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TOWARDS UNDERSTANDING THE SOURCES OF THE ECONOMIC POTENTIAL OF SERVICE-ORIENTED ARCHITECTURE: FINDINGS FROM THE AUTOMOTIVE AND BANKING INDUSTRY

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Abstract

This article presents a model that describes the sources of the economic potential of Service-Oriented Architecture (SOA). The model, initially based on a literature review, was thereafter refined by means of empirical evidence collected in the automotive distribution sector and the banking industry. The authors suggest that the economic potential of this new information systems architecture depends on its fundamental characteristics as well as on the individual business models and IT strategies of the companies wishing to use SOA. In addition to presenting a comprehensive model, this paper also presents selected examples from the fieldwork that illustrate how SOA can be used to create economic potential in the considered industries.

The authors furthermore introduce their current research efforts that are aimed at extending the developed qualitative model by using the identified drivers of SOA's economic potential as the basis of a quantitative profitability analysis.

Keywords: *Service-Oriented Architecture, Economic potential, IT strategy, Profitability analysis, Banking, Automotive distribution*

1 INTRODUCTION

Ever since information systems' (IS) development, they have been increasingly utilised in a greater number of business areas. This expansion, together with the formation of large standardised IS (such as ERP or CRM systems), has created significant challenges within and between enterprises: the growing number of mostly monolithic, and thus rather inflexible, IS has to be integrated (e.g. with interfaces between different IS) to provide seamless support for intra- and inter-organisational business processes. However, the many monolithic IS, connected via many complex interfaces, have largely created a rather inflexible IS landscape. With companies having to cope with global competition, short product lifecycles and a growing demand for custom-built solutions, new business processes have to be introduced swiftly, while existing ones are frequently changed. This requires a high degree of flexibility from the underlying IS landscape.

The architectural paradigm of a Service-Oriented Architecture (SOA) promises to resolve many of the existing IS architectures' conflicts by offering a higher degree of standardisation, uncomplicated interoperability and, simultaneously, high flexibility.

While the discussion and development of SOA's technological design have already yielded results that are mature enough (Oasis 2006) to initiate real-world implementations (e.g. Hillenbrand et al. 2006), the examination of SOA's economic potential is just beginning. The comparatively few articles that discuss SOA's economic perspective describe either one specific economic potential such as, for example, the increase in an IS's productivity (e.g. Zhang et al. 2004), or focus on multiple economic potentials but within a specific industry such as, for example, the insurance industry, banking etc. (e.g. Homann et al. 2004). These approaches are very helpful with regard to understanding a specific field in which an SOA could be deployed and offer suggestions on how the latter could develop in future. However, the majority of the identified articles give very little if any advice on how to generally identify SOA's economic potential (Beack 2006).

The aim of this article is to provide a cause-and-effect model that supports the basic understanding of the sources of SOA's economic potential. Consequently, the authors lay the foundation of a framework with which to explain SOA's economic potential in greater detail. After introducing the fundamental model, ongoing research towards such a framework concludes this article.

2 RESEARCH DESIGN

The research underlying this article was conducted in three phases consisting of (1) the construction, (2) the evaluation, and (3) refinement activities:

1. *Deductive construction of the initial model*

   In this exploratory first phase, an initial model was developed by taking existing research results on SOA's characteristics and effectiveness into consideration. The initial model's structure could be partly deduced from previous research. Some parts were also the result of SOA case studies' analysis as documented in the literature (e.g. Heffner et al. 2005a, Herr et al. 2004).

   The construction of the model was based on the assumption that concepts as complex as "SOA" and "economic potential" could not be easily substantiated. As a starting point, the authors therefore chose to deconstruct the two concepts to a set of more specific terms. In order to implement this approach, the authors used the literature on SOA and its economic potential to select a series of terms that describe the two concepts. To structure these, the terms were grouped into layers, which were defined by a comparable level of technical or economical abstraction. Evaluating the literature on the described relations between and the effects of the terms, the authors then connected them across the layers, which led to a network of effects originating in the technical characteristics and leading to the economic potential. The result was the first version of a model that illustrates SOA's theoretical and economic potential's cause-and-effect structure. This initial model will be explained in more detail in section 3.

2. *Verification of the initial model*

   The second phase aimed to verify the initial model construction's findings with the help of a field study based on structured interviews with subject matter experts.

   Interviewees were selected according to a 2x2 scheme. On the first level, they were distinguished as to whether they came from a business or an IT context. On the second level, experts who worked in the surveyed industries were separated from those who came from professional service firms dealing with these industries (e.g. industry-specific competence centres, or IT service providers with industry solutions). The functions of the interviewees ranged from senior executives such as CIO or CEO to Systems Architect or Business Analyst. A broad range of organizational areas were covered in the interviews, e.g. Sales and Distribution, Corporate Development, and Application Engineering. A convenience sample was drawn from all four fields of the 2x2 scheme. To maintain the balance between these four perspectives, the number of experts per field was kept as similar as possible. In order to understand SOA's effect in different industries, the interviews were conducted in the automotive distribution sector (11 interviewees) and the banking industry (18 interviewees).

   The interviews were based on an interview guideline that indicates how the subject matter experts' knowledge can be extracted and how best to confront them with the initial model in order to obtain useful feedback. The guideline also addresses the notion that real economic potential is only generated if applied to a current problem (Heinrich 2002, p. 252). Hence, the interviewees were asked to specifically comment on their field's current challenges within their respective industry, their business's general dynamics, and their degree of interaction with external partners in their value chain. The authors furthermore introduced the experts to a total of 10 elements per industry that represent the terms that are most likely to translate technical potential into business impacts.

   The interviews were conducted between 18 January and 13 February 2006. All interviews were recorded, transliterated and coded for analysis. The model's elements and links were derived by coding key terms from the interview protocols, aggregating related terms into code structures, and using these structures to relate the terms. In a cross-case analysis, reoccurring patterns were identified and made available for the following phases.

3. *Refinement of the initial model*

   The field study led to a deeper understanding of SOA's effects in the selected industries. This led to the formation of industry-specific cause-and-effect models, which were subsequently used to adapt and extend the initial model. For example, based on the experts' feedback, three additional elements were identified and various cause-and-effect links were refined or added.

The fourth phase will be to evaluate the model in more industries and provide further refinement. In addition, the quantification of the model's cause-and-effect relationships will be investigated as well as a possible weighting. While the authors present a first overview of this phase in section 6, the extension of the model to quantify the SOA's economic potential is currently research in progress.

3 CONCEPTUAL FOUNDATIONS

The authors' work is based on a definition of the SOA concept as based on scientific publications such as Dostal et al. (2005), Kossmann & Leymann (2004), and Erl (2005a). However, these publications do not offer one recognised definition of this particular IS architecture. Instead, they characterise SOA by providing a list of distinct characteristics. From these, this paper deduces a set of four core principles that define the SOA concept.

The first core principle is *modularity*. While Erl (2005a) describes this principle as autonomy, other authors (e.g. McGovern et al. 2003, p. 42) use the term modularity. It describes the need to limit a service to a specific, granular business functionality (Pasley 2005, p. 26). Adherence to this principle allows a quick and easy mixing and matching of services to optimally meet current requirements (Brown & Hagel 2003, p.56). The inclusion of modularity in SOA has improved the concept in comparison with earlier implementations that often lacked this characteristic (Estrem 2003, p.513).

The second principle is *loose coupling* (Erl 2005a). This concept describes the requirement that any two semantically compatible services can be coupled together. Since application-like logic is never realised in a static manner in an SOA (Kossmann & Leymann 2004, p.118), adherence to this principle is essential for the dynamic binding of components. To allow this coupling, the services must not be dependant on one another, i.e. the only connection they should have, should be their service contract (Brown et al. 2005, p. 728).

Open standards, the third core principle, is listed by Erl (2005b, p. 55) and Dostal et al. (2005, p. 9). Prior SOA implementations often created proprietary standards and, consequently, dependence on vendors or particular specifications. Proprietary standards constitute a problem in distributed systems, as it cannot be assumed that all parties use the same ones. This is especially true when considering process cooperation across organisational boundaries.

The fourth core principle is *simplicity* (Dostal et al. 2005, p. 9). This means that all interfaces, messages exchanged, and other parts of the system should be as simple as possible. When adoption of the architecture is considered, simplicity - in contrast to a tool that requires extensive training - stimulates diffusion. In the context of a predecessor of the SOA concept, the Carnegie Mellon Software Engineering Institute found that this approach’s complexity was an impediment to its adoption (Wallnau 1997).

The authors’ research on SOA’s core principles yielded additional characteristics that were either not defined precisely enough, or did not match the level of abstraction found in publications dealing with the core principles listed above. Closer examination suggested classifying them as possible economic benefits or theoretical technical potentials that would be achieved by the SOA’s application in a business context. 50 publications were systematically examined for terms that fall into this category. In order to document them, the authors aggregated terms with essentially the same meaning. Afterwards, these were associated with the one core principle that has the strongest causal link. The result is documented in table 1.

Service-Oriented Architecture			
Modularity	*Loose coupling*	*Open standards*	*Simplicity*
Application abstraction (e.g. Homann et al. 2004, Huhns & Singh 2005)	Fault tolerance (e.g. Heffner et al. 2005a, Huhns & Singh 2005)	Standardisation (e.g. Bresnik Kendler 2005, Garver 2005)	Reduced complexity (e.g. Herr et al. 2004, Homann et al. 2004)
Granularity (e.g. Pasley 2005, Diekmann & Hagenhoff 2004)	Flexibility (e.g. Kontzer 2005, Cherbakov et al. 2005)	Interoperability (e.g. Papazoglou & Georgakopoulos 2003, Papazoglou & Van den Heuvel 2005)	
Service composition (e.g. Vinoski 2003, Heffner et al. 2005a)	Orchestration (e.g. Heffner et al. 2005b, Carlson & Himler 2005)		
Reusability (e.g. Bort 2005, MacVittie 2005)			
Infrastructure virtualisation (e.g. Zhang et al. 2004, Messenheimer & Weiszmann 2005)			

Table 1. Overview of the theoretical technical potentials associated with each core principle of an SOA.

4 FUNDAMENTAL MODEL

As a result of their research, the authors developed a fundamental model to explain SOA's economic potential. In this section, the general structure of the model is presented first. As a second step, the technical and economical characteristics are explained. Finally, usage of the model is explained.

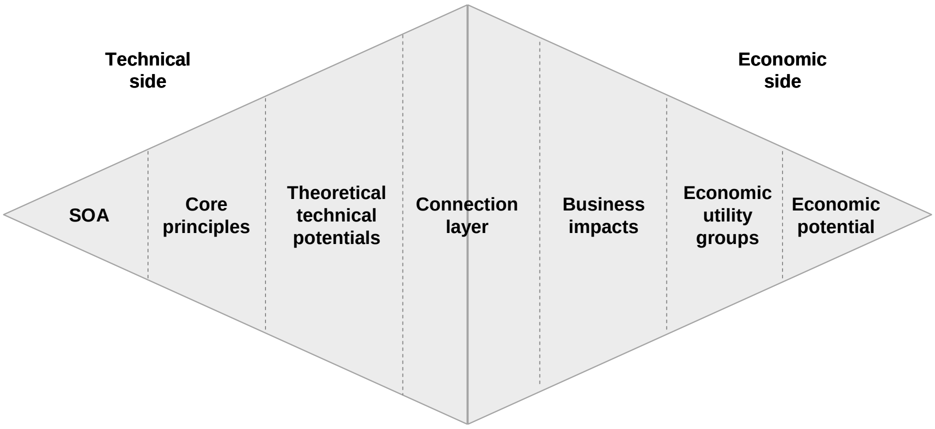

Figure 1. Conceptual depiction of the suggested fundamental model.

The model has a rhombic shape and is structured into seven layers that are linked from left to right. The linkages across the different layers allow the economic potential to be derived by means of the technical characteristics and effects' step-wise transformation into economic characteristics and effects. While the technical side explains SOA's technical characteristics and effects, the economic side aggregates SOA's economic impact to arrive at its overall economic potential. Each side consists of one central node representing the respective concept and two layers containing several elements with a comparable level of abstraction and the same semantic perspective on SOA. A connection layer links the two sides by converting the technical perspective into the economic perspective. All elements of the model are connected by arrows that demonstrate the causal relationship between the different layers. Since figure 1 is only a conceptual depiction, the arrows will be introduced in figure 2. Dashed arrows describe a secondary and less strong cause-and-effect link. The dashed boxes indicate that further elements might be added in the course of further research. Figure 2 presents the suggested model in detail.

On the technical side, the second left layer contains the four *core principles* (modularity, loose coupling, open standards, and simplicity) introduced in chapter three. One layer to the right, the *theoretical technical potential* is deduced. It consists of eleven elements that were identified during the literature review described in section two. The causal links follow the structure delineated in table 1.

The *connection layer* in the middle of figure 2 shows how the *theoretical technical potentials* of SOA are applied in order to generate the *business impacts* that finally lead to *economic potential*. The elements of this layer are the result of insights from both the literature review and the interviews.

The economic side of the suggested model starts with thirteen *business impacts* that are again based on the literature research described in Chapter 3 and the experts' suggestions during the interviews. They are the economic counterparts of the eleven *theoretical technical potentials* mentioned above. The *business impacts* describe the benefits that an IS architecture needs to generate in order to constitute an *economic potential* in the industries surveyed. The *economic utility groups* structure the *business impacts* in four groups of benefits that ultimately result in *economic potential*. A *time advantage* is achieved when a solution using SOA delivers results faster and can be implemented in less time than the previous one. The speed and timeliness of the business processes supported are thus dominant.

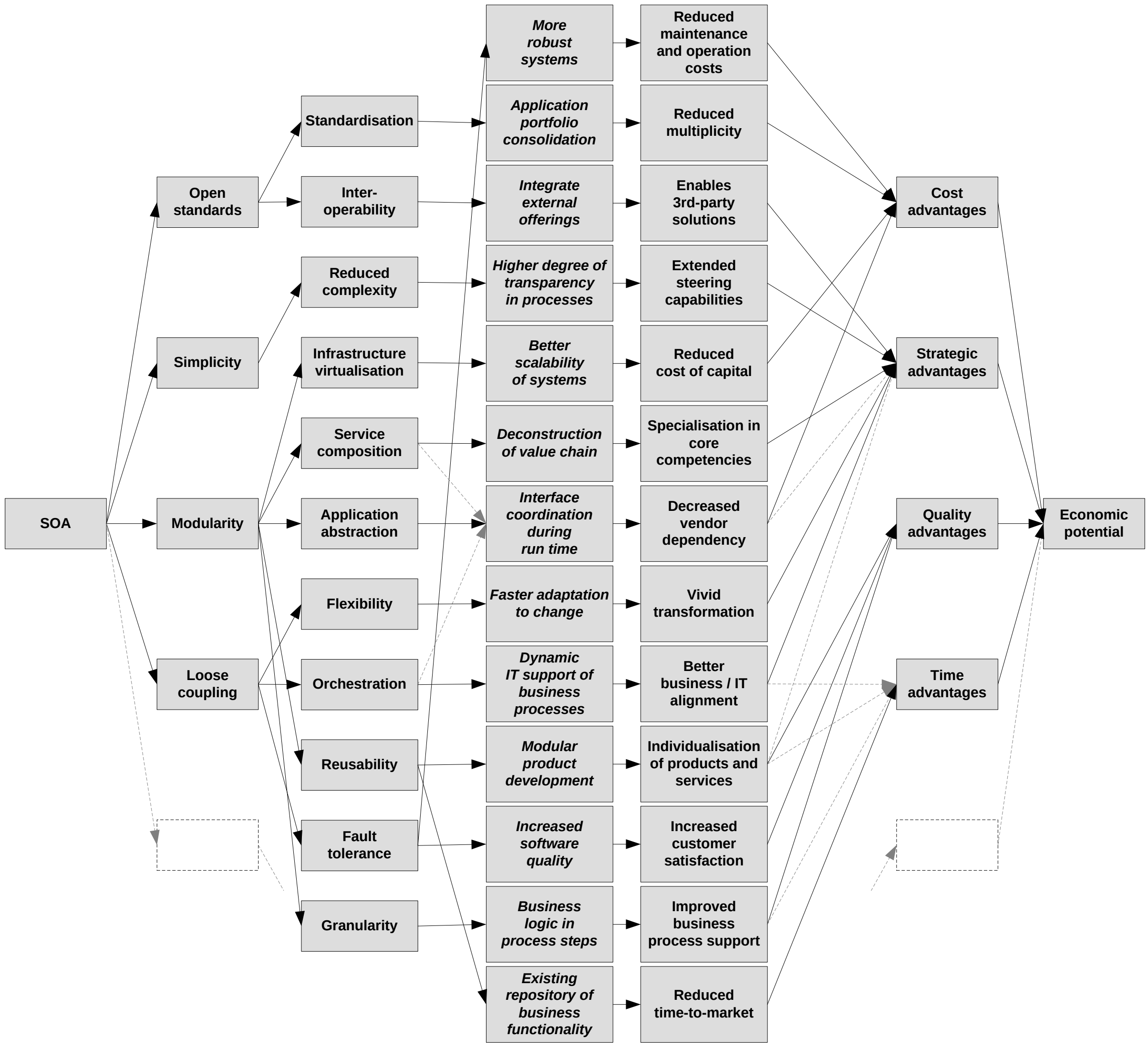

Figure 2. Detailed illustration of the suggested fundamental model.

When SOA results in a product, service, or process's *better quality*, a *quality advantage* is obtained. *Business impacts* are categorised as a *strategic advantage* when more or better strategic options are realisable than with non-SOA architecture. Porter's three generic strategies are adducted (Porter 1998, p. 35) in this regard. He mentions lowest cost, differentiation, and focus as generic strategic directions. If SOA can strengthen a company's position within these strategic dimensions, or allows for a change in strategic direction, a *strategic advantage* is obtained. The *economic utility group cost advantage* is chosen as a category whenever an SOA characteristic contributes to a reduction of costs that could not be reduced without it.

Based on the empirical insights gained from the interviews, the authors suggest the following four phases for applying the model in real-world settings:

- The first step in a business context is listing the economic and technical challenges with which a company is currently faced.
- The company then needs to decide which of the *business impacts* listed in the model are required or desirable in order to master the economic challenges. Hence, the application starts bottom-up by populating the economic side of the model. This already requires intense commutation between technical experts and business specialists.

- Once the elements of the business side have been selected and eventually complemented, the *connection layer* has to be filled. This is done by choosing from the elements and links suggested and, if necessary, devising further ones, thus identifying all possible realistic connections to the *theoretical technical potential* as introduced in the suggested model.
- With the *connection layer* in place, the model is completed by depicting the given cause-and-effect relations. Any element that cannot be connected in a way consistent with the logic presented above can be assumed to be irrelevant to the economic context in which the model is applied and should be removed.

In an extreme case, the analysis may not result in any links whatsoever. If so, SOA cannot be applied to generate *economic potential* for this context. Only when complete chains are present, can the inference be made that SOA constitutes an *economic potential*. Such chains are therefore clear documentation of SOA and *economic potential*'s expected causal interdependencies in a specific context, which allows an understanding of the *economic potential* of this IS architecture's sources and drivers.

5 EMPIRICAL FINDINGS

In chapters 3 and 4 it is already indicated that the fundamental model needs to be adjusted to the context in which it is applied. The authors' research has revealed substantial differences between the two industries observed. Whilst various elements of the model introduced to the interviewees required adaptation in order to match company and industry specifics, the model's general concept and methodology proved stable in all the interviews. Moreover, the approach received positive feedback from all the experts and specialists surveyed.

To illustrate the adaptations needed to produce industry-specific models, the following paragraphs will use exemplary cause-and-effect chains from the industry-specific models to highlight findings of the industry fieldwork and aggregate these. The chains presented below were selected based on the business experts' feedback regarding the most dynamic fields in their industries. They illustrate how SOA can be applied to create economic potential by addressing a specific business need.

5.1 Automotive Distribution Sector

The majority of the interviewees mentioned used cars as a currently very dynamic field in the automotive industry. The used car sales process is supported by information systems that offer presentation, database, search functions etc. Four players are involved in this process: The private seller can sell a used car to a dealer. The dealer then offers the car to customers. To attract a willing customer, various channels can be used: offline marketing activities, self-owned or brand-owned online market places for used cars, or external online market places. Whether the targeted area is local, regional or national depends on the channel chosen. The integration of dealers and car manufacturers' respective information systems would help to promote the sale of used cars and simplify the entire process.

Figure 3. SOA has the potential to realise Economic Potential in the automotive distribution sector through IS standardisation.

During the interviews it became apparent that there is no single adequate standard IS on the market that can combine the different IS in place as well as support the different used car sales processes. Furthermore, it is currently impossible to establish a single information system for all players involved in automotive distribution. This is due to the dynamic environment with its frequent changes with regard to the layout, content and functionality of the corresponding IS - especially web-based systems - as well as to political and power aspects.

Value can be created by introducing SOA. The automotive-specific *business impact “enables vertical integration”* describes the potential for better cooperation between dealers and car manufacturers by integrating the respective external partners (Figure 3). This *business impact* is connected to “*interoperability”* on the technical side. The link with this *theoretical technical potential* is possible as SOA’s *core principle “open standards”* allows all services to be easily connected via one standard. It would be easy to create interfaces between the dealer, importer and manufacturers of different car brands’ services. It is thus possible to connect existing or new IS once they comply with these open standards, thus generating *economic potential* in the automotive distribution industry.

5.2 Banking Industry

The banking experts’ input suggested that *economic potential* could be strongly generated with regard to products in the banking industry (figure 4).

Figure 4. SOA has the potential to realise product-related Economic Potential in the banking industry.

At the moment, one of the greatest challenges in the industry is the ongoing market consolidation (Sinn et al. 2005, pp. 8-9). Consequently, many companies that used to serve distinct markets in the financial services sector have started integrating their offerings. This has resulted in the concept of bancassurance: a type of company that offers comprehensive financial services and realises the concept of the one-stop shopping solution in the financial services market (Amato-McCoy 2005, pp. 44-46). A major advantage of such companies is that they can push all their products on the market using essentially the same distribution channels.

Firstly, however, this advantage needs to be implemented internally. In order to achieve such a product-related advantage, the individual products need to be compatible. While this mainly relates to their semantic compatibility, products implemented in a bank’s productive IS also need to be technically compatible. A product is technically supported by a collection of individual services, each of which represent a certain part of a product’s offered financial functionality and are loosely coupled and orchestrated by what is called ‘composite services’ (for a multi-tier model of services see Papazoglou & Georgakopoulos 2003).

The integration of products is a particular challenge to companies that realise bancassurance through mergers between insurance and banking companies. Because most of the productive IS in this industry consists of legacy systems, the existing solutions’ compatibility is very limited. If encapsulated and migrated to an SOA, this problem can be mitigated due to the reuse of the already implemented components.

Moreover, a product’s loosely coupled elements allow a financial service provider to carefully analyse which of these elements lie clearly within the company’s core competencies. In order to grow its business in a differentiated way, i.e. only in areas that are profitable, a company needs to identify those elements of its products that are particularly valued by its customers (Schwarz et al. 2005, p. 21). An SOA would therefore enable a financial services company to more precisely source those elements of its products from the market, e.g. mortgages from what is referred to as ‘credit factories’. This also results in the capability to reduce the degree of vertical integration, which leads to the ability to disaggregate the banking industry’s monolithic value chain (Benna et al. 2003, pp. 91-92).

5.3 Cross-Industry Analysis and Reasoning

The most important insight from this verification process is the dependence of an SOA's *economic potential* on a company's general business model. In this context, the role of IS is of particular importance. Hence, the research's results are in line with the IS research community's current discussion on IT and business alignment (Slaughter et al. 2006).

In the banking industry, IS play a vital role in the execution of daily business processes, i.e. the delivery of products and services. Hence, in this industry, the potential of an SOA is generally high. Additionally, the compilation of the insights from the interviews produced other cause-and-effect chains that showed consistent argumentation, even when abstracted from current business challenges. For example, the realisation of better product development capabilities was found to be substantial enough to establish *economic potential* via the category of *product advantages*. This finding suggests that the banking industry would be a well-suited *strategic* business case for a potential SOA project.

Conversely, an SOA's *economic potential* is much lower in the automotive distribution sector. Because IS make a mainly indirect contribution to products and services, SOA can primarily generate *economic potential* by improving operational excellence. Hence, a business case in this industry would need to focus on an efficiency-oriented application of SOA to a specific business process, as mere strategic arguments are likely to fail.

6 FURTHER RESEARCH TOWARDS AN ECONOMIC POTENTIAL FRAMEWORK FOR SOA

The justification of an SOA implementation by means of strategic reasoning alone is impossible, especially with reference to the automotive distribution sector (Symons 1990 pp. 195). If companies want to ensure their SOA strategy's success, they need a more substantial way of estimating this architecture's benefits. This is especially true when one considers that SOA is an infrastructure project. It requires substantial up-front investment that will only, if at all, amortise over time.

A corresponding profitability analysis based on the model presented in this paper can be accomplished by executing the following steps (see figure 5).

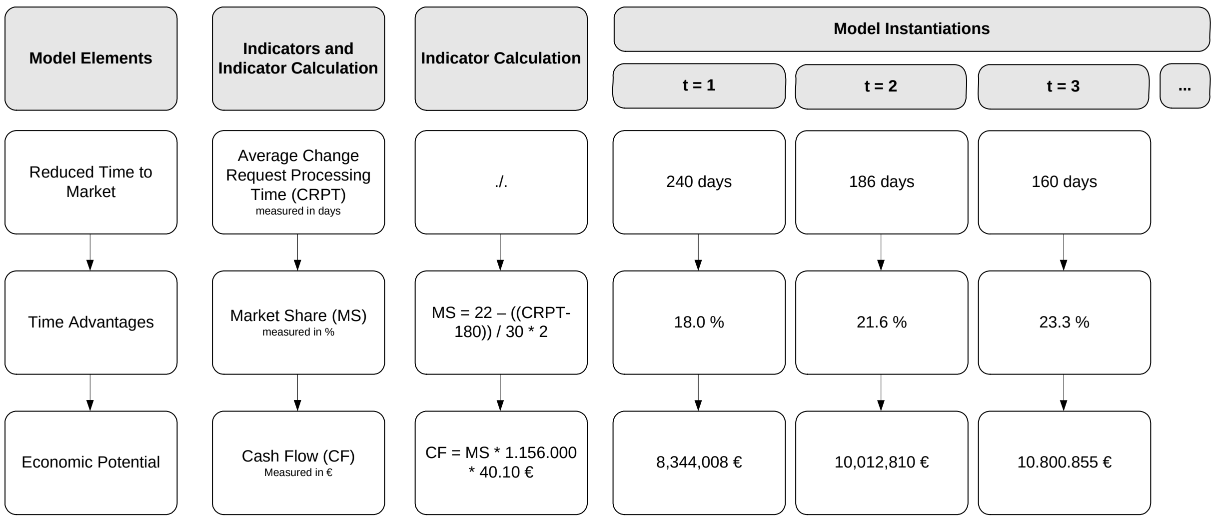

Figure 5. Example illustrating the operationalisation and quantification of the model in the banking industry.

1. *Operationalisation of the model elements*

   In order to make the model useful for a profitability analysis in terms of monetary value, an operationalisation of the model elements is required. In reverse order, starting with the economic potential, the model elements that need to be identified

   - are regarded as important for the overall *economic potential*,
   - can be measured by means of indicators due to data available in the enterprise,
   - have a potential to explain the value of downstream model elements, and
   - historical data can be collected for these elements (necessary for the next step).

   In the example in figure 5, the model element *reduced time-to-market* is measured with an indicator called *average change request processing time*. It measures the time span from a change request being documented until the changed function is available in the productive IS.

2. *Quantification of the cause-effect relationships*

   The quantification of the cause-effect relationships allows the calculation of downstream indicators as based on the value of upstream indicators. The necessary function can either be the result of an analysis of data from past SOA projects (e.g. generated by a regression analysis), or an estimation based on expert opinions (e.g. generated by means of a Delphi technique).

   The example in figure 5 contains a calculation that expresses how the swifter implementation of change requests can lead to swifter product availability, resulting in higher market shares. Here, a base market share of 22% can significantly grow if the company succeeds in decreasing the average time required to process change requests to below 180 days.

3. *Development of a cash flow*

   Since advanced profitability calculations require a multi-period cash flow for interest calculations, it is crucial that the last downstream indicators are monetary ones. Since it is very likely that SOA will unfold its full potential over the course of time, the model should be instantiated several times in order to obtain monetary results for all the periods that need to be analysed.

4. *Calculation of profitability*

   Once a multi-period cash flow is available, the profitability of the SOA project may be calculated using key figures like the net present value (NPV), the pay-off period, or the internal interest rate (IRR).

7 CONCLUSION

In this article, a model was suggested through which *economic potential* can be derived from SOA's *technical potential*. The chosen approach - analysing SOA by first deconstructing its effects and then sorting these in the form of the presented cause-and-effect model - yielded positive results.

As demonstrated, the resulting fundamental model was applied in the automotive distribution sector and the banking industry. To use the model in specific industries or enterprises, adaptation is, however, required. Adjusting the fundamental model to business challenges requires changes to its economic side by including, changing or omitting elements. All cause-and-effect relationships must then be validated and those not ending in economic potential must be removed.

The adapted qualitative model can subsequently be extended by weighting its elements as well as by assigning and measuring its indicators, thereby achieving a quantitative level. This is still research in progress and the authors have not as yet conducted empirical studies to verify this step. In order to do so, further interviews to extend the empirical basis are planned.

Several limitations were identified in respect of the research process: Firstly, a single, stable core model that can be applied without adaptation has not as yet been created. Secondly, only qualitative cause-and-effect relationships have been realised to date. However, to encourage the proliferation of SOA, a quantitative business case is required. Further steps should thus extend the empirical research in order to evaluate more industries with regard to SOA's economic potential, and in order to quantify the cause-and-effect relationships.

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