Quality Aspects in Service Ecosystems: Areas for Exploitation and Exploration

Christoph Riedl[1] christoph.riedl@in.tum.de
Tilo Böhmann[2] boehmann@iss-hh.de
Michael Rosemann[3] m.rosemann@qut.edu.au
Helmut Krcmar[1] krcmar@in.tum.de

[1]Technische Universität München
Boltzmannstr. 3
85748 Garching b. München,
Germany

[2]International Business School
of Service Management
Hans-Henny-Jahnn-Weg 9
22085 Hamburg
Germany

[3]BPM Group, Faculty of Information
Technology
Queensland University of Technology
126 Margaret Street
Brisbane, QLD 4000
Australia

ABSTRACT
Service Science, Management, and Engineering (SSME) is a research area with significant relevance to research and practice. Networked systems of web services are a field of service science that enjoys growing interest from researchers. The complex and dynamic environment of these service ecosystems poses new requirements on quality management that are insufficiently addressed by current approaches that focus mainly on the technical aspects of quality. This focus is a severe limitation for the development of service networks because it neglects perceived service quality from the viewpoint of service consumers. In this paper we propose a reference model for quality management in service ecosystems. This reference model is linked in particular to innovation and new service development. Towards the end we propose premises for the implementation and outline a future research agenda.

Categories and Subject Descriptors
H.3.5 Online Information Services

General Terms
Service Management, Measurement, Design, Human Factors.

Keywords
Web service, service ecosystem, quality management, innovation, New Service Development (NSD).

10th Int. Conf. on Electronic Commerce (ICEC) '08 Innsbruck, Austria

1. INTRODUCTION
In our growing service-based society electronic and Internet-based services play an important role. This development is acknowledged by academia, industry, and governments through current efforts to establish the new multidisciplinary research field Service Science, Management, and Engineering (SSME) [7, 9, 15, 21, 25].

Two of the main research objectives of Service Science are to "improve service productivity and quality" [14] as well as to broaden our understanding of service innovation [7].

Current research on service quality for networked services focuses mainly on functionality, availability, and performance (e.g., [6, 18, 29]). This is a severe limitation for the development of service networks because this approach neglects perceived service quality from the viewpoint of service consumers. Systems that narrowly reduce service quality to technical criteria cannot provide the information necessary for consumer-focused service quality management. However, due to the compositionality of services and sub-services unique requirements are created for service quality management in service networks. This demands an integrated view of quality management in service ecosystems that extends the dominating technical view with the view of the service consumer.

Therefore, an integrated quality management reference model has been developed to integrate the technical as well as the business aspects of quality management.

This research works towards the development and validation of a service quality reference model. While the actual model has been published previously [23] and will be briefly summarised below, we argue in this paper that quality management, more precisely the data collected during quality management, plays an important part in service innovation and can be even used to drive innovation. Thus, linking the two main themes in service science: quality and innovation.

The paper applies conceptual-analytical research methods in order to illustrate how this reference model can be used to derive requirements for the implementation and support of service quality management. These requirements are presented in the form of premises that should be considered when embarking on the task of implementing a service ecosystem. In addition to these implementation premises, potential research directions for the future study of service ecosystems are offered at the end of this paper. The research agendas offer potential avenues for researchers to explore new aspects of SSME.

The paper is structured as follows. In the next section, we contextualise our research by introducing the notion of service ecosystems. In Section 3 we propose four layers of quality management. Section 4 extends the layer model and presents a complete reference model for quality management in service ecosystems. Then, in Section 5, we explain a set of four feedback loops that link the activities of the reference model together and shows their relationship with innovation. Finally, in Section 6 we propose derived requirements for the implementation of a service ecosystem platform along with key research agendas that we see in the emerging field of service ecosystems. Section 7 concludes the paper.

2. SERVICE ECOSYSTEMS

Web services have become extremely popular in recent years and the success of Web service-centred business models such as Amazon.com demonstrate the real commercial success of these models. Building on their wide spread use new composite services are created that span across business boundaries in order to implement end-to-end business processes. This phenomenon of a large collection of Web services has been described as a *Service Ecosystem* [1, 2, 23, 24, 27]. In service ecosystems the idea of interconnected services is taken even further by putting constraints on the service delivery on a business level. A network of services ranging from core services such as payment processing, authorisation and monitoring services to special-purpose services can be used to launch other, new services in a mash-up fashion [1]. Thus, interconnected software-as-a-service networks form a service ecosystem. In these networks service providers could augment their services by distribution and delivery functions made available to them by the ecosystem (Figure 1). For example, such an ecosystem could provide payment and customer relationship management functionality that can be used by other providers to extend their own services. Furthermore, this allows them to concentrate on their core competencies and launch new services quickly due to the functionality already in place.

Though others do not use the name service ecosystem similar phenomena are researched in other areas, for example under the name of service value networks [8, 22, 24, 30].

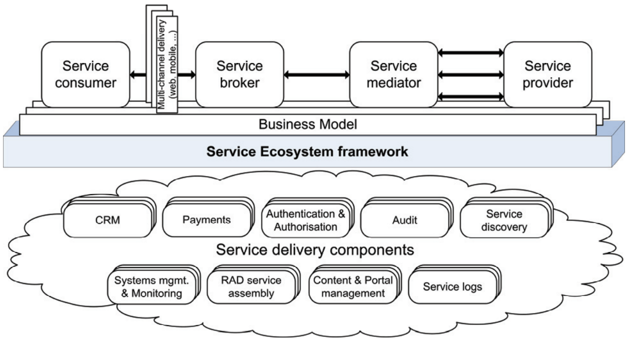

Figure 1. Top-level architecture of a Web service ecosystem (source: adapted from [1]).

Service ecosystems are characterised by their multitude of actors who engage in them and the various roles that these actors play [1]. First, there are service consumers who purchase and use the services offered. Service brokers generate value by bringing service consumers closer to service providers or offering service delivery through intermediaries that provider service delivery functions such as payment. Service mediators offer translation and mapping services, on a technical level, and thus allow brokers to concentrate on their core competencies [1]. Service providers, on the other hand, concentrate on offering their respective service in the best and most economic way without being distracted by the actual service delivery. A special type of service providers are the specialist intermediaries who do not offer services targeted at end-users but rather offer service delivery components that are used by other providers to create marketable services. Finally, there is the role of a platform provider that supplies the overall platform on which other providers, users, brokers, and mediators operate (e.g., salesforce.com and strikeiron.com).

This interconnected constellation leads to a separation of service provisioning and service delivery. The provider of a service may no be responsible for the actual service delivery to a service consumer. This is especially the case when other providers/brokers start recombining and repurposing services. Thus, a service provider is no longer in control of the actual delivery of its service which might be delivered to new customers, through different channels, in completely new composite services which would consequently lead to new, and potentially very different quality requirements to its own service.

Quality management in service ecosystems has to address this dynamic and interconnected nature by first, collecting quality relevant information from the system and service consumers and second by allowing services to address quality problems dynamically and to dynamically adapt to changes.

3. QUALITY MANAGEMENT

To address the broad topic of quality management [23] proposes to do so on four layers which have been identified during a literature review. The layers are Perceived Quality Measurement, Service Level Management, Fault Management, and Dynamic Service Provisioning (Figure 2).

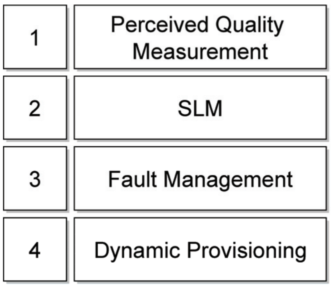

Figure 2. Quality management on four layers (source: [23]).

The first layer is *Perceived Quality Measurement* which is concerned with the measurement and evaluation of subjective quality judgments as they are perceived by service consumers. These subjective quality measurements could be performed using multi-item scales in the fashion of SERVQUAL [19, 20, 28].

The second layer is *Service Level Management* (SLM). SLM tries to improve the quality of service delivery through a cycle of agreeing, monitoring, and improving of a service [10]. However, SLM focuses on rather technical aspects of quality as they are captured in service descriptions which aim at objectively measurable metrics which can be used in service contracts. Hence, it is accompanied by a layer to measure the perceived quality of a service on top of it. Thus, metrics for SLM can be derived which result in better perceived quality on the preceding layer.

The third layer is *Fault Management*. It addresses quality management by fixing glitches in service delivery (through Incident Management) and resolving known problems (through Problem Management) [11].

On the last layer *Dynamic Service Provisioning* is concerned with the dynamic and on-demand aspects of service ecosystems. It addresses service composition and sub-service selection, as well as dynamic resource allocation [3, 12, 29]. The aim of Dynamic Service Provisioning is to select the best services available where best may also mean "up-and-running" as Web services may be removed, modified or relocated and thus become unavailable at any time and without prior notice [4].

4. QUALITY MANAGEMENT REFERENCE MODEL

As argued by [23] quality management requires an integrated view and cannot be decomposed in separate components. Hence, the authors developed a reference model for quality management in service ecosystems that can be used to guide the implementation of a quality management system for service ecosystems. The reference model is shown in Figure 3.

The core features of this reference model is that it offers an integrated view on quality management which covers all quality management functions from the four layers presented in the previous section. Moreover, it is aligned to the service life cycle and supports a recursive service model that allows application to a hierarchy of sub-services. The reference model is embedded in the reference design "house" as suggested by [16].

For a detailed description of the activities performed within each of the functions, please refer to [23].

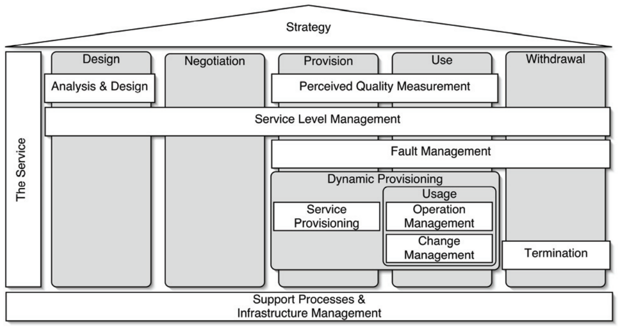

Figure 3. Quality management reference model for service ecosystems (source: adapted from [23]).

5. INTEGRATED FEEDBACK LOOPS

The activities performed within the quality management framework proposed above generate quality related information that other functions of the framework rely on. This information has to be made available in different forms ranging from individual, detailed measurements in real-time (e.g., status of a hard disc drive) to aggregated, overall measures that are collected over a longer period of time (consumer ratings of a service).

Thus, the four layers of quality management are linked through feedback loops that form a cascading system (Figure 4).

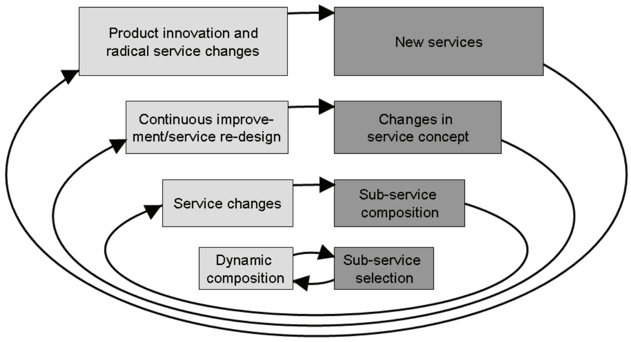

Figure 4. Integrated feedback loops for Web services: from dynamic service composition to incremental and radical service innovations (source: based on [23]).

The innermost circle is a fully automated loop of dynamic service composition. Here, sub-services are chosen based on (a) the given sub-service composition, (b) predefined quality metrics, and (c) the set of available, up-and-running services. This dynamic sub-service selection is fully transparent to the consumer and does not alter the service requested by the consumer. It is solely based on pre-defined quality metrics. Thus, the components used to deliver a service may change in order to improve its quality but the resulting end product stays the same.

The next layer is concerned with service changes and the sub-service composition that is to be executed on the dynamic composition layer. This feedback cycle is predominantly governed by a central change management process. This change management aggregates change requests from Fault Management and Service Level Management in order to create a coherent process for all changes that affect a service. This cycle is not fully automated like the dynamic composition on the previous layer. The service may change through incremental improvements based on the data collected during actual service provisioning. However, these improvements are purely focused on the service delivery and do not alter the resulting service product.

Then, the next layer focuses on redesigning the service and the underlying service concept. This is based on the holistic feedback collected through Perceived Quality Measurement. The re-design may involve changes to the overall service concept, that is, the organisation's business proposition and the service levels. Changes in the service concept will generally be visible to service consumers and should lead to higher perceived quality. The service concept is improved to achieve higher perceived quality.

The last layer goes beyond the previous three in that it extends the focus to include not only changes to the service concept but also business model changes, product line extensions as well as complete new service developments. The quality related feedback gathered which is more abundant that what is usually available for non-electronic services is used for general innovation activities and new service development.

While the first three layers can be classified as forms of process innovation ("changes in the ways in which [services] are created and delivered", [5], p.66) the last layer can be classified as product innovation ("changes in the things (product/services) which an organisation offers", [5], p.66).

6. DESIGN OF SERVICE ECOSYSTEMS

The design of business models and processes in Services Science and especially around service ecosystems is only at the beginning. However, by implementing a service ecosystem and the quality management reference model in particular also several challenges arise. Through the application of the reference model in an exploratory case study in public administration several requirements for the actual implementation of such a quality management system have been derived [23]. In the following sections we want to propose premises for the design of service ecosystems based on the reference model presented above and the requirements encountered during application within the case study. With these design premises we hope to guide the implementation of a quality management and innovation system in service ecosystems. Along with the premises for implementation we propose several open questions for a research agenda that can guide future research to develop understanding of some core aspects of service ecosystems.

The following sections are structured along the four layers of quality management introduced in Section 3 as well as a section on innovation aspects introduced in Section 5 on integrated feedback loops. Implementation premises (P) and questions for a research agenda (RA) are offered in each.

6.1 Perceived Quality Measurement

Value creation is always judged at the front-end where the user interacts with a service. In service ecosystems services interact in various ways, however, the value proposition is only made at the very end of the value chain to the consumer. Every service provider has to keep that in mind and make sure that providing adequate quality is honoured by the customer. Hence, service providers have to focus on perceived quality rather than just keeping an eye on Service Level Agreements which would be focused at the "next in line" service partner. In order to support perceived quality measurement it is necessary to put in place a front-end quality measurement where the consumer can rate how she perceived the quality of a service. However, in networked services this is not a trivial task and several core functions have to be provided by the underlying platform in order to support this function. First, the platform has to support an easy identification of the final service product in which the service under investigation is used. Second, the channel through which this service is delivered has to be known and third, the consumer of the final service product needs to be identified in order to collect perceived quality measurements from that user (e.g., through the use of a rating mechanism or comments). This leads us to the first premise:

> **P_1:** The platform has to support the identification of the final service product, the channel, and the service consumer to which a service is delivered.

In order to make these user perception ratings useful for this typically composite service some more steps are necessary. The platform has to support the aggregation and disaggregation of the perceived quality measurements in order to support improvements of composite services as well as individual service components. The framework presented in this paper and in [23] is a first step towards solving these challenges but much more remains to be researched. Thus, we propose the following research agenda (RA).

> **RA_1:** How can perceived quality be measured in composite services delivered over an open platform and how can the resulting measurements be used to improve both the composite as well as the individual services in a user-centred fashion?

Another aspect is the measuring technique used. Highly aggregated "thumbs-up/thumbs-down" evaluations or ratings that let the consumer assign one to five stars are very popular yet allow little differentiation. On the other hand, multi-item scales like SERVQUAL would allow a much more detailed quality evaluation but suffer user acceptance and would not be as easy to implement as simpler methods.

> **RA_2:** What are adequate subjective quality measures for the use in service ecosystems with regards to both user acceptance and expressiveness?

6.2 Service Level Management

For services targeted at the general public SLAs with consumers are usually not defined. However, in those cases the business organisation can play the customer role and sign an agreement with internal service provisioning on behalf of the anonymous service consumer. In that way, objectively measurable quality metrics are defined against which service provisioning can be evaluated.

For services procured from external partners SLAs are required as well. Due to the dynamic nature of service ecosystems sub-services are selected on-demand and possibly used only several times. Consequently manual SLA negotiation is not feasible and a fully automatic method is necessary where sub-services can be bound and released on a per-invocation basis. This is one of the fundamental core requirements for a working service ecosystem.

> **P_2:** Support for a flexible and fully automated SLM that allows signing SLAs at an on-demand basis and monitoring such agreements.

Technical implementations of such systems have already received widespread attention (e.g., [13]) but legal aspects of such a system are until now not well understood.

> **RA_3:** What is a valid yet feasible legal framework for the negotiation and monitoring of service level agreements in service ecosystems to govern multi-party service provisioning?

Selecting a service composition and negotiation agreements between the parties involved is only the first step. Once such a relationship has been established, the ongoing service provisioning and quality measurement needs to be rendered. For the provisioning of these multi-party services a governance structure is required that establishes who has the interest, authority, and resources to evaluate the quality of a composite service.

> **RA_4:** What are appropriate governance structures for multi-party services in service ecosystems that establishes who has the interest, authority, and resources to evaluate the quality of a composite service?

6.3 Fault Management

Since most of the services in service ecosystems are supposed to be composed of several sub-services fault management plays a crucial role. One key functionality that has to be offered by the platform here is to allow a complete tracking and monitoring of service execution of composite services. Without appropriate tracking and monitoring it would not be possible to identify the reason for the failure of a complex service execution that involves several sub-services. Consequently, in addition to the overall execution planning a detailed and real-time monitoring is necessary.

> **P_3:** The platform needs tracking support for composite service invocations that allows to pinpoint problems to individual sub-services or components.

Once problems have been tracked down to the actual source (i.e., the exact sub-service that caused the failure of the invoking overall service) appropriate measures have to be taken. In the best case a functionally equivalent service is available that can be used instead. However, if no such service is available other measures have to be taken. For that purpose appropriate service recovery strategies need to be defined that govern service failures. For example, if a payment processing sub-service for a rarely used credit card becomes unavailable the consumer facing option-list of available payment methods could be updated automatically. Thus, the service would have limited functionality (i.e., not offering this particular credit card as payment method) but would still be able to operate.

> **P_4:** Service recovery strategies need to be supported that allow augmenting a composite service in real-time according to actual sub-service availability.

6.4 Dynamic Service Provisioning

One of the key benefits of service ecosystems is that the decomposition of a service into its sub-services is not static. The decomposition is not made at design time of a service but only during execution where the best available sub-service (according to some sub-service selection model) is chosen. This dynamic sub-service selection can even happen on a per-invocation basis where subsequent invocations of the same service may use completely different sub-services depending on their availability and performance. This dynamic selection of services allows a provider not only to keep the desired service levels due to the selection of the best available sub-services. In some cases it may even increase the quality of the overall service when new and better sub-services become available and can be used instead. Dynamic service provisioning is a crucial component for quality management in service ecosystems.

> **P_5:** The platform has to support the dynamic discovery, binding, and usage of sub-services.

In addition to discovering and binding services on-demand service ecosystem platform should also offer the possibility of adapting the criteria according to which sub-services are selected in a dynamic fashion. Thus it would be possible to increase quality by dynamically adopting the selection criteria based on faults that occur or user perception. For example, if a specific service composition using a certain payment processing sub-service systematically receives inferior ratings than service compositions that use a different payment sub-service the selection criteria should be adapted dynamically to reflect this quality information.

> **P_6:** Platform support for dynamic adjustment of selection criteria for sub-services to allow dynamic adaptation to changing user perceptions.

6.5 Innovation

Based on the vast amount of quality related data gathered during quality management much feedback is generated regarding the operational quality of a service, the user perception of that service, and even about different variations of the service (which might occur due to dynamic sub-service selection and adaptation). Moreover, the feedback contains usage information such as which services are successful in the sense of high usage volume and which are unsuccessful. Thus, in addition to user perceptions, user demand can also be derived. This feedback can be used in the early phases of the innovation process (idea generation and idea evaluation [26]) to guide new service development. We want to add to the catalogue of research questions for new service development (NSD) proposed in [17] by looking in particular at how quality related data can be used for that purpose and what aspects of service ecosystems can offer new and innovative ways for NSD.

Service ecosystems should provide a means for services to become better the more people use them. More usage means more information about successful service compositions, subjective consumer evaluation, and other operational performance data. Real time monitoring of consumer's behaviour should be used to find out how new services or new features of existing services are perceived by consumers to guide innovation.

> **RA_5:** How can quality data, especially perceived quality, collected during quality management be used for service process innovation?

In the area of service ecosystems this allows some interesting innovation scenarios where the most successful service compositions can directly be evaluated and extended. Furthermore, the repository storing all services registered in the ecosystem can be a source of tremendous innovation potential. Service requests that could not be filled by the repository could be used to identify possible service gaps that would be of interest to others. Based on that indirect expression of consumer demand new services can be developed. Services that are highly thought (searched often and executed often) may indicate highly-critical services which can be optimised or extended.

Further more, searches that do return a certain service in their result set but this service is never executed, may indicate that wrong keywords have been provided for the service and it is actually irrelevant to the search request. In that case service descriptions need to be adapted to make the service more accurately discoverable. If a service is part of a search result but the service is never used it may also mean that the service is too expensive, is missing key features, or has other problems and that a competitor's service is used instead.

> **RA_6:** How can general usage data be used for service product innovation?

Since services in service ecosystems are likely to be highly composite the process of designing new services is likely to involve several actors. For example, an analysis of service usage patterns might suggest which services are frequently used together and might thus lend themselves to bundling and the design of new, innovative composite services. However, this will require that several actors of the service ecosystem come together to analyse their service usage patterns.

> **RA_7:** How can actors collaborate to design new services based on actual usage information and quality measurement data?

In summary, much of the information highly thought after by marketing in traditional industries can be gathered relatively easily in service ecosystems. It can provide complete transparency of what services are searched, which are actually used, by which consumers they are used, what quality rating that usage resulted in, which services are executed concurrently, and which services are never found or never executed. The challenge and the opportunity is to use that information effectively for new service development.

7. CONCLUSION

The paper first introduced the concept of service ecosystems. It then shows how this complex and dynamic environment poses new requirements on quality management that are insufficiently addressed by current approaches. A quality management reference model is summarised that can be used to implement a quality management system for service ecosystems.

The reference model illustrates what challenges are posed by the complex and dynamic nature of service ecosystems. It also illustrates opportunities for research and practice in the context of service ecosystems, such as leveraging usage data for service innovation. It illustrates in particular how quality-related data gathered during monitoring can be used to support service innovation and allows novel approaches to new service development.

In the last part of the paper we propose directions for future research and challenges for the actual technical implementation. These premises for implementation and the research agenda represent the views of the four authors and is in no way intended to be final or comprehensive. Thus we hope it can stimulate further research in the emerging field of service ecosystems – or prompt constructive disagreement in a debate about the future research challenges in bringing to life the vision of web-enabled service ecosystems.

8. ACKNOWLEDGMENTS

Parts of this research have been funded by a research project within the Australian Research Council (ARC) Linkage Schema (grant code LP0669244) including financial support from SAP and the Queensland Government. This research also received funding from the German Federal Ministry of Economics and Technology (BMWi) under grant code 10MQ07024. The responsibility for the content of this publication lies with the authors.

9. REFERENCES

[1] Barros, A., and Dumas, M. 2006. The rise of Web service ecosystems. IT Professional 8(5):31–37.

[2] Barros, A., Dumas, M., and Bruza, P. 2005. The move to Web service ecosystems. BPTrends.

[3] Benatallah, B. et al 2002. Declarative composition and peer-to-peer provisioning of dynamic Web services. In: Proceedings of 18th international conference on data engineering (ICDE'02). IEEE Computer Society, Los Alamitos, 297–308.

[4] Benatallah, B., Sheng, Q., and Dumas, M. 2003. The Self-Serv environment for Web services composition. IEEE Internet Computing 7(1):40–48.

[5] Bessant, J. and Davies, A. 2007. Managing service innovation. In: Bessant, J.; Davies, A.; Tether, B.; Howells, J.; Voss, C.; Zomerdijk, L. and Massini, S. (eds.) Innovation in Services - DTI Occasional paper no. 9, Department of Trade and Industry, UK.

[6] Canfora, G. et al 2004. A lightweight approach for QoS-aware service composition. In: Proceedings of 2nd international conference on service oriented computing (ICSOC'04).

[7] Chesbrough, H., and Spohrer, J. 2006. A research manifesto for services science. Communications of the ACM, ACM Press New York, NY, USA, 49, 35-40.

[8] Dorn, J., Grun, C., Werthner, H., and Zapletal, M. 2007. A Survey of B2B Methodologies and Technologies: From Business Models towards Deployment Artifacts. In: Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS 2007), IEEE Computer Society.

[9] IfM and IBM 2008. Succeeding through service innovation: A service perspective for education, research, business and government. Cambridge, United Kingdom: University of Cambridge Institute for Manufacturing.

[10] ITIL Service Delivery 2003. ITIL service delivery. Crown, electronic edition.

[11] ITIL Service Support 2003. ITIL service support. Crown, electronic edition.

[12] Keller, A. et al. 2002. Managing dynamic services: a contract based approach to a conceptual architecture. In: Network operations and management symposium (NOMS 2002). IEEE Publishing, Washington, pp 513–528.

[13] Keller, A., and Ludwig, H. 2003. The WSLA Framework: Specifying and Monitoring Service Level Agreements for Web Services. Journal of Network and Systems Management, 11, 57-81.

[14] Maglio, P., and Spohrer, J. 2008. Fundamentals of service science. Journal of the Academy of Marketing Science, Springer, 36, 18-20.

[15] Maglio, P., Srinivasan, S., Kreulen, J. T., and Spohrer, J. 2006. Service systems, service scientists, SSME, and innovation. Communications of the ACM, 49, 81-85.

[16] Meise, V. 2001. Ordnungsrahmen zur prozessorientierten Organisationsgestaltung. Publishing house Dr. Kovac, Hamburg.

[17] Menor, L., Tatikonda, M., and Sampson, S. 2002. New service development: areas for exploitation and exploration. Journal of Operations Management, Elsevier Science, 20, 135-157.

[18] O'Sullivan, J., Edmond, D., and ter Hofstede A 2002. What's in a Service? Distributed and Parallel Databases 12:117–133.

[19] Parasuraman A, Zeithaml V. A., and Berry LL 1988. SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. Journal of Retailing 64(1):12–40.

[20] Parasuraman, A., Zeithaml, V. A., and Malhotra, A. 2005. E-S-QUAL - A Multiple-Item Scale for Assessing Electronic Service Quality Journal of Service Research, 7, 213-233.

[21] Paulson, L. 2006. Services Science: A New Field for Today's Economy. IEEE Computer, 39, 18-21.

[22] Pigneur, Y. and Werthner, H. 2008. Design and management of business models and processes in services science. Information Systems and E-Business Management, Springer, 2008, online first, http://dx.doi.org/10.1007/s10257-008-0078-0.

[23] Riedl, C., Böhmann, T., Rosemann, M., and Krcmar, H. 2008. Quality Management in Service Ecosystems. Information Systems and e-Business Management (ISeB), 2008, online first, http://dx.doi.org/10.1007/s10257-008-0080-6.

[24] Sawatani, Y. 2007. Research in Service Ecosystems. In: Proceedings of Management of Engineering and Technology (PICMET '07), Portland, 2763-2768.

[25] Spohrer, J., Maglio, P. P., Bailey, J., and Gruhl, D. 2007. Steps Toward a Science of Service Systems. Computer, Jan. 40, 71-77.

[26] van Gundy, A. 1988. Techniques of structured problem solving. Van Nostrand Reinhold, 1988.

[27] Wu, C., and Chang, E. 2005. A conceptual architecture of distributed web services for service ecosystems. In Dascalu, S. (ed), 18th International Conference on Computer Applications in Industry and Engineering (CAINE 2005), 209-214.

[28] Zeithaml, V. A., Parasuraman, A., and Malhotra, A. 2002. Service quality delivery through Web sites: a critical review of extant knowledge. Journal of the Academy of Marketing Science. 30(4):362–375.

[29] Zeng, L. et al 2004. QoS-aware Middleware for Web services composition. IEEE Transactions on Software Engineering, IEEE Computer Society, 30(5):311–327.

[30] Zhang, D., Chen, M., and Zhou, L. 2005. Dynamic and personalized Web services composition in E-business. Information Systems Management, Auerbach, 22, 50-65.