Service Modularization in an Evolving Context: A Comparison between the Old and the New World of Automotive Engineering Services in Germany

Florian Müller

University of Bremen, Faculty of Business Studies & Economics, Bremen, Germany
mueller@is.uni-bremen.de

Abstract. Modularity in services has emerged as a promising design approach that offers a sound balance between cost-efficiency in service production and customization. However, the existing literature draws on a narrow scope of service design that considers certain characteristics of service as constraints to the successful adoption of the concept, i.e. service modularization. The growing importance of service as a central logic to explain value creation suggests the need to expand this view and to understand how service modularization and changes in dynamic service contexts may come together. This article makes a first attempt in this direction by exploring service modularization in the light of major restructurings in the field of automotive engineering services (AES) in Germany. Through 22 qualitative interviews with customers and providers of AES, this article presents a conceptual process model that explains how service modularization of AES is propelled by transformational forces in an evolving service context.

Keywords: Service Modularization, Service Modularity, Automotive Engineering Services, Evolving Context, Service Logic

1 Introduction

The increasing significance of service in our modern economy [1] is accompanied by a growing pressure on service providers to become more cost-efficient in service provision. On the other hand, customers are more demanding than ever and expect customized services for their individual needs [2]. Consequently, ambitions to achieve cost reductions and efficiency gains through service standardization [3] are contradicted by the fact that providers need to remain flexible to meet the heterogeneous demands of different customers at once.

From this challenge, service modularity has emerged as a promising design approach to achieve a sound balance between standardization and individualization at the same time [1]. In general, modularity can be viewed as an architectural principle that describes the decomposition of a complex system into smaller parts, i.e., modules that are characterized by a high internal cohesion but are loosely coupled among each other [4]. Standard interfaces between modules enable a high flexibility in the system and ensure that modules can function together as a whole [4].

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As of today, services are rarely considered to adhere to a modular design (except for specific industries like, e.g., logistics and financial services) [1] and the question of the extent to which different services are eligible for an adoption of the concept of modularity, i.e., modularization, is subject of a controversial discussion in the literature [5, 6]. Contrasting viewpoints have especially emerged from an evolving understanding of service. Currently, a large part of the literature limits the role of modular design to the level of service operations. From this narrow scope, certain service characteristics are considered constraints to modularization, e.g., an active customer in service processes [7, 8]. However, the current shift of the academic community towards a service-centric view of the world [5] suggests the need to expand the current view on service modularity and to elaborate on our understanding of how service modularization may take place in the dynamic service contexts of the real world [9, 10].

This article makes a first step towards this direction and explores interrelations between modular service design and an evolving service context at the case of automotive engineering services (AES) in Germany. AES are offered in a project-based fashion by professional service firms to large original equipment manufacturers (OEM) of automobiles for the design, production and testing of technical models for vehicle parts. Recently, industry studies outline a growing dynamic in the automobile industry and changes in the design of AES projects [11]. Considering the need for AES providers to balance contrasting aims of customization and standardization, modularity could be a solution. However, little is known on how contextual changes lead to a higher degree of modularity in services, thus limiting opportunities for modularization in dynamic sectors.

Consequently, the key objective of this research is to identify factors in the broader service context in which AES are developed and rendered that may facilitate modular AES design. Furthermore, the article aims to develop a conceptual model that explains such interrelations. As encouraged by past research, particular attention is devoted to the business relation between customers and providers [1, 12]. To tackle our research aim, we employ a qualitative field study among customers and providers of AES.

The paper begins with a brief outline of our theoretical understanding of service modularization and a brief description of the abductive research methodology. Subsequently, we present an analysis of transformational forces that cause changes in different interconnected layers and facilitate the modularity of AES. Chapter 5 explains how these changes in the design of AES come together with an elevation of the business relation between providers and OEMs. Our findings are summarized in a conceptual process model that illustrates causal relations between different layers of change, before we conclude with a discussion of research implications and future research avenues.

2 Research Background

The paradigm shift towards a service-centric view of service as a central logic to explain value creation raises tensions with the traditional assumption that certain service characteristics constrain modularization. Tensions are especially evident with respect to Service Systems Engineering (SSE) that adopts a systemic perspective at service as a socio-technical system that enables actors and resources to co-create value [13, 14].

The interaction of different parties with a service system allows for a systemic design. However, design choices in the practice are often determined by complex and rapidly evolving business environments [9], so that modularization may create tensions [7].

With respect to modular service design, the emergence of modular financial services [15] has shown that modularization processes may be triggered by changes in the service context, e.g. through technological advances or changes in legal regulations. Yet, little is known on how contextual changes propel modularization processes in the practice. Research on the interdependencies between modularization and evolving contexts seems especially important since scholars are now increasingly concerned with the design of services that are more adaptive to changes in dynamic contexts.

Service modularization is considered the decomposition of a service into smaller parts and a restructuring of these parts in form of service modules [2]. However, the nature of service is highly complex and modular service design shows in various forms [16] and in different dimensions [5]. This study draws on a well-established understanding of modular service design from Pekkarinen & Ulkuniemi [17] who suggest to examine service modularity in three different dimensions (*3D of modularity*): *Modularity in the service organization* refers to the organization, integration and use of internal or external resources in the service production. *Modular service processes* are built from modules based on information processes or physical operations. *Modular service offerings* relates to service elements whose value is separable and visible to the customer.

The industry context in which AES projects are designed and rendered is currently subject to an increasing dynamic. Providers of AES face growing competition and cost-pressure that lead to consolidations in the market [18]. Nowadays, the remaining players in the market offer a wide array of engineering services to a low number of OEMs that traditionally expect customized solutions for their individual needs. For the providers service modularization would be the concluding solution. However, little is known on modular service design in the AES sector. While in automobile manufacturing and supply chain processes, modularity has been a popular concept for many decades [1, 19], prior research outlines several characteristics of the AES sector as natural constraints to modular service designs, e.g., the reliance on complex problem solving during service provision and a close interaction between customers and providers [7, 8]. However, recent industry studies outline the transformative role of digitalization in the AES sector and indicate ongoing evolution in the design of AES projects that could lead to a higher degree of modularity in services [11, 18]. The dynamics of the AES sector create a particular interesting setting for an exploration of contextual variables that influence the application space for modular service design.

3 Methodology

In order to identify facilitators of service modularity in an evolving business environment – a phenomenon that is highly complex and insufficiently understood – a qualitative research design was chosen due to the explorative nature of our research aim. After familiarizing with the current body of knowledge on modularity in services, the research followed an abductive methodology which has been emphasized to be particularly useful to study ill-structured phenomena and to discover new things [20].

Consistent with an abductive approach to case research, collection of data, review of literature and the development of a framework for the analysis of the data were carried out in an intertwined fashion as part of an iterative process. Dubois and Gadde [20] describe this process as systematic combining and matching of existing theory, research framework, empirical world and findings. During this process the researcher moves back and forth between field observations and theoretical concepts in order to enhance both understanding of the field of research and the empirical data [20].

Data collection took place in one phase between December 2014 and June 2015. During this period, 22 semi-structured interviews were conducted among high-level executives within the German automobile industry. Potential interviewees were identified through an industry-specific key word search in the database of a public business network for employee roles and positions that were involved in the rendering of AES projects, which represents a form of judgement sampling [21]. Interviewees were invited to the research by email. This approach resulted in a response rate of 21 percent.

Interviews were carried out personally or by telephone and lasted between 30 and 60 minutes. From the side of AES providers interviewees were mostly CEOs and Business Unit Managers. From the side of the manufacturers interviewees were working as engineering, process or purchasing executives. All interviewees possessed deep industry knowledge due to a long work history (more than 10 years) in the automobile industry. Table 1 gives an overview of the sample characteristics. To increase the reliability of the data, interviews were audio-recorded and transcribed in German language [22] before later during the writing process, relevant quotes were translated into English. Systematics in the analysis and interpretation of the interview transcripts was supported by employing MaxQDA, a professional software for qualitative data analysis that was used to assign codes to relevant text passages in the interview transcripts.

Table 1. Sample Characteristics

Perspective	*Engineering service provider (P)*							*OEM (C)*			
Employees	0-1000		1001-5000			5001-15000		>15001			
Firm	P1	P2	P3	P4	P5	P6	P7	C1	C2	C3	*Total*
# Interviews	1	3	2	2	2	1	1	5	3	2	22

As given by the abductive approach, collection, analysis and interpretation of empirical data were carried out in parallel to the development of the scope and aim of the research and the research framework, so that the interview guidelines and the coding scheme evolved in the course of our study through multiple iterations of application, interpretation and adaption [20].

At the beginning of this process, a tentative research framework was derived from the literature on service modularity that comprised basic interview questions and a tentative coding scheme for the systematic analysis of the data. The first set of interview questions aimed to improve our general understanding of the design of AES and the dynamic context in which AES are offered and produced. Complementary perspectives of customers and providers at AES were considered to support this aim. Correspondingly the tentative coding scheme allowed us to examine the adherence of AES to basic principles and effects of service modularity e.g., loose coupling, reuse, bundling, flexibility and standardization [16, 23], in each of the 3 dimensions of service modularity

[17]. This approach gave our interpretation of the data orientation and still allowed the necessary flexibility to explore modularity in AES with an open mind.

During the research process the scope of the research and the research framework were narrowed and adopted to our findings. To give an example, when we denoted that several interviewees highlighted causal relations between modularization and regulatory changes, the coding scheme was enhanced with new codes to examine this relation throughout all interview transcripts. Likewise, over time codes were added to classify the variety of changes in the context of the AES sector into different layers (industry context, service design and business relation). Layers are an outcome of the abductive approach and help to lower the complexity in the outlined industry transformation. Further codes were added to capture causal relations between layers and temporal reference of statements (past, present and future). A continues comparing of findings with the literature on service modularity revealed a research gap with respect to how modularization processes interrelate with changes in evolving contexts.

Finally, after the aim of the research and the framework were refined in the course of a continuous direction and redirection of the study, the research process was ended when the scope of the research, the applied research framework and the empirical findings gave a sound and coordinated impression. At this point, interviews yielded only little additional insights and indicated a sufficient theoretical saturation [20]. In a last step, the findings were summarized and integrated into a conceptual process model.

4 Transformational Forces and Facilitators of Service Modularity

Interviewees from providers of AES and OEMs outline an ongoing transformation of the global automobile industry that manifests in a rapidly evolving business environment of the AES sector. Consistent with prior studies [11, 18], it has become evident that processes of digitalization and socio-economic change are major forces behind the current restructuration. In the course of our research, we denoted that changes in the AES industry could be located on three different interconnected layers: layer of the *industry* (1), *service design layer* (2) and, layer of the *business relation* (3). The layers evolved in the course of the abductive research approach. This chapter provides a brief outline of the three different layers of change and subsequently with a more differentiated understanding of key transformational forces.

The first layer comprises changes in the context of the automobile industry (industry layer). Changes concern multiple actors in the market and e.g., lead to AES providers becoming less dependent on the OEMs in terms of how they render their services.

Second, several changes can be denoted in respect to the design and rendering of AES projects (design layer) that allow for standardization, reuse and decoupling of service elements that were closely intertwined and tied to the approval of the OEMs in the past. Such changes were considered indications of an ongoing modularization of AES.

Third, we observe a shift in different socio-psychological characteristics of the *business relation* between AES providers and OEMs that elevates the longitudinal exchange relation between the parties onto a new level, e.g., in terms of trust and control.

Interviewees suggest a close relation between changes in different layers that connect to the increasing adherence of AES to principles of modularity. To gain deeper insights into how changes relate across different layers and to identify changes in the

context that facilitate modularization processes in the practice, next we present a more differentiated view at four major transformational forces that were outlined by the interviewees in close relation to changes in the design of AES:

- *OEMs adapt their traditional core competencies (development and manufacturing)* to new challenges of the digital age. This is especially shown by the OEMs increasing their investments into IT-related competencies, i.e., software development, while they leave the amount of technical engineering capacity on a constant level. Since the number of car variants has spiked in recent years and leads to an ever-growing demand for engineering capacity in the market, OEMs outsource more and more of their engineering activities and allow their providers to play roles that are more important in the automotive value creation chain.
- *Engineering projects grow in complexity and extent.* In the past, the OEMs' outsourcing strategies aimed at creating a large number of smaller engineering projects in order to yield cost-reductions. Today, OEMs attempt to bundle closely related engineering activities to larger project extents. Interviewees attributed shift in the outsourcing strategy to a rise in the complexity of in-car electronics, i.e., sensors and IT in modern automobiles that demand for a closer alignment of different engineering activities and increases the effort for the management and integration of different engineering projects.
- *A change in the legal regulations of service contracts* demands for a clearer separation between real project contracts and body leasing. Despite a clear differentiation between the workforce of customer and provider is requested by the law, this request was loosely handled in the past. It has been a common practice for AES providers to deploy their engineers directly on site at the OEMs. Interviewees outlined that the control of the legal request for a clearer differentiation would now suddenly be taken serious. As a first effect, service contracts now need to be specified in more detail. As a second effect, providers have to lower the proximity to their customer by relocating a majority of their workforce into their own office spaces.
- In recent years, *AES providers have shown a significant growth* in turnover and in the number of their employees. This growth is paralleled by an *increasing diversification* in the customer portfolio of many providers and in the variety of services offered. Several providers outlined opportunities from them to yield synergies from cross-customer learning and a growing dependency of the OEMs from external engineering expertise in certain technological fields related to AES.

To underline the strength and velocity of these transformational forces, several interviewees differentiated between an *"old world"* and a *"new world"* of AES. In this respect, a major breaking point between both worlds can be located between the years 2014 and 2015. The following sections present an analysis of AES design in the light of the outlined industry transformation in three dimensions of modular service design. The terminology (old world/new world) is thereby adopted to compare two contrasting service settings that determine the potential for modular service design of AES.

4.1 Service Modularity in AES Processes

AES processes are traditionally characterized by a high degree of interaction between customer and provider who co-produce the service in close collaboration. During the

analysis of our interview data, we observed changes in the interaction between the parties as well as in the controle and influence that the parties exert at the course of AES processes. The first change concerns *the authority over the extent and the intensity in the interaction*. In the old world, customers traditionally decided over their own role in the service process. In this role, they fulfilled a strong supervision function and determined the level of their involvement during service production. In the new world, providers and customers negotiate a work mode that lowers the controlling effort for the customer and gives the provider longer times of autonomous service production.

"Now, we have to find a balance between working in quiet without being disturbed by the provider and reporting to the customer as that we nowadays have to control the intervention of our customers. […] we had to establish our own reporting and project management processes to offer our customers more orientation, so that any developments for them do not come as a surprise. In this way, we impede that the customer interferes on a regular base, as it was a common practice in the past." (P1, CEO)

Interviewees stated that OEMs increasingly expect their providers to manage the necessary level of interaction between the two parties (e.g., for decision-making). In the new world, providers need to find an efficient level of interaction that is beneficial for both parties. At the same time, providers need to ensure a sense of control for their customers and update them with reliable information on the project progress on a regular base. Consequently, we see an enlargement of the interval of *customer-provider interaction*. In the old world, interviewees outlined a continuous dialog during service production and discussion on a low level of technical detail that led to many serial iterations through previously completed process steps and serial discussions. Providers expressed the need to concentrate the interaction at shorter and more efficient periods, i.e., to organize the interaction in a more *punctual* manner.

As a third change, OEMs handover some of the *service process authority* to their providers. In the old world, providers engineering activities were closely supervised by the OEM. Providers thus, could only exert a limited influence at the technical solutions. In particular, the alignment of dependencies between design decisions and other parties (e.g., other projects and departments) was usually under OEM authority. Interviewee comments suggest that customers in the new world are increasingly handing over this responsibility to their providers, who need to manage interdependencies, carry the risk over design decisions and thereby increasingly produce the service in full authority.

Table 2 summarizes the outlined changes in the process dimension. In the new world providers increasingly manage the interaction between them and their providers and gain more control over the customer interference with the actual engineering work. This encloses a larger space to providers for the modularization of internal processes for the development of technical drawings. In the new world, providers find more space for process standardization and have more freedom in the organization of (mostly human) process interfaces. Standardization is thereby introduced in a part of the value creation process that remains hidden from the customer, e.g., through automatization of repetitive tasks and the introduction of standards in the setup of internal projects. In addition, the interaction with the customer becomes more standardized. More process authority allows providers to introduce internal standards into controlling and reporting processes and the development of replicable routines for the preparation and

presentation of alternative solutions to the customer. These service elements are decoupled from the customized parts of the service and thus become available for use in different service projects. By drawing on combinations of standardized and customized services processes, providers maintain the necessary flexibility to meet individual expectations of the customer with respect to how the interaction between both parties is organized, while also increasing efficiency in major parts of the value creation process.

Table 2. Facilitators for achieving modularity in AES processes

Facilitator	*Old world*	*New world (trend)*
Authority over customer-provider interaction	Customer	Provider
Interval of customer-provider interaction	Short	Longer (punctual)
Service process authority	Customer	Provider

4.2 Service Modularity in AES Organizations

AES providers typically compose their internal resources (the majority consisting of human engineering capacity) along two different organizational dimensions. The first dimension mirrors key phases of the automobile product development process. Providers draw on competence teams that are organizational units specialized in phase-specific requirements and demands, e.g., competence teams possess knowledge and skills of advanced development, series development or simulation and assurance. As a second dimension, providers align their competences with different technological spheres of the automobile, e.g., interieur, exterieur or chassis development. Consequently, the combination of both dimensions (process and technology) forms a matrix organization. In theory, this service organization allows combinations of competencies along the technological and process dimension. However, in practice providers outlined several limitations with respect to opportunities to offer services based on combinations of different competence fields. Interviewees outlined additional combinatorial constraints that hardened the integration and connection of separate competences in the old world. However, we see several of these obstacles being reduced or even eliminated in the new world.

The first change concerns the *physical proximity between customer and provider*. AES providers typically draw on a decentralized engineering capacity that distributes across different service branches from which most lie in close distance to the development and manufacturing centers of the large German OEMs. In the old world, providers' had to integrate physically into the organization of their customers to enable co-production of the service on site of the customer in close collaboration. Thus, an important premise for successful service provision was that a large part of the provider's engineering workforce had deep knowledge of the customers' internal processes and was highly familiar with the decision-making culture of the customer.

"Until now many services were offered as projects in pretense, as that in theory responsibility and authority over our employees lay with us, but in reality it laid with the customer. Our workforce was at the customer's site, they were sitting in the customer's office space and the customer directed them to do this and to do that. […] At the moment there is a big movement, so that the manufacturers seek to reach a spatial

separation between them and their external engineering providers." (P3, BU Manager)

The number of provider employees working on site of the customer has significantly lowered in response to a recent tightening of compliance regulations and providers gain more authority over the course and outcome of their services:

"It is increasingly our decision which work packages we produce and where we do this. This is a major change that one can currently observe in the market." (P7, CEO)

This reduction of the proximity between the workforce of providers and OEMs leads to a concentration of the interaction between both parties at fewer *(human) interfaces*. In the old world, OEMs often discussed technical and project management decisions directly on the lower levels of the provider hierarchy. In the new world, much of the communication runs through a considerable lower number of well-networked intermediaries. Project managers often fulfill this function and manage the communication between their own project teams and the OEM. They often maintain a personal relation to relevant stakeholders that allows them to facilitate decision making within the internal organization of their customers. Finally, interviewees denote a "professionalization" of the IT and data management systems (DMS) for the organization and exchange of technical models and project related data but also a growing heterogeneity of these systems. While in the old world, customers usually had the authority over the DMS and providers were connected through remote- or on-site-access, OEMs in the new world often expect their providers to have their own IT-infrastructure in place and to manage the data exchange in full authority. Other interviewees expect a growing importance of third party DMS-solutions in the future. In this respect, IT-security, efficiency in the collaboration and compliance regulations are seen as contrary aims that yet remain an unsolved problem. To become more flexible and less dependent from OEM-specific premises providers are beginning to invest into their own IT.

The outlined changes (cf. Table 3) lower the barriers for providers for drawing upon their full range of competencies and engineering capacity when offering services to different OEMs. In the new world, it is increasingly the decision of the provider where and by whom certain engineering activities are carried out, so that value-creating activities are decoupled from the location where services are offered. This suggests the emergence of modular organizations that enable providers to offer a wider set of competencies at different service branches irrespectively of where the underlying engineering capacity are located. Providers can build upon their workforce from different corporate sites to put up the necessary capacities and the variety of competencies that are required to handle the complexity of larger projects in full authority. Modularity in the organization is also shown by the fact that providers stated to outsource a growing amount of repetitive engineering activities to other countries to yield cost reductions - a trend that is strengthened further by lowering barriers for the exchange of data.

Table 3. Facilitators of modularity in AES organization

Facilitator	*Old world*	*New world (trend)*
Physical proximity	High (integrated)	Low (dispersed)
Extent of customer-provider interfaces	Many interfaces on a low level-hierarchy	A few higher-level intermediaries
Data management authority	Centralized at the customer	Decentralized

4.3 Service Modularity in AES Offerings

AES are typically offered as highly customized service projects. Customization proceeds throughout the course of the service process and begins with a tender and proposal phase. Interviewees characterized the process of customization as a reciprocal dialog between customer and provider in which both parties negotiate the value of the service offering. Our findings show three significant differences between the old and the new world with respect to the process of customization and the decomposability of AES offerings.

First, several interviewees outlined that in the old world providers were mainly offering their engineering capacity to the customer and thus had only limited opportunities to offer combinations of their competencies. Providers indicated that the growing complexity and extent in AES projects further propel a shift in the focus of their offerings from capacity towards competencies:

"In simple words, we observe a transition from a focus at [engineering] capacity to competence. […] When projects become larger, the customer's confidence into the provider becomes more important, particularly into the providers' project management capabilities" (P3, Business Unit Manager)

Consequently, providers see growing opportunities to offer combinations of different competencies and to bundle engineering activities to larger service packages, which in the old world were offered as separate projects. Interviewees highlighted that their customers would increasingly expect them to enrich the value in their offerings through the integration of additional support services, such as more sophisticated project management processes that can lower the customers' controlling effort.

We further observe a change in the influence that providers exert at the design and the extent of service offerings. Analysis of our data revealed that in the old world, the boundary conditions for later service provision (e.g., interfaces to other projects and project content) were merely determined by the customer independently of the provider. Providers were mainly concerned to design an initial offering (delivered in written form as a project proposal) that matches the customers' requirements. In contrast, several interviewees outlined that customers would increasingly invite providers to integrate themselves during the specification of the tender, allowing them to participate in the fundamental design of their service offerings in a very early phase:

"What now defines our work is early integration of suppliers. […] Many suppliers offer this preparatory effort for free to take predominant positions during the commissioning phase. Then the coming tasks are put to the agenda and we consider in common who performs which task by oneself or in cooperation with a partner." (C2, Chief Engineer)

Finally, the customization process of service offerings develops from a persistent refinement towards a guided implementation of dynamically created configuration options during which the offering evolves incrementally from different customer choices. Providers and customers switch between phases of requirement specification, preparation of alternative options and subsequent decision making with the customer, which is in many ways a different work mode compared to the old world, where the solution went through a less structured process of direct and continues refinement.

The three outlined changes (cf. Table 4) facilitate modularity in AES offerings.

Providers stated that the offering of combinations of their competencies becomes a key to remain competitive in the marketplace. In this regard, providers outlined the importance for them to display the value inherited in different combinations as part of larger offerings. Providers gain new opportunities to influence project requests before official commissioning and can thereby incorporate interfaces between project parts that in the old world were often distributed among different providers. In this way, providers described ways to implement internal standards for collaboration and communication to increase efficiency in service production. On the other hand, providers point out the need to obscure the true degree of modularity in their service offerings to their customers in order to reap internal synergies. Competencies in the AES industry can be viewed as service modules, whose evaluation, selection, integration and rendering is part of a collaborative customization process between customer and provider. In the new world, this process is often guided by the provider.

Table 4. Facilitators of modularity in AES offerings

Facilitators	*Old world*	*New world (trend)*
Role of provider competencies in the offering	Lower	Higher
Provider influence on service project design	Lower	Higher
Nature of the customization process	Continuous	Incremental

5 Regulating Variables of Service Modularity

Changes in the design of AES – such as a lowering of the physical proximity between providers and OEMs – come together with a shift in the business relation between the two parties. In this respect, interviewees outlined changes in various socio-psychological factors, e.g., in terms of trust, expectations, appreciation, control and responsibility. While in the old world, providers were merely regarded as enhancements of the engineering capacity of the large OEMs, interview comments such as the following suggest that the relationship between the two parties elevates onto a higher level and the emergence of genuine engineering partnerships:

"The relation between engineering service providers and the manufacturers changes from one important point of view. One cannot speak about normal suppliers anymore, instead it must arise partnerships at eye level. […] Providers have to prove themselves for real partnerships to emerge." (C1, Head of Engineering Processes)

OEMs are now narrowing the scope of their own technical development activities and thus need to share larger proportions of project-related authority and risk to handle the complexity of engineering projects. This makes OEMs more dependent on the skills and resources of their providers. Interviewees stated that OEMs have to let loose when commissioned project amounts are increasing and that they need to have more faith into their provider's competencies and capabilities to carry out projects to full extent in own responsibility. Deeper analysis of our interview data suggests four major changes on the layer of the business relation.

First, providers outlined that their customers would increasingly expect them to act as advisors who demonstrate a yet unknown level of *sovereignty* in their services provided. This achieve this, providers need to develop a more profound understanding of interdependencies between their individual engineering projects and the complex project environment of the OEMs in which these projects are embedded.

The second change concerns the level of *confidence* of the customer into the capabilities of the provider. A high manager of an OEM indicated that an elevated level of confidence would be a premise for them to lower their control over their providers' engineering activities during service provision. Providers who seek to take over larger and more complex extents have to prove themselves as reliable and capable to manage the complexity of interdependencies within the project environment of their customers in own authority and create high service value over longer periods.

Thirdly, in return customers stated that they would demand from their providers a stronger *commitment* to take over larger financial risks in engineering service projects and manage these risks in own authority. Providers confirmed this and indicated an increased need for the development of improved risk management techniques to handle risks in service projects but also on the level of the project portfolio.

Finally, we see an increase in the *recognition* of the providers' competencies in specific technical fields of knowledge, e.g., in the field of lightweight construction. OEMs are recognizing the value that lies in the value of competencies, instead of viewing them as sole engineering capacity.

Providers, who successfully manage change in these four regulating variables will encounter a larger freedom to design their service production according to their own account and based on principles of modularity. However, OEMs indicate that providers who fail to manage the transition towards genuine partnerships are endangered to become subcontractors by the larger providers. They cannot expect to reap the same potential of service modularity as those providers in the first-tier.

6 Discussion and Conclusions

This paper examines service modularization in the rapidly evolving AES industry and presents an empirically grounded comparison between two contrasting service settings, in which AES projects are developed and rendered. Findings are aggregated into a conceptual process model (Figure 1) that locates changes in the AES sector onto three different layers of change. The industry-specific process model outlines four key transformational forces in the context of the German automobile industry (1) that lead to the formation of modular service designs in the AES sector alongside each of the three modularity dimensions (2). However, modularization comes together with changes in the business relation between customers and providers of AES. Closer analysis shows that changes in the design of AES and changes in four different characteristics of the business relation are mutually dependent, so that these factors are considered to regulate the potential for modular service design (Layer 3).

As to the consequences of the transformation, controversial views can be denoted. Providers outline both positive as well as negative effects on them. On the one hand,

they appreciate the development of genuine partnerships and opportunities for them to implement projects in full authority. Providers expect increasing opportunities to offer their services to new customers, e.g., to OEMs located in the US and in Asia. On the other hand, providers indicate that modularization enhances comparability of service offerings, which further reinforces the cost-pressure on providers that face increasing international competition. In this respect, some providers stated that they would mainly aim to achieve standards in service processes and organization but mask the full extent of modularity in their service offerings to reduce comparability in the marketplace. In general, modularity of AES is less a suitable strategy for providers to outperform competitors and rather becomes a prerequisite to remain competitive in the marketplace.

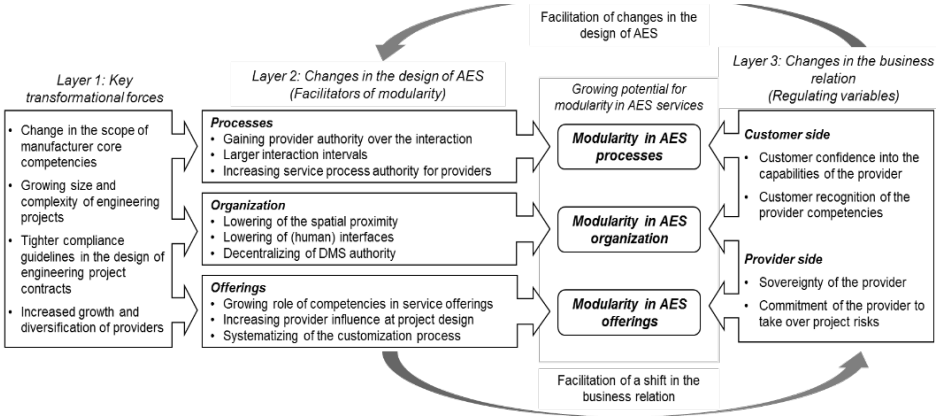

Figure 1. Causal relations between different layers of change and service modularity in AES

6.1 Theoretical and Practical Implications

Theoretical implications concern our understanding on the role of evolving contexts in service modularization processes. While existing research on service modularity is traditionally concerned with modularity in a specific context, this article is one of the first that examines how service modularization may be propelled by transformational forces in an evolving industry context [5]. The presented process model (Figure 1) offers an overview on several variables in the context of the AES industry that determine the potential for service modularity. Considering rapidly evolving contexts in our digital age [9], our findings underline the need to further elaborate on the role of modularity from a service-centric view [13, 14]. In this respect, in line with recent research in the field of service innovation, our findings underline the importance of modularity as an important theoretical design construct in the field of SSE [13, 14] that may contribute to our understanding of the relations and interactions of multiple actors in service ecosystems [10]. Contrary to the frequent assumption that modular service designs are necessarily an outcome of a systematic modularization initiative in a specific service context, the case of AES shows that an adoption of the concept, i.e. modularization may be driven by design choices created from changes in dynamic

business environments. In this respect, networked business relations should receive further research attention to develop more comprehensive modular design strategies for services [1]. The presented facilitators of modularity on different layers of change offer an interesting launch point for such research endeavors.

As for the *managerial implications*, the presented conceptualization of three different interconnected layers of change outlines a path for AES providers to develop a modular service design while also becoming more independent of their customers. In order to manage the transition to the new world of AES successfully, providers have to facilitate and manage changes on the layer of their business relations and in the design of their services in close coordination. Providers in this relation highlighted the role of a wide-reaching network to decision makers within their customers' organization and improved communication skills on the level of project managers. The outlined differences between the old and the new world of AES can be regarded in this respect as a development target for the design of AES at which providers can align the facilitation of design changes along the three modularity dimensions and elaborate on the systematic reshaping of their business relations. However, findings also show that providers need to consider the extent to which they reveal the degree of modularity to their customers. A modular service design, whose architecture is fully transparent to the customer, may expose the provider to a high cost-pressure, because customers can easily compare service modules with other offerings in the marketplace.

6.2 Limitations and Future Research Avenues

Our study is beset with some *limitations* that can motivate future research. First, this study builds upon a large set of data that allowed us to identify general changes in AES. However, generalizability of our findings is likely to be limited to the German AES industry until additional empirical studies have validate the presented causal relations in other service contexts. Second, despite the concept of the three dimensions of modularity is widely recognized, it leaves room for interpretation in terms of what modules are comprised of and how they can be identified in the practice. Because a universal definition of service modularity has not yet emerged [5, 6], we differentiated between modularity in three dimensions (3D of modularity) [17] and enhanced this understanding by the general effects and principles of service modularity - in particular those defined by Dörbecker & Böhmann [16], Bask et al. [6] and Tuunanen et al. [23]. While, this broader interpretation of modularity in services allowed the identification of several modularity effects and principles during the analysis of the interview data, our findings suggest the existence of different forms of modular service design.

To summarize, this study contributes an empirically grounded conceptualization on service modularization in the e context of the German AES sector that explains how service modularization and changes in an evolving service context may come together.

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