ERP On Demand Platform

Complementary Effects Using the Example of a Sustainability Benchmarking Service

The use of sustainability management information systems is again under discussion, this time on the subject of Green IS and IT for Green. Unlike former solutions, a new generation of software systems addresses the ecological improvement of all enterprise processes and enables an efficient provision of detailed environment-related information by connecting to ERP systems. Moreover, the integration of complementary sustainability management services promises – with the emergence of cross-enterprise, web-based platforms for business applications – both ecological and economic benefits. In this article, we show how the integration of a sustainability benchmarking service with an ERP on-demand platform generates self-reinforcing effects that can substantially support platform providers in market penetration and customer retention.

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1 Introduction

ERP applications offered as Internet-based software services (SaaS) so far only have a small market share (Benlian et al. 2009). The ERP world market leaders for traditional on-premise applications, SAP and Oracle, react ambivalently to this on-demand service: On the one hand, they point to the industry's continuing demand for traditional ERP solutions and are thus skeptical of the market potential of ERP on-demand solutions. Oracle founder Ellison considers it in principle difficult to make Cloud Computing applications more profitable (Forbes 2008). In addition to regulatory obstacles and critical privacy and security related aspects, SAP CTO Sikka particularly identifies so-called "mission-critical applications" to be a problem and therefore claims further technical development needs (InfoWorld 2010). On the other hand, SAP currently offers ERP on-demand solutions with Business ByDesign and Oracle via Netsuite. They bind significant corporate resources through the development of other software services, and see a growing willingness among companies to trust in cloud providers also for financial data (ComputerWoche 2010).

However, the changes which currently become apparent in the market for enterprise software are not limited to the choice between the alternatives ERP on-demand or ERP on-premise: Platforms for enterprise applications, such as "appexchange" by Salesforce or "Google Apps Marketplace" show how to successfully transfer the platform principle, as e.g. known from Apple's App-Store, to enterprise applications today. While the CRM on-demand provider Salesforce claims to already have offered more than 1,000 complementary services, so-called apps, via its Internet-based platform in October 2010, more than 200 different apps were available at Google's Marketplace six months after its opening in September 2010 that had already been used 4 million times. Given this success and the central importance of ERP software for managing companies, the integration of ERP on-demand and the platform approach appears promising.

This paper analyzes the utilization of the platform principle for an ERP on-demand provider. We do not consider possible cost savings for providers and users, but focus on the specific potential provided by an ERP on-demand platform. In our view, this mainly consists of the integration of complementary enterprise applications with the core ERP application and the resulting added value for service users as well as platform and service providers. We examine this value using the example of a software service for sustainability benchmarking (SBM) and explore how this may contribute to the lasting success of ERP on-demand platforms. As shown in Sect. 3, the quality of the SBM application as well as of corporate management can be significantly improved. In particular, a SBM software service that is integrated into an ERP on-demand platform is able to accelerate market penetration.

The paper is organized as follows: Sect. 2 summarizes the research on ERP on-demand and considers essential work dealing with the platform concept. Section 3 shows the relevance of an SBM for proactive corporate management and explains why it is advantageous to offer this service through an intermediary, i.e., a specialized software services provider. In Sect. 4, the integration of an SBM software service into an ERP on-demand platform is presented and a model to explain market penetration is developed using the system dynamics approach. Section 5 discusses the results and highlights further research needs.

2 State of the Art

In the following, we first outline the research gaps on ERP on-demand by means of a comprehensive literature search. We then explain the platform concept and discuss the essential work relevant for an ERP on-demand platform.

The scientific analysis of ERP applications designed according to the SaaS model has hardly been carried out so far. A search of title, abstract, and keywords in the databases Business Source Premier, MLA International Bibliography, EconLit, ScienceDirect, IEEE Xplore, ACM Digital Library, SpringerLink, DBLP, and Google Scholar found only six relevant results. As logical search term we used ("ERP" OR "Enterprise Resource Planning") AND ("on-demand" OR "as-a-service" OR "software-as-a-service" OR "Cloud Computing" OR "Platform as a Service" OR "PaaS"). The above databases considered the journals ACM Transactions on Information Systems, Communications of the ACM, European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of Management Information Systems, Journal of the AIS, Management Science, MIS Quarterly, and WIRTSCHAFTSINFORMATIK/BISE, among others. None of the six contributions found was published in one of these journals. In addition, Yang and Zheng (2010), Zhang et al. (2010a, 2010b) and Hofmann (2008) are merely three- or four-page conference or position papers and can therefore be considered only to a limited extent. Hajjat et al. (2010) and Chapman et al. (2010) can be classified as scientific research papers; however, they deal with the architecture of a SaaS service and the migration of data into an ERP on-demand service and thus only consider computer science related issues. It remains to note that the search for contributions from the business and information systems engineering (BISE) discipline provided no result through the above mention approach.

Table 1 Results of the literature review on "SaaS"

Databases	Search term: SaaS or Software as a Service[a]
Business Source Premier (including MLA International Bibliography, EconLit, and ScienceDirect)	11
IEEE Xplore	96
ACM Digital Library	6
Springerlink	2
DBLP	49
Google Scholar (without limitation to peer-reviewed journals)	144

[a] A detailed list may be requested from the authors

The literature review on the much more comprehensive concept of Software as a Service (SaaS) does provide a number of works presented in **Table 1**. In total, however, computer science related publications are dominant again, while IS-related contributions are available only sporadically. The contributions by Lehmann and Buxmann (2009) and Mathew and Sumesh (2010) dealing with SaaS and pricing have to be pointed out as well as Benlian et al. (2009) who empirically investigate the adoption of SaaS-based applications. Demirkan et al. (2010) analyze potential coordination strategies between software and hardware or infrastructure providers. Susarla et al. (2010) deal with modeling the relationship of SaaS providers and consumers as a principal agent problem illustrated by a SaaS CRM application. The question of what additional value is achieved through a SaaS-based application for enterprise customers by means of cost savings and flexibility or elasticity (Armbrust et al. 2009) remains unanswered.

In addition to Apple's App Store and marketplaces for business software offered by Google and Salesforce, generally platforms (also known as eco-systems) have long played a major role in information goods markets and in markets with physical products and services (Cusumano 2010; Kim et al. 2010). A central characteristic of such platforms is that actors using these platforms create more value together than alone (Kim et al. 2010, p. 151). Conversely, this means for the participating companies of a platform that their own success depends on the long-term vitality of the platform. This is especially true for knowledge-intensive industries such as ICT where companies often do not compete individually, but are sub-units in a competition of platforms which is highly influenced by self-reinforcing feedback (Arthur 1996, p. 104). In Sect. 4 we will tie in with this aspect and show how a SaaS-based SBM application that is integrated into an ERP on-demand platform may significantly contribute to the diffusion and economic success of the platform. For a start, however, we explain why SBM is increasingly relevant for companies.

3 SBM as a Service for Enterprises

3.1 Relevance of Sustainability for Enterprises

For years companies have been faced with expectations of different stakeholders to reconsider the direction of sustainability issues (Hoffmann and Busch 2008, p. 506). Practical implications for companies so far mainly concern the compliance to a variety of environmental laws in order to reduce liability or to allow better access to relevant resources. The growing trade of CO_2 emission allowances, the demand for green products, and sustainable investment funds are further indicators of the growing importance of an environmentally sustainable business policy (Chatterji and Toffel 2010; Dedrick 2010). Companies increasingly address the demands of the public, media, non-governmental organizations, and business partners for responsible, sustainable economic activities by means of certifications or publication of sustainability performance statements (Sharma and Henriques 2005, p. 174 f). Thus, in 2008 more than 80% of the *Global Fortune 250* published sustainability reports (KPMG 2009). The measurement and documentation of environmental impacts is meant not only to meet environmental compliance requirements (Sarkis 2003, p. 97), but also to provide a basis for improvements in a company's sustainability performance and resource productivity (Hervani et al. 2005, p. 330). This requires a systematic and deep analysis and control of all business objects, which includes not only a re-structuring of processes but also the development of innovations in the light of sustainability issues (Sharma and Henriques 2005, p. 160).

3.2 SBM for Corporate Management

In order to make a statement about the productivity of a business unit or a process, usually the use of a reference object to determine a performance gap is necessary. Such a comparative, relative efficiency measurement represents "the constitutive feature of benchmarking, which is a fundamental and by now well established concept of modern management and strategy research as well as business practice" (Hammerschmidt 2006, p. 89; translated). Benchmarking as a "search for industry best practices that leads to superior performance" (Camp 1989, p. 19) hence refers to a continuous, systematic process in terms of business administration which compares specific objects of study using various scales of reference. Due to an increasingly dynamic environment and complex markets on the one hand and limited rationality and scarcity of resources on the other, companies are striving to increase their own performance at reduced risk by means of learning from successes and failures of others. Solutions should not only be imitated, but rather seen in context with their own core competencies and developed further. The orientation towards competitors is also supposed to prevent that market requirements in resource allocation are not sufficiently taken into account. Benchmarking thus represents "a synthesis of the thesis 'market orientation' (search for opportunities) and the antithesis 'resource orientation' (capacity building)" (Hammerschmidt 2006, p. 93; translated).

In terms of sustainability policies Graafland et al. (2004, pp. 139 f) mention central reasons for SBM: It increases the transparency and credibility for stakeholders through the objectivity of a third party and improves the identification of a company's weaknesses. Eventually Reid and Toffel (2009, p. 1171) argue that companies often react to external requirements in order to follow their competitors who have already taken appropriate action. With the help of a SBM thus the next evolutionary step for the assessment of a company's sustainability performance can be reached (Hoffmann and Busch 2008, p. 506). The validity of information on a company's sustainability performance always depends on the quality and quantity of the provided data basis. In practice this means that with increasing scope and detail of information about a company's processes and products the potential significance of the sustainability performance to be measured can be increased (Melville 2010).

In addition to the comparative measurement and analysis in terms of a SBM, the establishment of methods such as ecological balance sheets or a Carbon Footprint for the systematic and comprehensive ascertainment of environmental effects has led to extending the consideration to cross-company processes. Here, it is essential to consider the entire life cycle of a product "from cradle to grave" (Tukker and Jansen 2006, p. 152 f). A particular challenge for the determination of the information results from the fact that for years companies have been reducing production intensity and outsource a variety of upstream processes to suppliers and other third parties for realizing specialization benefits. Accordingly, companies increasingly examine their entire value chain in terms of its (environmental) resource productivity in order to ensure the allocation of all environmental impacts according to their causes and to avoid double counting. Different institutions, such as the World Business Council for Sustainable Development or the National Renewable Energy Laboratory in the U.S., issue comprehensive recommendations as regards which environmental effects should be included in the analysis as inputs or outputs (Fava et al. 2009, pp. 492 ff). On the company's side, the need for detailed analyses exists (Wiedmann et al. 2009, p. 361), but the realization often fails as a consequence of difficulties in terms of data availability due to inconsistent approaches to the measurement and collection as well as the insufficient exchange of data between companies (Hoffmann and Busch 2008, pp. 517 f). In addition to such methodological problems, it is mainly the high costs of extensive analyses which hinder the sustainable development of enterprises (Butler 2011).

3.3 IT-Based SBM

During the last twenty years, information technologies have already led to crucial improvements as regards the operational efficiency of supply chains in terms of the well-established dimensions of cost, time, quality, and flexibility. Companies now also expect the realization of ecological improvements through the use of information systems, so-called "Green IS" (Dedrick 2010, p. 179; Melville 2010, p. 3). For example, ERP data on machinery and process lead times may provide a detailed data basis for sustainability management by linking these to respective energy costs and CO_2 concentration. Also in product development, the access to ERP data, such as material and supplier choice, could allow conclusions on environmental effects during the product life cycle. Different materials are made comparable by transformation into CO_2 equivalents and can therefore be included in calculating optimization. Furthermore, physical properties, such as weight or size, which may influence the transport and energy consumption during use and recovery of the final products, are calculated prior to development (Fuping 2010, p. 28; Linton et al. 2007, p. 1075).

Apart from increased data quality, also shorter reaction times constitute an essential benefit of information systems for sustainability management. To date, enterprises' sustainability-relevant data are mainly collected manually using questionnaires or semi-automatically through the import of different documents and tables (Butler 2011). Given the Global Reporting Initiative, the Dow Jones Sustainability Index, the EPA Climate Leaders Greenhouse Gas or Toxic Release Inventor for instance, a number of established and competing standards exists (Chatterji and Toffel 2010), causing immense personnel expenses both on the part of data providers through the data compilation and preparation and on part of the user during data collection. Therefore, companies often draw upon specialized service providers, such as SAP or C2P GreenTech info (Butler 2011, p. 19).

3.4 Advantages of an Intermediary

Currently available SBM on-premise applications allow extensive comparisons inside a company. However, to perform inter-organizational comparisons, enterprises often join benchmarking networks and groups exchanging experience, such as the Carbon Disclosure Project. This results from very high data collection costs as well as the necessary adaptation of data due to different software. The involvement in such a cooperative network platform is supposed to enable the transfer of core capabilities, which also includes tacit knowledge in addition to explicit knowledge assets (Hammerschmidt 2006). Although companies are pursuing different, sometimes contradictory objectives even within one value chain and inter-organizational benchmarking has long been considered unthinkable, it can be observed that companies increasingly realize that the additional benefits through collective "learning" may prevail the risks of opportunistic behavior for all parties concerned (Helper et al. 2000, p. 468). The essential importance of an inter-organizational exchange of information for meeting corporate sustainability objectives is also highlighted by Linton et al. who particularly identify the large potential for improvement in product development and reuse of raw materials and by-products through re-design (2007, pp. 1078 f).

Outsourcing not only reduces costs of acquisition and maintenance of relevant expertise and knowledge, but also increases objectivity and thus credibility with third parties (Kolk and Mauser 2002, p. 25). Furthermore, permanent contact and a greater number of relationships make it possible for a benchmarking service provider to detect trends early (so-called innovation effect). As a mediator between both sides of the market (data supplier and benchmarking consumer), he has a strong interest in permanently keeping up the relationship with the companies in order to save agreement and coordination costs for repeated acquisition of data and also to establish a positive reputation and thus create trust.

4 Integration of the SBM into an ERP On-Demand Platform

In the following we analyze how the integration of a SaaS-based SBM application into an ERP on-demand platform may significantly increase and accelerate the market success of both components. As a basis, we use an ERP on-demand platform which is not being offered at the market in this form. This platform for SaaS-based enterprise applications is characterized by the fact that the success of the participating actors significantly depends on the vitality of their platform (Arthur 1996, p. 100). This is, among other things, due to feedback effects which have been studied intensively as increasing economies of scale in economic disciplines, e.g., in the context of organizational path dependence (for a review see Sydow et al. 2009) or strategic management (Markides and Williamson 1996). Since comparative-static analysis methods do not allow for a holistic view of feedback of an integrated ERP on-demand platform, we have chosen a qualitative system dynamics approach that considers the systemic interconnections as well as complexity and dynamics of social and economic systems (Coyle 2001, p. 10; Forrester 2010).

4.1 Methodology

The bounded rationality and the predominantly linear thinking of individuals lead to the fact that decision makers often do not directly recognize dynamic behavior of social systems and their functional relations (Richmond 1997, p. 133) and, due to these misjudgments, make changes to the system that may have unintended consequences (Senge 1990, p. 58). Based on system thinking, i.e., the disclosure of mental models and the representation in formal models, knowledge about system identity such as its structure or behavior can be generated. In this case, each model element has a real world counterpart so that an adequate analysis of the causes of problems and their consequences contribute to decision making (Senge 1990, p. 73). Following the axioms of system dynamics, social systems interact with their environment. Interactions are represented via causal arrows between system elements, whereas the kind of impact (positive or negative) is visualized through polarities. Since any impact between two system elements directly or indirectly becomes a cause of new impacts itself, dynamic time figures evolve from cause-effect-chains, which can only be explained and predicted by means of models and sufficient knowledge of the internal system structure (Senge 1990, p. 63). Hence, the modeling process forms the center of system thinking (Forrester 1994, p. 246).

Forrester originally refers to the quantification and simulation of a formal model as a necessary step for the traditional system dynamics approach to reach a solution (Forrester 1961, 1994, p. 245). However, since the early 1980s more and more purely qualitative models have been developed which are limited to the description of the system and the creation of causal loop diagrams (Coyle 2000, p. 225). The starting points of these models are the lack of availability of valid data, the idealized representation of reality due to the restrictive nature of flow charts, and the tendency to develop models that are too detailed and complex to allow for common learning, which actually is the main purpose of system dynamics (Wolstenholme 1999, p. 424). Hence, especially in situations of great complexity and uncertainty, a qualitative approach in terms of "system thinking" (Senge 1990) or "qualitative modeling" (Coyle 2000, p. 225) is sufficient and appropriate (Forrester 2010). Here, hypotheses will be formulated based on an appropriate theory so that the problem behavior is (endogenously) generated from the feedback structure of the model. To visualize the hypotheses-based causalities, mainly causal diagrams are used. Following Coyle (2000, p. 240), the benefit of qualitative modeling results particularly from the facts that very complex problems can be visualized in a simple and compact form, that the problem focus is sharpened during the discussion and analysis, and that the identification of feedback can already explain system behavior. Since the objective of this paper predominantly consists of explaining the added value of an integrative SBM service within an ERP on-demand platform from a dynamic perspective for scientists and practitioners, in the following we develop a qualitative model that discloses feedback within the platform and offers sufficiently realistic predictive power despite simplifying assumptions to reduce complexity.

For this purpose, we will draw upon information and network economy for the definition and derivation of suitable hypotheses as well as upon concepts of adoption and diffusion research. The

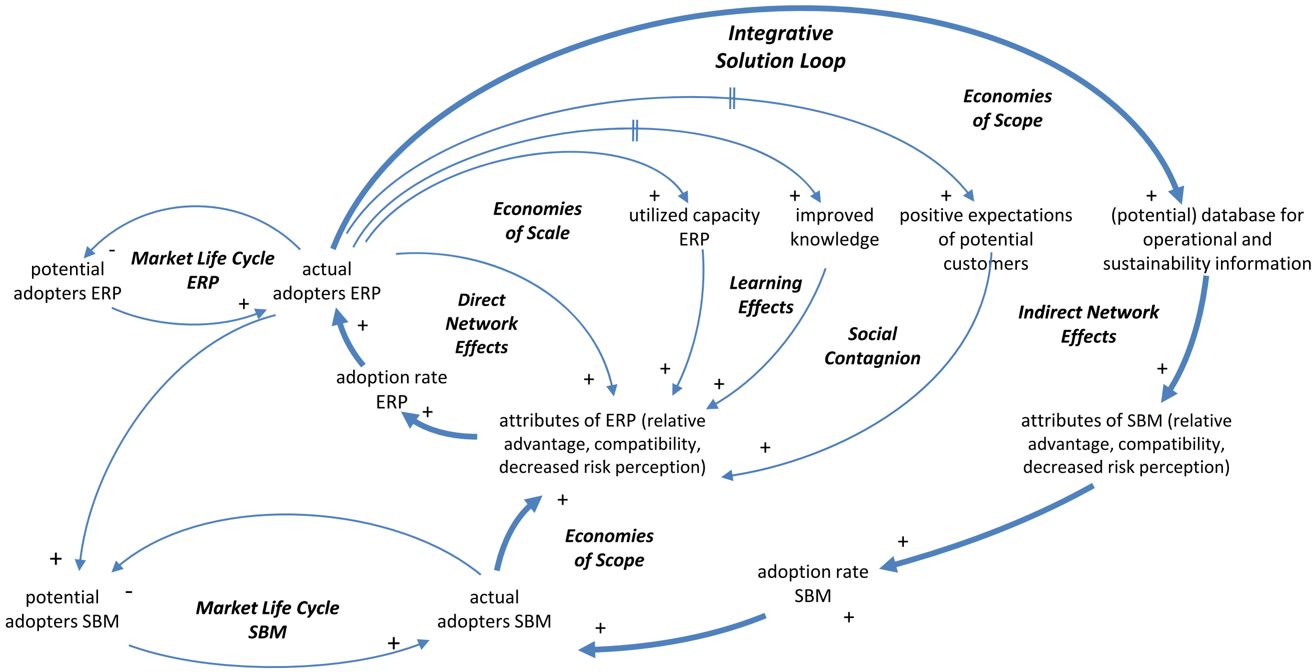

Fig. 1 Feedback of an integrated ERP on-demand platform

starting point of investigation is the problem definition, which is carried out from a dynamic perspective (Forrester 1961): How does an integrated SBM complementary service affect the market penetration of an ERP on-demand platform? The remaining aspects of the modeling process are subject of the next section.

4.2 Feedback of an integrated ERP On-Demand Platform

After a problem is defined, it is important to first identify key variables, i.e., central factors which explain the system structure and behavior patterns. A dynamic perspective requires the behavior of the variables over time to be taken into account. Key variables and temporal behavior eventually enable the development of a causal loop diagram which helps to detect and visualize cause-effect relationships. **Figure** 1 shows the result of our analysis. Due to the model's complexity, we first present the identified key variables and draw attention to their interactions. In order to facilitate the comprehensibility of the arguments for the reader, we will in the following distinguish between key variables and feedback.

Diffusion curve: Limited by the maximum market potential (*potential_adopters*), the diffusion curve of an ERP on-demand application and a SBM service can be described as an S-shaped curve through the aggregation of the individual purchase or adoption processes, becoming steeper with increasing diffusion or adoption (*adoption_rate*) (Rogers 2003, p. 272). Product-related factors are considered the most important influencing determinants for the diffusion of an innovation (Gatignon and Robertson 1985, pp. 850 ff). According to the classification proposed by Rogers (2003, pp. 221 ff), here the innovation attributes (*attributes_of_ERP/SBM*) relative advantage, compatibility, and complexity are particularly significant (Moore and Benbasat 1991, pp. 195 ff). Relative advantage represents a measure of the extent to which the innovation is preferred to alternative offerings. This superiority may result from economic reasons, time savings, or status issues. In addition to the existence of common standards, compatibility also describes the innovation's consistency with existing values, needs, and experiences of the consumer. While the first two influencing factors have a positive impact on the rate of adoption, complexity, i.e., the difficulty of understanding and applying an innovation, leads to a delay of adoption (cf. Rogers 2003, pp. 233, 249, 257). As an additional obstructive feature the perceived risk is mentioned as an influencing factor considering the fact that the adoption of an innovation is determined by the pursuit of risk reduction (see **Fig.** 1).

Network effects: Information technologies are often characterized by network effects when people use a common standard and thus form a common network (Brynjolfsson and Kemerer 1996). Here, direct network effects refer to the added value of a product resulting from the increasing number of network users (Katz and Shapiro 1985). These effects are identified in the model through the loop between *actual_adopters_ERP* and *attributes_of_ERP*. Particularly regarding the use and management of information systems there is a variety of standardization advantages both for the application and support of IT (Lee and Mendelson 2007, p. 395): The coordination of a standard platform facilitates the exchange of information, generates a larger repository of configuration knowledge and problem solving options, and increases the availability of complementary software. As already shown, this particularly applies to knowledge-based services such as SBM (see Sect. 3). Therefore, we can conclude that network effects are also of great importance for the success of an ERP service, since the diffusion of a system may additionally result in a higher interoperability (syntactic and semantic compatibility) between companies and provides an advantage compared to less common solutions. Another cause for network effects can be seen in so-called *learning and experience effects* (Arthur 1996, p. 103).

High-complex products, such as software applications, require an introductory period to establish a sufficient understanding (Moore and Benbasat 1991, p. 200). The resulting learning expenses and uncertainty of potential consumers have an obstructive effect on their adoption (Rogers 2003, pp. 233 ff). If an established standard exists, it is more likely that customers will be able to draw upon existing knowledge and easier to appoint employees who are familiar with the standard. Especially in case of standardized corporate applications, such as ERP systems, the experience and expertise of the users may lead to switching costs or even lock-in effects (Varian et al. 2005, p. 21).

Learning and experience effects on provider side: Conversely, providers may exploit users' collected experience and their suggestions for further product development. Moreover, they can gain experience (*improved_knowledge*) and develop capabilities (Rosenberg 1982) themselves in the course of service provision which can also be used for quality improvements (Fichman and Kemerer 1997, p. 1345). Furthermore, empirical studies show that in many industry sectors unit costs can be reduced by an average of 20–30% with a simultaneous doubling of output as a result of experience (Dutton and Thomas 1984, p. 235). Also an ERP provider will be able to realize some cost reductions with growing demand, among other things, as a result of increasing experience and specialization in data collection, data normalization and data analysis as well as through standardized contracts and volume discounts for the use of the network infrastructure, which in turn can positively affect the adoption rate. Since building knowledge and experience is time consuming, a delay must be taken into account during modeling. In the case of time savings here, e.g., a first-mover advantage may come into effect.

High fixed costs: Investments in building an information infrastructure and the production of information are usually associated with significant costs and uncertainty. Information is an intangible good which continues to exist even with repeated use and which can be quickly transported and consumed via media. Thus, costs largely occur during the initial creation of information, whereas reproduction and distribution cause very low marginal costs. Once these sunk costs are realized, information providers can achieve significant economies of scale with increasing dissemination of information (Arthur 1996, p. 100). Economies of scale and capacity utilization are also a major selling point for cloud computing (Armbrust et al. 2009, pp. 10 f). While development, maintenance, and administration of ERP applications in form of SaaS is carried out only once, the provider can quickly and inexpensively make the application available to a variety of customers via the Internet. The customer, in turn, uses the application via the Internet without owning it and pays for its use, usually in the form of a subscription fee (Lehmann and Buxmann 2009). The potential economic benefits of a software service from the customers' perspective can be seen in the fact that companies can afford IT departments that are not fully stretched with capacity limits that are designed for the maximum usage (Armbrust et al. 2009, pp. 10 f). At very different points in time and with fluctuating demand a specialized and large software service provider can then achieve a significantly higher utilization of data centers by means of statistical multiplexing and virtualization technologies. Moreover, additional economies of scale result from discounts for energy, hardware, and bandwidth when operating very large data centers (Armbrust et al. 2009). As shown in **Fig. 1**, the capacity utilization of ERP providers increases with an increasing number of users, which enables significant cost savings (*utilized_capacity_ERP*). These gains may – for example, through investments in improvements or price reductions – increase the relative advantage of the ERP service which in turn promotes adoption and dissemination.

Social influences: Since investments in enterprise software constitute adoption decisions which bear uncertainty due to their specificity, potential users, when searching for information and shaping preferences, frequently turn to the observed product selection of prior adopters (Bikhchandani et al. 1992) (*positive_expectations_of potential_customers*). Such effects are important for Internet-based goods and services for two main reasons: On the one hand, the complexity of the adoption decision resulting from the flood of data and information is reduced by means of selecting popular offerings. On the other hand, information about the preferences and decision behavior of third parties is more easily accessible in digital markets, due to e.g. recommender systems and user experience (Duan et al. 2009, p. 23). Duan et al. demonstrate empirically that informational cascades have an increasingly positive impact on the adoption of lower ranking products (Duan et al. 2009, p. 25). As opposed to network effects, informational cascades and social contagion (Angst et al. 2010) do not refer to the increase in economic benefits of the goods or services, but to the reduction of uncertainty. Since in accordance with the diffusion theory particularly late adopters and laggards adopt only after advanced steps of dissemination (Rogers 2003, pp. 284 f), we may assume a substantial time delay also here.

Economies of scope: If a provider is in a situation where it is more cost-effective to market several products jointly, economies of scope or synergistic effects may result (Panzar and Willig 1981, pp. 268 ff). Often these effects originate from sharing common resources and the transfer of skills (Markides and Williamson 1996, p. 340). Economies of scope on the consumer side are often referred to as indirect network effects (Katz and Shapiro 1985, p. 424). The benefit increase is not a direct result of the relation between the actors of a network, but is rather caused by the additional (further) development of complementary services due to the increasing numbers of users. Today, sustainability benchmarks are primarily based on published data which partly can be questioned in terms of their reliability and objectivity and thus ultimately as regards their information value (Chatterji and Toffel 2010, p. 1163; Graafland et al. 2004.). Although the offers from established software vendors like SAP and Microsoft basically provide an automated access to various information systems using appropriate application programming interfaces, but also here the data basis is mostly provided by estimated "average" values. The comparison with the industry average (average practice) is contrary to the principle of benchmarking which inherently focuses on the best comparison partners (best practice) (Camp 1989, p. 19). Furthermore, a superficial investigation and use of highly aggregated and unverified data does not allow for an effective detection of performance gaps in accordance with the objectives of SBM (Hervani et al. 2005). Overall, providers of larger enterprise solutions appear superior compared to specialized benchmarking service providers, since the latter must first develop interfaces for greater automation with customer information systems. In addition, ERP and SCM providers may, possibly in interaction with their own benchmarking services, draw upon existing competencies in the design of business processes and better ensure syntactic and semantic comparability of data (*database_for_operational_and_sustainability_information*). In doing so, ultimately also the proportion of quantitative information for sustainability management can be increased.

Self-reinforcing effect of an integrated ERP platform: As **Fig. 1** illustrates, the combination of an ERP on-demand system and a complementary service such as the SBM leads not only to complementary effects on the sides of both providers and consumers. Instead, the combination also leads to a complex positive feedback effect that mutually intensifies the diffusion of ERP on-demand and SBM services. A combined ERP and benchmarking application duplicates the scale effects as both services are provided completely digitized. The reason is to be found in very large data centers which lead to considerable cost savings when purchasing hardware, network bandwidth, and power compared to medium-sized data centers (Armbrust et al. 2009, pp. 5 f). Theoretically, any on-demand benchmarking provider may operate very large data centers and thus ultimately achieve low unit costs. However, this requires a sufficient workload to actually achieve the targeted reduction in unit costs.

This is exactly where the integrated ERP and benchmarking on-demand provider which can start from an existing ERP customers' base achieves a systematic advantage. It begins with a higher workload than a service without ERP basis. In this way, the provider is able to share realized unit cost reductions with the customers through reduced prices and to gain additional customers. Consequently, with each additional benchmarking customer the unit costs decrease so that again more customers are attracted through price reductions. Such an extreme unit cost digression is not possible for a traditional provider since a saturation point is quickly reached and additional customers again increase costs at some point.

5 Discussion and Outlook

The subject of this paper is the integration of a sustainability benchmarking application into an ERP-on-demand platform. The focus is on the potential added value and market penetration of the services offered. After discussing the relevance of a SBM for proactive business management, we used network and information economy as well as diffusion and adaptation research to identify and describe feedback effects and key variables between the core ERP application and the benchmarking service. Using the system dynamics approach we then developed a dynamic model visualized in the form of a causal loop diagram. This allows a holistic view on interdependencies. As result, an ERP on-demand platform with an integrated SBM service promises a more rapid and deeper market penetration for both applications compared to a separate offer.

However, the results of the demonstrated advantages of an integrated ERP on-demand platform have to be put into perspective in several respects. By means of the developed qualitative model we achieve the objective to visualize decision-making possibilities for researchers and practitioners through the identified structures and patterns of behavior. However, no statements about the extent and strength of the effects can be made. This would require a further step involving the extension of the qualitative model to a parameterization and quantification in the form of mathematical simulations according to the traditional system dynamics approach (Forrester 1994, p. 245). This would allow for an evaluation by means of iterative simulation runs and ultimately a market forecast for the optimization of marketing strategies and capacity planning. A second limitation arises from the assumptions about the willingness of companies to provide data for the ERP on-demand provider. This "optimistic" assessment is based on the fact that companies already using SaaS applications must rely on a trustful handling of their data. In the event of a failure, ERP on-demand providers such as SAP explicitly arrange for system access.

According to our analysis, running an ERP software service as an application platform also appears profitable for other services that are based on ERP data in a similar way as benchmarking services. Given the central importance of an ERP system for corporate processes, the integration of applications requires a particular accuracy (Benlian et al. 2009, p. 422). Applications, such as ERP systems and benchmarking services, which have greater strategic importance and specificity should be offered by the platform provider. Due to his responsibility and liability for the entire platform, this indicates more credibility for potential customers than if offered by an individual complementary service provider. Such additional applications would in turn lead to both a better utilization of computing capacity and to a higher attractiveness of the offer for customers. In this context, it is interesting for practice whether third-party providers similar to Apple's App Store should be approved, which consequences may result from the competition between the applications on the platform, and thirdly, how they should be positioned in regard to the platforms of ERP competitors. An answer to these questions requires extending the presented model to competitors and intense competition.

The admission of third-party providers makes it appear reasonable to evaluate the impact on trust relationships. Since companies will not necessarily trust third-party providers on a platform to the same extent as the ERP provider, trust building measures such as reputation or isolation mechanisms, e.g., access monitors (Schneider 2000) or process analysis (Accorsi and Wonnemann 2011), must be evaluated. In particular, the multi-party computation approach could play a central role for this purpose (Yao 1986) as this approach focuses on enabling the comparison of data between systems without disclosing the data between these systems. The threshold for the participating companies to provide data would be reduced significantly.

The increasing connection of objects to the Internet, such as cargo containers, electricity and gas meters, or machines equipped with temperature, motion, position, or moisture sensors, provides significant potential to further improve the data base for SBM providers (Dedrick 2010; Melville 2010). Apart from direct and detailed energy consumption that can be measured in an automated way, precise tracking of containers and products allows for a more accurate determination of CO_2-emissions. However, the cross-company exchange and thus the provision of these data for a SBM require information exchange infrastruc-

Abstract

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ERP On Demand Platform

Complementary Effects Using the Example of a Sustainability Benchmarking Service

Platforms for SaaS-based enterprise applications are prospering and the number of on-demand ERP vendors is increasing. We combine both phenomena for the first time and illustrate how the integration of a sustainability benchmarking service into an on-demand ERP platform provides added value beyond pure cost savings. By applying a qualitative system dynamics approach we identify self-reinforcing mechanisms which allow a faster and more comprehensive market penetration compared to providing these services separately.

Keywords: ERP-On-Demand, Diffusion, Platform, Qualitative System Dynamics, SaaS

tures which are so far only rudimentarily available. Finally, the availability of better data will not necessarily lead to higher benchmarking quality (Wiedmann et al. 2009). To account for a large number of comparison criteria, such as cost, CO_2-emissions, waste, or product units, appropriate procedures should be used. Therefore, it is necessary to examine to what extent they are already available.

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