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Critical Success Factors of Service Orientation in Information Systems Engineering

Derivation and Empirical Evaluation of a Causal Model

While the buzz about service orientation is on a decline, organizations are constantly moving towards service oriented designs. However, service orientation turns out to be as much of a managerial challenge as of a technical one. In order to better understand these challenges we answer the following questions: What are the characteristics of successful implementations of service oriented information systems? What are the critical success factors influencing these characteristics? For answering these questions we successfully test a cause-effect relationship model. In the core of this model we differentiate the variables "overall service orientation infrastructure success" and "service orientation project success". They reflect the important differentiation between two perspectives on successful service orientation.

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1 Introduction

Service orientation is a broad concept for describing and designing phenomena as different as services and products in a value chain, or the interface definition and functional description of pieces of software. In this article we focus on service orientation as a design paradigm for information systems engineering. We consider information systems (IS) as the entirety of persons, business processes, and information technology (IT) that process data and information in an organization (cf. Bacon and Fitzgerald 2001; Brookes et al. 1982; Tatnall et al. 1996; Vessey et al. 2002). Hence an IS includes IT artifacts as well as business artifacts. Typical IT artifacts are software systems, software services, and hardware (Winter and Fischer 2007). Typical business artifacts are processes, organizational units, responsibilities, informational flows, and functional services (Davenport 1993; Winter and Fischer 2007).

In recent years service orientation is discussed as a fundamentally new design paradigm for IS which promises to significantly improve the manageability and changeability of increasingly complex IS. While often discussed in a software engineering context, service orientation as a design paradigm is not limited to software engineering (Lankhorst 2005; Schelp and Winter 2007): By composing/configuring complex solutions from a set of loosely coupled building blocks, IS engineering goals and thus IT/business alignment goals are also supported (Aier and Winter 2009; Sambamurthy et al. 2003). The main goal of service orientation then is to reintroduce the flexibility into IS, thereby supporting the constant and efficient re-alignment of business and IT artifacts to business changes and technology innovations.

The goal of service orientation builds on the properties of the underlying service concept. An important property of a service is its production of a specified result by performing certain actions. However, the service consumer must not need to know which actions are performed in order to produce this result (transparency). A second property of services is their granularity. A service should produce a meaningful result for a given context while overlapping in functionality as little as possible with other services (separation of concerns). Both properties foster loose coupling of services which supports the flexibility to change a system comprised of such services.

While there is consensus of opinion that service orientation as a design paradigm contributes to flexibility of organizations (Ahsan and Ye-Ngo 2005; Coronado et al. 2004), there are a number of still not well understood challenges. Examples are the design of functional (i.e. non-technical) services, service complexity management, service governance, or IT/business alignment in a service oriented environment. The reasons for this situation are to be found in the following facts:

(a) Service orientation as a design paradigm fundamentally breaks with established and well understood ways to design IT artifacts as well as business artifacts.
(b) Service orientation creates a new source of complexity because service oriented artifacts (e.g., enterprise services) are introduced in addition to existing artifacts (e.g., traditionally designed software modules).
(c) The more exhaustive service orientation coverage is, the more benefit will be generated due to positive network externalities.
(d) Because of these network externalities and the fact that service orientation addresses IT as well as business artifacts, the number, and diversity of stakeholders rises, and thus the probability of inconsistent design goals increases.

The analysis of critical success factors (CSF) is commonly accepted as a useful approach to cope with complexity in IS research (Rockart 1979). In order to guide service oriented IS engineering and thereby cope with the issue of complexity, we focuses on the following questions:

(1) What are the characteristics of successful implementations of the service oriented design paradigm in IS engineering?
(2) What are the critical success factors influencing, driving and/or, determining these characteristics?

The remainder of this article is organized as follows. Section 2 builds the theoretical arguments for the proposed research model based on a literature review. In Sect. 3, hypotheses are consolidated into our research model which will be operationalized and tested using the partial least squares (PLS) approach to structural equation modeling (SEM). The results of the empirical test of our research model are presented in Sect. 4. Finally, in Sect. 5 we provide a discussion of the findings and suggest topics for future research. Section 6 summarizes and concludes the article.

2 Theoretical Foundations

In order to understand and evaluate CSF of service orientation, it is necessary to describe the characteristics of successful service oriented IS design. Based on a literature review, we derive a set of CSF as well as a set of corresponding indicators to measure the proposed CSF. Since there are only very few scientific and/or practitioner-oriented publications reporting on the introduction of service oriented IS engineering (e.g., Antikainen and Pekkola 2009; Bieberstein et al. 2005; Heutschi and Legner 2007; Hochstein and Brenner 2006; Lee et al. 2010; Wong-Bushby et al. 2006), we have also reviewed literature of related research on ERP and EAI.

2.1 ERP, EAI, and Service Orientation as Cutting Edge Concepts for Enterprise Integration

The idea of a consistent, flexible, and aligned IS is nothing new and may be paraphrased as IS integration. In this context, service orientation has at least two preceding cutting edge concepts – enterprise resource planning (ERP) and enterprise application integration (EAI). The ERP integration approach is to design a comprehensive IS that consolidates a large number of data and functionalities into a single and consistent software system. However, the successive introduction of ERP systems in large organizations has usually led to a number of inconsistent ERP instances, thereby partitioning the big integration challenge into a set of smaller ones (e.g., by region, product, organizational unit, etc.). The problem of enterprise-wide IS integration remains unsolved, at least for large organizations. EAI acknowledges the benefits of a number of smaller best-of-breed IS and separates the integration function into a central and thus consistent integration infrastructure. EAI however is not instrumental to improve IT/business alignment. Further increasing the level of granularity of the architectural elements, service orientation improves their interoperability by deploying the service paradigm on the technical level as well as on the level of functional services. In doing so, service orientation fundamentally breaks with established approaches to IS design, e.g., by challenging the paradigm of highly integrated data (as in ERP and to some degree in EAI), by consequently not restricting itself to IT artifacts (as EAI and to some degree ERP do) and thus by applying the idea of loosely coupled services on each layer of the business to IT stack as well as through this stack (Aier and Winter 2009).

For the purpose of this article – the confirmation of CSF of service oriented IS design – we argue that ERP, EAI, and service orientation share major commonalities, the most obvious being the aim of IS integration on enterprise level.

From an architectural perspective, however, ERP, EAI, and service orientation are different approaches. They are not the result of an incremental evolutionary development, but instead of radical changes followed by phases of stability. This development may be explained by means of the punctuated equilibrium theory (PET) which originated in biology (Eldrege and Gould 1972) and has subsequently been adopted in management and IS literature. PET describes organizations as primarily stable residing in an equilibrium where, building on arguments from institutional theory (e.g., Tolbert and Zucker 1983), inertia builds resistance to organizational change due to the “deep structure” (Gersick 1991) of interrelated organizational parts and competitive, regulatory, and technological systems (Romanelli and Tushman 1994). These phases of stability will be punctuated and interrupted by short, discontinuous bursts of change, e.g., caused by technological innovations. Network externalities, as they can be found with ERP, EAI, and service orientation, may cause multiple stable equilibrium to exist at the same time. Thus the incumbent equilibrium may persist long beyond the time when the new technology has become superior (Loch and Huberman 1999).

Our basic assumption is that IS integration evolves in accordance to the punctuated equilibrium pattern where ERP, EAI, and service orientation are technological punctuations. However, while technologies evolve, the fundamental problem of bridging the conceptual as well as cultural gap between business and IT seems to remain unsolved. This organizational resistance may be explained by an organization’s inability to deal with new technologies – which is closely linked to Clark’s architectural uncertainty (Clark 1985) which may negate the usefulness of a firm’s current set of procedures and thus fosters organizational inertia.

Therefore our research model is closely related to existing CSF research in the fields of ERP and EAI. On that basis, we contribute an empirically validated causal model.

Table 1 Key CSF of integration projects

Critical success factors	Somers and Nelson (2001)	Nah et al. (2001)	Gericke et al. (2010)
	Topical area and contribution		
	ERP, empirical exploration, and confirmation	ERP, literature review	EAI, literature review, and empirical confirmation
Integration strategy	×	×	×
Governance	×		×
Momentum, resources, and strategic importance	×	×	
Culture and communication	×	×	×
Integration architecture and design	×	×	×
Adequate characteristics of integration projects	×	×	×
Transparency of design artifacts	(×)		(×)

2.2 Critical Success Factors of Service Orientation

We have carefully analyzed the body of literature from both the ERP and the EAI field that explicitly deals with the identification of CSF. While there are a lot of quality publications on CSF of ERP, much less literature deals with CSF of EAI. However, the available literature on ERP as well as on EAI already reviews and integrates a broad range of explorative as well as confirmative work on CSF in the respective fields. Instead of replicating such review and integration, we summarize the findings by referring to three integrative publications. We extract the individual ERP and EAI CSF, harmonize the underlying concepts, and categorize the results into broader but still homogeneous factors.

For an overview of CSF of ERP we refer to the reviews and integrations by Somers and Nelson (2001) as well as by Nah et al. (2001). While Somers and Nelson have chosen an empirical approach analyzing cases studies and confirming the findings from these analyses, Nah et al. provide a detailed analysis of existing literature on CSF of ERP.

To the best of our knowledge, the only exhaustive, detailed literature review on EAI success factors is Gericke et al. (2010). They use their literature review and integration as a foundation to explore a list of factors that significantly influence the success of EAI implementation.

Table 1 summarizes the main findings of the aforementioned publications and provides a compact overview of CSF that have been identified for ERP and EAI, respectively.

We will operationalize these CSF by defining appropriate success indicators in the following.

2.3 Success Indicators of Service Orientation

By analyzing a select set of both practitioner-oriented and scholarly literature on ERP, EAI, and service orientation, we identify success indicators that are suited to instantiate and operationalize the seven above identified success factors. If necessary, the success indicators suggested by literature on ERP and EAI are reformulated and/or adapted to account for the specific characteristics of service oriented IS engineering.[1] Due to space limitations, the detailed discussion of the critical success factors of service orientation and derivation of adequate indicator variables is documented in Aier et al. (2010) and summarized in the following.

Service orientation as a design paradigm for IS engineering addresses a broad range of stakeholders within IS units as well as in business units (Klose et al. 2007). The more importance promoters of service orientation have in an organization, the more successful service orientation infrastructure and consequently individual projects addressing service orientation are expected to be (e.g., Nah et al. 2001). It is therefore critical to service orientation to be addressed in a *strategic (integration) initiative* endowed with the necessary *momentum*, *resources*, and senior *management support* (Holland and Light 1999). Only senior management is in a position to enforce strict *governance* of service orientation which is a prerequisite for service reuse and cost reduction (Bieberstein et al. 2005).

Since service orientation fundamentally breaks with traditional IS design paradigms, it is important to promote a *culture* of willingness for such change (Weill and Ross 2004). In order to adequately manage stakeholders, promoters, and opponents of transformation, *communication* of both necessity and benefits is essential (Nah et al. 2001).

The novelty of service oriented design results in a lack of design guidelines which are proven to contribute to successful service orientation. However, there is a set of fundamental *design guidelines* which constitutes service oriented design and thus has to be implemented to make projects addressing service orientation successful. These design guidelines are, for example, loose coupling (Heutschi and Legner 2007), abstraction from technical implementation (Wong-Bushby et al. 2006), or alignment of IT, business processes, and information objects (Schwinn and Winter 2007). These guidelines constitute an important part of *integration architecture* (IEEE 2000; The Open Group 2009).

In order to ensure the success of early service orientation projects and to generate quick wins for the concerned stakeholders, the careful selection of early *projects with adequate characteristics* is of high importance (Hochstein and Brenner 2006). Projects with a lower complexity are more appropriate to understand the effects of service oriented design decisions in a controlled environment (Sneed and Brössler 2003). At the same time projects with a low complexity should also generate a perceptible benefit for the involved business stakeholders in

[1] Although success indicators are reformulated for service orientation, we reference original ERP/EAI literature.

order to create success stories (Hochstein and Brenner 2006).

A prerequisite for a good service design is the *transparency of essential design artifacts* such as business processes, information objects, existing applications, and services (e.g., Puschmann and Alt 2004).

2.4 Characteristics of Successful Implementations of Service Orientation

Finally, we have analyzed the body of literature on the service oriented design paradigm in order to identify characteristics of successful service orientation. In the following, we argue that there are two disjoint classes of success of service orientation: (1) overall service orientation infrastructure success and (2) service orientation project success. This discussion is documented in detail in Aier et al. (2010) and summarized in the following due to space limitations.

Service orientation is not a single project but a design paradigm. The introduction and diffusion of service orientation needs several projects to build a significant number of services which we refer to as "service orientation infrastructure". Therefore classical project success factors as, e.g., described by Slevin and Pinto (1987) are attributed to service orientation infrastructure. The benefit of an existing service orientation infrastructure lies in the reuse potential of existing services in different projects (Bieberstein et al. 2005). The reuse of services is enabled because the required functionality is encapsulated in rather small, but self-contained partitions in contrast to monolithic blocks of functionality (Stal 2006). Thus, service orientation may lead to less redundant implementations of functionality resulting in lower IT operations costs (Lam 2005).

On project level, reuse as well as easier recombination of existing services may lead to shorter IT projects and thus to reduced IT development costs (Themistocleous and Irani 2001). Shorter cycle times will increase the perceived availability of IT support on a project level (Wong-Bushby et al. 2006).

Finally, service orientation infrastructure may be described as successful if the business users' satisfaction increases due to the infrastructure-related services provided by IT departments (DeLone and McLean 2003).

2.5 Hypotheses on the Interdependencies of Critical Success Factors and Successful Service Orientation

Based on the described CSF as well as on the indicators of success, we have derived the following hypotheses from an extensive literature review. In the literature review we have included publications from the field of service orientation as well as from previous research on EAI success factors as well as ERP success factors. Unlike existing work, the core of our model explicitly hypothesizes the dependencies between an existing service orientation infrastructure which provides a significant number of potentially reusable services and a service orientation project delivering value to an end user. A service orientation infrastructure shows significant network externalities which are according to PET (Loch and Huberman 1999) an important precondition for the migration from an existing equilibrium to an emerging one.

H1: The achievement of overall service orientation infrastructure success positively influences the achievement of service orientation project success.

A similar effect has been observed in EAI scenarios (Puschmann and Alt 2004) or with infrastructure components in general (DeLone and McLean 1992, 2003).

H2: Momentum, resources, and strategic importance of the service oriented paradigm positively influence the achievement of overall service orientation infrastructure success.

H2.1: Service orientation strategy is positively associated with momentum, resources, and strategic importance of the service oriented paradigm.

H2.2: Service orientation governance is positively associated with momentum, resources, and strategic importance of the service oriented paradigm.

Momentum, resources as well as the strategic importance which are assigned to service orientation will foster the development of a beneficial service orientation infrastructure. Similar dependencies can be observed in EAI (Lam 2005) and ERP (Holland and Light 1999) scenarios. The preconditions for H2 are an existing service orientation strategy (Nah et al. 2001) as well as effective processes (and organizational responsibilities) for service orientation governance (Nah et al. 2001; Sumner 2000; Themistocleous and Irani 2001). Also in line with the argumentation of PET (Gersick 1991), Miller and Friesen have shown that momentum plays a significant role in organizational transformation and for stabilization after revolutionary change (Miller and Friesen 1980).

H3: Culture and communication positively influence the achievement of overall service orientation infrastructure success.

In addition to the strategic importance given to service orientation, culture, and communication supporting fundamental change will contribute to a successful service orientation infrastructure (e.g., Holland and Light 1999). Especially the language action perspective and the underlying speech act theory emphasize language as the means to perform action (Flores and Ludlow 1980). In our context with diverse stakeholder groups, the creation of a "shared understanding" against a shared background (Habermas 1984) is of utmost importance (Umapathy and Purao 2007).

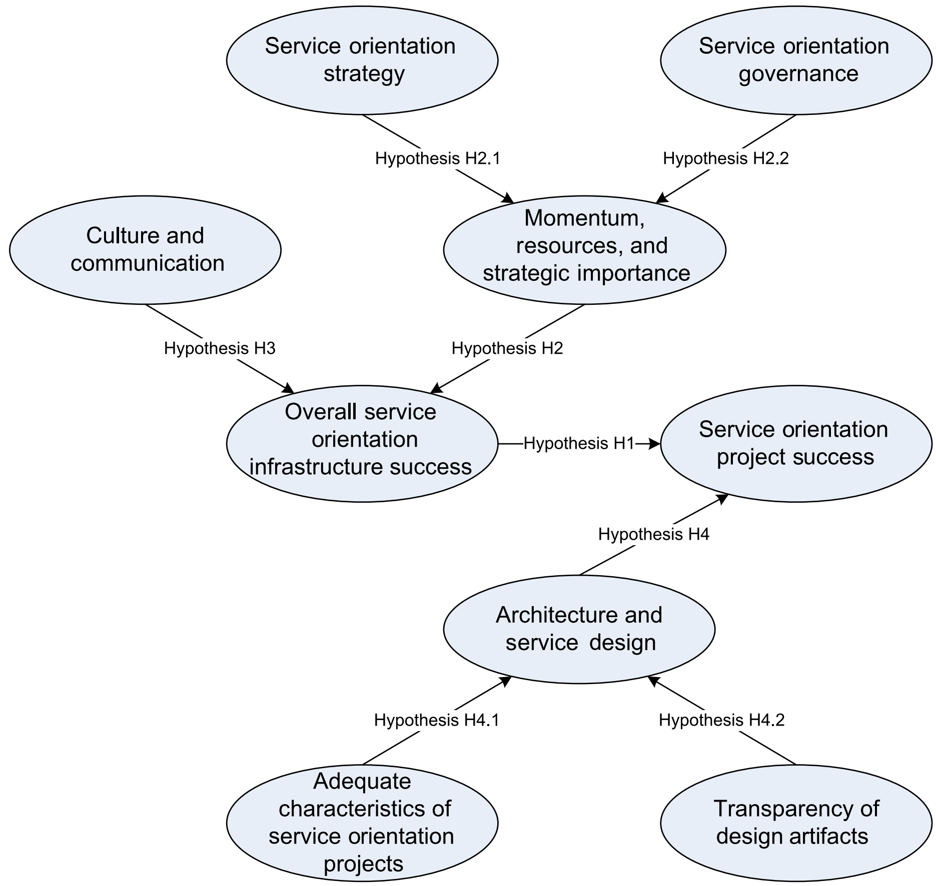
H4: Architecture and service design positively influence the achievement of service orientation project success.

H4.1: Adequate characteristics of service orientation projects are positively related to architecture and service design.

H4.2: Transparency of design artifacts is positively related to architecture and service design.

A strong service design is a necessary condition for a successful service orientation project (Heutschi and Legner 2007). A strong service design may be achieved – especially in an early stage – with the provision of the required transparency (Nah et al. 2001). Especially since service orientation projects comprise a diverse group of stakeholders according to cognitive fit theory (Vessey and Galletta 1991) an appropriate visualization will impact project success. Initial service orientation projects in particular have to be carefully selected in order to benefit from existing momentum and in order to focus on actual service design than on political needs. Therefore service orientation projects that have a low complexity

Fig. 1 Research model



(Hochstein and Brenner 2006) and address existing needs for change (Nah et al. 2001) may be appropriate starting points.

3 Research Model and Methodology

The research model is based on the hypotheses discussed in the previous section (cf. **Fig. 1**). It has been operationalized and tested using the partial least squares approach. The PLS approach to structural equation modeling has minimal requirements on measurement scales, sample size and residual distribution (Wold 1985).

SEM is a particular approach to multivariate data analysis allowing for the formulation, calculation, and testing of causal effects between variables that are incapable of direct observation and measurement (Schumacker and Lomax 1996). In order to reproduce these so-called latent variables (LVs), a measurement model is used that relates each LV with one or more quantifiable indicator variables (IVs). The entirety of all LVs and their interrelations constitutes the structural model. By means of SEM, the hypothesized causal model, consisting of both the measurement model and the structural model, is tested against empirical data.

The data set for the evaluation of the causal model was gathered through a written survey. The survey instrument was developed based on the theoretical arguments presented in the previous section. These arguments are also supported by information that we gathered in interviews with practitioners. Each construct, i.e. each LV, was operationalized by multiple IVs. In our research model, the number of IVs used for measuring an LV is between a minimum of 2 and a maximum of 6. The research model comprises a total of 9 LVs and 33 IVs.

Each IV was represented by a particular question on the survey instrument. The items were measured on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). All questions were formulated to measure the respondents' personal attitude/opinion towards the indicators and characteristics of successful service orientation. The survey instrument was both reviewed by academics and pre-tested with selected professionals. The responses from the pre-test were not included in the final sample. Based on this initial feedback, minor wording changes were made to the questionnaire. Furthermore, 4 test items were included in the survey instrument to check the quality and reliability of the responses. These test items were not part of the research model.

The final survey included 37 items for the representation of the research model and for quality assurance. In addition, the survey featured six questions relating to demographics and the status of service orientation initiatives in the respondent's companies.

The questionnaire was sent to approximately 12 800 IT professionals that were selected randomly from our research institute's database. Study participants were recruited among some 4 500 medium-sized and large companies from almost all industry sectors, operating in Switzerland, Germany, or Austria. The survey was administered in German language only. Respondents were offered free access to the results of the study. 289 completed surveys were returned. Based on a thorough examination and comparison of the responses to the test items, 64 questionnaires were discarded due to poor data quality. Accordingly, the final sample comprises 225 observations, containing a small number of observations from the same companies. Each observation refers to one individual from one company.

The overall response rate is therefore roughly 1.75%. Although the response rate is relatively low when compared to similar surveys, we are reasonably confident that it does not bias our results (cf. e.g., Keeter et al. 2006).

Respondents came from various industries. The top three industries – consulting, banking, insurance, and financial services, as well as software and information technology – jointly account for more than half of the data set. Nearly two-thirds of the respondents work for large companies that employ more than 1000 persons. The respondents' expertise has been controlled by assessing the status of service orientation in their respective organizations. However, the respondents' expertise shows no significant impact on survey results.

The survey items, i.e. the IVs used for measuring the LVs of the research model, are documented in **Table 2**. All latent variables were operationalized in reflective mode. Reflective measurement models – as opposed to formative measurement models – are characterized by the fact that IVs are considered to be manifestations – not defining characteristics – of an LV. Consequently, changes in the IVs' value will not cause a change in the value of the associated LV. By contrast, a value change of an LV will result in parallel changes of the IVs' parameter values. The IVs must therefore be sufficiently similar to each other or even refer to the same subject matter: Reflective measurement models assume that all IVs measure the same underlying phenomenon that is represented by an LV (Chin 1998).

4 Results

The research model was tested using the PLS approach to SEM. PLS-Graph (version 3.0, build 1126), developed by Chin and Frye (Chin 2001), was used for data analysis. In contrast to covariance-based SEM techniques such as LISREL or AMOS which make strong assumptions about the underlying data set and require a sound theoretical basis as a necessary precondition for the analysis, the prerequisites of the (more robust) PLS approach are similar to those of linear regression (cf. Gefen et al. 2000). PLS allows, however, for the simultaneous analysis of all paths of the research model. Linear regression only supports the analysis of one path at a time. Therefore, the PLS approach was chosen to fit the model.

The research model is comprised of a measurement model and a structural model. The measurement model specifies the interrelations between IVs and LVs. The structural model describes the causal relationships between LVs.

4.1 Measurement Model

The quality of a reflective measurement model is determined by the three factors: (1) construct reliability (internal consistency), (2) convergent validity and (3) discriminant validity (Bagozzi and Yi 1988).

PLS Graph offers two parameters to test for the internal consistency of the survey items: (1) composite reliability (CR) and (2) average variance extracted (AVE). The recommended threshold value for CR is 0.6; AVE should be greater than 0.5 for the construct to be considered reliable (Bagozzi and Yi 1988). The estimated CR is well above this threshold value for all LVs. Estimated AVE index values confirm this result for all but two constructs (**Table 2**).

Convergent validity is shown when the IVs' loadings on the respective LVs are sufficiently high and statistically significant. Significance tests were conducted using the bootstrapping routine of PLS-Graph with 500 re-samples. Apart from a few IVs that exhibit smaller loadings, parameter estimation yields loadings well above a 0.7 threshold value. Furthermore, all t-statistics are far in excess of the critical t-value of 2.58, indicating that they are statistically significant at 1% level at least (Gefen and Straub 2005). In fact, all loadings but one are even significant at 0.1% level (**Table 2**).

Discriminant validity measures the degree to which the IVs of different constructs are related to each other. It can be assessed by examining item loadings to construct correlations or by comparing the square root of the LVs' AVE to the constructs' correlations (Gefen and Straub 2005). For the former test to show discriminant validity, IVs' loadings on their respective LV must be higher than their cross-loadings on any other LV. For the latter test, the square root of the LVs' AVE must be significantly larger than any correlation between this LV and the other constructs. **Table 3** shows the results of this test for discriminant validity. With one exception, the square root of the LVs' AVE is strictly higher than any inter-construct correlation of the respective LV.

4.2 Structural Model

The structural model is constituted by the entirety of all latent variables and their causal relationships. The results of the evaluation of the research model are depicted in **Fig. 2**.

The explanatory power of the structural model is assessed by means of the squared multiple correlations (R-squared) of the dependent latent variables (Chin 1998). 57.1% of the variation in LV3 ("momentum, resources and strategic importance") are jointly explained by LV1 ("service orientation strategy") and LV2 ("service orientation governance"). This value points to substantial explanatory power. The other R-squared values of the research model are also encouraging: 40.7% of the variation in LV5 ("overall service orientation infrastructure success") is jointly explained by LV3 and LV4 ("culture and communication"), 43.5% of the variation in LV6 ("service orientation project success") is jointly explained by LV5 and LV7 ("architecture and service design") and 47.0% of the variation in LV7 is jointly explained by LV8 ("adequate characteristics of service orientation projects") and LV9 ("transparency of design artifacts").

The predictive power of the structural model is assessed by means of the standardized path coefficients between the latent variables as well as by their level of significance. All path coefficients are positive, exceed the recommended 0.2 value and are statistically significant at the 1% level (H2) or even the 0.1% level (all other hypotheses). Therefore, all of the hypotheses that underlie the research model are found to hold.

Similar results can be obtained by performing linear regression analysis on an individual level, i.e. by analyzing each path of both the measurement model and the structural model at a time.

5 Discussion

The study at hand presents several findings which constitute significant advancements of prior research: Firstly, by adopting and expanding pre-existing contributions that investigate the success factors of ERP and EAI, it provides

Table 2 Survey items, construct reliability, and convergent validity

		Mean	Standard deviation	Loading	*t*-statistic	CR	AVE
LV1:	**Service orientation strategy**					0.818	0.692
IV1.1:	Definition of tangible goals for service orientation projects	4.57	0.723	0.8648	23.3542		
IV1.2:	Derivation of service orientation strategy from corporate strategy	3.94	1.090	0.7979	23.1280		
LV2:	**Service orientation governance**					0.897	0.743
IV2.1:	Definition of organizational responsibilities for managing the service landscape	4.24	0.930	0.8748	38.9655		
IV2.2:	Definition of processes for service development and service adaptation	4.25	0.876	0.8666	27.7968		
IV2.3:	Definition of service ownerships	4.20	0.960	0.8444	22.8133		
LV3:	**Momentum, resources, and strategic importance**					0.860	0.610
IV3.1:	Allocation of an adequate budget for service orientation projects	4.36	0.905	0.8391	21.1439		
IV3.2:	Assignment of professionals/experts with adequate knowledge to service orientation project teams	4.52	0.797	0.8112	16.5015		
IV3.3:	Existence of service orientation promoters within the organization's senior management	4.38	0.971	0.8560	30.8115		
IV3.4:	Anchoring of service orientation projects in corporate strategy	3.68	1.189	0.5859	7.2600		
LV4:	**Culture and communication**					0.894	0.586
IV4.1:	Paying attention to the management of communication between business and IT	4.34	0.974	0.7816	21.9950		
IV4.2:	Paying attention to establishing and maintaining common terminology	4.41	0.830	0.7812	20.3971		
IV4.3:	Existence of distinct willingness for change	4.01	0.842	0.6756	13.4438		
IV4.4:	Adequate liaison and support of all service orientation project stakeholders	4.02	0.868	0.8147	22.5525		
IV4.5:	Adequate liaison and support of the service orientation project promoters	3.98	0.913	0.8321	32.7733		
IV4.6:	Adequate liaison and support of the service orientation project opponents	4.01	0.923	0.6929	12.8234		
LV5:	**Overall service orientation infrastructure success**					0.771	0.530
IV5.1:	Reduction of intermediate-term IT operating costs	3.38	1.046	0.6580	10.8413		
IV5.2:	Increase of business users' satisfaction with provision of the IT department's services	3.76	1.111	0.7009	14.9945		
IV5.3:	Reutilization of functionality implemented/encapsulated in services	4.26	0.963	0.8167	26.4344		
LV6:	**Service orientation project success**					0.716	0.458
IV6.1:	Reduction of IT development time needed for responding to business requirements	3.87	1.016	0.6292	8.5027		
IV6.2:	Reduction of intermediate-term IT development costs	3.84	0.980	0.6598	7.0438		
IV6.3:	Increase of availability of IT support	3.81	0.975	0.7358	12.9821		
LV7:	**Architecture and service design**					0.733	0.367
IV7.1:	Observance of the design principle of defining loosely-coupled services	4.00	0.919	0.6678	7.7624		
IV7.2:	Observance of the design principle of abstracting services from their technical implementation	3.98	0.995	0.6907	8.2091		
IV7.3:	Observance of the design principle of aligning services with business processes	4.30	0.993	0.6763	11.0200		
IV7.4:	Observance of the design principle of aligning services with information objects	3.45	0.939	0.3176	2.9710		
IV7.5:	Existence of a high-performance technical infrastructure/implementation	3.71	0.959	0.5947	9.8288		

Table 2 (*Continued*)

		Mean	Standard deviation	Loading	*t*-statistic	CR	AVE
LV8:	**Adequate characteristics of service orientation projects**					0.762	0.516
IV8.1:	Selection of low-complexity service orientation projects	3.84	1.137	0.6770	9.0260		
IV8.2:	Identification of existing needs for change and definition of correspondent service orientation projects	3.77	1.069	0.7255	9.2003		
IV8.3:	Selection of appropriate early adopters for service orientation	3.74	1.011	0.7506	14.4752		
LV9:	**Transparency of design artifacts**					0.856	0.598
IV9.1:	Application of business process models in conjunction with service orientation projects	4.24	0.943	0.7930	24.5820		
IV9.2:	Usage of models of the application landscape in conjunction with service orientation projects	3.74	0.938	0.7277	15.9427		
IV9.3:	Application of information object models in conjunction with service orientation projects	3.86	0.859	0.7667	19.6846		
IV9.4:	Usage of models of the service landscape in conjunction with service orientation projects	4.06	0.862	0.8025	26.2863		

Table 3 Discriminant validity

Latent variable	Square root of AVE	Correlations								
		LV1	LV2	LV3	LV4	LV5	LV6	LV7	LV8	LV9
LV1	0.832	1.000	0.626	0.714	0.706	0.560	0.463	0.583	0.432	0.575
LV2	0.862	0.626	1.000	0.639	0.623	0.473	0.488	0.601	0.486	0.553
LV3	0.781	0.714	0.639	1.000	0.700	0.573	0.491	0.559	0.430	0.575
LV4	0.766	0.706	0.623	0.700	1.000	0.602	0.468	0.539	0.463	0.530
LV5	0.728	0.560	0.473	0.573	0.602	1.000	0.527	0.454	0.429	0.369
LV6	0.677	0.463	0.488	0.491	0.468	0.527	1.000	0.593	0.337	0.450
LV7	0.606	0.583	0.601	0.559	0.539	0.454	0.593	1.000	0.434	0.655
LV8	0.718	0.432	0.486	0.430	0.463	0.429	0.337	0.434	1.000	0.377
LV9	0.773	0.575	0.553	0.575	0.530	0.369	0.450	0.655	0.377	1.000

insight into the success factors of service orientation as an integration approach in information systems engineering. Secondly, the research at hand depends on a broad and heterogeneous empirical basis. By means of structural equation modeling, it is aimed at explaining causal relationships between various factors influencing service orientation success on the one hand, and the indicators of successful service orientation on the other hand. Thus, the present study differs from prior research in view of the fact that it does not merely enumerate and/or postulate CSF deduced by means of qualitative research. Rather, the results rely on a comprehensive, quantitative analysis. Thirdly, the study shows that successful service orientation can be described as overall service orientation infrastructure success and service orientation project success. This differentiation allows for understanding and communicating the necessity of complementing every short/medium term service orientation initiative with a continuous program that fosters service orientation as a sustained integration approach. Fourthly, the study provides insight into the factors that drive the success of service orientation: Service orientation infrastructure success, on the one hand, was found to be positively influenced by culture and communication as well as by momentum, resources, and strategic importance. More than 40% of the variance for service orientation infrastructure success is explained by these variables. Service orientation project success, on the other hand, is positively influenced by architecture and service design as well as by the overall service orientation infrastructure success. These two variables jointly explain more than 43% of the variance for service orientation project success.

5.1 Limitations

Three limitations to our research seem to be particularly noteworthy: (1) the poor quality of the LV7 measurement model, (2) the heterogeneity of the sample and (3) the limited generality of our findings for IS design.

The analysis of the LV7 measurement model ("architecture and service design") shows that this partial model is somewhat flawed. The estimated AVE index value points towards weak internal consistency, the small loadings of the IVs suggest weak convergent validity and the high correlation between LV7 and LV9 ("transparency of design artifacts") indicates weak discriminant validity. We nevertheless choose to keep LV7 in the model since it offers sufficient explanatory power with respect to LV6 ("service orientation project success").

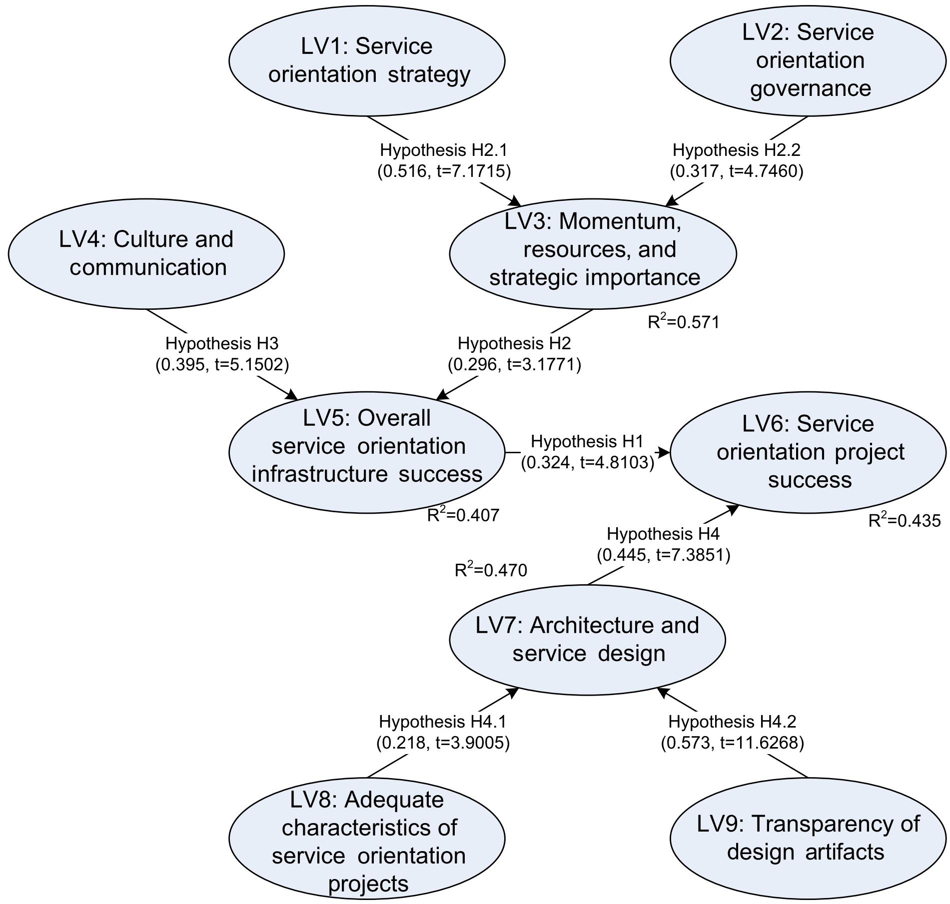


Fig. 2 Research model results

The reason for the weak support for LV7 ("architecture and service design") may be found in the missing experience of practitioners with successful service design. Although research efforts are undertaken to develop service design guidelines – primarily for IT architecture (Schelp and Winter 2007) – practitioner interviews reveal that there is hardly any knowledge on which service design guidelines proved to be successful. Service design guidelines for business architecture were hardly reflected at all.

The second issue is the heterogeneity of the sample. As reflected in the demographic profile of the sample, respondents came from various industry sectors and from companies of different size. Moreover, they indicated to have unequal knowledge as well as experience with respect to service oriented IS design. So far, our research has not shed light on these contextual factors that might contribute to, or that might hinder success service orientation.

Finally our model has proven to hold for causal relations of successful service oriented IS design. This does, however, not imply that our model holds for other IS design paradigms that either are not service oriented or that do not focus IS integration.

5.2 Implications

Descriptive research like this study on service orientation CSF allows not only to better understand existing IS phenomena, but should also inform design research (cf. Hevner et al. 2004). This research was motivated by the practice demand to increase the probability of success of service oriented IS engineering programs, thereby justifying respective program investments. In order to construct an appropriate innovative artifact, e.g., a method that prescribes how to manage such programs, we need, however, to better understand

(1) What are the characteristics of successful implementations of the service oriented design paradigm in IS engineering?
(2) What are the CSF influencing, driving and/or, determining these characteristics?

Since we have refined the requirements of the environment by answering research question one, our research contributes to Hevner's (2007) *relevance cycle*. We have also contributed to the *rigour cycle* by answering research question two. At the same time our research leaves open questions and implies further questions whose answers may contribute to the knowledge base (theory building, Sect. 5.2.1) or may contribute to artifact construction (Sect. 5.2.2).

5.2.1 Implications for Theory Building

We strongly encourage research which investigates the influence of contextual factors on service orientation success. The contingency theory of leadership (Fiedler 1964) argues that there is no "best way" of organizing or leading an organization. Instead, there are various internal and external factors that influence organizational effectiveness. The organizational style must therefore be contingent upon those factors. Translated into the context of service orientation success, it stands to reason that contingency factors such as industry sector, organizational size or prior experience with service orientation might influence the factors

Abstract

Stephan Aier, Tobias Bucher, Robert Winter

Critical Success Factors of Service Orientation in Information Systems Engineering

Derivation and Empirical Evaluation of a Causal Model

Service orientation has been a major buzz-word in recent years. While the buzz is on a decline, organizations are slowly, but steadily moving towards service oriented designs. However, service orientation turns out to be as much of a managerial challenge as of a technical one. The most important complexity drivers in the service oriented design of information systems seem to be (a) inconsistent design goals of stakeholders and (b) the pursuit of exhaustive service orientation coverage. This research focuses on the following two questions: (1) What are the characteristics of successful implementations of service oriented information systems, and (2) what are the critical success factors influencing, driving and/or, determining these characteristics? Data of an empirical analysis is used to test a set of cause-effect relationship hypotheses based on nine latent variables. In the core of this model we differentiate the variables "overall service orientation infrastructure success" and "service orientation project success". The hypothesized interrelationships between the nine variables lead to a causal model which is proven to hold.

Keywords: Critical success factors, Service orientation, Information systems integration, Structural equation model

affecting both service orientation infrastructure and service orientation project success. While first tests have shown that company size has no significant impact on the success of service orientation for IS engineering, further in-depth analyses need to investigate this aspect.

Another opportunity for further research can be found in the field of service design guidelines. As discussed in the previous section, there are only a few publications on service design guidelines – and only as far as IT architecture is concerned. Regarding business architecture, there is hardly any publication on service design. Empirical validation of successful service design guidelines – especially for service oriented business architecture – is non-existent and practitioners' experiences are limited. However, service design guidelines which have proven to be successful will be beneficial for the practitioners' community and therefore represent a reasonable goal for explorative research.

Furthermore, a promising opportunity for further research consists in addressing the question of why we have seen and still see a constant need for change in the field of IS integration approaches given the (pre-existing) knowledge of the CSF of integration projects. In particular, what has caused, influenced, and driven the change from ERP to EAI and from EAI to service orientation? Some starting points to address this question are the following:

(1) Our insights into the success factors of IS integration are still insufficient or even wrong.
(2) There must be other, yet unknown CSF that are a necessary prerequisite to the implementation of the known CSF (such as the granularity or the impact of integration mechanisms (data vs. application vs. business systems on all levels)).
(3) The known CSF are in fact the right ones but have never been implemented successfully so far.

5.2.2 Implications for Artifact Construction

Service orientation has emerged from the software engineering field. In order to realize the benefits also on the business side, a generalization of service orientation strategy, service orientation design guidelines, service orientation project portfolio management as well as service orientation governance is necessary.

With increasing business orientation, however, the significance of service orientation for business performance is increased, and appropriate management approaches are needed. It becomes a key capability for CIOs to systematically develop value-adding service orientation infrastructure and to systematically manage service orientation projects. This study is aimed at this very capability. Based on our survey, we can state that service orientation infrastructure success is directly linked to service orientation project success.

Although the "business digestion" of service orientation has already advanced, there are several open issues where further investigation and novel design artifacts are needed. On the one hand, the interplay of service oriented IT architecture, service oriented business architecture and service oriented integration of both creates novel challenges: design goals, design methods and successful patterns may be more different than expected (or hoped for). As an example, the reuse goal, which is definitely crucial for service oriented IT architecture, may be of far lesser importance for service oriented process design. On the other hand, service orientation strategy and service orientation governance may also be more different than expected (or hoped for) since flexibility/efficiency tradeoffs, development vs. operations costs, decentralization vs. centralization benefits, etc., could deviate significantly between the various classes of services in business architecture and IT architecture.

While our study reliably presents CSF for service orientation infrastructure/project success, especially the service oriented design of the business architecture is not well understood. The challenge is to win the business stakeholders' support for a service oriented design paradigm and to translate service orientation knowledge of the IT domain into the very different domain of business architecture.

6 Conclusion

To the best of our knowledge, this article is the first causal analysis into the CSF of service orientation in IS engineering. Based on related research in the fields of enterprise wide systems integration, ERP, and EAI, we theoretically developed and empirically evaluated a research model aimed at explaining these CSF. We found that successful service orientation can be described as overall service orientation infrastructure success and service orientation project success. Overall service orientation infrastructure success, on the one hand, is positively influenced by culture and communication as well as by momentum, resources, and strategic importance. Service orientation project success, on the other hand, is positively influenced by architecture and service design as well as by the service orientation infrastructure success.

We concede that this article is a first step towards understanding the parameters that drive successful service orientation programs. Nonetheless, it should be understood and used as groundwork for additional research which is needed to develop a refined understanding of the CSF of service oriented IS design as well as the interrelations between these factors. As we have noted in the discussion, research that explores the potential influence of contextual factors on service orientation success as well as research that specifies and empirically validates service design guidelines is required in particular.

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