mentioned an increase of the throughput or development-speed, such as the increase of the black box process rate (the mechanical processing of inventory changes) via platform standardization. The aggregation of data was also mentioned by three experts, e.g., in the context of a centrally managed SAP MM aggregating purchasing requisitions and hereby improving the purchasing conditions. Other examples mentioned were related to security, new developments, employee focusing and the decoupling of applications.

With regard to specific business units, 75% of the 47 respondents confirmed that "a higher IT diversity is necessary in innovation-generating business units". As visualized in , it could be confirmed that innovation-generating business units require a certain level of IT diversity. Concluding, to support respective business units, enterprises can increase their freedom by allowing the use of more standards or non-standard products.

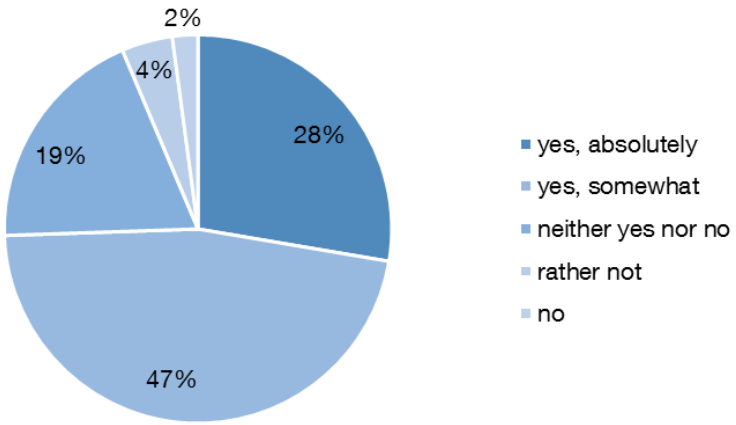

Figure 28: Innovation-generating business units require a higher IT diversity level

Thus, IT standardization may indeed enable technical innovation. In some cases, the restrictions in particular architectural layers can even enable new functionality, e.g., by aggregating data. Especially in innovation-generating business units IT standardization should not be overstated.

3.13 Diversity: a constituting element of application landscape complexity

Previous research regarded diversity to contribute significantly to application landscape complexity (Schuetz et al., 2013; Mocker, 2009). To analyze in how far diversity has the same drivers and consequences as complexity, respective questions were included in the online survey. Regarding the drivers of complexity, the findings described by (Mocker, 2009)Schneider and Matthes (2014) were used to derive the required hypotheses including local decision making, business complexity, legal requirements, technological progress and short-term optimization. Figure 29 visualizes in how far the survey participants confirmed these drivers also for application landscape diversity. Strong conformations could be observed for short-term optimization (87%), technological progress (83%), business complexity (60%) and local decision making (92%). Legal requirements are an exception because 78% of the respondents disagree that although might be considered to drive complexity, they do not necessarily drive diversity. Nevertheless, complexity and diversity share most of the driving forces.

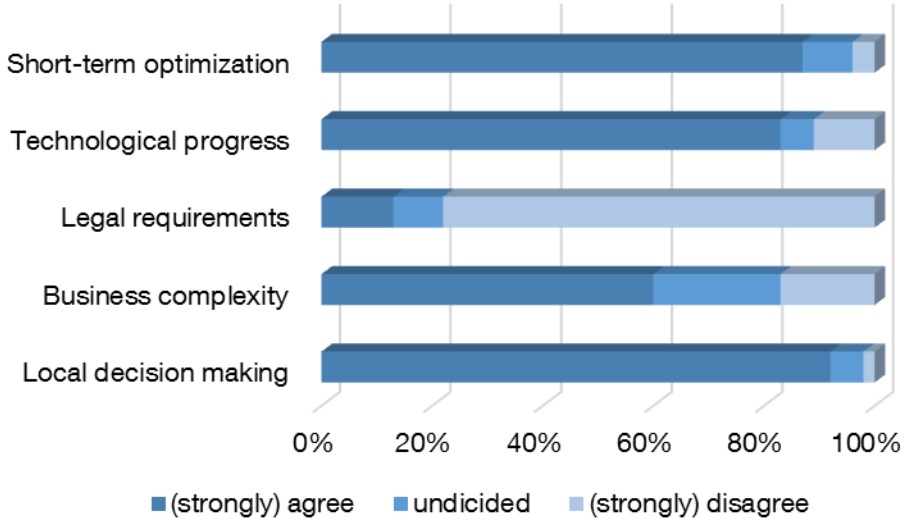

Figure 29: Complexity drivers and their influence on diversity

In addition to the aforementioned drivers of application landscape complexity, its consequences were also analyzed to evaluate if they are observable also for diversity. According to Schneider and Matthes (2014), the main complexity consequences comprise increasing costs, increasing number of errors, increasing dependence on certain skills, decreasing flexibility and increasing shadow IT. Figure 30 visualizes in how far the survey participants observed similar consequences for an increase of application landscape diversity.

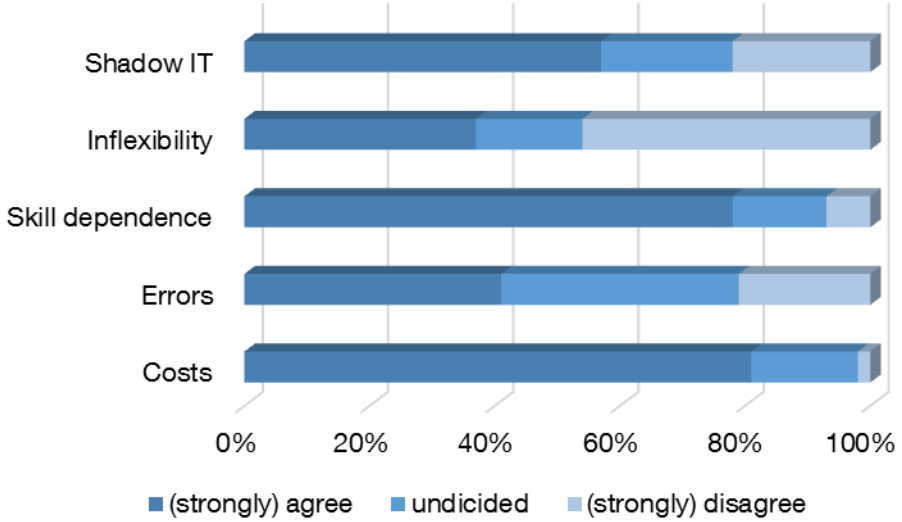

Figure 30: Complexity consequences influenced by diversity

Again, strong confirmation could be observed for four complexity consequences including shadow IT (57%), skill dependence (78%), errors (41%) and costs (81%). However, the opinions about the effect of diversity on inflexibility should be doubted due to the given answers. A deeper analysis of this aspect seems to be required.

Based on the provided answers, it can be concluded that many of the driving factors of complexity also drive diversity. Furthermore, an increase in application landscape diversity leads partly to the same outcome as in crease of overall complexity.

4 Conclusion and future research

4.1 Summary

IT standardization is a task currently performed by most practicing enterprise architects. However, research on the benefits and drawbacks of IT standardization is still in its infancy and empirical investigations are scarce. Therefore, the goal of this research was to identify motivations and means for IT standardization currently prevalent in practice as well as observable and expected effects of IT standardization. In addition, the relationship between IT diversity and IT complexity should be analyzed.

To provide the required overview and insights from practitioners, an online survey has been designed and executed based on several hypotheses derived from respective literature. With this survey, 47 completed questionnaires have been collected. The participants work in different industrial sectors, including finance, IT and manufacturing, but work all for a company headquartered in a German-speaking country. Most companies established their EAM functions more than five years ago and about two thirds use a well-known EAM framework, e.g. TOGAF, to guide their EAM. More than half of the participants were enterprise architects and the majority has more than nine years of relevant professional experience. For most participants, IT standardization is a major challenge and the introduction of new standard can require multiple years.

The survey revealed that the most prominent motivation for an increase of IT standardization are expected cost savings in the area of IT operations. However, less than half of the survey participants are aware of any instrument implemented in their company to measure the amount of such savings and many participants knew cases in which unexpected side-effects occurred, e.g., the implementation of changes in adjacent systems. The instrument most often used to foster IT standardization is a centralization of IT governance and the explicit definition of standard components. Nevertheless, the survey revealed that currently the enterprise architects do not have the required influence to foster IT standardization. Business processes have been considered to be a good starting point but only a few architect can actually exert influence at this level. In many companies, IT standardization is not performed equally for all business domains. For example, HR payroll and logistics systems are often excluded from standardization. Regarding the influence of IT standardization on technical innovation, the survey was not able to provide clear results. Lots of evidence has been found that standardization can hinder technical innovation but many survey participants were able to describe cases in which IT standardization fostered innovation. However, with increasing IT standardization the dependence on certain technologies or vendors grows. Finally, the survey was able to demonstrate that IT diversity shares many of the drivers and consequences commonly attributed to IT complexity. The drivers include local decisions, short-term optimization, technological progress and business complexity. The similar consequences include increasing costs, increasing error rate and increasing dependence on certain skills or people. Beside the valuable insights in today's standardization practice, these observations might fuel research on the inter-relationship of IT complexity and IT diversity.

4.2 Critical reflection and future research

The results of the described survey are limited by the number of participants which cannot be regarded to be representative for the whole industry. In addition, the participating companies are all headquartered in a German-speaking country which might bias the results. Due to missing constructs and models, the questionnaire ascertains only the perception of the participants. Therefore, the results are shaped by subjective opinions of the participants.

Accordingly, future research should try to substantiate the intermediate results provided by this survey by applying a quantitative approach. This requires that the degree of IT standardization can be quantified and assessed in many organizations by following a consistent definition and by using the same indicators. Likewise, the proposed effects of IT standardization need to be assessed. Having both at hand, statistical methods can be applied to underpin the validity of the results of this survey. Unfortunately, current literature does not provide the required indicators. Future research should therefore focus on the development of indicators enabling a holistic quantification of IT diversity. In addition, qualitative research endeavors, e.g., case studies or focus group interviews, might be suitable to identify reasons or context factors which are responsible for the contradictory effects of IT standardization, e.g. on innovation, which have been observed in this study. The identification of such mediating factors would help researchers and practitioners to better understand the effects of IT standardization and thus make better-informed decisions regarding the transformation of application landscapes.

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