Features of IT Service Markets: A Systematic Literature Review

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Abstract. The provision of IT solutions over electronic marketplaces became prominent in recent years. We call such marketplaces *IT service markets*. IT service markets have some core architectural building blocks that impact the quality attributes of these markets. However, these building blocks and their impacts are not well-known. Thus, design choices for IT service markets have been made ad-hoc until now. Furthermore, only single aspects of such markets have been investigated until now, but a comprehensive view is missing. In this paper, we identify common features and their interrelations on the basis of a systematic literature review of 60 publications using grounded theory. This knowledge provides an empirical evidence on the interdisciplinary design choices of IT service markets and it serves as a basis to support market providers and developers to integrate market features. Thereby, we make a first step towards the creation of a reference model for IT service markets that provides a holistic integrated view that can be used to create and maintain successful markets in the future.

Keywords: Systematic literature review · Market architecture · Service marketplaces · Grounded theory · Service-oriented computing

1 Introduction

The business model of App stores became drastically popular by the introduction of Apple App Store and Google Play providing mobile applications in 2008 [53]. Nowadays, the range of IT solutions provided by electronic marketplaces goes beyond mobile applications. There are *API marketplaces* (e.g., ProgrammableWeb[1]) that allow trading APIs among programmers. *Cloud markets*

[1] programmableweb.com. Accessed May 2016.

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(e.g., AWS marketplace[2] and Salesforce AppExchange[3]) support enterprise application developers with cloud services. Furthermore, *software repositories* [42] (e.g., Binpress[4]) facilitate the exchange of source codes [31]. We call such electronic marketplaces providing IT solutions *IT service markets*.

Until now, all these markets have been developed ad-hoc and without any systematic process or reference model. Furthermore, only single aspects of such markets have been investigated, but a complete view is missing. As a consequence, IT enterprises and entrepreneurs that also wish to grow their businesses by employing marketplace models encounter unforeseen challenges, which make them go out of budget and fail to deliver a successfully running IT service market. Reported failures mainly show that they miss to include core functionalities of IT service markets, e.g., application discovery, rating and reviewing, or application categorization [1,2,50]. Another problem that arises is that many market functionalities are not applied although they have been investigated and implemented in academia for many years. For example, there are masses of tools and concepts for service matchers [52] or for composition engines [15] that have never been integrated into IT service markets because the developers of such functionalities do not have much knowledge about market models.

One main reason for such deficiencies is the lack of any reference model for IT service markets. A reference model provides a comprehensive set of building blocks of a concept and their important relationships. This allows the communication of shared knowledge among the community and enables reusing well-established solutions [43]. According to this, a reference model for IT service markets is beneficial to the research community as well as to practitioners regarding two different perspectives: (a) Providers of such markets, like enterprises or individuals, gain a benefit because they can use the comprehensive insight into the design choices of IT service markets in order to develop and integrate new market features and, thereby, improve their market's success. (b) Developers of market functionalities like matchers, composition engines, reputation systems, etc. benefit from the possibility to take into account how their components can (and have to) interact with the market or with specific market features, in order to become applicable in practice.

A first step towards a reference model for IT service markets is to gain a comprehensive view on their interdisciplinary building blocks. Such a comprehensive view is still missing in the literature. Schmid and Lindemann [60] developed a generic reference model for electronic markets that mostly considers elements of business architecture. However, infrastructure and application aspects, e.g., service orchestration for software services, are overlooked. Moreover, some work provides a detailed perspective on IT aspects, e.g., high performance service recommendation mechanisms [24]. Furthermore, other work that considers both business and IT aspects is limited to certain instances of IT service markets, for instance, a comparison of Apple App Store and Nokia Ovi Store [65].

[2] aws.amazon.com/marketplace. Accessed May 2016.
[3] appexchange.salesforce.com. Accessed May 2016.
[4] binpress.com. Accessed May 2016.

In this paper, we provide a first step towards a holistic integrated view on IT service markets by identifying their business and IT building blocks (*features*) that are addressed in literature. Accordingly, our research question is:

RQ What are the primary features of IT service markets and how are they related to each other?

In order to answer this question, we performed a systematic literature review (SLR) [35], aiming at capturing as many publications as possible related to our research question. The SLR filtering process resulted in the identification of 60 (out of 333) publications that focus on certain aspects of IT service markets or that propose an instance of an IT service market. We developed an extraction scheme using grounded theory (GT) [61] to interpret the data and extract a primary set of features from the final set of the publications. The results of our survey reveal a categorization of the mostly addressed functional features of IT service markets and the relation between those features.

In the following, Sect. 2 describes the survey procedure including the filtering process of the literature. Section 3 presents the process of literature analysis and the extraction scheme of the features. Section 4 discusses the extracted features and their interrelations. In Sect. 5, we discuss how our work is distinguished from the other works. Section 6 presents concluding remarks and future work.

2 Survey Procedure

The objective of our investigation is to extract the primary features of IT service markets, which are discussed in literature. We follow Kitchenham's guidelines [35] in performing a systematic literature review (SLR) to ensure reproducibility and minimizing biases regarding our results. The literature search is performed between February 2016 and May 2016. We chose **Google Scholar** as the search database, as suggested by Kitchenham [36]. Google Scholar is a meta-search engine that performs searches through several digital libraries.

Initially, a review protocol is specified, which is driven from the **RQ** and our fundamental context (IT service markets). The review protocol defines the step by step actions that are undertaken in the SLR. In this section, we describe how the publications are filtered at each stage using precise criteria (search phrases and in-/exclusion criteria). In addition, we applied snowballing [68] by inspecting the outgoing references cited by the sources, aiming at identifying more relevant sources related to our context.

1. Initial Set of Sources: To find the initial set of sources, we defined a set of search terms. The ideas of the search terms are inspired from the **RQ** and our observation of the existing IT service markets as discussed in Sect. 1. Our main search terms are *service* and *market*. We specified alternative terms to detect as many of the relevant sources as possible. *Software*, *App*, *application*, *third-party*, *plug-in*, and *component* are the alternatives to the term *service*. Furthermore, the alternatives to the term *market* are defined as *marketplace*, *store*, *"App store"*,

repository, *"archive network"*, and *catalog*. Lastly, we determined our search phrase as a combination of the search terms and boolean operators. During the search, a source is selected if at least one of the terms from each set appears in the title. This process resulted in finding 329 sources. Supplementary material including the complete lists can be found in our technical report [31].

2. Final Set of Sources: We filtered the initial set of sources using the in-/exclusion criteria. We included a source if: (a) it deals with the definition of IT service markets, (b) it deals with one of the functional or the non-functional aspects of IT service markets, (c) it introduces a new instance of IT service markets, or (d) it considers architecture of IT service markets. Furthermore, the source must be available through the most prominent digital libraries, e.g., Springer Link, ACM Digital Library, IEEE Xplore, Citeseer library, and Science Direct. We excluded a source from our survey if: (a) the service discussed by the source is not an IT solution and (b) the marketplace, provided by the source, provides other services/products than IT solutions. We evaluated the sources firstly based on their abstracts and conclusions. Secondly, if we still could not decide about the relevance of a source, we read the whole source. After applying in-/exclusion criteria, the set of results consists of 142 sources. We added two additional exclusion criteria:

- the source should not be in the form of a preface, tutorial, book review, or presented slide. This allows us to focus on the high quality research, e.g., by excluding the publications, which have not been peer reviewed.
- the source should not be published earlier than 2008. The reasons for choosing this specific year are the introduction of the concept of cloud market by Buyya et al. [7] and the launch of the first mobile App stores ever, Apple App Store and Google Play in 2008 [30]. Using this exclusion criterion, we focus on the most recent work. We expect the most prominent research achievements, which were published before 2008, are reflected by the recent work.

At this stage of filtering, the final set of results includes 60 sources that objectively address the concept of IT service markets.

3 Extraction Scheme of Features

This section presents the extraction process of primary features from the final set of sources. The challenge regarding IT service markets is that firstly, unlike other paradigms like cloud computing [47] and service-oriented computing [27], there is no reference model or comprehensive definition. Consequently, the publications do not usually address IT service markets directly. Secondly, when addressing IT service markets, the publications use inconsistent terminologies according to the underlying technologies. For instance, we encounter alternative words for "service", e.g., "application", "App", "SaaS", "API", etc. As a result, we cannot directly identify a set of features from the sources using keyword-based data search. Instead, an interpretation of the information provided by the sources is needed.

We developed an extraction scheme for primary features of IT service markets based on an adoption of grounded theory (GT). Glaser and Strauss [20] originally proposed GT to support researchers to elaborate a theory or a theoretical report of the general features of a topic by performing a bottom-up conceptualization of the data. Such data is collected based on empirical observations. We follow the guidelines provided by Wolfswinkel et al. [69] for rigorously reviewing and analyzing literature using GT.

The literature analysis consists of an initial excerpting and three stages of codings (open, axial, and selective codings). Initially, research focus of the sources is excerpted according to an initial research question. Open coding is the process of grouping a set of excerpts into a concept and building categories from a set of concepts. Each category is an abstract interpretation of its concepts. Axial coding is the process of defining sub-categories and specifying the relation between categories and sub-categories. By selective coding, main categories and the relation between them are identified [69].

To extract primary features of IT service markets from the final set of sources, in the first step, we inspected the sources carefully, while having the **RQ** in mind. During reading, we looked for possible answers to our **RQ**. Specially, we considered *what* the sources deal with. We highlighted and made notes of the data, where a building block, component, or architectural element of IT service markets is discussed. After extracting the important information, we applied the open coding, which resulted in 41 codes in total. In the second step, we performed axial coding. In comparison with the open codes, the axial codes capture less specific architectural concepts. We also considered *what interrelations* the research results discover regarding the concepts. Finally, we developed six main categories by performing selective coding: reputation system, business model, recommendation system, mediating electronic product catalog (MEPC), security, and service level agreement (SLA). We terminated the process of coding, when, so called, *theoretical saturation* happened. This means no new category, concepts, or interesting relations could be found [61].

The result of our extraction scheme is shown in Fig. 1. The tables within demonstrate the research focus of the sources regarding the main categories. A table is dedicated to each main category. Each table represents the sub-categories of each category. A cell marked with X denotes that a sub-category is discussed by the source. In addition, some sources studied the relation between a main category with other categories. In this case, the tables demonstrate such relations by the columns with border lines at the right side of the tables. A cell marked with O denotes that such a relation exists between the main category and another category that is discussed by the source.

As an example, we explain how the coding technique resulted in generating the main category reputation system (cf. Fig. 1(a)). After reading the sources and extracting excerpts, we started to perform open coding from [39], which resulted in the identification of two concepts: ranking chart and download rank. Afterwards, [25] shared the concept download rank with [39] and generated a new concept App mining. This process proceeds with [9,24,32,38,64], which resulted

Selective Code	Reputation system								
Axial Codes	Ranking		Reviewing					Security	Business model
Open Codes	Service rank	Ranking chart	Download rank	App mining	Review interpretation	Sentiment analysis	Rating		
[39]		X	X						
[25]			X	X					O
[32, 9]		X							O
[38]			X						O
[64, 24]	X								
[44]				X					
[11]				X	X		X		
[18]				X	X	X	X		
[22]						X	X		
[10]								O	

(a) Reputation system

Sources	Revenue model	Price model	Product portfolio	Business strategies	**Reputation system**
[34]	X		X		O
[48, 49]	X				
[41]			X		
[25, 38]	X	X			O
[32]		X		X	O
[9]	X			X	O
[56]		X		X	O
[65]	X			X	
[28, 24]			X		
[67]			X		
[21, 5]	X	X			
[54]		X		X	

(b) Business model

Sources	Service composition	Semantic interpretation	Service discovery	Service matching
[4]	X		X	X
[48]	X		X	
[33]		X		
[17]				X
[64]	X	X		
[67, 3, 37]	X	X	X	
[24]	X			X

(c) Recommendation system

Sources	Service repository	Portal	QoS analysis	**Reputation System**	**Business model**	**Security**
[71]	X					O
[13]				O		
[12]			X			O
[26]		X			O	
[8]	X		X			
[19]		X				O
[6]	X	X	X			
[40]	X					

(d) Mediating electronic product catalog (MEPC)

Sources	Privacy	Policy	Code analysis	Malware detection
[16]		X	X	
[10, 71]				X
[19]	X	X	X	
[23, 12, 62, 64, 14, 54]	X			
[29]	X			
[66]		X		
[40]	X	X		

(e) Security

Sources	QoS analysis	Dynamic SLA	Monitoring system	**Business model**
[70]		X		O
[64]		X		
[6, 66, 54]	X			
[51, 40]			X	

(f) Service level agreement (SLA)

Fig. 1. The distribution of features and their relations among the sources

in sharing two concepts ranking chart and download rank with the previous sources and in generating a new concept service rank. Later, by performing axial coding, we grouped service rank, ranking chart and download rank into one category: ranking. Furthermore, the open coding of [11,18,44], and [22] shared App mining with previously coded sources and generated two new concepts: review interpretation and sentiment analysis. These two concepts are categorized as reviewing through the axial coding. Moreover, the open coding of [11,18,22] generated the category of rating. Finally, we grouped three categories of ranking, reviewing, and rating into a main category of reputation system. In addition, the coding process reveals links (sharing codes) between reputation system and two other main categories, which we have identified later (security and business model). More details about the coding results can be found in [31].

4 Discussion

In this section, we report the results of the literature analysis. The results are the identification of six main categories and their sub-categories related to our **RQ** as shown in Fig. 1. The main categories represent the most abstract architectural elements of IT service markets. We call them *primary features*. We also call the sub-categories *sub-features*. While reporting the information regarding each feature, we answer three questions: (a) What is the feature? (b) What are its sub-features? (c) What are the relations between the feature and other features? In the following, Sect. 4.1 discusses the questions (a) and (b). Section 4.2 answers the question c). In addition, Sect. 4.3 offers analytic data regarding the results.

4.1 Primary Features of IT Service Markets

Reputation system is responsible for collecting and aggregating users' ratings and generating rankings. A well-functioning reputation system builds trust among market participants [55]. The main sub-features, identified by our literature analysis, are rating, reviewing, and ranking (cf. Fig. 1(a)). Reviewing consists of the possibility that users can insert their comments and then the interpretation of such comments. While interpreting the reviews, IT service markets need to support opinion analysis, an informative interpretation of a mass amount of user reviews, and detecting inconsistencies between user comments and ratings [18]. Furthermore, rankings are associated to services, market participants, and reviews. Service ranking algorithms highly rely on the download rank as a valid indicator to generate ranking charts [39].

Business model outlines the elements that make a business successfully generate and deliver value to its stakeholders including customers [63]. The most important sub-features are revenue model, price model, product portfolio, and business strategies (cf. Fig. 1(b)). Revenue model includes market providers' strategies to choose revenue sources, revenue sharing for service compositions, and generated revenue for developers [48,49]. Price model includes the strategies to choose pricing schemes by market providers for developers to grant access to

the market platform and by developers for service consumers [56]. Furthermore, product portfolio represents the strategies regarding characteristics of a service, e.g., product diversification, which is the support for multi-homing [28] (i.e., a company's strategy to support multiple platforms with one software product). Further examples are covering several service categories, and targeting different groups of users. Business strategies [63] are analytic plan-makings regarding the competitive environment of markets, e.g., service providers' decisions on licensing greatly influence their survival in the market.

Recommendation system handles the discovery and delivery of a desired service using existing knowledge and statistics in the markets [57]. Our results show that recommendation systems in IT service markets involve service discovery, service matching, semantic interpretation, and service composition (cf. Fig. 1(c)). Service discovery includes techniques, like comprehensive service specifications or SLA-based service selection, to optimize the discovery of a service in the pool of services. Service matching is a decision-making function that evaluates an approximate matching of a request to a service specification or a software service to an execution resource. Service composition enables the dynamic provisioning of individually composed services, each provided by different providers. The outcome of a recommendation system can be enhanced by taking the advantages of semantic interpretation, for instance, by employing ontologies to improve the service discovery [4,34,48].

Mediating electronic product catalog (MEPC) acts as an intermediary between requesters and providers of services by linking several service catalogs to each other and allowing requesters to search through those catalogs in electronic marketplaces [60]. In this paper, we take the concept of MEPC in electronic marketplaces for IT service markets. As shown in Fig. 1(d), the concept of MEPC in IT service markets is mainly discussed as portal, service repository, and QoS analysis. A portal is where service providers make services and their specification available to requesters. Furthermore, a service repository hosts back-box services, source codes, or catalogs of service specifications that are published on the portal. In addition, MECPs demand assuring Quality of Service (QoS) by including QoS analysis. Examples of QoS are multi-tenancy, elasticity, and scalability of service repositories [12,26].

Security is another important feature within IT service markets. The subfeatures are privacy, policy, code analysis, and malware detection (cf. Fig. 1(e)). IT service markets need to protect the integrity of users' sensitive data, which can be misused by third-party applications. Moreover, source code analysis, intrusion detection and malware detection algorithms need to be employed to avoid malicious applications in the markets. Market providers may consider such security techniques as market regulations and laws [71].

SLA is a contract between service providers and requesters to ensure a certain degree of quality. This is directly related to the on-time and scalable fulfillment of QoS expectations, which implies using QoS analysis and monitoring system. In addition, dynamic SLAs support frequent changes in service requesters and the heterogeneity of execution resources (cf. Fig. 1(f)) [51,70].

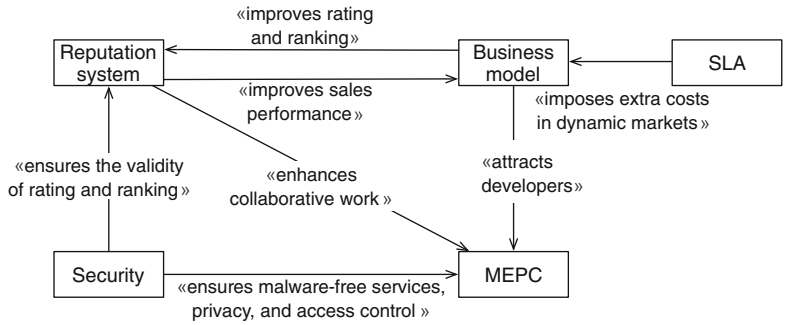

Fig. 2. Outline of the interrelations between the primary features

4.2 Primary Features Interrelations

The literature analysis reveals the significant interrelations between the primary features (see the cells marked with O in Fig. 1). Figure 2 summarizes these interrelations. An arrow from feature A to feature B shows that A influences B in a certain way that is shown as an arrow label.

Business Model – Reputation System: Both business model and reputation system significantly affect each other. On one hand, strategic decisions taken regarding price model and product portfolio mainly influence rating and ranking. A suitable pricing scheme improves users' ratings, service rank, and customer loyalty. For instance, IT services with a combination of free and paid price models receive a better download rank in the market [38]. Furthermore, strategies regarding product portfolio like diversifying service categories improve rating and service rank [33,38]. On the other hand, rating and ranking affect sales performance and users' willingness to pay. Consequently, they influence business model and revenue model of the market [9,25].

SLA – Business Model: Execution of software services demands execution resources. Service providers normally purchase such resources from external resource providers. In dynamic markets, requesters of a service change frequently, which implies changes in requirements and the corresponding SLAs. Service providers, who would like to support a wider range of requesters, need to be able to cope with such heterogeneous SLAs. To avoid SLA violations, the service providers have to take care of heterogeneous execution resources needed by different SLAs. This situation continuously imposes extra cost on the service providers. Such trade-offs between cost and the fulfillment of SLAs need to be foreseen in a business model by choosing suitable resource allocation algorithms that handles dynamic SLAs with minimum costs [70].

MEPC – Reputation System: IT service markets that enable collaborative service development among developers need to motivate developers by providing transparency of activities. This makes the developers interested in self-promotion and improving their reputation. In this case, a reputation system facilitates rating

and ranking for developers. This is additionally supported by providing incentives to developers [13].

MEPC – Security: Service repositories as a sub-feature of MEPCs need to detect new samples of known malware families in order to ensure malware-free services [71]. Other security concerns of service repositories are privacy and access control, which demand encrypted queries on repositories [12]. Furthermore, centralized portals improve the policy enforcement by market providers. For instance, the market providers may apply such policies to third-party applications before granting access to the markets. An example of such policies is security validation to avoid misusing users' privacy-sensitive data [19,26].

MEPC – Business Model: Business strategies taken regarding MEPCs greatly impact on attracting developers to the market. However, such strategies usually come with trade-offs. For instance, centralized portal makes developers' businesses centralized and more accessible to their customers. In addition, it reduces the distribution costs imposed on the developers. Such costs include the maintenance costs of updating services and registration fees of the market entrance. However, centralized portals restrict developers' freedom, because they have to conform to a centralized market policy. Once they cannot conform to the centralized policies, they leave the market [26].

Reputation System – Security: Generating valid rankings demands a high degree of security in preventing and detecting manipulated ratings and spam reviews. In addition, such manipulated ratings and rankings unjustly persuade service consumers. The consequences are disturbing trust and decreasing the QoS delivered by the market [10].

4.3 Result Analysis

Figure 3 shows the popularity of features determined on the basis of the literature from 2008 to May 2016. One interesting finding is that the *business model*, as well as *security*, and *reputation system* have been identified as important features ranging from 19 % to 22 %. The reason for the first might be that both computer scientists and economics are interested in business models of such markets. In contrast, *SLA*s have only been mentioned in 11 % of the publications. One reason could be that this is a concept well known from cloud computing, but not within marketplaces for mobile apps, where more simple contracts are needed in order to target a large mass of end users.

Furthermore, Fig. 4 presents the distribution of the sources of the survey per year. The number of publications increased significantly from 2008 to 2012. This explains the attention that IT service markets as an emerging technology received from the research communities due to the introduction of the mobile App stores (Apple App Store and Google Play) in 2008. However, the decreasing number of publications in the following years shows a decline in research interests, probably due to remained open questions that make further spread of IT service markets challenging in other domains rather than mobile applications,

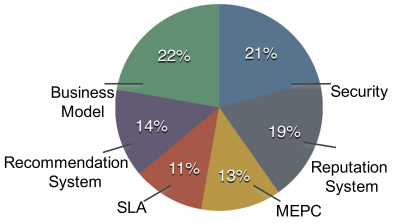

Fig. 3. Distribution of feature popularity from 2008 to May 2016

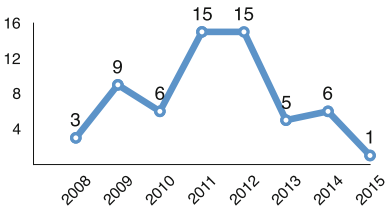

Fig. 4. Distribution of the total number of sources per year

e.g., barriers of establishing in-house marketplaces for enterprise applications. Moreover, the survey captures no sources, which are published in the year 2016. This can be for the reason that the time frame of this survey covers only less than half of this year.

5 Related Work

Until now, there is no survey or work that studies IT service markets independent of their underlying technologies while covering both business and IT building blocks. [59] analyses deficiencies in business strategies of existing IT service markets and suggests a set of design choices to be considered by market providers to achieve market's success. [49] makes a deeper discussion on the business model of mobile App stores by considering the impact of aspects like platform differentiation and quality assurance on market's success. [30] aims at identifying the common features of marketplaces in software ecosystems by observing the existing App stores on the web. [58] specifies a business model for software companies that covers technological aspects, however, core aspects of IT service markets, e.g., reputation, are not considered. [46] discusses business and marketing considerations in developing Apps for mobile App stores.

Moreover, [26] presents technical design choices concerning providers of mobile App markets, e.g., platform integration alternatives, and the impact of these choices on developers' work. There are already works in the literature that consider business and IT aspects of IT service markets, however, the comparisons are limited to certain instances of IT service markets: [65] compares Nokia Ovi and Apple App Store based on organizational, technological, and market innovation factors. [45] performs an analysis of Google Play and Windows Phone Store to identify the most common analysis topics.

6 Conclusion and Future Work

We performed a systematic literature review of the publications that address the concept of IT service markets. In particular, we extracted the architectural

building blocks of IT service markets from the final set of publications using the guidelines provided by grounded theory. The results show that the most prominent architectural building blocks are business models, security, reputation systems, recommendation systems, mediating electronic product catalogs, and service level agreements. Furthermore, the results reveal that the design choices of the features are not independent, but rather, they influence the outcome of each other. Such effects ultimately contribute to the markets' success.

This knowledge gives market operators, IT enterprises, and service providers an insight into IT service markets and their design choices regarding an enhanced market development and feature integration. However, there is still a need for an investigation of benefits and risks of IT service market model for enterprises. In the future, our results will serve as a conceptual basis that we will use in developing a reference model for IT service markets. In addition, such a reference model will include interface definitions and interaction protocols between different market participants and components. Furthermore, processes of market development and technology realization can be an interesting future research direction. As a benefit, new IT service markets can be developed much more efficiently and existing IT service markets can be improved so that they satisfy stakeholders as well as customers.

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