Perspectives for Web Service Intermediaries: How Influence on Quality Makes the Difference

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Abstract. In the service-oriented computing paradigm and the Web service architecture, the broker role is a key facilitator to leverage technical capabilities of loose coupling to achieve organizational capabilities of dynamic customer-provider-relationships. In practice, this role has quickly evolved into a variety of intermediary concepts that refine and extend the basic functionality of service brokerage with respect to various forms of added value like platform or market mechanisms. While this has initially led to a rich variety of Web service intermediaries, many of these are now going through a phase of stagnation or even decline in customer acceptance. In this paper we present a comparative study on insufficient service quality that is arguably one of the key reasons for this phenomenon. In search of a differentiation with respect to quality monitoring and management patterns, we categorize intermediaries into Infomediaries, e-Hubs, e-Markets and Integrators. A mapping of quality factors and control mechanisms to these categories depicts their respective strengths and weaknesses. The results show that Integrators have the highest overall performance, followed by e-Markets, e-Hubs and lastly Infomediaries. A comparative market survey confirms the conceptual findings.

Keywords: Web Service Intermediaries, Web Service Quality, QoS-Management, Monitoring Power, Stakeholder Power

1 Introduction

According to Goldman Sachs the market for Software-as-a-Service (SaaS) will reach $21.4B in 2011. Gartner forecasts that by 2012, one-third of software revenue will be generated through SaaS [1]. While SaaS is enabled by a wide variety of Web technologies, it arguably builds on the service-oriented computing paradigm and one of its key facilitators is Web service architecture. Web services support the interaction between distributed software components of inter-organizational application systems based on Web-enabled middleware mechanisms. In particular, the growth of SaaS can be expected to go in sync with an increased requirement for Web service intermediaries that provide necessary platform and market mechanisms as value-added services.

Antipodal to this expectation, we observe the shrinkage of leading Web service directories like Xmethods (www.xmethods.com) and the discontinuation of the Universal Business Registry (UBR) in 2005. In spite of more than 50,000 entries of individual Web services [2] UBR's failure is commonly explained by the unsatisfactory quality and relevance of the presented Web services [2, 3, 4]. Correspondingly, it can be observed that current practices of service utilization mainly concentrate on secondary business processes, where failures are less critical (e.g., weather service, SMS, address collection, sales & marketing support etc.). Safety-critical Web services like credit checks are usually the domain of specialist providers and rarely covered by all-purpose intermediaries.

For an initial indication of Web service quality, we conceived a comparison of the availability of 100 Web services based on the raw data of Seekda's daily-performed availability test (www.seekda.com). We applied raw data that was gathered in periods between six months and two years and found that 23 out of the 100 analyzed Web services were stated to be below 90% availability. A total of 22 Web services had an availability of between 90% and 97.99%. While 25 Web services were available between 99% and 99.99% of the time, only 14 of 100 Web services showed constant, i.e. 100% availability. For our sample of 100 Web services, we calculated an average availability of 91.22%. For comparison, Siemens describes the meantime between failures (MTBF) of a typical panel in industrial automation as 5.8-6.1 years at a 24/7 utilization (source: www.automation.siemens.com). This means that during these 6 years the component has 100% availability. In highly safety-relevant areas like air traffic management, 100% availability of software and components is expected for more than 10 years (source: Deutsche Flugsicherung). For an even higher quality, three redundant systems need to be deployed in parallel.

While this discrepancy in industrial practices might be due to a variety of reasons, it is an existential problem for Web service intermediaries to amend the situation. Part of the problem is to exactly understand, how different types of intermediaries might influence the quality of Web services and which general strategies of quality management they might apply to guarantee the quality of their Web service portfolio.

In this paper we present a study about significant quality factors for Web service intermediaries. In particular, we aim to contribute a conceptual framework to assist the discussion of intermediation strategies with respect to quality concerns. As to achieve this goal, we have conducted a comparative analysis of Web service intermediaries. Based on state-of-the art and aiming at a differentiation of quality management, we have refined a specific taxonomy for Web service intermediaries and selected a set of 21 quality factors as well as respective control mechanisms. These have been verified by means of actual observations from six Web service intermediaries. To the best of our knowledge, there is currently no other work addressing fundamental factors of Web service quality management for different groups of intermediaries.

In the next section, we present the basics of our taxonomy for intermediaries and Web services. In section three, we outline quality aspects for Web services and further present our mapping of quality factors to Web service intermediaries. The results of our market study of Web service intermediaries are presented in section four. Our work closes with conclusions and outlook in section five.

2 Working Taxonomy for Web Service Intermediaries

As our examination requires a specific perspective on Web service intermediaries, we have refined common classifications into a respective working taxonomy that differentiates significant factors of Web service quality management.

2.1 Working Taxonomy for Intermediaries

Tapscott [5] classified distributed networks in accordance to their level of integration and control into agora, aggregator, alliance and value chain. Agora stands for self-organized electronic marketplaces with negotiable pricings in contrast to the more hierarchically organized aggregator. For business models of higher integration, Tapscott positioned the alliance as a self-organized value creating community while the value chain is the most hierarchical and highly integrated form of a distributed network. In [6] Meier built on this taxonomy, dividing the value chain into integrator and distributor. Zooming further into the terminology of Web service intermediaries, Legner [2] provides a rather functional, tripartite taxonomy consisting of electronic Market (e-Market), electronic Hub (e-Hub) and Infomediaries. In her taxonomy, the functions that are analyzed for differentiation are information provision, customization, matching, transaction, assurance, logistics, collaboration, integration and standardization. Legner's definition of electronic markets unifies agora and aggregator into one single type. The emerging role of e-Hubs describes an intermediary that facilitates supply chain collaboration within a vertical industry.

In order to categorize intermediaries with respect to quality assurance and opportunities of improvement, we suggest further elaborating on Legner's taxonomy towards a more technical orientation that comprises the intermediaries' mechanisms and levels of integration and supply. Therefore, we add Meier's category of Integrators. The definition of the Integrator does not interleave with the existing classes, as it is the only category, where Web services are hosted within the intermediary's infrastructure and where he has detailed insight into and direct influence on the Web service and its environment. Table 1 summarizes our working taxonomy.

Table 1. Technically oriented Taxonomy of Intermediaries.

Intermediary groups	Infomediary	e-Hubs	e-Market	Integrator
Goal	actively collecting, pre-processing and providing information	enabling supply chain collaboration, no sales	marketplace for web services	optimized, highly integrated supply chain
Characteristics	- web services off-site - traffic off-site	- web services off-site - traffic off-site	- web services off-site - traffic routed through	- web service residence and integration on-site
Intermediary's stakeholding power	none	exclusion mandate for web services	influence on portfolio	influence of web service design and portfolio. Owns supply infrastructure
Examples of Web service intermediaries	SeekDa	Xmethods, Remote Methods, WebServiceList	eSigma	StrikeIron

As an additional aspect, Fig. 1 outlines areas of influence for intermediaries in the supply infrastructure. Influence Area 1 is limited to the traffic between client and web service provider. Influence area 2 includes Area 1. Additionally it comprises the supply infrastructure as a whole. Infomediary and e-Hub do not influence any data

traffic while using a Web service. Thus, they cannot manipulate any of the Influence Areas. The e-Market serves as access point to the entirety of all offered Web services. Positioned in the *Influence Area 1*, e-Markets control all traffic between the client and the Web service provider(s). The Integrator is omniscient to all traffic coming from and going to the client (apart from network communication between client and Integrator). Thus he is in control of *Influence Area 2*, which includes Influence Area 1.

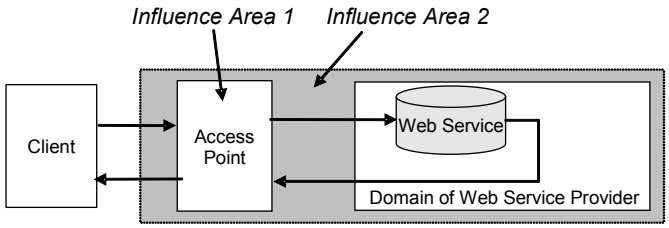


Fig. 1 Influences Areas on Quality of Web Services

2.2 Taxonomy for Web Services with Respect to Intermediation

We understand a Web service as a software component that is identified by a URI. Its interfaces and bindings are capable of being defined, described and identified as XML artifacts. A Web service supports interactions with other software components using XML messages exchanged via Internet protocols [7, 8]. We have intentionally narrowed our study to this kind Web services and do not consider further connotations that include web application services or human-based Web services [9].

Following our refined taxonomy for intermediaries and in support of our goal to analyze their quality aspects, Web services can be further categorized according to their storage and execution location as off-site or on-site with respect to the intermediary. On-site Web services are hosted on an intermediary's own physical or virtual infrastructure and can be further sub-grouped into native (meaning produced by the intermediary or in accordance with the intermediary's design directives), and non-native Web services. For this study, we exclude quality effects that are specific to Web service composition. Therefore, we do not distinguish common categories such as atomic and composite Web services [7, 10].

3 Quality factors of Web Service Intermediaries

Quality, like beauty, is in the eye of the beholder. It depends on the individual and on subjective requirements on non-functional Web service characteristics like response time, reliability or security [11, 12]. In contrast to functional characteristics that deal with the structural façade (e.g., service types, messages, interfaces and operations), non-functional attributes describe a set of constraints over the functionality of a Web service [13, 14]. In our understanding, this set of constraints defines the QoWS.

The need for a general QoWS concept is not new. Concerns on Quality of Service (QoS) have long-lasting roots in business fields such as marketing where research mainly focused on the viewpoint of the requestor. Seen generally, QoS relates to differences between expected and actual service provision [14]. In the more closely related field of distributed systems, QoS is not a novel problem either. However, SOC poses a number of additional issues [10]. Service-oriented systems consist of distributed components that are loosely coupled over public networks such as the Internet. Circumstances that are outside of the control of provider and consumer obviously influence a consumer's Web service experience. Thus, e.g. response times as a quality factor of Web services relate to additional network properties than those of locally distributed systems. This kind of distributed setting demands a definition of clear responsibilities in the process of measuring QoWS, e.g. what to measure, how to measure, who does the measuring and where measures are to be taken [10, 15].

For our analysis, we aim at a QoWS model that considers all stakeholders, i.e. consumer, intermediary and provider or, when put into a technical context, service environment (e.g., underlying hardware and network infrastructure), application services and end-users [16].

3.1 Applied Concept of Web Services Quality

For the purpose of our comparative study of Web services intermediaries, we took the Web Services Quality Model (WSQM) as starting point. This upcoming standard is still under development but published in consecutive draft versions by OASIS [17]. It incorporates quality attributes, so-called quality factors, for almost all aforementioned non-functional parameters of QoWS and is more suitable to assess the QoWS than generic quality of software standards such as ISO 9126 or ISO 25000. In our quality-driven, domain neutral analysis of Web services intermediaries, WSQM shortcomings such as missing abilities to consider emerging QoS parameters (e.g., adaptability, context-awareness) or the limits of semantic description [16] can be ignored.

WSQM is a conceptual model that defines the roles, activities and factors to assess Web service quality in the lifecycle of Web services. In WSQM, quality factors are categorized into three groups: *Business Value*, *Service Measurement* and *System Information*. Each group has up to four quality factors and many more sub-quality factors. In the current version of WSQM, we counted a total of six quality factors, 23 sub-quality factors and many lower level factors. The vast amount might be explained by OASIS's intention to provide a common ground for the definition of service level agreements for Web services.

Following our research goal to correlate influence mechanisms on QoWS with specific types of intermediaries, we can limit our analysis on WSQM's sub-quality factors. We only have to deviate from this coarse grained consideration in those specific cases, where the underlying lower level quality factors demand for differing influence mechanisms. In these cases, we integrated those lower level factors into the scope of our analysis. For the sake of clarity, we further merged the fine grained security sub-quality factors into *authorization management*, *trace management* and *distributed authorization*. In the following, we outline our relevant set of 21 quality factors for the evaluation of Web service intermediaries (see Table 2).

Table 2. Mapping Table of Quality Factors and Intermediaries (implications of "observe", "inquire", "negotiate", "adjust", and "define" are discussed in section 3.2)

		Intermediaries			
	Quality Factor	**Infomediary**	**e-Hub**	**e-Market**	**Integrator**
Business Value Quality	*Service Cost*	observe	inquire	inquire / negotiate	inquire / negotiate
	Service Sustainability	-	-	observe	adjust
	Service Aftereffect	-	-	observe	adjust
	Service Recognition	observe	observe	observe	observe
	Service Reputation	inquire	inquire	inquire	inquire
Service Level Measurement Quality	*Response Time*	observe	observe	observe	adjust
	Maximum Throughput	-	-	observe	adjust
	Availablitity	observe	observe	observe	adjust
	Accessibility	-	-	observe	adjust
	Sucessability	-	-	observe	adjust
Business Process Quality	*Reliable Messaging*	observe	observe	negotiate / define	define
	Transaction Processing Capability	observe	observe	negotiate / define	define
	Collaborability	observe	observe	negotiate / define	define
Suitability for Standards	*Conformability*	observe	observe	negotiate / define	define
	Interoperability	observe	observe	negotiate / define	define
Security Quality	*Authorization Management*	observe	observe	negotiate / define	define
	Trace Management	observe	observe	negotiate / define	define
	Distributed Authorization	-	-	define	define
Manageability Quality	*Mangement Information Offerability*	observe	observe	negotiate / define	define
	Observability	-	-	negotiate / define	define
	Controllability	-	-	negotiate / define	define

To assess the quality factor *business value quality*, we analyze the sub-quality factors service cost, service sustainability, service after-effect, service recognition, and service reputation. Service cost summarizes the availability of qualitative information on pricing, billing and compensation that a provider of a Web service publishes to consumers or intermediaries. Service sustainability, qualitatively describing the business value that is brought into the company of the consumer, cannot be observed directly by intermediaries. However, we argue that intermediaries may infer positive service sustainability from recurring Web service requests by the same consumer. Similarly, service after-effects, describing rather quantitative effects of service consumptions such as Return-on-Investment, can only be inferred from recurring Web service invocations. Intermediaries can easily survey Service recognition, assessing a consumer's attitude towards a Web service before invocation, and Service reputation, being the counterpart of service recognition after invocation.

Sub-quality factors of *service level measurement quality* cannot only be observed qualitatively but can be measured quantitatively. Both, response time and maximum throughput can be revealed through monitoring network traffic. For both sub-quality

factors, however, considerations based on the intermediary's positioning with respect to Influence Areas (see Fig. 1) need to be taken into account (e.g., additional network latency between client and access point is only measurable by clients but not intermediaries). Indicators of stability like availability, accessibility, and successability describe ratios of uptime against downtime. A similar measure is the number of Web service invocations compared to the number of acknowledgements and successful replies. Again, the ability of intermediaries to observe these quality factors will depend on the influence position of the individual Web service intermediary.

We assess *business process quality*, representing a Web service's available functionality for collaborating among other Web services, qualitatively by means of a Web service's support for reliable messaging, transactional processing quality and collaborability. The parameters of the quality factors *suitability for standards are* assessed by the sub-quality factors conformability and interoperability. We introduce the quality factors *authorization* and *trace management* to analyze capabilities of Web service intermediaries with respect to the quality factor service quality by aggregating all sub-quality factors that required authorization into the quality factor *authorization management* and all sub-quality factors requiring tracing capabilities into the factor *trace management*. Of particular interest in this respect are the stakeholder powers of intermediaries for influencing these quality factors, which is why we specifically looked for capabilities for the management of distributed authorization.

Finally, we assess manageability quality, defined as the ability to consistently manage Web services, by means of *management information offerability*, *observability* and *controllability*. While the sub-quality factor management information offerability represents the availability of Web service information that is not changed by the environment (e.g., relationship to other resources), observability and controllability refer to features that allow the user to monitor and control operational properties (e.g., operational status of a Web service and related resources).

3.2 Mapping Quality Factors to Intermediary Classes

In this section, we focus on the question of how quality factors can be observed in the individual business models of intermediaries. We are particularly interested in identifying differences among intermediaries. The resulting mapping of quality factors to potential levels of influence per type of intermediary is illustrated in Table 2 above.

For our analysis, we initially introduce the categories *observe, inquire, negotiate, define,* and *adjust* that indicate to the level of tangibility of quality factors for individual intermediaries. We consider intermediaries to have the ability to *observe* a certain quality factor, if they are able to identify the existence of a quality factor through analyzing Web service descriptions like WSDL or related resources. An intermediary has *inquire* capabilities assigned, if we see potential means to poll additional quality information through interviews or surveys. More powerful than pure observation is the co-determination of quality factors. We refer to this aspect as the ability to *negotiate* on the existence or level of quality factors. If an intermediary has abilities assigned that surpass co-determination such as the role of a dominator, we conceive that he exerts abilities to *define* values of quality factors. As soon as intermediaries not

only define but also quickly respond to changes in value of quality factors, we assign the ability to *adjust* quality by regulating a Web service environment.

Furthermore, we identified two major types of influences that intermediaries may bring into effect. Firstly, intermediaries may exert *monitoring power*. Monitoring power may be applied to internal or external sources of quality. Thus, the category inquiry clearly relates to applying monitoring power of external sources of quality (e.g., inquire about service reputation among consumers), while the observe category may be applied to both internal and external resources (e.g., observe security quality as defined in WS Policy documents or observe a Web service's availability through active testing). Secondly, intermediaries may exert *stakeholder power*. By bringing stakeholder power into effect, Web service intermediaries may negotiate, define or adjust quality parameters according to the described levels of quality co-determination. Since the capability of quality adjustment closely relates to our concept of native and non-native Web services, we only identified adjustment capabilities for Integrators. Furthermore, we can conclude that monitoring powers are a prerequisite for stakeholder powers, since intermediaries cannot negotiate, define or adjust quality that they cannot observe or inquire.

The conceptual analysis leads us to the following hypothesis that we want to verify in the course of the following market analysis: (i) Infomediary's and e-Hub's levels of influence may only reach out as far as monitoring power is concerned. (ii) E-Markets and Integrators are equally powerful with respects to monitoring power but differ in their respective levels of stakeholder power. (iii) Integrators possess stronger stakeholder powers as they successfully apply their concept of native Web services.

4 Market Analysis

Based on Legner's sample set [2] we compared a number of active Web service intermediaries to underpin our hypothesis. We complemented the original set with the Infomediary *Seekda* due to its complementary concept (see Fig. 1) and its outstanding portfolio of Web services (>27000). The results were accomplished through explorative analysis of the intermediaries. We present our findings categorized into monitoring and stakeholder power according the powers of influence that we identified above. In the following only quality criteria are listed that were applied by at least one intermediary.

4.1 Communication of Quality

As shown in Table 3, all providers apart from the Infomediary offer possibilities of a trial. However, with regard to the many options, customers need pre-selection support from intermediaries before entering the phase of Web service selection.

In terms of business value quality, most intermediaries provide pricing information. Whereas e-Markets and Integrators have this information available based on their transaction mechanisms, e-Hubs depend on community cooperation. The In-

fomediary depends on the ability to correlate discovered WSDLs and price documents.

None of the analyzed intermediaries provides information on the quantity of invocations. Whereas this information is unavailable for Infomediaries and e-Hubs, e-Markets and Integrators have this information available and withhold this important information on sustainability from potential customers.

Table 3. Comparative Analysis on Monitored and Communicated Quality Factors

	Quality Factor	SeekDa!	WebServiceList	Xmethods	RemoteMethods	eSigma	StrikeIron Market Place
	Business model	Infomediary	e-Hub	e-Hub	e-Hub	e-Market	Integrator
	Residence	off-site	off-site	off-site	off-site	off-site	on-site / native
Business Value Quality	*Service Cost*	yes	no	no	yes	yes	yes
	Service Sustainability	no	no	no	no	no	no
	Service Recognition	yes	no	no	no	no	no
	Reputation (score)	yes	yes	no	yes	no	no
	Reputation (Descriptive)	yes	no	no	yes	no	no
Service Level Measurement Quality	*Response Time*	yes	no	no	no	yes	yes
	Availability	daily availability check	no	no	no	hourly availability check	minute-by-minute availability check
	General information through trial	no	yes	yes	yes	yes	yes

As with commodity retailers like Amazon or Ebay, most of the intermediaries make use of reputation mechanisms. This qualitative reviewing system is valid in the commodity segment and certainly makes sense for safety- or security-irrelevant applications. However, for important business applications, the results are too vague and too easily influenced. We encountered multiple cases of descriptive reputations, where Web service providers themselves had entered the descriptions.

Only the crawler-based Infomediary makes use of Internet-traffic to indicate service recognition. Often utilized for this is the Google PageRank [18], which calculates the relevance of URLs. We see this as an indicator for service recognition. The analyzed e-Markets and Integrators frequently verify response time and availability. Further, the Infomediary verifies this information through daily testing routines. Being neither part of the process, nor actively searching for data, e-Hubs have no access to this kind of quality information.

4.2 Mechanisms to Ensure Web Service Quality

As important as decision support for the customer are pre-selection and maintenance of high quality standards. In this context, stakeholder power is decisive. Whereas Infomediaries and e-Hubs are limited on passing user-feedback to the Web service providers, e-Markets and Integrators can apply the whole catalog of portfolio management mechanisms. Table 4, gives a respective overview.

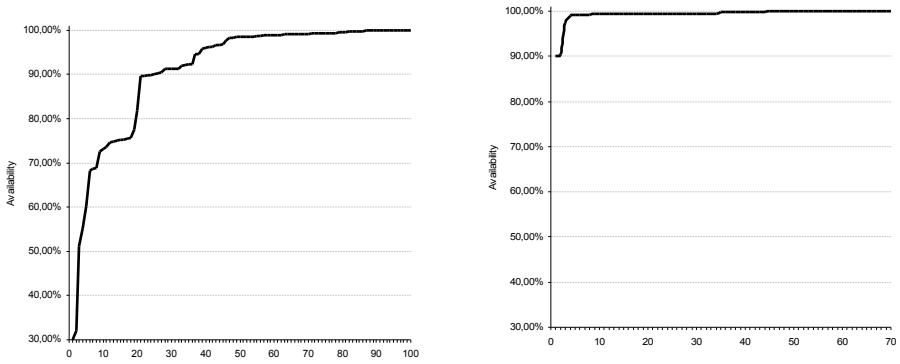
The analyzed e-Market fits this role with a precise and comprehensive initial quality revision process and a limitation of Web services according to specific standards insuring an initial level of quality. However, an obvious lack of quality maintenance procedures leads to the fact that eSigma's overall performance based on the quality factor is poor. Availability is only marginally differentiable from the average market performance. Being placed in Influence Area 1 (see Fig. 1), e-Markets only have ba-

sic portfolio management possibilities such as portfolio cleansing through eliminating low-performers. Further, they can apply motivational or assertive influence onto their ecosystem. This could comprise the completion of missing Web services or the improvement of underperforming Web services. Although no information was made available, the high quantity of non-available Web services in the e-Market suggests that no or at maximum only minor portfolio management mechanisms are exerted.

Table 4. Comparative Analysis on Exerted Stakeholder Power to Ensure Web Service Quality

	Quality Factor	SeekDa!	WebServiceList	Xmethods	RemoteMethods	eSigma	StrikeIron Market Place
	Business model	Infomediary	e-Hub	e-Hub	e-Hub	e-Market	Integrator
	Residence	off-site	off-site	off-site	off-site	off-site	on-site / native
Portfolio Management at Intermediary level	*Selective display of services based on quality*	no	no	no	no	yes	yes
	entrance assessment per web service	no	no	no	no	yes	yes
	Continuous web service assessment / escalation routines	no	no	no	no	no	yes
	Portfolio optimisation	no	no	no	no	no	yes
	Portfolio cleansing	no	no	no	no	no	yes
Feedback to WS provider	*Statistics*	no	no	no	no	no	yes
	User-based error feedback	no	no	no	yes	no	yes

Being equally powerful in terms of stakeholder force towards Web service providers, the Integrator wins a clear lead against the e-Market in terms of quality observation and exercisable control. With the services being hosted in the Integrator's domain, he has significantly better possibilities to monitor the quality of infrastructure and the performance of Web services. His insight even becomes omniscient if the Web services are of native nature. Secondly, being the owner of the domain and servers, many of the quality-deciding criteria depend directly on the Integrator's infrastructure. He decides upon levels of server utilization, concepts of replication etc.



a) Web service samples 1-100, different intermediaries

b) Web service samples 1-70, only Integrators

Fig 2. Comparison of Long-Time Availability of Web Services

The results of a comparative analysis of the quality factor *availability* for Integrator-hosted and not Integrator-hosted Web services supports this statement (see Fig. 2). The overall availability of the latter mentioned Web services is significantly lower than the availability of Integrator-hosted Web services. No difference in availability of Web services was measurable between e-Hubs and e-Markets. When we compared 76 samples from StrikeIron's marketplace, we calculated an average availability of 99.37%. We therefore assume that the analyzed Integrator performs major factors of centralized portfolio management on the one hand, and decentralized optimization through escalation routines and statistics on the other hand.

5. Conclusions and Outlook

In this paper, we have presented the results of our comparative analysis of quality management for Web service intermediaries. Out of multiple sources, we refined a working taxonomy of Web service intermediaries and further identified a set of 21 quality factors. Based on the mapping of Web service quality factors to types of Web service intermediaries, we examined the Web service portfolio of existing intermediaries. In the performed comparison of potential and implemented mechanisms for quality assessment and publication to the customers, we found that none of the analyzed intermediaries exhausted their potential for improvement. A better monitoring of quality could reduce the customer's pre-selection time and support his choice of quality. Furthermore, the increased competitiveness in the market of intermediaries calls for more focus on quality factors.

Clearly, perspectives for Web service intermediaries will depend on their potential to maintain and improve quality and thus on the type of stakeholder power they possess. Control over Web service design or even control over the supply environment, i.e. platform ownership, will be increasingly required to stay competitive. Lacking both, neither Infomediaries nor e-Hubs are in a position to exercise sufficient quality

monitoring or quality management. Accordingly, we expect a trend towards e-Markets and Integrators that is already observable. StrikeIron, originating from an e-Hub operates now as Integrator. eSigma just repositioned itself from an e-Hub to an e-Market. Also Seekda recently announced its upcoming e-Market.

But are there possibilities for e-Markets to balance their backlog against Integrators? Further research is recommended to investigate whether a transformation of the native Web service concept to a distributed context of e-Market and suppliers could reproduce the concept's inherent advantages coupled with the dynamism and emergence of the e-Markets' self-organized ecosystem. To shed light on this crucial question for the prospective shape of the market of intermediaries, an analysis needs to be conducted on collaboration, observation and control patterns from a managerial and a technical point of view.

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