On the advantages, perils and pitfalls of using Cloud Computing and Open Source Software in Small and Medium-Sized Businesses. The case of a German entrepreneurial company

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Abstract

Cloud computing (CC) and open source software (OSS) both stand out to be valuable means to address prevailing requirements of small and medium-sized enterprises (SME). For instance, such requirements include their demand for flexibility, scarcity of skills and money, and their operative focus. This paper investigates the case of e-commerce adoption by means of CC and OSS in a venture capital driven entrepreneurial SME in the online retail industry. The case study provides qualitative evidence that some of the commonly asserted value propositions of CC and OSS do not hold true in real application scenarios. For instance, the cost-saving and flexibility aspect, often mentioned with regard to CC, seems to be largely questionable. Even though OSS can help to save money, its pay-off on the scarcity of skills and flexibility requirements of SME is seen to largely prevail.

Keywords

E-commerce, open source, cloud computing, small and medium-sized enterprises.

Introduction

Undoubtedly, the Internet is the driving force for electronic commerce (e-commerce). In 1994, first came the vision of Jeff Bezos, founder and chief executive officer (CEO) of Amazon. Bezos believed that by massively using the Internet as distribution channel, the company could become the largest bookseller in the world. With an annual turnover of more than 74 billion dollars in 2013, Bezos' vision has since long become true. Amazon has not remained an online bookstore, but it is the world's largest online retailer.

Since 1994, many underlying technologies have been invented and developed. The speed at which this development took place is unmatched in history. While transaction costs such as the cost of accessing the Internet dropped sharply, computing power doubled almost every 18-month.

The open source software (OSS) movement brought up a variety of infrastructure technologies such as Linux, Apache, sendmail, programming languages such as PHP as well as database management systems such as MySQL or PostreSQL. More recently, the open source movement has also contributed entire e-commcerce systems at the application layer. For instance these include Magento, PrestaShop, osCommerce, Oxid and xt:Commerce, to name a few.

The latest driving force of e-commerce has become the cloud computing (CC) paradigm, since entrepreneurs are no longer forced to invest into expensive infrastructure and hardware. Instead they can

-at least in theory- purchase the required software and hardware as business evolves by leveraging the pay-as-you go paradigm of cloud-based business models.

Within the frame of this paper, we investigate the case of a small entrepreneurial e-commerce company by means of in-depth analysis of a single case study. Essentially, we would like to draw propositions on benefits and risks of the joint use of cloud computing and the open source paradigm as the primary means of infrastructure sourcing. The fundamental research question we would like to contribute to is: which of the commonly anticipated benefits of either of the two involved concepts really materializes in the context of small entrepreneurial e-commerce companies and what risks may an SME encounter.

We employ the case study research methodology (CSR) proposed and discussed by scholars as Eisenhardt (Eisenhardt 1989, Eisenhardt & Graebner 2007), Yin (Yin 1994) and Benbasat (Benbasat 1987). This method is especially useful in orer to derive rich and insightful descriptions of a specific instance of a phenomenon, which according to Yin (1994) should be grounded on a variety of data sources. For our research we had the opportunity of unlimited access to log files from instant messaging tools, email exchange between the SME and the development partner, the operative task tracker MantisBT as well as a rich set of project planning documents.

Although it is evident that multiple cases would strengthen the course of argumentation towards a common thread (Yin 1994, Eisenhardt 1989, Benbasat 1987), the revelatory nature of the selected single case prevails (Siggelkow 2007, Benbasat 1987). This is because one would hardly find other evidence of companies small in size, entrepreneurial in nature, and venture capital funded that is taking the risk of being an early adopter for cloud computing and massively employing OSS throughout the entire value chain.

Structure of the paper

The paper is structured as follows: First the related concepts cloud computing (CC) and the open source software (OSS) movement are explained. We briefly highlight the fundamentals of each of those concepts and outline the individual value proposition they offer for small and medium-sized enterprises (SME). Consequently, we introduce the case and summarize different development steps as well as the challenges that appeared during the company's growth. Furthermore, we will contrast the anticipated general value proposition of CC and OSS as taken from the definitions and related literature with the concrete case experiences in order to finally derive hypotheses on a model of success factors and risk while combining the two paradigms within an entrepreneurial e-commerce growth strategy.

Related terms

Cloud Computing

An early definition by the European Network and Information Security Agency (ENISA) describes cloud computing as an “on-demand service model for IT provision, often based on virtualization and distributed computing technologies” (Perili et. al. 2009). The German Bundesverband Informationswirtschaft (BITKOM) defines the term as a form of demand-actuated and flexible IT asset utilization that is being provided in real-time over the Internet and paid per use (Münzl et. al. 2009). The National Institute for Standards and Technology of the U.S. Department of Commerce defines the term as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” (Mell and Grance, 2011). A unanimously agreed upon, as well as commonly shared, definition on cloud computing does not exist (Vaquero et. al. 2009). However, the following collection provides a set of features that is condensed from the definitions provided by related literature.

Scalability (Goyal and Dadizadeh 2009; Lewis 2010; Buyya et. al. 2009; Nurmi et. al. 2008; Mell and Grance, 2011), *variety of resources* (Goyal and Dadizadeh 2009; Lewis 2010; Armbrust et. al 2009; Nurmi et. al. 2008), *virtualization* (Perili et. al. 2009; Goyal and Dadizadeh 2009; Lewis 2010; Buyya et. al. 2009), *pay-per-use* (Perili et. al. 2009; Goyal and Dadizadeh 2009; Buyya et. al. 2009), *resource optimization* (Perili et. al. 2009; Goyal and Dadizadeh 2009; Buyya et. al. 2009) and *automatic adaption*

(Lewis 2010; Buyya et. al. 2009; Nurmi et. al. 2008) are the topmost mentioned features of cloud computing. Its fundamentally *internet-centric business model* (Goyal and Dadizadeh 2009; Armbrust et. al 2009), *user friendliness* (Buyya et. al. 2009; Nurmi et. al. 2008) and *service-level agreements* (Buyya et. al. 2009) are features that are also part of some definitions. In summary, cloud computing is essentially a new IT procurement model that substitutes long-term strategic investments decisions with a demand-oriented, short-term style of procurement.

Open Source Software

The term open source has been invented jointly by Tim O'Reilly, Bruce Perens and Eric S. Raymond. In 1998, during the days of the well-known browser war, these three men were consulting Marc Andreessen, founder and former chairman of Netscape on strategy (Raymond 2001). During the aftermath of that meeting, Netscape decided to distribute the source code of its browser freely under an open source software license (Netscape 1998).

Microsoft's strategy, to ship its browser MS Internet Explorer together with the operating system Windows, had massively diminished Netscape's market share and destroyed its business model. The terms open source software and free software[1] are closely related and differ mostly on an ideological level. Open source became the world's most popular term for this software development and distribution paradigm. Open source software[2] requires three fundamentals:

Firstly, the software must be available in a human-readable and understandable form. This means the source code has to be available. Secondly, the software must be freely usable, copyable, and (re-) distributable. Thirdly, the license must allow changes and modifications, and permit redistribution of modified versions of the software (O'Reilly 1999).

Since its invention by Finnish computer hacker Linus Torvalds in 1992, Linux became the driving force of open source software. Today it is the most popular operating system in data centers across the world, and as such, runs on almost all of the 500 top-ranked supercomputers in the world. Henceforth, Linux has become one of the major synonyms for OSS. Open source software recognizably changes the proprietary software development and distribution paradigm. Table 1 shows the most prominent differences. It is important to differentiate between traditional open source software and commercial open source software. The former usually grows out of a community of interest; the latter is usually introduced by a single commercial entity, and often a former proprietary software product.

	Proprietary software	**Traditional open source software**	**Commercial open source software**
Software type	Proprietary	Open source	Open source
Kind of distribution	Only binaries	Source code and binaries	Source code and binaries
Development process	Closed, usually non-public roadmap	Open, often no visible roadmap	Semi-open, often visible roadmap
Support	Usually by vendor or system integrators	Community or specialized system integrators	Vendor, community or specialized system integrator

[1] Term already exist since Richard M. Stallman started the GNU project in 1984

[2] Free software requires the same

Cost	License fee and / or perpetual support fee	No license cost, specialized system integrators may ask for support contract	No license fee (open source license), license fee (commercial license) and / or perpetual support
Code changes to core components by end-user	Not possible	Possible	Possible
License type	End-user license agreement (EULA)	Open Source License	Open Source License / Commercial License
Example	Windows, SAP	Apache Webserver, Linux	MySQL, SugarCRM, Magento

Table 1: Differences between open source and proprietary software

Summary on the individual value propositions

SMEs, according to the actual definition of the European Commission, are companies that have less than 250 employees and an annual turnover of less than or equal to 50 Mio. €, as well as a balance sheet total of less than or equal to 43 Mio. €.

SMEs can be differentiated from large enterprises by a couple of specific requirements. For example, SMEs need to be much more flexible than large enterprises. They have to react to changing environmental conditions and customer demand much faster than large enterprises in order to maintain their share in the market. Usually they are not as diversified as large enterprises, nor do they usually poses a large relative market share. SMEs usually do not have enough financial resources to strategically restructure their product and service portfolio if external conditions (e.g. customer demand / bargaining power of suppliers) change. Due to their limited brand recognition, scarce monetary resources, and often limited local visibility, the war for talent is significantly harder for them.

In summary it all comes down to their ***operative focus*** (Wang et. al. 2006) and prevailing ***demand for flexibility*** (Stonehouse & Pemberton 2002; Passerini et. al. 2012). ***Scarce resources*** of ***skilled people*** and ***money*** (Windrum & Berranger 2002) are reinforcing these requirements. Cloud computing as well as open source software offer SMEs various advantages with regard to these generic requirements. Table 2 aligns the value propositions of CC and OSS to those requirements.

	Cloud Computing	**Open Source Software**
Demand for Flexibility	Scalability	No vendor lock-In, test upon demand, ability to modify code
Scarce money / cost	Pay-as-you go	No license cost
Scarcity of skilled people	User-friendliness	Open source community
Operative focus	No strategic investment into	No long-term contractual

	hardware assets necessary. Landscape grows as business expands	requirements

Table 2: Generic value proposition with regard to the generic constraints of SME

Case Study

The instance of this case study is a young entrepreneurial company. It started back in mid-2011 with a team of 3 people, and expanded its operations throughout 2012 and 2013 to reach an actual headcount of roughly 30 employees. The forecasted annual turnover is 10 Mio. € by mid 2014. The company extensively used, and will continue to use, open source software and the cloud computing paradigm within its business development. After initially starting with private equity of the founders, the company received two rounds of venture capital (VC) funding; first, from a group of peers that contributed own equity, and more recently from a well-known family office. The company offers around 10000 different products in five categories. Its focus group is young women between 18-35 years of age. The company operates a special-interest shop and belongs to the food industry.

The case study covers the entire growth period of the company from mid-2011 until the end of 2013. During that period, a major redesign of the e-commerce platform has been accomplished (as of February 2013). The system landscape has been extensively expanded to match the requirements in terms of usability, transactions, and visitors. Although the company owns a small shop, the vast majority of trade is conducted online. The company maintains stocks at its headquarters, at a logistic partner approximately 300 km away from its headquarters, and also operates via drop-shipping. Drop-shipping means the producer of the goods ships them directly to the end customer upon trader's request.

Outset of the project

The company decided to implement the Magento e-commerce platform. Magento is the market leader in OSS-based e-commerce solutions. Magento is commercial open source software, offered with either a community license[3] or an enterprise license. Magento was acquired by Ebay Inc. in 2012. At the beginning of the case study, there was evidence that the company had already invested an amount of close to 25.000 € to implement the first version (HTML templates and initial setup) of the online store. However, the shop was not fully operating as of August 2011. The checkout process was not working at that time, which meant that customers couldn't make final payments for goods in their shopping carts. This caused the business to postpone the initial test phase (closed customer circle) by roughly two weeks until the problems with the checkout, and some other major performance issues, had been fixed.

The first version of the IT infrastructure already leveraged cloud-based infrastructure. The company sourced two LAMP-stacks that comprised Linux, Apache, MySQL, and PHP from Rackspace; one for their production system, and one for running a test system and a blog aside. Rackspace is a globally operating U.S. based cloud computing company located in San Antonio, Texas with 10 data centers across 6 global regions, close to 5000 employees, and a 2012 annual turnover of 1.3 billion dollars. Rackspace, along with its larger competitor, Amazon, is considered to be a pioneer in the CC market, and it offers infrastructure cloud components as well as IT managed services.

Initial phase

During the first phase of the case study, the supplier had to fix several issues with used JavaScript libraries before the checkout procedure was finally working and the test-run could finally commence. An investigation of the case had shown that the primary installation was overloaded by improper use of

[3] In case of Magento this is the OSI-accredited Open Software License (OSL)

JavaScript functions. However, after fixing the obvious problems that had hindered customers from purchasing products, Magento unveiled several performance problems that had to be fixed iteratively.

Most of the performance issues, according to the supplier, stemmed from the software design of Magento. The software design uses a flexible design pattern to abstract domain models from database entities. This design pattern is named the entity, attribute, and value (EAV) model. Since this pattern adds complexity to the runtime layer, the performance of Magento is relatively poor in standard installations, and requires considerable performance tweaking. This is due to the fact that even comparably easy transactions require the database to do a lot of joins to create objects from almost normalized relational database tables.

Whereas other e-commerce systems -such as Oxid- allow comparably easy performance tweaks that can be done at database (MySQL), webserver (Apache), or middleware layer (PHP), Magento requires the full range of database (e.g. query cache, storage engine, index structures) as well as Apache and PHP tweaks in order to work. Furthermore, multiple caching hierarchies based on memcached and the full-table cache Varnish needed to be employed. Even if all of these productivity tools were open source software as well, it needed a good deal of expertise and engineering to combine these software artefacts. However, by using and integrating all these means, the supplier was finally able to reduce the processing time for a single page rendering from close to a second to under 0.1 seconds.

Integration phase

Within the following integration phase several additional systems have been ramped up and partly connected by the supplier. Amongst these integration steps were:

- Ramp-up and integration with after sales system ORTS via SOAP / WSDL
- Ramp-up of an email management and file storage solution based on Microsoft Office 365
- Implementation and integration of a custom-build order tracking module
- Stock and shipment data synchronization with the used proprietary, cloud-based enterprise resource planning solution Actindo
- Ramp-up and integration of the weblog applications Piwik and Google Analytics

Re-launch and scale-out

Towards the end of 2012 / beginning of 2013, a redesign and major re-launch project was part of a marketing campaign conducted within the third phase of venture funding. This project included a complete redesign of the shopping front-end, as well as the planning and roll-out of a massive, cloud-based scale-out architecture. The challenge was to increase the amount of potential database transactions (e.g. concurrent checkout quantity) from 10 to 300 and delivery of pages by at least the factor 100. By applying an analytical test framework based on the OSS test suite JMeter, the Apache webserver and the integrated search of Magento have been identified to be critical bottlenecks regarding the desired maximum workload. The supplier used the analytical test framework to perform the five important consecutive steps:

- Analysing the as-is user-interactions regarding structure
- Cloning productive infrastructure and run tests to identify bottlenecks
- Debottlenecking and instantiation of the to-be scale-out architecture
- Validating the assumptions with increased artificial workload
- Revalidation of assumptions with real workload

Comparison of value proposition with case study results

In the following table, we contrast the general constraints of SMEs, which are their ***demand for flexibility***, the ***scarcity of money***, the ***lack of skilled people,*** and their ***operative focus*** with the findings from our case and the general value propositions of the two technology building blocks. The results are shown separately for cloud computing and open source software.

	Cloud Computing	**Open Source Software**
Demand for Flexibility	The cloud infrastructure is quite flexible. It allows one to easily configure additional instances if this is demanded (e.g. by TV campaigns). However, cloud computing offers in field of e-commerce applications that are not yet usable at a SaaS level. In stark contrast to CRM solutions, for example. This means the infrastructure layer can be scaled, whereas the application layer still requires a lot of manual and technically-skilled work.	The ability to change code and especially the flexibility to combine open-source based applications systems has proven to be of unprecedented value for the rapid growth of the company. In the investigated case as much as five open source infrastructure and application systems have been connected and integrated. The consequent usage of OSS across the IT chain allow to change everything that needs to be changed. Anyhow, considerable engineering is still necessary.
Scarce money / cost	Cloud computing might not be that cheap. Especially if the demand isn't too volatile and limited to special time frames (e.g. typical e-Commerce scenarios). The capital risk of downtimes as well as the hardware maintenance cost are mitigated / lowered by the cloud business model, though.	Even if there is no cost for licenses, improvements to application systems in order to create sustainable business benefit still require skilled personnel and considerable investment. In fact, common requirements can be developed jointly by cost sharing partnerships. But the flexibility of OSS especially allows SME to turn money into sustainable competitive edges.
Scarcity of skilled people	Even if cloud infrastructure instances can be easily created, backuped, cloned, destroyed, and monitored, the application layer still requires skilled people. The scarcity of skilled people is not linked to a certain kind of proprietary software or infrastructure component, hence. Instead an SME can	The open source community of established OSS applications such as Magento, ORTS or others is an invaluable source of information and skilled personnel.

	source skill from a wide community of OSS developers and integration partners.	
Operative focus	This has proven to be a major benefit. Investment and purchase of hardware can be almost entirely substituted by ad-doc procurement. By connecting OSS components in the right way an almost linear scale-out allows to concentrate on the operative business. This would not be possible with dedicated infrastructure components that need to be purchased and installed, rather than just provisioned.	Although open source software does usually not involve long-term contractual obligations, strong partnerships between users (in our case the SME) and developers (the development partner) are necessary to keep systems up and running and fix problems. In this regard OSS does not differ from proprietary products.

Table 3: Comparison of value propositions with case findings

Drafting propositions from cases

After introducing the terms cloud computing and open source software, we have provided an overview of the generic value proposition of CC and OSS with regard to the special economic perspectives of SMEs (see Table 2). We have presented a case study that has been conducted on a venture capital funded German entrepreneurial company and the development as well as expansion of its system landscape between 2011 and the end of 2013. Finally in the previous section we have contrasted the case study findings with the general value proposition of CC and OSS with regard to SMEs. In summary we draw the following propositions regarding the qualitative character of SME.

Demand for Flexibility

- Unlike its general value proposition, cloud computing might still lack flexibility in regards to changing business models, business processes, and scaling business. When speaking of cloud computing, one could assume building or aligning a system landscape is just a matter of selection, combination, and actual usage and doesn't involve technical skill. Reality is different, however, overarching concepts and standards regarding service level agreements (SLA) and exchange interfaces do not yet exist. This is a general problem, at least for overall risk considerations. The availability of scalable and modifiable e-commerce cloud computing offers in the SaaS provisioning mode is limited to standardized single instance shop solutions rather than multi-node scale out solutions.
- In order to leverage the plethora of possibilities to flexibly combine different open source software components, SMEs must select their suppliers carefully. The supplier that planned the scale out and did most of the debottlenecking, testing, and feature add-ons during all phases and was capable and always matched customers' expectations. The system administrator as well as the designers responsible for the re-launch did not perform as expected. The dependence on external skill cannot be alleviated by either CC or OSS, it is supposed to be a function of company size and supplier management rather than technology strategy.

Cost

- Cloud computing, especially compared to dedicated and managed hosting, is still at its infancy. Huge savings are not materializing. In our case, monthly rates after scale-out were approximately 2000 € a month including on average 4 webserver nodes, a database server node a test instance, and a special purpose node for static content (cloud files) plus additional 2000 € for system administration. Dedicated resources within the computing center of a German infrastructure provider such as Hetzner, Strato, or 1und1 should be comparably cheaper. Furthermore cloud computing creates new vendor lock-in because SLA's and migration interfaces are not standardized across the industry. This might become crucial in the future. The fact that Rackspace is massively pushing for the standardized cloud platform OpenStack, that theoretically allows easy migration across providers, might alleviate that risk.
- With OSS, SME can save money as compared to proprietary software. However, integration, development of add-ons, and user-specific customizations still require significant investments. In our case, investments into the strategic development of the IT-platform sum-up to almost 0.5 Mio. €. A major benefit is that given the appropriate OSS license, the SME can turn money into sustaining competitive edges by means of qualified development partners. This is a major benefit over proprietary software that would hardly allow turning a standardized software product into a customized e-commerce platform. Throughout the case study period internal staff accounted for multiple development expenses. Contrasting these figures, it is hard to believe that license cost of 30000 € would have been decisive if a proprietary system would have been more flexible then Magento. The fact that proprietary software does not allow to create sustainable competitive edges is by far the more convincing argument.

Scarcity of skills

- Cloud computing –at least at the investigated infrastructure layer- is relatively user-friendly. It is comparably easy to instantiate, clone, or delete virtual nodes. However, a complex e-commerce platform still needs skilled personal that SMEs usually do not have. The scarcity of skill is not significantly eliminated by the increased user-friendliness of cloud platforms, but remains a common and largely technology-independent threat.
- Mature, well-established OSS usually comes with a huge community. Skills are easier to acquire as compared to proprietary software. Partly because OSS is often built on top of other OSS (as in the case of Magento), and partly because the user base is considerably larger (i.e. common need is a precondition for building out OSS communities). Major reasons for open source developers to take part in open source projects are peer recognition as well as job prospects. Due to this open and collaborative development process that is common for open source software development, resources are more visible, contribute code and knowledge, and interact across organizational boundaries. Consequently, skill is more readily available for mature OSS with a huge installed base and community than for proprietary software products.

Operative focus

- CC, compared to traditional hardware investments, is significantly advantageous with regard to the operative focus of SMEs. It substitutes long-term (strategic) investments with on-demand procurement and provisioning. However, this operational advantage can easily be overcompensated by higher cost and vendor lock-in.
- With regard to the operative focus, OSS does not largely differ from proprietary software products. As for business continuity, reliable long-term support partnerships need to be established in order to keep the business up and running. The only difference is that open source software, due to its paradigm and distribution model, can be downloaded, tested, and used in the very moment somebody decides to do so. Proprietary software still comes with the burden of purchasing licenses and potentially license enforcement (dongle, online-checks, etc.). However, this process has been streamlined in the context of digital distribution of immaterial goods.

Literature link and discussion of findings

Rolandsson et. al. (2011) recently investigated the impact of the open source development paradigm on the classical software industry. By investigating different software vendors (proprietary, hybrid as well as open source), the authors found out that open source, in general, altered software engineering concepts visibly towards a more open and collaborative work style and knowledge exchange. This is well in line with the case study findings. The open and collaborative style of the Magento community allowed the development partner to source additional developers as well as test-run, improve, and integrate modules that have been invented by other users. In our case, OSS has been widely used for the IT systems linked to the primary value chain. With regard to desktop productivity tools, communications (email, telephone), and enterprise resource planning (ERP), the IT-infrastructure still involved proprietary despite cloud-based offers. These have been selected because they were either cheaper or more easily rolled-out. This finding is well in line with the findings of Kramer and Jamous (2012). Kramer et. al. (2012), by comparing OSS and proprietary ERP-systems in SMEs, claimed that support played a major role for success for those companies. Our case strongly supports this finding. A body of literature on the joint use of CC and OSS in SMEs, to our knowledge, does not yet exist.

Summary and Outlook

Venture capital (VC) driven entrepreneurial companies need to plan ahead. In order to acquire private equity they need to come up with convincing business models and well-written business plans containing proper value-chain analysis, including a competitive growth strategy. What is questionable, though, is the fact that a proper IT-strategy component did not seem all that important for the VC in the case we investigated throughout this paper. This is not to say it did not exist, but it was far less elaborate than the rest of the business plan. This is especially interesting considering the fact that the information intensity, which is commonly understood as the amount of information that is being processed throughout the value chain and / or inherent to the traded goods or services, is comparably high in the investigated case.

From the general value proposition a combination of CC and OSS seems to be the perfect match for SMEs to meet their objectives and create sustaining, yet flexible edges. This is especially true with regard to the common SME constraints shown in table 2. However, the reality of our case still looks different. Even if CC fulfills the promise of scalability on the infrastructure level, it is still not elaborate enough to match the desired grade of flexibility with regard to SME operations (at least in the field of e-commerce). By desired grade of flexibility, we mean the ability to restructure parts of the business process and reestablish proper IT-alignment with little or no IT-knowledge.

OSS genuinely offers that kind of flexibility since it comes with a plethora of APIs and standardized data formats. It might also help to save money as compared to proprietary software. In VC driven e-commerce companies, the flexibility offered by the fact that the product can be modified as intended is far more important than the cost-saving aspect, even if skilled development partners are still a fundamental requirement. Strong and long-term partnerships with experienced suppliers are very important to match the requirements inherent to the operative focus of SMEs. OSS usually prevents from being locked-in by a certain software vendor. SMEs cannot easily substitute suppliers, though. Even if this is genuinely true for all supplier relations inside SMEs, it might create undesired lock-in.

CC is still in its infancy. Unlike the case presented here, most German SMEs we have seen throughout the course of our research have important arguments against cloud computing. These reach from the belief that they no longer control their data, to the concern that business critical data could be silently used by CC providers to ultimately hamper the SME's business model. The recent Trans-Atlantic affair further fueled that caveat. This research is surely just the beginning. Considerably more cases have to field test the coexistence and relation of CC and OSS even together with proprietary software in a hybrid set-up. Future research should also distinguish between the information intensity of the products and services of the SMEs offer. This allows for better classification of the type and the market of the company, and the potential leverage the technology might deliver. Doubtlessly, a limitation of our contribution stems from the fact that the investigated case belongs to a specific industry. For better generalizability, the single case constraint needs to be abandoned in favor of multiple case or even quantitative evidence across different industries. Finally, a method of strategic system landscape engineering for SME should comprise all findings to a constructivist and design-oriented methodology.

References

Perilli, A. and Manieri, A. and Algom, A. and Rhoton, J. and Rohr, M. and Biran, O. and Lindstrom, P. and Nair, S. K. and Dimitrakos, T. 2009, “Cloud Computing - Benefits, risks and recommendations for information security”, Technical Report, European Network and Information Security Agency (ENISA).

Vaquero, L. M. and Merino, L. R. and Caceres, J. and Lindner M. 2009, “A break in the clouds: Towards a cloud definition”, *ACM SIGCOMM Computer Communication Review*, pp. 50-55.

Goyal, A. and Dadizadeh, S. 2009, “A Survey on Cloud Computing”, Technical Report, University of British Columbia.

Lewis, G. 2010, “Basics about Cloud Computing”, Techreport, Software Engineering Institute (SEI), Carnegie Mellon University.

Armbrust, M. and Fox, A. and Griffith, R. and Joseph, A. D. and Katz, R. H. and Konwinski, A. and Lee, G. and Patterson, D. A. and Rabkin, A. and Zaharia, M. 2009, “Above the Clouds: A Berkeley View of Cloud Computing”, Techreport, University of California Berkeley.

Buyya, R. and Yeo, C. S. and Venugopal, S. and Broberg, J. and Brandic, I. 2009, “Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility”, *Future Generation Computer Systems*, 25, pp. 599-616.

Nurmi, D. and Wolski, R. and Grzegorczyk, C. and Obertelli, G. and Soman, S. and Youseff, L. and Zagorodnov, D. 2008, “The eucalyptus open-source cloud-computing system”, *Proceedings of Cloud Computing and Its Applications*.

Raymond, Eric S. 2001, “The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary” O'Reilly Media

Netscape 1998, “Netscape Announces Plans to Make Next-Generation Communicator Source Code Available Free on the Net”, http://www.prnewswire.com/news-releases/netscape-announces-plans-to-make-next-generation-communicator-source-code-available-free-on-the-net-76399462.html, last visited 11.04.2014

O'Reilly 1999, Open sources voices from the open source revolution.

Eisenhardt, K. M. 1989, “Building Theories from Case Study Research”, *The Academy of Management Review, Academy of Management*, 14, pp. 532-555.

Eisenhardt, K. M. & Graebner, M. E. 2007, “THEORY BUILDING FROM CASES: OPPORTUNITIES AND CHALLENGES”, *Academy of Management Journal, 50*, pp. 25-32.

Yin, R. K. 1994, Case Study Research: Design and Methods, *Sage, Thousand Oaks, California*, xvii, 171 pages.

Benbasat, I., Goldstein, D. K. & Mead, M. 1987, “The case research strategy in studies of information systems”, *MIS Quarterly, Society for Information Management and The Management Information Systems Research Center, 11*, pp. 369-386.

Rolandsson, B.; Bergquist, M. & Ljungberg, J. 2011, “Open source in the firm: Opening up professional practices of software development”, Research Policy, 40, pp. 576 – 587.

Kramer, F. & Jamous, N. 2012, „Zero Commercial Software Strategy - eine Fallstudie“, Tagungsband der Chemnitzer Linux-Tage 2012, Universitätsverlag Chemnitz.

Kramer, F.; Gómez, J. M. & Pousttchi 2012, K. Hildebrand, „Enterprise Resource Planning in KMU - eine vergleichende Studie von proprietärer und Open Source Software“, HMD - Praxis der Wirtschaftsinformatik, dpunkt.verlag, 285, pp. 20-33.

Siggelkow, N. 2007, “PERSUASION WITH CASE STUDIES”, Academy of Management Journal, 50

Münzl, G.; Przywara, B.; Reti, M.; Schäfer, J.; Sondermann, K.; Weber, M.; Wilker, A. 2009, „Cloud Computing: Handlungsempfehlungen des BITKOM“, Bitkom

Mell, P. & Grance, T. 2011, “The NIST Definition of Cloud Computing”, National Institute of Standards and Technology (NIST), U.S. Department of Commerce

Wang, C.; Walker, E. A.; Redmond, J. 2006, “Ownership Motivation and Strategic Planning in Small Business”, Journal of Asia Entrepreneurship and Sustainability, 2:4

Stonehouse, G. & Pemberton, J. 2002, “Strategic planning in SMEs - some empirical findings”, Management Decision, 40:9, pp. 853-861

Passerini, K.; El Tarabishy, A. & Patten, K. 2012, “Information technology for small business managing the digital enterprise”, Springer

Windrum, P. & de Berranger, P. 2002, “The adoption of e-business technology by SMEs”, Working Paper, 2002-023, Maastricht Economic Research Institute on Innovation and Technology