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Towards A Set of Requirements for A Holistic IT Solution Engineering Approach

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Abstract

IT solutions are integrated bundles of products and services that create high value for the customer by meeting individual technical, organizational, and business needs. The complexity of designing and provisioning IT solutions requires companies to restructure their organizations towards supporting customer-relational lifecycle activities. Hence, researchers particularly focus on developing methods for designing IT solutions. In this paper, we suggest reconceptualising the fundamental process of solution engineering by highlighting the role of sales in integrating requirements elicitation and exploiting business opportunities. Furthermore, we include the phase of module engineering to capture experiences from providing IT solutions. Based on a multiple case study analysing IT solution procurement processes, we argue that the extant set of design methods still follow the traditional product-centric processes of first producing and then selling IT solutions. Hence, we suggest requirements for a holistic IT solution engineering approach by combining implications from literature and our case study.

Keywords

IT solutions, service engineering, requirements, multiple case study

INTRODUCTION

Organizations from a variety of industries face a high market pressure and an often ruinous competition on prices. In order to differentiate from competitors, those organizations frequently expand their offerings (Becker and Krcmar 2008; Böhmann et al. 2008). In this setting, two trends are observable: product-oriented organizations follow the notion of *servitization* and develop and market product-related services (Vandermerwe and Rada 1988), while service-oriented organizations apply the idea of *productization* to include products in their services or market services as product (Baines et al. 2007). The convergence of these two trends (cf. Figure 1) results in integrated bundles of products and services, called *solutions,* wherein the importance of single components diminishes and the value of the holistic bundle grows (Becker and Krcmar 2008, 169; Leimeister and Glauner 2008, 248). Marketing research shows that solutions create high value for the customer by meeting individual technical, organizational, and relational needs (Tuli et al. 2007).

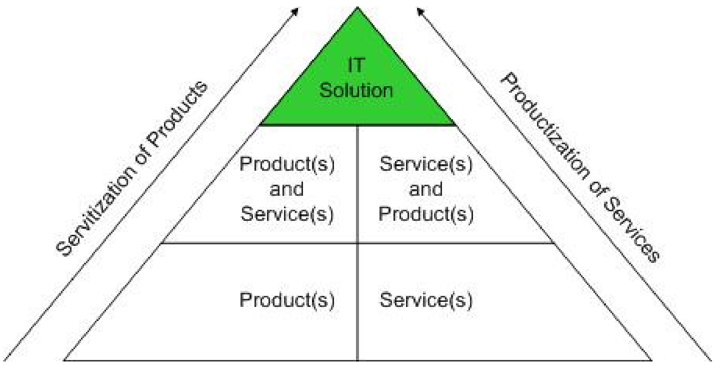

Figure 1: Evolution of IT solutions (Source: Adapted from Baines et al., 2007, 1546)

Although the idea of solutions is applied in multiple industries, solutions are frequently provided in the IT industry. Commonly, the offering of customer-specific bundles consisting of hardware, software, and service components is known as *IT solutions.* An example of an IT solution is the installation, operation, and support of a webhosting solution. In this case, the IT solution provider offers and integrated bundle of hardware (e.g., in the forms of servers or network equipment), software (e.g., in the forms of operating systems and application software), and services (e.g., in the forms of requirements analysis, customization, implementation, and operation).

The tasks of designing, offering, and providing integrated bundles of hardware, software, and services results in the following three central challenges: First, Böhmann and Krcmar (2007) highlight the need of simultaneous development of hardware, software, and services into customizable components. Second, Tuli et al. (2007) and Burianek et al. (2009) suggest that the processes of procuring, customizing, and providing an IT solution has to be embedded in a customer-relational solution process, which includes requirements analysis, customizing, implementation/deployment, and servicing/operations activities. Third, Berkovich et al. (2009) suggest that processes of designing and providing IT solutions need to address changing requirements over the asynchronous lifecycles of an IT solution and its components.

In a multiple case study analysing IT solution procurement processes, we find that addressing these challenges is essential. However, our research shows that the approach of IT solution engineering itself has to be reversed. The classical product-centric process of first producing and then selling is not compatible with IT solutions. Five cases analysing procurement processes in major German and European companies from different industries show that sales activities take place before service engineering activities in the temporal course of procurement processes.

To really meet customer's needs, we suggest that sales activities have to take place upfront and that IT solutions then have to be designed in cooperation between the provider and the customer. Therefore, as a first step to enhance existing IT solution engineering respectively service engineering approaches or to develop a new integrated IT solution engineering approach, the authors propose a set of nine requirements combining ideas from IT solution service engineering literature as well as from the multiple case study.

The remainder of this paper is organized as follows: First, characteristics of IT solutions are elaborated in section 2. Then, in section 3, the results of a multiple case study on IT solution procurement processes in five different companies are shown. Next, a discussion section including the comparison of existing approaches and the set of 9 requirements for a holistic IT solution engineering approach are presented in section 4. The paper concludes with a critical appraisal of our work as well as suggestions for future research in section 5.

CHARACTERISTICS OF IT SOLUTIONS

Burianek et al. (2009) suggest defining IT solutions according to the following three characteristics: (1) IT solutions meet customer's needs, (2) IT solutions consists of bundles of products and services, (3) IT solutions are highly integrated. This definition is used as a structure to elaborate the characteristics of IT solutions in the remainder of this section.

IT Solutions Meet Customer's Needs

IT solutions are designed to meet the customer's individual needs (Baines et al. 2007; Schmitz 2008; Tuli et al. 2007). Customers are not interested in a product or service per se, but they are interested in a solution to their problems (Leimeister and Glauner 2008). Consequently, the IT solution provider has to offer activities of a customer-provider relational solution process (cf. Figure 2). Those activities are comprised of requirements analysis, customization, implementation/deployment, and servicing/operations (Burianek et al. 2009; Tuli et al. 2007).

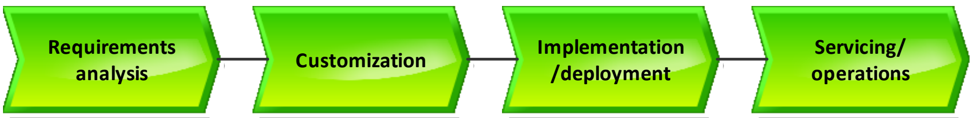

Figure 2: The customer-provider relational solution process (Source: Adapted from Tuli et al. 2007, 5)

Requirement analysis is the activity designed to elicit functional and quality requirements. While functional requirements refer to features the IT solution should exhibit, quality requirements do not only pertain to material quality, but foremost to quality of service (Schmitz 2008) and will be accounted for in Service Level Agreements (SLAs) (Langer et al. 2008). However, the requirements analysis is also important for the IT solution provider to become aware of the customer's broader business needs. Addressing the customer's business needs is pivotal to delivering a solution that meets the customer's expectations (Schmitz 2008).

Following the analysis of requirements, IT solution providers have to customize their solution (Berkovich et al. 2009). In this activity, providers select, modify, and adapt products and services which work well with each other and meet the customer's business needs (Tuli et al. 2007). In order to make IT Solutions customizable, providers usually modularize technical systems and processes and define interfaces describing possible component combinations. Usually, systems and processes are modularized in front-end and back-end components, whereas only front-end components are visible to customers. However, some customer requirements might be unrealizable by merely combining existing components. In this case, individual components must be developed by modifying standard components or sourcing additional components (Böhmann and Krcmar 2007).

Next, the IT solution will be implemented and deployed into the customer's environment, e.g., by connecting the IT solution with the customer's business process and by integrating systems (Tuli et al.2007). In this step, it is important to note that IT solution providers frequently continue to operate existing customer processes or systems for economic reasons or due to customer preferences, which might lead to a selective outsourcing (Böhmann and Krcmar 2007).

Once an IT solution is deployed, the provider will provide servicing/operations activities. These activities can range from simple controlling and support activities to operating business processes or even deploying new features due to evolving requirements (Tuli et al.2007).

Along the lifecycle of IT solutions, providers face changing requirements (Berkovich et al. 2009). In particular, requirements change in the implementation/deployment phase. Furthermore, adapted or new requirements might occur due to planned or unplanned changes in other lifecycle phases as well. Requirement changes can arise due to new customer strategies (e.g., a changing output, outsourcing), technological advances (e.g., product or process innovation), or changes in the provider's portfolio (e.g., enlargement of offer, reduction of offer) (Burianek et al. 2009). Therefore, IT solution providers are required to answer to requirements changes dynamically and to scale their solutions according to customer needs (Burianek et al. 2009, 21; Tuli et al.2007, 7).

IT Solutions Consist of Bundles of Products and Services

IT solutions consist of classical products as well as service components. Classical products can be hardware (e.g., machinery, electronic modules) and software (e.g., operating systems, security software) or combinations of these two components. Services range from consulting-oriented services (e.g., technical consulting) and project-oriented services (e.g., installation, integration) to functional-oriented services (e.g., maintenance, inspection) and operational-oriented services (e.g., operating business processes, support). All components of an IT solution are adapted to each other (Burianek et al. 2007).

An IT solution is not a fixed combination of products and services. Different combinations of components are possible (Burianek et al. 2009; Schmitz 2008) and, consequently, as the bandwidth of IT solutions reaches from selling and maintaining a machine to operating business processes on behalf of the customer, different operator models exist (Burianek et al. 2007). Baines et al. (Baines et al. 2007) and Maier et al. (Maier et al. 2005) discern three operator models, *product-oriented*, *use-oriented*, and *result-oriented*, based on the degree of immateriality (service components) of the IT solution.

Product-oriented operator models are applied when a product is sold in a traditional manner and additional after-sales service, i.e., maintenance or repair, are offered. When the IT solution provider does not sell a product, but makes it available for use to the customer, the use-oriented model is employed. The provider needs to supply all activities ranging from providing and servicing to the disposal of the IT solution in this operator model. In the result-oriented operator model, the IT solution provider sells a result or capability. For instance, the IT solution provider might sell a product he constructed himself with his own assets on behalf of the customer.

Although components can be single-sourced on the market (Becker et al. 2008), the importance of single components diminishes in an IT solution. By adapting single components to each other and by consequently focusing on customer needs, the value of the bundle is higher than the value of its components (Leimeister and Glauner 2008). This value-added is often named *1+1=3-effect* (Burianek et al. 2009). By not focusing on single components, the IT solution provider prevents the customer from cherry-picking and can realize a higher margin by offering a bundle (Burianek et al. 2009; Schmitz 2008).

The provision of components needs to be well coordinated. The performance of IT solutions usually is not measured by expenditure on material and personnel, as for product manufacturers, but by usage, performance, and value. Usage measures usually refer to usage time or usage frequency. Performance measures usually refer to availability or throughput and value measures to revenue or output (Burianek et al. 2009).

IT Solutions are Highly Integrated

Integration refers to the technical-organizational combination of the IT solution components (Berkovich et al. 2009). The more inclusive an IT solution becomes, the more important it is to fully adapt single components to each other as the number of compatibility constraints increases (Burianek et al. 2009). Therefore, both product and service components should be developed jointly to guarantee ease of integration (Berkovich et al. 2009; Leimeister and Glauner 2008). Due to different manufacturing periods and different lifecycles of single parts, however, this can be a challenge for IT solution providers (Berkovich et al. 2009; Berkovich et al. 2009).

In contrast to classical product manufacturers, where the relationship is transactional, IT solution providers usually foster a relational business relationship with customers (Burianek et al. 2009; Schmitz 2008). Based on the degree of integration, interaction can range from a punctual connection (e.g., financial services) to a permanent connection (e.g., when operating business processes for the customer) (Burianek et al. 2009). Moreover, the degree of integration can vary during the lifecycle of the IT solution. For example, a higher degree of interaction can be observed during the requirement analysis activity, while a lower degree of interaction usually can be observed during the disposal activity (Burianek et al. 2007).

Nonetheless, not only the provider, but also the customer has to adapt his own organization to that of his business partner. The customer must be willing to communicate information on operations and processes as well as on political structures, so that the IT solution provider can effectively meet the customer's needs. As a result, both the customer's and the provider's personnel has to be trained and the performance of an IT solution is directly influenced by management of both parties (Böhmann and Krcmar 2007; Tuli et al.2007).

Summary of IT solutions characteristics

IT solutions are designed to fulfil the customer's business needs. An IT solution provider should offer activities included in the customer-provider relational solution process, i.e., requirements analysis, customization, implementation/deployment, and operation/servicing. In addition, operator and performance models need to be specified and quality requirements to be described in SLAs.

Moreover, an IT solution consists of standard and individual components. Standard components are products or services that can be purchased on the market. Individual components require the adaptation of standard components or the implementation of new products or services. The more standard components the IT solution consists of, the easier the customization activity for the provider. IT solution providers therefore should modularize their portfolios.

In the implementation and deployment phase, the provider and the customer not only have to roll out hardware and software, but also deploy business and support processes, as well as an organizational structure. Existing systems, processes, and organizational structures need to be adapted when designing an IT solution.

Especially important in the IT solution context are changing requirements. Both the customer and the provider need to deal with the fact that requirements change during the different lifecycle phases of an IT solution. At the end of the lifecycle, the IT solution provision needs to be terminated or replaced.

MULTIPLE CASE STUDY

In order to find practice requirements for an IT solution engineering process, the authors performed a multiple case study. The goal of the multiple case study was to find out how organizations procure IT solutions, which allowed us to make inferences from procurement processes on IT solution engineering.

A multiple case study was chosen as, according to Benbasat et al. (1987), case research in information research is clearly useful when a natural setting and contemporary events are in focus, which applies in this research. After explaining the setting, the authors will show some detailed results from five cases and finally conclude findings for an IT solutions engineering process.

Setting

The case study was carried out in cooperation with a German mid-sized consulting firm and participants were two professional-level employees of the consulting firm with a combined experience of over 15 years (five and ten years each). Object of the research were five procurement processes where the participants have assisted and know both the provider and the customer side. The procurement processes took place at two DAX-listed (German stock market index for blue chips) car manufacturers (Apha and Beta), a European Aerospace company (Gamma), a mid-sized IT Service provider for a bank (Delta), and a German public authority (Epsilon).This sample was chosen as it represents a sufficient cross-sectional area of industries and company sizes and as a comparison of private and public organizations was possible.

The participants were asked to detail the typical processes when procuring IT solutions in the respective organizations. Additionally, they were asked to describe each single activity, to draw workflow diagrams and to name inputs and outputs. Also, the participants were questioned on problems in existing projects and ideas for improvement. An extract of the case study is presented in the following paragraphs.

Results from Five Procurement Processes

Case Alpha Alpha is a car manufacturer that procured a data processing centre solution. First, the car manufacturer collected requirements, which he derived from similar systems he had in place. Then, he contacted potential providers who he summoned to submit proposals for his specific IT solution. Based on the collected customer requirements, the providers started to engineer IT solutions and finally submitted their proposals. Solely based on the price, the car manufacturer then awarded a contract and the winner customized, implemented, and operated the data processing centre.

The whole process was characterized by changing requirements. Especially the requirements elicitation revealed itself as insufficient as only an as-is-analysis and not a to-be-analysis was performed. Moreover, the requirements that occurred in the implementation and operations phase raised problems as the procurement process was rather unstructured and both parties wanted to avoid iterations in order not to lose time. Also, providers struggled to meet economies of scale as the customer's requirements were very specific. When the IT solutions were finally operated, however, the two parties finally collaborated quite successfully as they mutually agreed on SLAs during the contract negotiations.

Case Beta In the second case, the car manufacturer Beta procured an application management solution as well as application development services. He proceeded similar to the car manufacturer in the first case and collected requirements by himself by simply combing existing requirements documents for different systems and then invited to tender. Moreover, he refused to further communicate with potential contractors until the proposal submission. He only let those potential contractors take part in the contract competition, which already have once had a business contract with the car manufacturer and argued that all of the competitors already have enough information on the company and the required IT solution. Due to the contract value of over 60 Million Euro none of the competitors complained.

Again, problems occurred during the whole process as both parties could not handle changing lifecycle requirements. Also, due to the inflexible behaviour of the car manufacturer, the potential providers had to deal with all requirements changes by themselves. Sometimes, this was challenging as they lacked expertise in specific components. Similar to the first case, the operation of the IT Solution was successful as both parties agreed on SLAs during the contract negotiations. Moreover, the contract winner was successful in adapting the IT solution to the existing organization, systems, and processes of the car manufacturer.

Case Gamma In contrast to the first two processes, Gamma rather followed a structured process in the procurement of a 10 Million Euro configuration management solution: Gamma first performed an as-is-analysis as a configuration management solution already has been provided for five years by a different provider. The as-is-analysis included the organization, systems, and processes. Based on the as-as-analysis, Gamma then performed a to-be-analysis and issued an invitation to tender. In several iterations with Question and Answer activities between Gamma and potential providers, a provider who can best fulfil the given requirements can be determined. However, owing to political qualms and unclear responsibilities and although a contract winner is determined, the contract is never awarded and both parties (Gamma and the contract winner) uphold the project organization until today.

Due to the fact that Gamma performed both the as-is and the to-be analysis on its own, Gamma was rather inflexible with regard to requirements changes during the contract negotiation. The contract winner, therefore, was quite restricted and had to design its IT Solution according to the ideas of Gamma. This was especially challenging, as some requirements did not make sense for the provider. An interesting point in Gamma's procurement process was the fact that, although Gamma had a similar IT solution in place before and followed a rather structured process, data was poor. This leads to a re-elicitation of requirements.

Case Delta Similarly, Delta had a structured procurement process in place, too. Delta first elicited requirements in an as-is- and to-be-analysis on its own and then elaborated those requirements with potential providers. Based on the requirements, the potential providers then engineered IT solution concepts and submitted their proposals. Due to the structured process and the low complexity of the procurement, Delta could easily compare the proposals and find a suitable provider by finding a trade-off between both prices and features.

Although the procurement process was planned in detail, problems finally occurred in the implementation phase: Delta had several projects in place and as several IT solutions were introduced at the same time, resources had to be shared across projects. Also, the cooperation in the elaboration of requirements with potential providers lead to a successful IT solution on the one side, however, with regard to the low complexity of the IT solution, the cooperation was rather time-intense and could have been shortened on the other side. Moreover, due to the negotiating power of the customer, the provider finally agreed to support customer-individual features in some specific fields, although he had to forego some economies of scale.

Case Epsilon The last case considered in this multiple case study is a public sector IT solution procurement. In many countries, e.g. for all member countries of the European Union and for Australia, there are formalized guidelines which prescribe a detailed procurement process (Bundesministerium des Inneren 2009, Commonwealth of Australia 2005). According to those guidelines, Epsilon elicited requirements upfront and was not allowed to change requirements during the whole procurement process. The potential providers, therefore, had to conceptualize IT solutions solely based on the given requirements and submit their proposals. Epsilon then chose a provider based on a trade-off between prices and features, according to a prescribed evaluation schema.

Although the procurement process was structured, it was quite long compared to private sector procurements. To some degree, this might be attributed to the inflexible structure; however, to a large degree this might be attributed to waiting periods for legal complaints. Similar to the former cases, the provider struggled to keep costs down due to many customer-individual requirements.

Findings

As demanded in IT solutions literature, one can state that all cases follow a process of requirements analysis, customization, implementation/deployment, and servicing/operations activities. Some process steps were also performed in cooperation between the provider and the customer. Also, the organizations considered the existing organization, systems, and structures in their requirements analyses and could successfully integrate the new IT solution in their specific environment. In some cases, the provider and the customer mutually agreed on SLAs for the servicing/operations activities.

A gap between literature and practice, however, manifested itself with regard to changing requirements over the lifecycle of the IT solution. Most organizations already struggled to change requirements after the requirements analysis phase due to an inflexible procurement process. This resulted in time-inefficiencies and difficulties for the providers to fully meet the customer's requirements. The cases, therefore, show the importance of a flexible requirements management.

A major difference between literature and practice, however, reveals itself with regard to the customer-provider relational solution process. While the customer-provider relational solutions process assumes that providers first engineer a general IT solution, which then can be sold by customizing, implementing, and operating it for different customers, practice does not follow this product-centric perspective.

On the contrary, all five cases show that the sales process takes place upfront and that, based on customer-given requirements, the IT solution is engineered second. A modularization of components, e.g. in front-office and back-office activities, to partly adapt to customer-individual needs while maintaining an underlying standard organization is performed by some providers. The modularization allows the provider to realize economies of scale, however, the cases show that a fully general IT solution might not be realizable.

In sum, the authors conclude from the multiple case study that an IT solution engineering approach should incorporate a project-centric instead of a product-centric perspective to better adapt to the customer's needs. Also, the IT solution engineering process should be reverted to include a sales activity at the beginning of the engineering process.

DISCUSSION

Based on the findings from literature on IT solutions and the multiple case study, 10 approaches to design IT solutions are evaluated by the authors in this section. The comparison, however, is not restricted to IT solutions engineering approaches, but also includes service engineering approaches. This is reasonable as the service component is especially important in IT solutions and existing service engineering approaches might include important know-how. The results are then discussed in order to derive requirements to enhance existing approaches or to develop a new IT Solution engineering approach.

Comparison of Existing Approaches

As argued in the findings paragraphs in the previous sections, the following IT solution characteristics revealed themselves as the most important criteria to evaluate existing engineering approaches (cf. Table 1) : (1) the inclusion of customer-provider relational activities, (2) the inclusion of an upfront sales activity, (3) the support of front- and back office modules (modularization), (4) the feature to customize the IT solution, (5) the consideration of the existing environment (organization, systems, and process), (6) a continuous enhancement of components to account for lifecycle requirements changes.

As shown in Table 1, none of the existing approaches does fulfil all requirements. Moreover, the inclusion of customer-provider relational activities (1), the inclusion of sales activities (2) and the consideration of the existing environment (organization, systems, and processes) (4) is supported by none of the solution engineering approaches (Botta 2007, Spath/Demuß 2006, van Halen et al. 2005) and by none of the service engineering approaches (Shostack 1982, Ramaswamy 1996, Jaschinksi 1998, Schneider et al. 2006, Hoogeweegen et al. 1999, Burr 2002, Hermsen 2000).

Table 1. Comparison of existing approaches from solution engineering and service engineering

Approach: \ Evaluation criteria:	Inclusion of customer-provider relational activities	Inclusion of sales activities	Modularization	Customization of the IT solution	Consideration of existing environment	Continuous enhancement of components
A framework for the development of Product-Service-Systems (PSS) (Botta 2007)	-	-	+	-	-	o
Development of hybrid products (Spath/Demuß 2006)	-	-	o	-	-	o
MEPPS Handbook (van Halen et al. 2005)	-	-	o	-	-	o
Service Blueprinting (Shostack 1982)	-	-	o	-	-	-
Service Design and Management Model (Ramaswamy 1996)	-	-	o	-	-	o
Approach by Jaschinski (1998)	-	-	o	-	-	o
Fraunhofer IAO Model (Schneider et al. 2006)	-	-	+	-	-	-
Modular Network Design (Hoogeweegen et al. 1999)	-	-	+	-	-	-
Modularization of Technical Services (Burr 2002)	-	-	+	-	-	-
Configuration of Technical Services (Hermsen 2000)	-	-	+	O	-	-
+ fulfilled; o partly fulfilled; - not fulfilled (not addressed)						

With regard to the third evaluation criteria, however, all approaches at least partly support modularization. Especially, the work of Botta (2007), Schneider et al. (2006), Hoogeweegen et al. (1999), Burr (2002) and the Hermsen (2000) fully support the modularization idea. All of these approaches either allow to define subcomponents or to decompose the IT solution. The remaining approaches, which partly fulfil the modularization criteria, at least allow to model subcomponents of the IT solution.

An evaluation criterion which is barely supported by any of the approaches is the feature to customize the IT solution. While none of the solution engineering approaches (Botta 2007, Spath/Demuß 2006, van Halen et al. 2005) supports this criterion, only one service engineering approach partly fulfils the criterion: Hermsen (2000) foresees to configure and parameterize service components. As the service engineering approach does not consider product elements, however, this feature cannot fully be transferred to IT solutions.

In turn, a continuous enhancement of elements to account for lifecycle requirements is partly fulfilled by all solution engineering approaches and partly fulfilled by two of the service engineering approaches. The solution engineering approaches by Botta (2007), Spath/Demuß (2006), van Halen et al. (2005), however, do only have a product-centric perspective on the continuous enhancement of IT solution elements. The service engineering approaches by Ramaswamy (1996) and Jschinksi (1998), on the contrary, do only have a service-centric perspective on the enhancement of elements, as both approaches allow iteratively designing services.

Requirements for an IT Solution Engineering Approach

Based on the findings from literature on IT solutions and the insights from the multiple case study, the authors derive 9 requirements (cf. Table 2) for the enhancement of existing solution respectively service engineering approaches or for the development of a new IT solution engineering approach.

The first requirement refers to the inclusion of customer-relational solution process activities. As customers are not interested in a product or service per se, but in a solution to their problem, the IT engineering approach should include activities of the customer-relational process, e.g., requirements analysis, customization, implementation/deployment, and servicing/operations. All of those activities should be performed in cooperation between the provider and the customer.

The second requirement demands an IT solution engineering approach to foresee an activity to negotiate mutually agreed SLAs. SLAs are useful in the servicing/operations phase, which spans most of the lifecycle, to control the processes associated with the IT solution.

Table 2. Requirements for an IT solution engineering approach

Evaluation criteria	No.	Requirement
Inclusion of customer-provider relational activities	1	Account for customer-relational activities
	2	Develop mutually agreed SLAs
Inclusion of sales activities	3	Account for upfront sales activities
	4	Include a project-centric perspective
Modularization	5	Support the development of front-end and back-end modules
Customization of the IT solution	6	Account for customizing IT solutions
Consideration of existing environment	7	Adapt of the customer's existing environment
Continuous enhancement of components	8	Continuous enhancement of services
	9	Account for disposal/replacement at the end of the lifecycle

Next, as stated in the multiple case study, an IT solution engineering approach needs to account for the fact that sales activities usually take place before the actual service engineering activity. This requirement is especially important to make the IT solution engineering approach relevant in practice.

Moreover, especially in the servicing/operations phase, IT solutions are different from products. While products are sold to be used and new requirements lead to new products, IT solutions are constantly enhanced. In order to account for changing requirements, both the provider and the customer should have a project organization for the IT solution in place, which leads to requirement four.

Nonetheless, providers might not want to forego economies of scale by performing individual sales and service engineering activities for every customer individually. Consequently, an IT solution engineering approach should support modularization. As organizations in the multiple case study struggled to some degree to realize economies of scale, the authors propose the following process (cf. Figure 3), to combine the idea of an upfront sales activity and realizing economies of scale through modularization. The idea of the process is to first perform the sales activities and then to perform the solution engineering. Across multiple projects, the provider can identify modules that are reusable in different contexts and for multiple customers. Those modules can then be encapsulated and be used as building blocks for future IT solutions (module engineering).

Figure 3: Proposal for a new IT solution engineering process

The sixth requirement is closely linked to the fifth requirement. It requires the IT solution engineering approach to develop components to be customizable. This is necessary, as the proposed IT solution engineering approach makes use of reusable modules. However, modules are only reusable, when they can be customized to fulfil the customer's individual needs.

Based on IT solutions literature, the authors derive the consideration of the customer's existing environment as next requirement. An IT solution is not a product that can be bought and simply plugged in. IT Solutions are technical-organizational combinations of products and services and have to be integrated into the customer's environment. Therefore, an IT solution engineering approach needs to account for interfaces to different organizations, systems, and processes of various customers.

Also, an IT solution is not a one-time investment. Usually, the provider and the customer of an IT solution enter a long-term business relationship. However, over the lifecycle of an IT solution, requirements change due to a changing business environment or to changing demands on the provider or the customer side. An IT solution engineering approach should, therefore, be flexible and allow handling requirement changes dynamically over the IT solution lifecycle.

Finally, the multiple case study showed, that IT solutions are sourced repeatedly. Therefore, an IT solution engineering approach should account for the fact that after the end of the lifecycle, the IT solution might either be disposed or replaced. In latter case, it would therefore be useful, if knowledge from previous IT solution lifecycles can be conserved for future IT solution procurements.

CONCLUSION AND OUTLOOK

We first analyse literature to find typical characteristics of IT solutions. We then perform a multiple case study to gain insights into five IT solution procurement processes. In a next step, we use the findings from the literature analysis and the multiple case study to analyse and compare existing approaches to solution and service engineering. We find that none of approaches fulfils all evaluation criteria and that some criteria are not fulfilled by any approach. Therefore, we derive nine requirements for the enhancement of existing service engineering respectively solution engineering approaches or for the development of a new holistic IT solution engineering approach.

A major requirement we derived from the multiple case study is that the sales activity usually takes place before the service engineering activity. However, as providers need to realize economies of scale and cannot treat each customer individually, we concluded that an IT solution engineering approach basically has to consist of three steps: module engineering, sales, and service engineering. In the beginning, sales are always the central and service engineering the following step when selling an IT solution. Over time and across project, however, the provider might identify reusable modules which work in various settings and which can be defined and used as building blocks in IT solutions projects for various customers (module engineering)That said, our research is not without its limitations. Further case study research might be needed to find more requirements from the field and to better understand identified requirements. Moreover, the case study deliberately focused on customer processes as IT solutions are designed to fulfil the customers' needs. However, a case study on providers' processes might deliver useful insights as well and could be combined or opposed to insights from the presented case study.

This contribution is intended to fill the gap where an integrated IT solution engineering approach is lacking. We hope that practitioners find our requirements useful when implementing IT solution procurement or engineering processes in their organizations. Researchers might use the requirements as a starting point for the enhancement of existing or the development of new IT solution engineering approaches.

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