The Market for Services: Economic Criteria, Immaturities, and Critical Success Factors

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Abstract
Mature service markets, which facilitate the reuse of services by efficiently coordinating service supply and demand, are a cornerstone for the breakthrough of the service-oriented computing (SOC) paradigm. Accordingly, the Web service technology already comprises a standard for the creation of service registries to ease the development of service marketplaces. In parallel with the increasing popularity of SOC, forecasts have moreover prophesied service marketplaces to rapidly evolve and become lucrative. Up to now, however, only very few service marketplaces emerged and managed to establish themselves. To investigate possible reasons, we analyze the structure of today’s service markets against the criteria of perfect markets as benchmarks from economic theory. As a result, we identify numerous immaturities of today’s service markets which are closely examined. To mitigate identified immaturities, we derive critical success factors and describe how to transform them into marketplace features. In particular, we show the resulting architecture of CompoNex – a model marketplace, which is currently being developed in a design science approach to facilitate the trading of services in today’s markets.

1. Introduction
With its concept of composing applications by discovering and invoking available services to accomplish a task [31], service-oriented computing (SOC) promises to foster the move to industrialized application development in which existent software artifacts are reused where possible [6, 37]. Making use of existing services in a modular make-and-buy approach during development is expected to help reducing the development time, raising the quality, and ensuring the flexibility of new applications [31, 37, 4]. Due to these advantages, SOC and especially the development of applications based on the Web services technology stack has attracted great attention both in research as well as in industry [39]. SOC has even been prophesied to become “a prevailing software engineering practice, ending the 40-year domination of monolithic software architecture” [25].

A key prerequisite for realizing the promised improvements of reuse-based application development and leveraging the SOC paradigm is the formation of global and corporate service markets [6, 30, 4]. They provide access to extensive service catalogs and coordinate the service supply with the demand of application developers. To foster the development of such service marketplaces, the Web service core technology already comprises the Universal Description, Discovery, and Integration (UDDI) standard which covers the creation of service registries [39]. Since 2003, numerous market forecasts and scientific publications moreover predicted service marketplaces to quickly evolve and rapidly grow in size [7, 34, 37]. Platform-specific service marketplaces are finally a cornerstone for the emergence of (Web) service ecosystems [4] which are expected to build around complex software platforms like e.g. Salesforce’s or SAP’s enterprise resource planning (ERP) core frameworks.

Despite their strategic importance and the technological support by current SOC technologies, however, only very few service marketplaces emerged and successfully established themselves. Many marketplaces were instead unable to become profitable and dropped out of sight again. The public UDDI registry with its global service catalog was taken out of service since it was never sufficiently populated with service providers. Even service marketplaces such as Salesforce’s AppExchange or StrikeIron, which are often referred to as being among the market leaders [4], are still sparsely populated with service providers and hence far from working profitable. While SOC by now has become a widespread application building concept, the expected service market (r-) evolution apparently did not happen yet.

Starting from this controversial impression, in which expectations and reality significantly diverge, we investigate possible reasons and identify cause-effect relationships that apply in today’s service markets. To that end, we analyze service markets against the criteria of perfect markets from
economic theory. These criteria characterize mature markets which work efficiently and hence serve as benchmark for service markets. Building upon the conducted theoretical analysis as research method, we address the following questions: how differ service markets from perfect markets and how affect detected immaturities service trading? How can service market immaturities be mitigated to facilitate the coordination of service supply and demand? To answer the second research question, we (i) abductively draw suggestions from economic theory as critical success factors and (ii) use findings of the analysis to suggest new marketplace features. These features are integrated into the design of CompoNex, a model marketplace that is currently being developed in a design science approach [14, 36] to mitigate (some of) today’s difficulties in service trading.

The paper is organized as follows: in the next section we discuss related work to confirm the research gap and relate our approach to others. In section 3, we describe the criteria of perfect markets in detail. We then analyze service marketplaces against these criteria in section 4. To mitigate identified immaturities of today’s service markets, we derive critical success factors for the business plan of marketplace operators in section 5. We describe how to transform these success factors into marketplace features and show the resulting architecture of the CompoNex model marketplace in section 6. Finally, we present implications for research and practice as well as future directions.

2. Related Work

The formation of mature service markets, which efficiently coordinate the supply of services with the demand, has been emphasized as an important success factor of the SOC paradigm already since 2003 [37, 30, 34, 29, 7]. In literature, service marketplaces for specific software platforms are furthermore recognized as nucleus for the emergence of (Web) service ecosystems, which are populated with specialized brokers and intermediaries [4]. These brokers and intermediaries will have to create value by bringing service consumers closer to service providers and/or by providing service delivery functions such as e.g. payment.

As a consequence of their importance, service marketplaces have repeatedly been inspected and evaluated, e.g. with respect to their usability for service consumers [11, 4]. Simultaneously, approaches to enhance specific features of service marketplaces have been researched, such as e.g. more detailed service description techniques, semantic search algorithms, or cataloging approaches [31].

Comprehensive investigations of the unexpected development of service markets, which does not meet the ambitious expectations, are still missing though. To the best of our knowledge, dedicated analyses of service markets and the reasons behind the rather unsatisfactory development do not exist. Only on the basis of such analyses, however, will researchers and marketplace operators be able to counter existing market immaturities with specifically adapted business plans. The derived architecture of the CompoNex model marketplace moreover suggests novel features with functionality that is missing in most of today’s service marketplaces. The findings presented in this paper can thus provide a theoretical basis for marketplace operators to check if their business strategies are indeed appropriate to trade services in nowadays markets.

3. Economic Market Criteria

To analyze current service markets, we first of all take a look at the economic theory of markets and describe perfect markets as benchmarks for our evaluation. In general, markets can be characterized as real or virtual locations that concentrate on trading economic goods (commodities) in order to achieve coordination between demand and supply. They manage commercial transactions [10] to accomplish good-exchange (coordination) between sellers and buyers and thereby attempt to avoid any kind of friction that interferes with the coordination process [38]. Regarding e-commerce scenarios, electronic marketplaces - among a variety of different trading locations - turned out to be the superior platform to trade digital goods [23].

In economic theory, the perfect market describes the most efficient coordination between sellers and buyers [16, 42, 27]. Although it is almost impossible for real markets to completely fulfill the theoretical characteristics of perfect markets, even nearly perfect markets (e.g. stock-exchanges and commodity markets) have proven themselves to be superior to other markets and thus emphasize the importance of perfect markets as a generally desirable state. In particular, using the theory of perfect markets as a benchmark helps pointing out immaturities of actual markets [19]. For our analysis, we therefore use the criteria of perfect markets to define our ideal for a mature service market.

We consider the following perfect market criteria to match current service markets against [13, 20, 16, 42, 27]:

1. Competitive agents. Buyers and sellers are competitive, which means they are price takers. They do not have any kind of market power and hence are not able to influence the price setting. This is usually advanced by a large number of buyers and sellers, while none of them is dominating enough to influence the market price through purchases or sales [20]. Furthermore, agents must not have personal preferences for a special counterpart (i.e. no seller is being favored).

2. Homogeneous goods. To ensure that buyers are indifferent regarding the different sellers, there must be a homogeneous good provided by all sellers [13]. Thus,
offered goods have substitutes and buyers view them as interchangeable. In principal, substitutability is supported by establishing standards for the production of goods and avoiding dependencies between goods. Substitutable products also make sure that preceding acquisitions of goods have no effect on future acquisitions (discreteness of commercial transactions), so that changing the manufacturer remains possible in future.

3. **Perfect information.** Agents have perfect information about the price, quality, and overall structure of future goods. This information is an important basis for buyers to assess the suitability of goods to satisfy their needs. It also assures that agents are fully aware of prices, hence they know whether a price is too high or low [12].

4. **Absence of market barriers.** There are no market barriers (such as e.g. patents or copyrights) so that participants are free to enter or leave the market at any time without having to incur specific expenses. Consequently, a new agent in the market is able to sell its product as easily as a long-established one [5].

5. **Absence of transaction costs.** There are no transaction costs, meaning that goods can be traded without any supplementary costs. This implies that processes like selection, contract negotiation as well as settlement (distribution and compensation) do not cause costs.

6. **Spot markets.** No temporal or regional constraints regarding the good exchange apply. Trading is hence not affected by the location (areal distance) of participants, time differences (temporal distance), or opening hours.

4. **Immaturities of Service Markets**

When applying the above-mentioned perfect market criteria as ideal for desirable (mature) service markets, it becomes obvious that a variety of criteria is violated today (see figure 1). Violations of these criteria lead to market immaturities, since they induce frictions that interfere with the coordination of service supply and demand. To endorse the emergence of working service markets, which efficiently coordinate supply and demand, identified immaturities should be addressed and mitigated where possible.

Thereby, it is helpful to differentiate between customized immaturities, which are caused by inappropriate marketplace business plans, and system-dependent immaturities. System-dependent immaturities either stem from the traded good (software services) itself or the current state of the art in the still emerging SOC discipline. While customized immaturities can be eliminated by (re-) designing business plans accordingly, system-dependent immaturities generally have to be accepted as predetermined for today’s service markets. Often, however, they can at least be mitigated by taking appropriate actions.

But the digital, intangible nature of software services (which can broadly be defined as “acts of performance offered by one party to another” [22]) also brings advantages: using an information network such as the Internet, they can be accessed from everywhere and almost immediately after conclusion of the contract. In general, electronic service marketplaces can consequently include services from all over the world into their catalogs and offer them to potential consumers. Since no principal temporal or regional constraints regarding the trading and usage of services exist, service marketplaces can be regarded as *spot markets*.

**Figure 1. Cause-effect diagram with reasons for immaturities of today’s service markets.**

Despite this advantage of service markets, many market segments today are only populated with a small number of service providers or dominated by a few providers with outstanding reputation. This is especially true for service marketplaces that either specialize around a specific software platform or concentrate on brokerizing services of specific vertical application domains (such as enterprise resource planning). Currently, StrikeIron offers approximately 40 services for a total of 10 different domains, while Salesforce’s AppExchange is populated with around 250 services that build upon Salesforce’s ERP platform. Sparsely populated markets, however, do not satisfy the ideal of having competitive agents who compete in large numbers and, seen individually, are unable to influence the setting of prices.

Reasons for this situation are twofold. On the one hand, SOC - despite its success - is not yet a mainstream approach in commercial application building, which limits today’s market sizes and accordingly the number of providers. While this system-dependent market immaturity has to be accepted as predetermined, it fortunately is expected to change in the mid-term future (cf. section 1). In the meantime, marketplace operators will have to actively attract new providers. On the other hand, new as well as small- and medium-sized service providers today are often not being trusted by consumers in the same way as well-established
and large-sized providers with higher reputation [24, 17]. Reputation as the major trust-establishing factor, however, is easily (mis-)used by service providers to create personal preferences of consumers so that service providers with high reputation are able to dominate even more densely populated markets and to set service prices [18].

In literature, approaches to even strengthen reputation as trust-establishing factor exist [17, 18]. Today’s service markets can accordingly be characterized as reputation-based markets, in which reputation is a key factor for good-exchange [41]. Based on the belief that providers will not risk loosing their reputation by offering low-quality or faulty services, a provider’s high reputation leads to a high confidence in the quality of his services [33, 18]. Subsequently, services offered by providers with high reputation will be preferred to those which are offered by less notable or less known providers. At the same time, though, reputation-based markets introduce severe market entry barriers, since especially new (and small-sized) providers without a competitive initial reputation are disadvantaged. In the worst case, they will even be unable to successfully enter the market. Today’s reputation-based service markets hence violate the criterion of absent market barriers.

Essentially, a provider’s reputation serves as a substitute for detailed information about the offered goods [41]. Reputation thus becomes especially important when offered goods are difficult to assess. Currently, (Web) services have to be viewed as such complex goods whose characteristics remain difficult to evaluate for consumers. In order to efficiently assess the functionality and non-functional properties (the quality) of services, consumers would require extensive information which is only contained in comprehensive service descriptions [37, 31]. Such information, however, typically is not provided by today’s service marketplaces. Even market leaders like StrikeIron do at most provide a description of the programming interface, which is specified in the Web Service Description Language (WSDL). While such an interface description helps to successfully bind and invoke a service, it is not sufficient to evaluate its functionality and quality in detail [37, 31].

As a consequence, the criterion of perfect information is violated in today’s service markets. Consumers are in fact forced to treat services as experience goods [26] whose characteristics cannot be completely assessed until after buying. Being unable to assess the behavior of software artifacts leads to extreme difficulties in software reuse [9] and makes it difficult to distinguish between alternate services, though. Where consumers are left unable to discriminate between goods before buying, the corresponding market in general is likely to malfunction [1].

To compensate this deficiency, service marketplaces often provide access to service test versions which can be assessed by consumers prior to the acquisition of a fully functional version. Forcing consumers to gather information about provided services mainly on the basis of exhaustive testing burdens them with additional efforts, however. As a consequence, the costs for selecting a suitable service increase significantly so that the criterion of absent transaction costs is violated. In worse cases, the total costs for service assessments can even exceed any saving that is obtained by service reuse [40]. Then, COTS (commercial-of-the-shelf) based application building is likely to fail.

Another key characteristic of today’s service markets is the constitution of long-lasting trading relationships between service consumers and providers. Such trading relationships usually encompass multiple service acquisitions because current services are likely to be dependent on provider-specific implementation conventions, platforms, or software environments [4]. As a consequence, services with differing assumptions about underlying implementation conventions and environments probably are incompatible to each other. The initial acquisition of a service hence binds consumers at least to providers which belong to the same service ecosystem. In service ecosystems, like e.g. SAP’s or Salesforce’s own service marketplace, providers usually follow the same conventions and assume a common environment or platform that underlies implementations [4]. The constitution of such lock-in effects, however, violates the criterion of homogeneous goods which are substitutable and acquired in discrete commercial transactions.

Ensuring a large-scale service substitutability would require establishing generally binding technical and content-related (domain-specific) standards for the development of services. Despite the widely accepted basic Web service technology, however, SOC is far from such exhaustive standardization. And it remains questionable whether even an exhaustive standardization would be able to completely avoid the emergence of platform dependencies and heterogeneities in practice, since it would cement an existing state of the art and interfere with innovations [35]. Large-scale substitutability of services will thus remain a goal which is rather difficult to achieve even in a longer-term future.

Nevertheless, a variety of partial standards, which create competing market segments, are expected to emerge in the nearer future [4]. Such standards may develop with technical binding models (e.g. Web services and CORBA) or frameworks (like SAP’s Business by Design software) upon which specialized services can be developed. Service substitutability is thus likely to increase within specific market segments. Eventually, it will improve further if market segments merge and adopt common standards. Until then, however, consumers will need to have access to information about a service’s dependencies prior to its acquisition.

Without doubt, taking measures to bring service markets closer to fulfilling the perfect market criteria are demanding tasks for marketplace operators. Especially measures to pro-
vide the required information about services and minimize transaction costs will be difficult to implement, since services are highly abstract goods which always will require a certain amount of explanation and assessment. It is thus likely that neither perfect information nor absence of transaction costs are completely reachable goals. However, marketplace operators should at least address the analyzed issues and develop instruments to mitigate identified immaturities in order to facilitate service trading. Stocks and bonds impressively demonstrate that even goods, which require explanation and assessment, can be traded efficiently.

5. Critical Success Factors

Service marketplace operators are especially affected by the analyzed deficiencies of today’s service markets, since these can have unpleasant consequences for their business success (i.e. service sales, profit etc.). To improve economic success, marketplace operators should therefore address present immaturities already when developing the business plan, which determines the corporate strategy to put a business idea into practice. Business plan development is usually based on a so-called SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis [2]. It investigates whether a business idea should be put into practice and what precautions ought to be taken when doing so.

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<tr>
<th>Strengths</th>
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<td>company-dependent</td>
<td>company-dependent</td>
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<tr>
<td>Opportunities</td>
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<td>• service markets are an important cornerstone for SOC</td>
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<tr>
<td>• lucrative market forecasts</td>
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<td>• still possible to supersede competing marketplaces</td>
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<tr>
<td>Threats</td>
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<td>• unsatisfactory competition</td>
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<td>• presence of market barriers</td>
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<td>• insufficient information about functional and non-functional service properties</td>
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<td>• unreasonably high transaction costs</td>
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Figure 2. SWOT analysis for service markets.

A SWOT analysis helps examining the market environment and the applying general business conditions in order to identify strategic opportunities and threats. The market analysis conducted in section 4 can thus be viewed as a part of a SWOT analysis to determine a service marketplace business plan (see figure 2). A SWOT analysis is further used to determine a corporate’s capabilities to realize a business idea and to make corporate strengths as well as weaknesses explicit. Threats and weaknesses which have been identified during such an analysis describe potential risks which endanger the aspired business success. They have to be faced by devising critical success factors with suitable measures to minimize or eliminate business risks [2].

Developing a complete business plan highly depends on the respective company, which plans to establish a service marketplace, and its individual capabilities. For that reason, we concentrate on devising universally valid critical success factors to mitigate the threats analyzed in the previous chapter. To ensure a broad applicability, we firstly elaborate general strategies and refine them with particular measures (which are enumerated in brackets). These measures have been developed during a perennial research project and may be supplemented with company-specific actions.

5.1. Sparsely Populated Market Segments

When establishing a service marketplace, operators will first of all have to prepare for sparsely populated market segments, which each consist of merely a small number of service providers. Today, this is especially the case in market segments that either focus on vertical application domains or specialize around specific software platforms. The business strategy of marketplace operators thus has to concentrate on ensuring a profitable amount of service trading.

This can be achieved by (1) covering many market segments and avoid marketplace specialization (at least until the number of services has increased in general). On the one hand, all-purpose service marketplaces are likely to better leverage investments by aggregating market shares from different segments. Hence, they probably outperform specialized competitors which today have difficulties in gaining a profitable market share. On the other hand, universal marketplaces need to appropriately support different market segments and target audiences, which may differ from one another and may have specific demands (e.g. regarding the search and description of services or the support).

Therefore, it is essential to (2) provide a well-structured service catalog with efficient access to segment-specific services. Marketplace operators moreover have to implement segment-specific trading forums in order to avoid deficiencies and provide a suitable platform for service providers and consumers. Services for SAP’s Business by Design Platform, e.g., are marketed in a slightly different fashion than services for Salesforce’s ERP platform.

Since service consumers are probably unable to satisfy their demand in sparsely populated market segments, it is also conceivable to (3) invert the supplier-inquirer relationship by permitting consumers to call for tenders. Service consumers are then encouraged to publish their requirements as specification and invite tenders from interested service providers. The marketplace delivers published requirement specifications to service providers who, upon acceptance of their tender, implement a suitable service.

To increase the trade volume, marketplaces should try to actively match supply and demand. This can be achieved by (4) providing notification services which inform service
consumers of newly provided services and service providers of newly published calls for tenders. Wherever applicable, alternative or supplemental services may be offered to consumers. To facilitate trading, marketplace operators should finally actively attract a greater number of agents.

Consumers can be attracted by enhancing the marketplace usability, e.g. by (5) offering specific user interfaces for target audiences (which is crucial for all-purpose marketplaces), (6) providing community tools that go beyond mere feedback forums as currently provided by StrikeIron or Salesforce’s AppExchange (community tools could e.g. include discussion and support boards etc.), and (7) integrating marketplace services (such as services search, browsing, and acquisition) into third party applications to ease market access. Suitable third-party applications that may directly be connected to marketplaces via specialized plug-ins encompass computer-aided software engineering tools like Microsoft’s Visual Studio .NET, Eclipse etc..

Innovative small- and medium-sized service providers, which are expected to build the supporting pillar of service markets [37, 4], can be attracted by reducing market entry barriers, e.g. by providing value-added services to (8) ease the settlement of commercial transactions [30]. Marketplace operators could, e.g., offer to take over solvency checking or collection. Provisioning of such services is not only helpful for service providers, but simultaneously opens up new sources of income for marketplace operators who can realize economies of scale and offer at competitive prices.

5.2. Reputation as Trust-Establishing Factor

To attract new service providers, marketplace operators also need to address the problems associated with reputation-based markets. In such markets, service sales are dependent on the provider’s reputation which, however, also disadvantages new and smaller-sized providers. Marketplace operators therefore have to provide means to increase trust in the services offered by such providers.

By (9) providing a certification service, marketplace operators can confer their reputation to service providers and so especially enhance the trust in services offered by new and smaller-sized providers. A certificate is a written guarantee that a service complies to a given description and correctly implements advertised features [15]. Certificates may additionally attest the conformity with standards to provide information about the substitutability of a service.

To facilitate long-term service usage and take precautions against discontinued support or bankruptcy of service providers, marketplace operators may offer (10) escrow services. They can act as fiduciaries who offer to keep source codes and documentation of services in escrow. If a provider is unable to continue support, artifacts in escrow will be handed over to the consumers. Although escrow services do not avoid discontinued support, they at least mitigate the risk of acquiring third-party services and especially enhance confidence in small- and medium-sized providers [3].

Means which (6) enable consumers to provide feedback on acquired services facilitate discriminating between services regardless of the provider’s reputation. As part of the community tools, such a mechanism generates trust in goods instead of relying on reputation of manufacturers. It also helps separating high-quality from faulty services.

5.3. Detailed Information about Services

Service marketplaces will, however, have to further mitigate the significance of reputation as trust-establishing factor and decrease unacceptably high transaction costs, which mainly stem from exhaustive service testing. To that end, marketplace operators should allow service providers to document adequate information about a service, which is required to distinguish it from others and to assess whether it is suited to fulfill consumer’s requirements. This can be advanced by (11) making explicit comprehensive service specifications.

Unlike service test versions, specifications explicitly describe service characteristics [21] and can directly be processed by consumers. By evaluating service specifications instead of test versions, the overall transaction costs can thus be reduced. The extent and format of service specifications are determined by a specification framework which has to be predefined by marketplace operators. It should prescribe the provisioning of detailed purchasing information (such as pricing models and the scope of supply) as well as technical service properties. Since the specification of services continues to be a research question, it yet remains to be clarified what technical properties ideally should be documented. According to the current state of the art, technical properties should not only refer to the programming interface, but also encompass functional and non-functional service characteristics (see figure 3) as well as dependencies to other services [28, 37, 4].

<table>
<thead>
<tr>
<th>Static View (Structure)</th>
<th>Functionality / Concepts (domain-related)</th>
<th>Architectural Design / Interface (Logical)</th>
<th>Implementation / Quality (Physical)</th>
</tr>
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<tbody>
<tr>
<td>Information Objects (Entity Model)</td>
<td>Type Declarations, Properties (Attributes)</td>
<td>Usability, Maintainability, Portability</td>
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<tr>
<td>Operational View (Effects)</td>
<td>Functions (Operations Model)</td>
<td>Events, Methods, Exceptions, Assertions</td>
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<tr>
<td>Dynamic View (Interactions)</td>
<td>Processes (Flow Model)</td>
<td>Interaction Protocols</td>
<td>Reliability, Efficiency</td>
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Figure 3. Technical service properties [28].

Establishing a service specification framework not only facilitates the discrimination between services, but also is a prerequisite for providing certification and call-for-tenders services, which require specifications as input. Simultane-
ously, large-scale usage of specifications is likely to intensify the demand for certification which guarantees the factual conformance of service specification and implementation (so that extensive validation is rendered superfluous).

6. Service Marketplace Design Implications

The theoretically motivated critical success factors have been validated with regard to their effectiveness to mitigate detected immaturities of service markets. First of all, we therefore conducted a series of semi-structured interviews with SOA practitioners that potentially participate as service consumers in the developing service markets. The goal of these interviews was to empirically evaluate which of the proposed measures they generally viewed as desirable for service markets. To that end, our interview protocol contained three sections: the first section covered demographic information about the interviewees, the second asked for the relevance of immaturities, and the third asked for the effectiveness of the proposed critical success factors.

Interviews were conducted with 14 practitioners from four German organizations (a software manufacturer, two banks, and a consulting company). They had a high level of SOA expertise and repeatedly used services to design or implement applications. While participants consistently found the identified immaturities to be of critical relevance, their judgment of the deduced critical success factors varied stronger. An apparent support (67% and higher) has been identified for success factors 11, 9, 2, 5, and 6. A moderate support (50% and higher) has been identified for success factors 10 and 7, while factors 4 and 3 only got a weak support (33% and higher). No apparent support only was identified for success factors 1 and 8, which are more relevant for service providers and marketplace operators though. In total, the empirical evaluation hence indicated that the success factors were generally considered to be helpful.

The interviews served as an ex-ante validation of the developed concepts [32] which preceded the implementation during our iterative design science approach [14]. To evaluate the critical success factors more concretely, we have begun to implement them as part of CompoNex, a model marketplace to trade software units (i.e. components and services). The implementation serves as a validation by instantiation [14]. The already completed architecture thereby shows how critical success factors can be realized as novel features of electronic marketplaces to trade services.

To fulfill success factor (1) (cf. section 5), CompoNex has been designed as a publicly accessible, all-purpose marketplace that implements a commission-based profit policy. Its current stage of development, which will be augmented with newly implemented features, is made accessible at www.componex.biz. Thereby, we distinguish core features, which have to be implemented to enable service trading, and value-added features, which further facilitate service trading. While the implementation and evaluation of core features is already completed, some of the value-added features are still under realization and will remain to be evaluated in future iterations. Some general impressions on their (completed) design will nevertheless be provided.

6.1. Architectural Design

The architectural design of CompoNex realizes the deduced critical success factors as separate marketplace components and is based on the following general principles: it is modular to facilitate marketplace maintenance and extension with new features [35]. It reuses existent functionality where possible to reduce development costs [35]. It encapsulates individual marketplace features to support their autonomous evaluation, independent evolution, and arbitrary composition in order to determine an optimal feature-mix. It makes marketplace features accessible for arbitrary third-party applications to better integrate CompoNex into existing development environments (cf. success factor (7)).

The CompoNex architecture contains three layers (see figure 4): the implementation layer encapsulates the functionality, which is divided into several components (each implementing a distinct marketplace feature). The service layer provides a common application programming interface that contains core and value-added services. It exposes the functionality to all the clients that access the marketplace (and may be specialized for different market segments, cf. success factor (5)). To provide a platform-independent access to marketplace features, the interface makes use of the XML Web service technology. The client layer currently comprises a generic Website as graphical user interface and a plug-in to access marketplace features from Microsoft’s Visual Studio .NET. Additional clients, such as segment-specific Websites and plug-ins for further development environments, are under development.

The core features consist of repositories to store service offerings and calls for tenders (success factor (3)), as well as the customer relationship management (CRM) and pay-
ment components. Both the service and the call-for-tenders repository provide structured catalogs that distinguish various application domains and market segments (success factor (2)). They build upon a common specification framework to provide detailed information about services and to implement various search functions which, e.g., can use a consumer’s reference specification as input to match and rank provided services against. As a critical success factor of its own (11), the chosen specification framework not only determines large parts of the catalog structure and search strategy, but also influences the design of many other marketplace features. It will be detailed separately later on.

The CRM stores contact information and logs commercial transactions. This data is used by the payment component to collect fees from service providers. The payment component can be augmented to also interoperate with marketplace services that realize solvency checking and collection. As value-added service, it can then also receive payment on behalf of service providers (success factor (8)).

To actively match supply and demand (success factor (4)), CompoNex contains a notification service as part of the value-added services. It uses a publish/subscribe pattern [8] to notify consumers of newly published services and providers of newly published calls for tenders. To that end, providers and consumers can register their respective search queries with the notification service which performs it in regular intervals and automatically delivers new results.

To increase the trust in third-party services (and especially those offered by new and smaller-sized providers), the CompoNex marketplace also offers escrow and certification services (success factors (10) and (9)). A dedicated escrow repository stores the source codes and documentation of services (which may also include test cases etc.). The artifacts under escrow can be made available to consumers either if the provider signals discontinued support, bankruptcy, or another customer-specific condition. The certification service builds upon the common specification framework and takes a service together with its specification as input to validate compliance. If the evaluation is positive, the certification service issues a certificate by digitally signing the submitted specification.

Community tools complement the value-added services of CompoNex. They provide a forum for the exchange of feedback on services, discussions of reference configurations, or inquiries for support. The user forum is being designed to improve the usability as postulated in (6).

6.2. Specification Framework

Several marketplace features build upon a service specification framework that delivers information about provided services or published calls for tenders. Since the specification framework also determines what information about services can be utilized by consumers/publishers, it simultaneously has to support a variety of different tasks (such as service search, certification, evaluation, interoperability tests etc.). The CompoNex marketplace therefore builds upon the WS-Specification framework [28] which covers all the aspects shown in figure 3 and has been evaluated with respect to its effectiveness in a perennial research project.

The WS-Specification framework augments the structure of UDDI [39] and provides thematically grouped information using a variety of perspectives and a mix of well-established notations (see figure 5). Since it is used to specify what a service is doing without detailing how this is achieved, it does not publish any business-critical internal aspects - an important argument for service providers.

The specification framework provides general and commercial information (about the provider, distribution channels, pricing, scope of supply etc.) as the so-called white pages. The yellow pages contain classifications of the application domain which are used to store and retrieve services in structured catalogs. The main part of the framework is devoted to provide technical information about services in order to support a detailed search and compatibility check. Thereby, the so-called blue pages document the business functionality of a service using conceptual models and an ontology format based on the Web Ontology Language (OWL). The green pages deliver information about the software architecture of a provided service. They contain interface descriptions, assertions (i.e. pre- and postconditions), and interaction protocols. The grey pages finally contain information about the non-functional service properties and describe service-level agreements using the ISO 9126 quality model and its standardized quality attributes.

While such information helps consumers to better conduct the tasks mentioned before, the specification framework requires a significant amount of data to be deliv-
еред by service providers. It therefore has to be examined whether providers will actually be willing to document such an amount of data. In general, they are at least able to do so, since most of the requested information can be obtained as by-product during service development. Except for using the certification service, the CompoNex marketplace moreover does not enforce the provisioning of all requested information in order to market a service. Since providers with more detailed information allow consumers to better assess their service and so create a competitive advantage, though, the market mechanisms are likely to favor those and so encourage the provisioning of “complete” specifications.

7. Conclusions and Future Directions

In this paper, we have analyzed service markets against criteria from economic theory to provide explanations for the apparent discrepancy between expected and observed development of service markets. We thereby identified numerous immaturities of service markets and derived eleven critical success factors for marketplaces to counter them. Using the CompoNex marketplace as example, we furthermore illustrated how to transform critical success factors into novel marketplace features that cannot be found today.

The results of our research have implications both for practice and academia. For practice, they show how a better coordination of services supply and demand can be achieved to make the reuse-based SOC paradigm work more efficiently. The conducted market analysis, the discovered cause-effect relationships, and the deduced success factors provide a theoretical basis for marketplace operators to validate their own business models against. The provided theoretical basis thereby goes beyond analyst reports such as [11]. The presented marketplace design further suggests concrete novel features which marketplace operators might consider to take over and include into their solutions. By leveraging the proposed marketplace design, participants will be allowed to populate service markets more easily. An increasing number of participants is likely to boost the number of commercial transactions so that the profits of marketplace operators will probably rise accordingly.

To adopt novel features, marketplace operators do not even have to provide implementations themselves. Instead, they might choose to outsource features (such as solvency checking or payment) to specialized intermediaries. In doing so, they contribute to the prophesied rise of (Web) service ecosystems in which multiple specialized intermediaries are involved in a commercial transaction [4].

For service providers and consumers, our results provide indications how a more mature approach to support the trading of services might look like. It might be taken as a reference against which current and future marketplaces can be compared to find a suitable trading platform. Especially for new as well as small- and medium-sized providers, such a trading platform has to minimize market entry barriers as well as to facilitate the initiation and settlement of commercial transactions. For consumers, a suitable trading platform has to come up with explicit, extensive information about services so that they can better discriminate between alternative choices. Only then will consumers be able to treat services more as commodities than as experience goods whose characteristics cannot be assessed until after buying. From an economic viewpoint, however, this is a key prerequisite for markets to function properly.

For research, our results signal the need to build and test a comprehensive theory about the economy of software services. As (Web) services technologies mature and the reuse-driven SOC paradigm evolves into a mainstream approach, the efficient procurement of services is becoming a focal topic of interest. This topic raises substantial technical and economic questions that remain to be investigated in detail, though. Above all, it yet has to be determined how services have to be appropriately described so that they can be certified by third parties, found in catalogs, and assessed by consumers. In parallel with many other research questions, it is currently unclear how different distribution channels and pricing models can be specified or how they can be enacted in an automated fashion. To arrange for a large number of service providers, it finally remains to be researched how market entry barriers can be lowered and the influence of trust and reputation can be reduced.

The research presented in this paper provides just a first step towards the formation of such a theory. However, it outlines a framework of topics worthwhile to be investigated further. Regarding the already proposed marketplace features, we will use the implemented CompoNex marketplace to further evaluate their effectiveness empirically. Future studies will have to concentrate on providing additional, technically and economically founded, solutions for detected market immaturities and on revealing further cause-effect relations that apply in service markets. The developed theory of the economy of software services will then have to be examined for its applicability in the more general Service Sciences, Management, and Engineering discipline.

References


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