Factors Influencing the Adoption of Cloud Computing: A Mixed-Methods Approach

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Preface

This cumulative dissertation was prepared in the Accounting and Information Systems Department of the Institute for Information Management and Information Systems at Osnabrück University from March 2012 to March 2015. The doctoral thesis was supervised by Prof. Dr. Frank Teuteberg. Prof. Dr. Oliver Thomas was the co-advisor.

First and foremost, I would like to thank my supervisor, Prof. Dr. Frank Teuteberg, for his outstanding guidance and continuous feedback on my research, which decisively helped me to reach the targeted goal. His advice was invaluable. I thank him for giving me this opportunity to prepare my doctoral thesis in my area of interest.

Additionally, I would like to thank Prof. Dr. Oliver Thomas for co-advising this doctoral thesis.

Furthermore, I would like to express my appreciation to the current and former members of the Accounting and Information Systems Department, especially Dr. Matthias Gräuler, Mr. Florian Stiel and Mr. Volker Frehe, who provided critical suggestions and fruitful feedback during my research endeavor through numerous discussions, and Dr. Benedikt Martens, who supervised my bachelor and master theses and encouraged me to apply for a student assistant position, thus accompanying me on the first steps of my academic career. I would also like to thank Mr. Adrian Fietz, Mr. Stefan Truh, Dr. Nicolai Walter, Dr. Ayten Öksüz and Prof. Dr. Jörg Becker, who are co-authors of publications contained in this cumulative dissertation and who provided insights and new perspectives during the development of my doctoral thesis.

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Last, but not least, I acknowledge my sincere appreciation of my friends, and especially my family, for all of their support, encouragement, and validation during this time. To them I say, "*Your share of this doctoral thesis is greater than you know. Thank you!*"

Osnabrück, March 31, 2015 *Marc Walterbusch*

Notes on the Structure of the Document

This cumulative dissertation is divided into two parts.

Part A provides an overview of the included research papers and places them into a broader context. In addition to the theories applied and methodological approaches used, the results of the various research papers are discussed. Subsequently, the substantial implications for both practice and research are presented, the limitations of the work are discussed, and starting points for future research are summarized. Consequently, Part A is a stand-alone document that contains the necessary lists of, e.g., equations at the beginning and references at the end.

Part B contains the research papers that are discussed in Part A. Each of these papers is a self-standing document, i.e., each paper has its own table and figure numbering, its own citation style as well as its own reference list.

Contents

Part A: Introductory Overview

List of Abbreviations

AHP	analytic hierarchy process
BYOC	bring your own cloud
BYOD	bring your own device
FAQ	frequently asked question
IaaS	infrastructure as a service
IS	information systems
IT	information technology
NeuroIS	neuroscientific methods within the information systems discipline
NIST	National Institute of Standards and Technology
PaaS	platform as a service
QDA	qualitative data analysis
SaaS	software as a service
SIM	subscriber identity module
SLA	service-level agreement
TCO	total cost of ownership

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1 Introduction

1.1 Motivation

Cloud computing is a technology that has gained increasing attention because of its considerable benefits, which include reduced costs, reduced complexity and increased flexibility (Weinhardt et al. 2009; Marston et al. 2011; Armbrust et al. 2010). To obtain these benefits, cloud computing utilizes existing technologies, such as grid computing, virtualization and web services, for online delivery of scalable information technology (IT) services, frequently on the basis of a pay-per-use pricing model (Klems et al. 2009; Youseff et al. 2008; Armbrust et al. 2010; Walterbusch et al. 2013a). One of the most-cited definitions of cloud computing, from the National Institute of Standards and Technology (NIST), is the following:

> *"Cloud computing is 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 & Grance 2011).

In 2008, the Gartner Group predicted that cloud computing would reach the mainstream within two to five years (Gartner Group 2008). However, in their latest hype cycle for emerging technologies (Gartner Group 2014), they stated that cloud computing had not yet reached the *plateau of productivity* but rather was still in the *trough of disillusionment*[1], as shown in *Fig. 1*. The reason for this situation may be that cloud computing continues to face skepticism because of various concerns regarding, e.g., data privacy and security (Ryan 2011). In particular, (enterprise) customers transfer (sensitive) data to cloud computing providers, and the end-user rents the right to use cloud computing services via a web browser with minimal need to interact or even without the necessity of interacting directly with a sales assistant. These two aspects result in a strong unilateral dependency and require a high degree of trust in the provider (Walterbusch et al. 2013b). Additionally, publicity regarding the PRISM[2] program has brought these aspects to the forefront of public interest. Consequently, specific requirements regarding,

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[1] The names of the phases, e.g., *plateau of productivity* and *trough of disillusionment*, were adopted from Gartner's Hype Cycle for Emerging Technologies (Gartner Group 2014).

[2] PRISM is a surveillance program that provides the National Security Agency (NSA) "*[...] direct access to the systems of Google, Facebook, Apple and other US internet giants [...]*" and allows collecting "*[...] material including search history, the content of emails, file transfers and live chats [...]*" (The Guardian 2013).

e.g., security, privacy, accountability, and auditability, must be met to fulfill the expectations of business partners and to build long-term business relationships (Walter et al. 2014). Thus, overcoming information asymmetry, enhancing transparency and eradicating behavioral uncertainty is of high importance to build trust between cloud computing providers and their (prospective) customers (Benlian & Hess 2011). Therefore, although most research to date has focused on technical aspects and aimed to improve the actual security of cloud computing services (Yang & Tate 2012; Ramireddy et al. 2010), there is also an urgent need to understand the factors that affect the adoption of cloud computing services from the points of view of both private users and companies. If cloud computing is to reach its full potential, a clear understanding of the factors that influence its adoption is mandatory to improve both present and future cloud computing services.

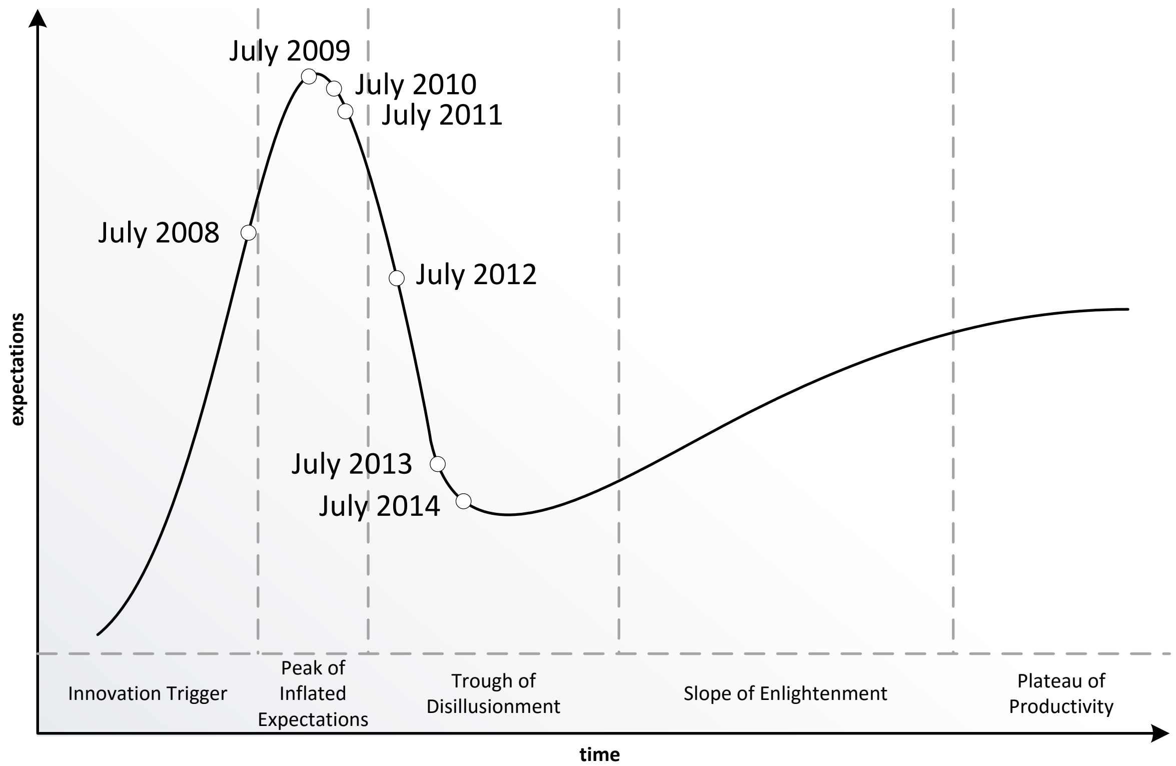


Fig. 1: Development of Cloud Computing in Gartner's Hype Cycle for Emerging Technologies (Gartner Group 2008, 2009, 2010, 2011, 2012, 2013, 2014).

1.2 Aim

Motivated by the above considerations, the aim of this doctoral thesis is to explore, describe, analyze and explain the factors that influence the adoption of cloud computing using various qualitative and quantitative research methods, i.e., by employing a mixed-methods analysis

(Venkatesh et al. 2013). The aim is not to consider all minor and major factors that possibly influence the adoption of cloud computing because the dominant factors may depend on the context (e.g., existing IT infrastructure, vision and strategy) of the research subject (e.g., private end user, company or government); thus, there is an indeterminable number of possible influencing factors. Therefore, the factors treated in this doctoral thesis provide an overview of the large variety and overall extent of the influences; however, the author does not claim that the list of factors is complete.

1.3 Structure

This dissertation is structured as follows. In Sec. 2, the selection of contributing papers is explained, followed by a presentation of the framework of the research contributions used as the basis for this doctoral thesis. The applied theories and research methods are introduced in Sec. 2 as well. In Sec. 3, the individual research designs and key findings of each research contribution are presented, following the overall structure of the framework. As a first step, a serious game[3] is conducted to explore various factors that influence the adoption of cloud computing services (Walterbusch et al. 2013b). Based on these initial findings, the factors explored during the serious game and some additional factors are described and analyzed in detail. These factors include the cloud computing market (Walterbusch, Truh, et al. 2014), costs (Walterbusch et al. 2013a), trust (Walterbusch, Gräuler, et al. 2014), affectedness[4] (Walterbusch & Teuteberg 2014a), shadow IT[5] (Walterbusch, Fietz, et al. 2014), and sustainability (Walterbusch et al. 2015). Furthermore, the factor of information asymmetry, especially regarding bridging the information asymmetry with various information presentation methods, is explained (Walter et al. 2014). Following these findings, a research agenda, which contains a recommended research design and lists the theories that are relevant in the context of the adoption of cloud computing,

[3] Serious games are defined as "*any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment*" (Deterding et al. 2011), e.g., train or educate users, or to observe and evaluate their actions and decision (Zyda 2005).

[4] In this doctoral thesis, *affectedness* is understood as being directly involved in the effect of or being influenced by an event, e.g., an incident with a cloud computing provider. Affectedness can also be explained best when taking pure *information* into account. The difference between pure *information* and personal *affectedness* is that in case of *information*, the subject only knows that something happened, without him or her being directly affected, e.g., some customers suffered a downtime but the subject is *not* one of them. In contrast, in the case of *affectedness*, the subject is not only informed about the event but is also directly affected, e.g., some customers suffered a downtime and the subject *is* one of them.

[5] *Shadow IT* is defined as the business processes that support IT solutions and tools that replace or extend the IT functionalities officially provided by the IT department. However, these IT solutions are not part of the IT governance strategy and thus are not generally known, accepted or supported (by the IT department) (Shumarova & Swatman 2008; Rentrop & Zimmermann 2012).

is proposed (Walterbusch & Teuteberg 2014b). Subsequently, a synthesis of the research findings in terms of their implications for practice and research, including limitations, are discussed in Sec. 4. Finally, in Sec. 5, this doctoral thesis ends with the overall conclusions.

2 Research Design

2.1 Selection of the Research Contributions

In the following, the selection of the research contributions for this cumulative dissertation is presented. Further research contributions by the author of this doctoral thesis are not included either because they are still under review or the topic is not within the scope of the doctoral thesis. Given these criteria, the research contributions presented in *Tab. 1* were selected.

#	Title	Ranking VHB	WKWI	AR	IF	References (incl. publication source)
A	Exploring Trust in Cloud Computing: A Multi-Method Approach	B (7.37)	A	30 %[6]	-	**Walterbusch, M.**; Martens, B., Teuteberg, F.: Exploring Trust in Cloud Computing: A Multi-Method Approach; In: Proceedings of the 21st European Conference on Information Systems (ECIS 2013), Utrecht, Netherlands, 2013. *[1], *[2]
B	Hybride Wertschöpfung durch Cloud Computing *(translation: Hybrid Value Added in Cloud Computing)*	[7]	-	-	-	**Walterbusch, M.**; Truh, S.; Teuteberg, F.: Hybride Wertschöpfung durch Cloud Computing, In: Modellierung 2014 (Workshop "Dienstleistungsmodellierung") *(translation: Modeling 2014 (Workshop „Service Modeling"))*, Vienna, Austria, 2014. *[1], *[3]
C	Evaluating Cloud Computing Services from a Total Cost of Ownership Perspective	C (6.69)	-	-	-	**Walterbusch, M.**; Martens, B.; Teuteberg, F.: Evaluating Cloud Computing Services from a Total Cost of Ownership Perspective; In: Management Research Review, Vol. 36, No. 6, 2013, S. 613-638. *[1], *[4]
D	How Trust is Defined: A Qualitative and Quantitative Analysis of Scientific Literature	D (5.92)	B	55 % to 65 %[8]	-	**Walterbusch, M.**; Gräuler, M.; Teuteberg, F.: How Trust is Defined: A Qualitative and Quantitative Analysis of Scientific Literature, In: Proceedings of the 20th Americas Conference on Information Systems (AMCIS 2014), Savannah, USA, 2014. *[1], *[5]
E	Datenverluste und Störfälle im Cloud Computing: Eine quantitative Analyse von Service Level Agreements, Störereignissen und Reaktionen der Nutzer *(translation: Data Losses and Disruptive Events in Cloud Computing: A Quantitative Analysis of Service Level Agreements, Disruptive Events and Users' Reactions)*	D (5.44)	C	53 %[9]	-	**Walterbusch, M.**; Teuteberg, F.: Datenverluste und Störfälle im Cloud Computing: Eine quantitative Analyse von Service Level Agreements, Störereignissen und Reaktionen der Nutzer, In: Proceedings der Multikonferenz Wirtschaftsinformatik 2014 *(translation: Proceedings of the Multi-conference Wirtschaftsinformatik 2014)* (MKWI 2014), Paderborn, Germany, 2014, S. 2227-2240. *[1]
F	Schatten-IT: Implikationen und Handlungsempfehlungen für Mobile Security *(translation: Shadow-IT: Implications and Recommendations for Mobile Security)*	D (5.16)	-	B	-	**Walterbusch, M.**; Fietz, A.; Teuteberg, F.: Schatten-IT: Implikationen und Handlungsempfehlungen für Mobile Security; In: HMD – Praxis der Wirtschaftsinformatik, Heft 295 (Schwerpunktheft "Mobile Security") *(translation: HMD – Praxis of Wirtschaftsinformatik, No. 295 (Special Issue "Mobile Security"))*, 2014. *[1], *[6]

Tab. 1: Selection of Research Contributions.

[6] The acceptance rate was found on the Facebook page (ECIS 2013).
[7] The *Dienstleistungsmodellierung* is ranked in neither the VHB ranking nor the WKWI ranking.
[8] The acceptance rate was found on the conference website (AMCIS 2014).
[9] The acceptance rate was found in the proceedings (Suhl & Kundisch 2014).

#	Title	Ranking				References (incl. publication source)
		VHB	WKWI	AR	IF	
G	A Decision Model for the Evaluation and Selection of Cloud Computing Services: A First Step Towards a More Sustainable Perspective	C (6.93)	-	-	1.89[10]	**Walterbusch, M.**; Martens, B.; Teuteberg, F.: A Decision Model for the Evaluation and Selection of Cloud Computing Services: A First Step Towards a More Sustainable Perspective, In: International Journal of Information Technology & Decision Making (IJITDM), 2015, published online ready.*[1], *[7]
H	"May I help You?" Increasing Trust in Cloud Computing Providers through Social Presence and the Reduction of Information Overload	A (8.48)	A	-	-	Walter, N.; Öksüz, A.; **Walterbusch, M.**; Teuteberg, F.; Becker, J.: "May I help You?" Increasing Trust in Cloud Computing Providers through Social Presence and the Reduction of Information Overload, In: Proceedings of the 2014 International Conference on Information Systems (ICIS 2014), Auckland, New Zealand, 2014. *[1], *[8], *[9]
I	Towards an Understanding of the Formation and Retention of Trust in Cloud Computing: A Research Agenda, Proposed Research Methods and Preliminary Results	C (6.78)[11]	-	-	-	**Walterbusch, M.**; Teuteberg, F.: Towards an Understanding of the Formation and Retention of Trust in Cloud Computing: A Research Agenda, Proposed Research Methods and Preliminary Results, In: Proceedings of the 11th International Conference on Trust, Privacy & Security in Digital Business (TrustBus 2014), Munich, Germany, 2014. *[1]

Comments

*[1] Prof. Dr. Frank Teuteberg is a co-author of every publication, and he participated in critical reflection regarding the methodological orientation and content of each publication.
*[2] Mr. Benedikt Martens supervised the master thesis by Mr. Marc Walterbusch, upon which this publication is based, and provided critical feedback and fruitful suggestions for improvement.
*[3] Mr. Stefan Truh made a considerable contribution to this work, especially regarding the theoretical foundation.
*[4] Mr. Benedikt Martens supervised the bachelor thesis by Mr. Marc Walterbusch, upon which this publication is based, and provided critical feedback and fruitful suggestions for improvement.
*[5] Mr. Matthias Gräuler worked in strong cooperation, i.e., in equal parts, with Mr. Marc Walterbusch, on the research contribution; however, the initial idea for this paper originated from Mr. Marc Walterbusch, who also presented the paper at the conference.
*[6] Mr. Adrian Fietz made a considerable contribution to this work, especially regarding the execution of the expert interviews and the first step in interpreting the data acquired from various experiments.
*[7] The contribution by Mr. Benedikt Martens is primarily the execution of the simulation study.
*[8] Mr. Nicolai Walter and Mrs. Ayten Öksüz worked in strong cooperation with Mr. Marc Walterbusch, i.e., in equal parts, on this paper. Mr. Marc Walterbusch primarily worked on the research methodology, the theoretical background of trust and the experimental preparation and execution. Mr. Nicolai Walter and Mrs. Ayten Öksüz primarily focused on the statistical analysis, theoretical background, and construct measurements. Mr. Nicolai Walter presented the paper at the conference.
*[9] Prof. Dr. Jörg Becker critically reviewed the methodological orientation and gave fruitful feedback concerning the content.

Legend

AIS = Association for Information Systems Journal Ranking (Association for Information Systems 2015)
AR = Acceptance Rate
IF = Impact Factor according to Journal Citation Reports
VHB = Verband der Hochschullehrer für Betriebswirtschaftslehre (*translation: German Academic Association for Business Research*) – Journal Quality Index 2.1 (VHB 2008); the rankings of the outlets contained in this table are identical in the new version, the Journal Quality Index 3 (VHB 2015), except concerning the journal *Management Research Review*, which is ranked C in JourQual 2.1 but not contained in JourQual 3
WKWI = Wissenschaftliche Kommission Wirtschaftsinformatik – Orientierungsliste 2008 (*translation: Scientific Commission Information Systems – Guidance List 2008*) (Heinzel 2008)

Tab. 1: Selection of Research Contributions (continued).

2.2 Framework of the Research Contributions

The framework of the research contributions is divided into the consecutive sections *exploration*, *description & analysis*, and *explanation*, which all lead to a *research agenda* (*Fig. 2*). The general purposes of *exploration* are *(i)* to become more familiar with a phenomenon or topic of

[10] The journal is currently (the latest available ranking is from 2013) ranked 12th out of 79 in the category of *Operation Research & Management Science*, and 24th out of 135 in *Computer Science, Information Systems* (JCR 2013).
[11] The *International Conference on Trust, Privacy & Security in Digital Business* is not ranked, but the proceedings have been published in the *Lecture Notes for Computer Science*, which is ranked in the VHB ranking.

interest, *(ii)* to focus on eliciting important constructs and determining the best methods to measure these constructs, and *(iii)* to use the findings as the basis for developing concepts and methods for detailed, systematic descriptive or explanatory studies. The general purposes of *description & analysis* are *(i)* to discover and subsequently elaborate on phenomena of interest and *(ii)* to ascertain facts rather than test theories. In contrast, the general purpose of *explanation* is to test theories, i.e., hypothetical causal relationships between theoretical constructs, and, thereby, not only to assume that relationships exist between variables but also to assume causality, i.e., variable *A* influences variable *B* in a positive or negative manner (Recker 2013; Pinsonneault & Kraemer 1993; Yin 1984; Pentland 1999; Gregor 2006). The concluding *research agenda* provides the foundation for extending the knowledge base for the information systems (IS) community to keep current (Vom Brocke et al. 2009).

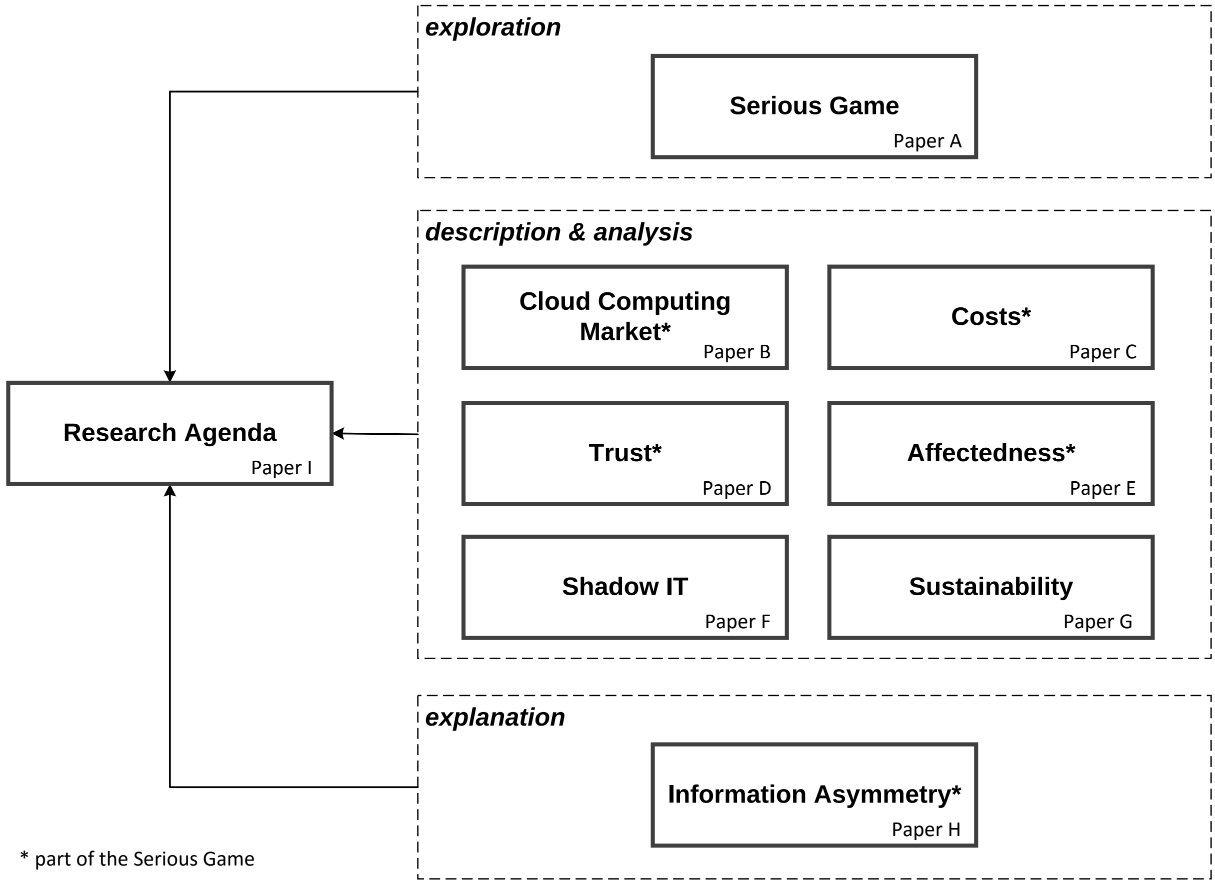


Fig. 2: Framework of the Research Contributions.

In the context of this doctoral thesis, the cloud computing market and the factors that influence the adoption of cloud computing are explored in paper A using a serious game (Walterbusch et al. 2013b). In a simplified cloud computing market, the participants, who represent cloud computing customers, opt for one of three providers or a mediator in each of several rounds. Between each round, events that affect the provider occur, and the customer selects a provider or the mediator again. Inter alia, the factors of information, affectedness, and costs are found to be important factors that influence the adoption of cloud computing services provided by the mediator or providers. (Walterbusch et al. 2013b)

Based on the initial findings, the factors explored during the serious game, along with additional factors, are described and analyzed in detail, starting with the cloud computing market in paper B (Walterbusch, Truh, et al. 2014). All market participants and the value flows between them are described and analyzed; in particular, the hybrid value added is emphasized (Walterbusch, Truh, et al. 2014).

Regarding the cloud computing market, the focus of paper C is primarily on the economics of cloud computing services (Walterbusch et al. 2013a). The results of the serious game (see paper A) indicated that costs have a positive effect on a (potential) user's trust in a cloud computing provider (Walterbusch et al. 2013b). If the cost of the cloud computing service is comparatively high, trust in the provider is more important. Based on current cloud computing providers, a formal model for calculation of the total cost of ownership (TCO) of cloud computing services is derived and then converted into a web-based prototype, thus by-passing the typical outsourcing phases of initiation, evaluation, transition and operation. (Walterbusch et al. 2013a)

In the cloud computing market (see paper B), all of the present value flows indirectly imply monetary risks, such as non-payment, and non-monetary risks, such as data loss or flawed advice (Walterbusch, Truh, et al. 2014). These risks can be counteracted using a variety of control mechanisms, such as redundant backups, or by implementing signals provided by the respective cloud computing provider, such as certificates. However, the more a user trusts a given cloud computing provider, the more likely he or she is to accept risks when adopting cloud computing services from this provider and, consequently, during the establishment of a long-term business relationship, i.e., the customer's trust in the provider based on their relationship can outweigh the perceived risks of future transactions. Therefore, trust definitions, both within the IS discipline and between disciplines, are described in detail and analyzed in depth in paper D (Walterbusch, Gräuler, et al. 2014). Generally speaking, trust is the willingness of a party to be vulnerable to the actions of another party and therefore to take risks based on the expectation that the other will perform a particular action that is important to the trustor, irrespective of the trustor's ability to monitor these actions or the existence of other control systems (Mayer et al. 1995).

The results of the serious game (see paper A) indicate that a user's affectedness, i.e., his or her negative personal experience with the provider, has a negative effect on the ongoing adoption of a cloud computing service (Walterbusch et al. 2013b). Typically, this affectedness is based on risk occurrence. Therefore, several risks in cloud computing (e.g., unplanned downtime and irreversible data loss), which are subsumed under the term disruptive events, are described and analyzed based on a qualitative assessment of known disruptive events, such as those announced on corporate blogs, in paper E. (Walterbusch & Teuteberg 2014a)

Cloud computing services on mobile devices favor the use of shadow IT in companies because of advantages such as location-independence and distributed cooperation; therefore, the implications and recommendations for mobile security are thoroughly described and analyzed in paper F (Walterbusch, Fietz, et al. 2014). Employees might already use cloud computing solutions such as Dropbox without management's permission or knowledge. As discussed in paper F, this behavior not only increases risks for companies, such as missing backups, loss of compatibility, and corporate espionage, but also introduces opportunities. For example, an assessment of the shadow IT used by company employees can reveal needs regarding the IT infrastructure that were previously unknown to the IT department. (Walterbusch, Fietz, et al. 2014)

The economic perspective regarding the adoption of cloud computing services is the primary focus of the previous research contributions, especially papers A through C. Consequently, in paper G, the focus decidedly shifts towards sustainability (Walterbusch et al. 2015). A decision model for evaluating and selecting cloud computing services is presented. In this model, the economic, environmental and social perspectives, are all considered and encompassed by the term *sustainable information systems management*. A simulation study highlights the need to consider these perspectives when adopting a cloud computing service. (Walterbusch et al. 2015)

In paper H, explanation is the focus (Walter et al. 2014). In paper A, hypothetical causal relationships between theoretical constructs are tested as well; however, the aim of paper H is not to explore but rather to explain[12] (Walterbusch et al. 2013b; Walter et al. 2014). The serious game results (see paper A) indicate that information about a cloud computing provider has a positive effect on the adoption of this provider (Walterbusch et al. 2013b). Consequently, the focus of paper H is different forms of information presentation. The methods of presenting the

[12] One of the differences between exploratory and explanatory studies, even though both test theory, is the different significance threshold values for the inferential statistical calculations. For example, in an explanatory study, Cronbach's alpha, which indicates internal consistency, should be at least 0.7 (Nunnally 1978; Kline 1998; Guilford 1956), whereas in an exploratory study, a value of 0.6 is sufficient (Nunnally 1978).

information of service-level agreements (SLAs) in conjunction with privacy policies discussed in this paper are the following: *(i)* text-based only, *(ii)* text-based with an additional search box with auto-completion functionality and *(iii)* text-based with an additional social recommendation agent. It is demonstrated that embedding the two different assistive website elements, i.e., the search box and social recommendation agent, into a website that contains a cloud computing provider's SLAs and privacy policies positively influences the perceived trustworthiness of the cloud computing provider by reducing perceived information overload and increasing perceived control as well as social presence. In turn, a cloud computing provider's trustworthiness, as perceived by a user, directly influences the user's intention to adopt the cloud computing service. (Walter et al. 2014)

Based on the results of the aforementioned studies, the lessons learned concerning the applied research methods and the future research directions included in the previously stated research contributions, a research agenda is proposed. The research agenda, which is presented in paper I, identifies the factors that influence and those that are influenced by trust in cloud computing and, consequently, arrives at a fundamental understanding of the formation and retention of trust (Walterbusch & Teuteberg 2014b). As a result, a mixed-methods approach that is suitable to achieve the stated goal is presented. It consists of the following research methods: literature review, laboratory experiments, semi-structured expert interviews, surveys, vignettes[13], (retrospective) thinking aloud[14], and neuroscientific methods (NeuroIS[15]). This mixed-methods approach has the ability to verify, reaffirm, and refine theories regarding cloud computing or to create new ones. Additionally, a first set of theories concerning trust in cloud computing to be tested is proposed. (Walterbusch & Teuteberg 2014b)

[13] Vignettes are focused descriptions or short stories about hypothetical characters, approximate real-life situations, or a series of events and structures. They are normally limited to a brief time span, to one or a few key actors, and/or to a bounded space. They can reference important points in the study of perceptions, beliefs and attitudes to which a subject, assuming the role of a fictitious character, is invited to respond in a variety of manners, e.g., making a decision, rating on a scale, evaluating a behavior of the actor in the vignette or providing free-text answers (Goyal et al. 2013; Gould 1996; Dennis & Robert 2012; Robert et al. 2009; Miles & Huberman 1994; Hughes 1998; Finch 1987; Zafar et al. 2012; Staples & Jarvenpaa 2000; Barnett et al. 1994; Aronson & Carlsmith 1968; Trevino 1992; Chae et al. 2005; Greenberg & Eskew 1993).

[14] (Retrospective) thinking aloud requires the test persons to orally paraphrase thought processes while (or after) fulfilling a certain task. Based on transcripts of these verbal protocols, the experimenter can understand the cognitive processes and the resulting behavior (Seaman 1999). (Retrospective) thinking aloud is limited by the participants' abilities to articulate their thoughts (Seaman 1999). Because it is difficult to simultaneously perform a certain task and think aloud, it is recommended to rely on retrospective thinking aloud, which occurs directly after fulfilling the given task. (Walterbusch & Teuteberg 2014b)

[15] *"NeuroIS is a subfield in the IS literature that relies on neuroscience and neurophysiological theories and tools to better understand the development, use, and impact of information technologies (IT). NeuroIS seeks to contribute to (i) the development of new theories that make possible accurate predictions of IT-related behaviors, and (ii) the design of IT artifacts that positively affect economic and non-economic variables (e.g., productivity, satisfaction, adoption, well being [sic])"* (R. Riedl et al. 2010).

2.3 Theoretical Background

Tab. 2 provides an overview of the theories used in the research contributions described in Secs. 2.1 and 2.2. The theories are not discussed in detail; however, more detail can be found in the resources provided. Papers A (Walterbusch et al. 2013b), G (Walterbusch et al. 2015) and I (Walterbusch & Teuteberg 2014b) are notable in this context because they cover a wide range of theories. In paper A, the focus is on exploration; therefore, the paper reports tests of a wide range of theories. Furthermore, important constructs are elicited, and the best methods for measuring them are discussed to complete the descriptions or to recommend follow-up studies, as indicated in Sec. 2.2. In paper G, a decision model for the evaluation and selection of cloud computing services on the basis of economic, environmental and social factors is presented, and this model is based on a solid theoretical background. In paper I, a research agenda is proposed. In that context, various theories and their contemporary relevance regarding the research focus are discussed.

Theory	Paper									References
	A	B	C	D	E	F	G	H	I	
Agency Theory	✓						✓	✓	✓	Coleman (1994), Alchian & Demsetz (1972), Jensen & Meckling (1976)
Commitment-Trust Theory	✓			✓[16]	✓				✓	Morgan & Hunt (1994)
Expectation Confirmation Theory									✓	Churchill & Surprenant (1982), Oliver (1977), Oliver (1980)
Institutional Theory							✓			Selznick (1948)
Production Cost Theory							✓			Albach (1981)
Reasoned Action, Theory of	✓									Komiak & Benbasat (2006), Fishbein & Ajzen (1975), Ajzen & Fishbein (1980)
Relationship Theory							✓			Kern (1997)
Resource-Based Theory							✓			Wernerfelt (1984)
Signaling Theory	✓							✓		Ross (1977), Spence (1973)
Social Exchange Theory	✓							✓		Blau (1964)
Stakeholder Theory		✓[16]								Freeman (1984)
Technology Acceptance Model								✓	✓	Davis (1989), Venkatesh & Davis (2000), Venkatesh & Bala (2008), Venkatesh et al. (2003), Davis (1986)
Transaction Cost Theory	✓		✓[16]				✓		✓	Williamson (1981), Williamson (1985), Coase (1937)

Tab. 2: Theories Discussed in the Research Contributions.

Because the economic perspective prevails in most of the papers, the *transaction cost theory* is one of the theories that is most often explicitly or implicitly discussed in the research contributions, along with *agency theory* and *commitment-trust theory*. *Agency theory* considers the information asymmetry between the customer (principal) and provider (agent) in the context of

[16] The theory is not explicitly mentioned in the work, but it is implicitly used.

the adoption of cloud computing services. The cornerstones for a successful business relationship, i.e., commitment and trust, manifest themselves in the *commitment-trust theory*. Because paper F treats a rather unexplored phenomenon within the IS discipline, shadow IT, it is not based on existing theories (no IS theories that applied to the research focus could be identified). Furthermore, *transaction cost theory*, which has been used to explain the use of shadow IT by other researchers[17], assumes a conscious "*[…] make-or-buy decision* (Walker & Weber 1984) *[…]*" (Zimmermann & Rentrop 2014). Therefore, in any case in which shadow IT is implemented by an employee without a conscious decision to autonomously use it rather than contacting the internal IT department, *transaction cost theory* does not apply.

2.4 Methodological Approach

The overall methodological approach used in this doctoral thesis is a mixed-methods approach, which is an approach that combines qualitative and quantitative research methods to explore, describe, analyze and explain the various factors that influence the adoption of cloud computing services. There are many reasons to apply a mixed-methods approach to this topic: *(i)* Complementary views can be incorporated, e.g., a systematic literature review can be used to derive hypotheses and then the hypotheses can be tested using an experiment. *(ii)* A more complete picture of a research area can be formed from a developmental perspective and each piece can build on previous findings, e.g., factors that influence the adoption of cloud computing can be explored in an exploratory serious game and subsequently, described, analyzed, and explained using another method. *(iii)* Inferences obtained from one approach can be corroborated using another approach, e.g., a recurring stream of thought can be extracted from expert interviews and then confirmed in a laboratory setting. *(iv)* The weaknesses of one approach can be compensated by using another, e.g., a formal TCO model can be postulated based on an assessment of real cloud computing providers and the scientific literature, and then its completeness can be evaluated using expert interviews (Venkatesh et al. 2013). Diversity, in terms of obtaining divergent views of the same phenomenon, is not the purpose of this mixed-methods approach (Venkatesh et al. 2013).

Tab. 3 provides an overview of the research methods used in the research contributions described in Secs. 2.1 and 2.2. As for the theories used in the research contributions (see Sec. 2.3),

[17] For example, Zimmermann & Rentrop (2014) argue that the choice of "*organizing the implementation of the desired solution autonomously, or carrying out the transaction with the IT department using formal processes […] describes a type of make-or-buy decision* (Walker & Weber 1984)*, which is theoretically substantiated in Transaction Cost Theory […]*".

the research methods are not discussed in detail; however, details can be found in the sources provided in the table.

Quan. / Qual.	Theory	Paper A	B	C	D	E	F	G	H	I	References
Quantitative Research Methods	Experiment	✓							✓		Recker (2013), Zimmermann (1972), Wilde (2008), Wilde & Hess (2007)
	Formal Deductive Analysis			✓				✓			Zhu et al. (2004), Jenkins (1985), Wilde & Hess (2007)
	Simulation							✓			Cha et al. (2008), Nance (1994)
	Survey						✓				Reips (2002)
Qualitative Research Methods	Case Study			✓				✓			Palvia et al. (2003), Bonoma (1985), Yin (1984), Kaplan & Duchon (1988), Benbasat et al. (1987), Dubé & Paré (2003), Recker (2013)
	Expert Interviews	✓	✓	✓			✓	✓			Bryman & Bell (2007), Patton (2002), Meuser & Nagel (2009), Walsham (2006)
	Other Qualitative Analyses (e.g., Content Analysis, Description, Observation)		✓	✓	✓	✓		✓			Wilde & Hess (2007), Sidorova et al. (2008), Sullivan (2001), Myers (2009), Recker (2013)
	Prototyping			✓							Davis (1992), Hevner et al. (2004), Hevner (2007)
	Systematic Literature Review	✓	✓	✓	✓	✓	✓	✓	✓	✓	Vom Brocke et al. (2009), Webster & Watson (2002)

Tab. 3: Research Methods Used in the Research Contributions.

3 Summary of the Research Results

3.1 Exploration Using a Serious Game

As the basis for this doctoral thesis, an exploratory study that used a serious game was performed in the study titled *Exploring Trust in Cloud Computing: A Multi-Method Approach* (Walterbusch et al. 2013b). The objective of that study was to answer the following research questions: (i) *What are the particular factors that influence the level of trust in cloud computing?* (ii) *How do these factors influence the level of trust in cloud computing?* In that paper, we did not refer to the adoption of a cloud computing service but rather considered the cloud computing market from the perspective of trust. The decision for or against the adoption of a cloud computing service was operationalized as placing trust in the mediator or one of the providers and, consequently, making oneself vulnerable to the mediator's or provider's actions (Mayer et al. 1995).

Initially, a systematic literature review was conducted to become more familiar with the topic of interest and to determine a suitable and adequate research design. The literature review concluded that there has been an important amount of related work from the technological perspective. However, although there are already scientific investigations in this area, most of them are limited to argumentative/deductive methods and thus lack supporting empirical evidence. (Walterbusch et al. 2013b)

Model Constructs	Importance		Interview IDs
	Qualitative	Quantitative	
Information	high	73 (sum)	
Certificates	high	20	1, 2, 3, 4, 5, 6, 7, 8
IT Security	high	25	1, 2, 3, 4, 5, 6, 7, 8
Problem Management	low	5	1, 4, 5, 7
Legal Compliance	high	11	1, 4, 5, 6, 7, 8
SLAs	medium-high	6	1, 2, 4, 6
Availability	low	6	1, 2, 4, 7
Reputation	high	37 (sum)	
Transparency	high	15	1, 2, 4, 5, 6, 7
Company's Size	medium-high	8	1, 4, 5, 6, 7
Competence	medium-high	8	3, 5, 6, 7
Reference Customers	medium-high	6	5, 7, 8
Negative Incident	medium-high	11	1, 4, 6, 7, 8
Entity's Risk Aversion	high	15	1, 3, 4, 5, 6
Entity's Disposition of Trust	medium	8	1, 4, 5, 6

Tab. 4: Factors That Influence the Adoption of Cloud Computing Services.

Subsequently, a theory was developed through inductive reasoning based on existing theories and relying on eight expert interviews. After coding[18], factors were deduced, aggregated,

[18] In this context, *coding* refers to qualitative data analysis (QDA).

and grouped as the result of the theorizing process (following Urquhart et al. 2010); these factors are shown in *Tab. 4*. (Walterbusch et al. 2013b)

In both interview data and the relevant scientific papers, a process-related perspective regarding trust is prevalent. Based on the work of Puranam & Vanneste (2009), a cycle of trust was determined; it is shown in *Fig. 3*.

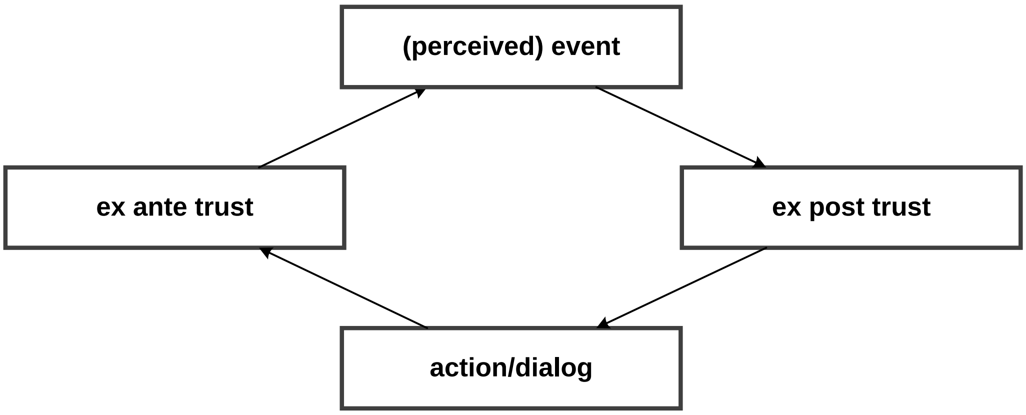


Fig. 3: Cycle of Trust adapted from Puranam & Vanneste (2009) (Walterbusch et al. 2013b).

Using inductive logic, systematically relevant key factors were derived based on the findings from the systematic literature review and expert interviews (*Tab. 4*). Subsequently, hypotheses that include the previously identified relevant key factors were formulated (see *List 1*). (Walterbusch et al. 2013b)

H1 *Risk Aversion* of the customer will have a negative effect on *Trust in Provider* (Benlian & Hess 2011; Komiak & Benbasat 2006).

H2 *Information* on a provider will have a positive effect on *Trust in Provider* (Alchian & Demsetz 1972; McKnight et al. 2002; Benlian & Hess 2011).

H3 *Disposition to Trust* will have a positive effect on *Trust in Provider* (Komiak & Benbasat 2006; Park et al. 2011; Kim et al. 2008; McKnight et al. 2002).

H4 *Affectedness* (negative personal experience with the provider) will have a negative effect on *Trust in Provider* (Zucker 1986).

H5a *Positive Reputation* of a provider will have a positive effect on *Trust in Provider* (Josang et al. 2007; Koehler et al. 2010).

H5b *Average Reputation* of a provider will have no effect on *Trust in Provider* (cf. H5a).

H5c *Negative Reputation* of a provider will have a negative effect on *Trust in Provider* (cf. H5a).

H6 *Costs* will have a positive effect on *Trust in Provider* (Blau 1964).

H7 *Trust in Provider* will have a negative effect on *Number of Provider Changes* (Wicks et al. 1999; Williamson 1979).

List 1: Hypotheses (Walterbusch et al. 2013b).

To verify (or prove false) the hypotheses in *List 1*, a serious game was designed. The serious game was based on a simplified cloud computing market. In this context, ‘simplified’ means that the entire market comprised three providers, one mediator, and the customers. Participants in the game take on the roles of customers, whereas the mediator and providers are pseudocomputer-controlled, i.e., their actions are deterministic, depending on the customers' choices. The customers are free to decide whether they purchase the cloud computing service directly from the provider or via a mediator. By using the direct distribution channel, the customer is offered cost advantages; however, in turn, the customer has to accept losses in terms of service and security. Although the cost of the cloud computing service increases when the service is purchased via a mediator, the customer benefits from a lower probability of risk occurrence because the customer receives greater data and failure safety. The serious game is split into multiple iterations, each of which are split into multiple rounds. One round consists of a predefined request, a deterministic event and a provider selection by the customer, who is represented by the test persons in the game. The events were derived based on the findings from the expert interviews and systematic literature review (see *Tab. 4*). They were assumed to influence the test person's decision to adopt the cloud computing service either from the mediator or from one of the providers. The results of the serious game can be observed in the logical explanatory model shown in *Fig. 4*. (Walterbusch et al. 2013b)

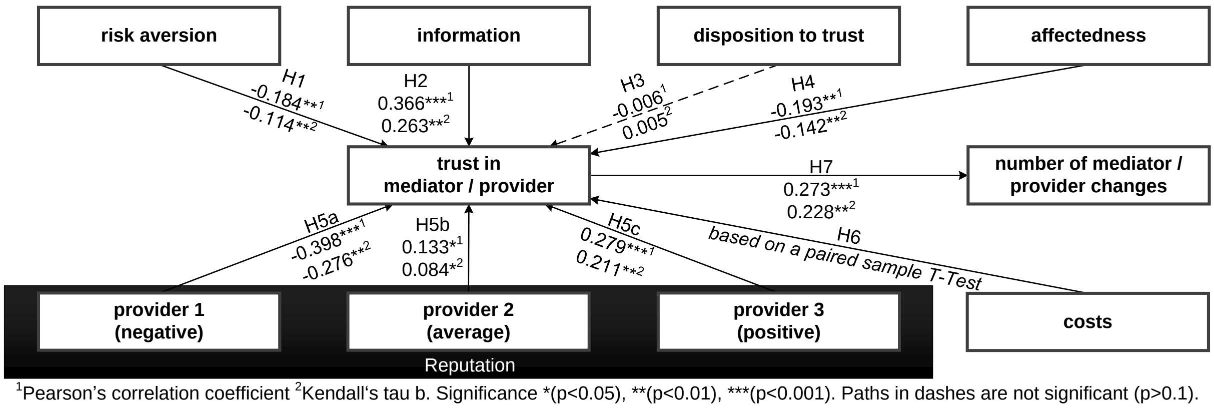


Fig. 4: Logical Explanatory Model (*n=231*) (Walterbusch et al. 2013b).

In summary, it was demonstrated that a user's decision to adopt a cloud computing service from a mediator or a provider depends on several factors. The results of the serious game indicated that the factors *risk aversion*, *(personal) affectedness*, a provider's *reputation*, *information* regarding and provided by the provider and the *costs* of the cloud computing service were influential in building *trust in the mediator/provider*. In turn, the *trust in the mediator/provider* had a statistically significant correlation with the *number of mediator/provider changes*. The factor *disposition to trust* had no statistically significant correlation with *trust in the mediator/provider*. These results are valuable to those in the cloud computing business for assisting in decision-making and understanding the market mechanisms in a cloud computing environment. The findings of the exploratory study were then used as the basis for the detailed and systematic descriptive and explanatory studies. (Walterbusch et al. 2013b)

3.2 Cloud Computing Supply Chain Network

In the previous paper (Sec. 3.1), a *simplified* cloud computing market was used for the serious game. In contrast, the aim of the paper whose title translates to *Hybrid Value Added in Cloud Computing* (Walterbusch, Truh, et al. 2014) was to describe the *entire* cloud computing market, including stakeholders and value flows between participants, with special emphasis on the hybrid value added. The main research question to be answered was (i) *How can hybrid cloud computing services*[19] *be developed in cloud computing?* The following subordinate questions were also addressed: (ii) *Which (legal) restrictions have to be considered?* (iii) *Which processes of adding value are likely to be relevant?* (iv) *Which risks does adding value pose, especially in cloud computing?* (Walterbusch, Truh, et al. 2014)

In addition to the detailed description of the phases of the development of hybrid cloud computing services, which consist of (a) *analysis of the status quo and consulting the customer*, (b) *planning of the hybrid service*, (c) *legal aspects during planning*, (d) *implementation of the hybrid service*, and (e) *support*, the following processes for adding hybrid value were discussed: (a) *strategic positioning of the offer*, (b) *pricing of the offer*, and (c) *monitoring prices*. In the context of the description of the phases of the development of hybrid cloud computing services, a model for representation and explanation of hybrid cloud computing services was derived. For this purpose, prominent models (Böhm et al. 2010; Knolmayer 2007; Leimeister et al. 2010) were analyzed and, following the constructivist paradigm (Wilde & Hess 2007), synthesized to form the model depicted in *Fig. 5*. This model is then used to understand aspects of the cloud computing market, including the role and function of a hybrid cloud computing provider. To track the value flows contained in the generic supply chain network, the e³value methodology[20] (Gordijn & Akkermans 2001) was applied. In this methodology, value creation is nonlinear:

[19] In that paper, *hybrid cloud computing service* does not refer to the deployment model *hybrid cloud* (Mell & Grance 2011). Rather, the phrase refers to *hybrid value added in cloud computing*, i.e., a hybrid synthesis of cloud computing services, such as infrastructure, platform or software as a service (IaaS, PaaS, or SaaS), with a service, such as analysis, consulting, migration, support, customizing or orchestration. In contrast with an autonomous and uniform cloud computing service, an added service is both integrative and individual. (Walterbusch, Truh, et al. 2014)

[20] The e³value methodology is a graphical representation of network architectures in which the end user is an integral component.

services are intertwined but managed independently. In this type of value creation, each provider focuses on his core competencies. Corresponding (complementary) services are merged. The end user is the starting point for the service request and the end point of the value creation. All values added to the cloud computing service within the supply chain network are paid for by the end user (Böhm et al. 2010).

The semantical and syntactical validation of the mentioned processes and the presented artifact (see *Fig. 5*) were implicitly and explicitly based on expert interviews. The explicitly conducted interviews revealed that the generic model and its derivation are comprehensive. Furthermore, the broad range of possibilities for utilization of the generic model was noted. All criticisms (suggestions) mentioned during the interviews were addressed. For example color highlighting of the hybrid cloud computing provider and the end user has been added for clarity. (Walterbusch, Truh, et al. 2014)

The risks of service bundles for customers were also presented. A company that outsources processes into the cloud could experience a loss of knowledge or know-how because its own information technology department no longer needs to administer these parts of its infrastructure (*loss of knowledge*). Furthermore, the company loses direct control over the outsourced processes. Thus, it can be difficult for the customers to monitor these processes (*loss of control*). Consequently, the customers have to rely on the hybrid provider to ensure the security of the outsourced data. The hybrid provider must also solve problems because the customer has no ability to step in and resolve problems on his own (*dependency*). Because the hybrid service was not planned and implemented by the customer himself or herself, the hybrid provider might have performed a misanalysis, or the customer might not have properly articulated his or her ideas, expectations, strategy or vision (*misanalysis*). Therefore, the customer might pay for a hybrid service that he or she might not be able to use as intended. If adjustments are required, additional costs may incur. Consequently, the entire process might be delayed, such that the service is not available as planned (Sakthivel 2007). Risks also arise because sensitive data leaves the company's premises and is delivered to the hybrid provider. Compliance with applicable legal regulations must be ensured (*legal compliance*). The customer's Internet connection is also a single point of failure. If the Internet connection is temporarily unavailable, the customer has no access to his data or applications until the connection is reestablished. The hybrid provider also has an obligation to ensure that the service is permanently available. Therefore, it is important to protect against *unplanned downtime* from, e.g., an outage (Walterbusch & Teuteberg 2014a).

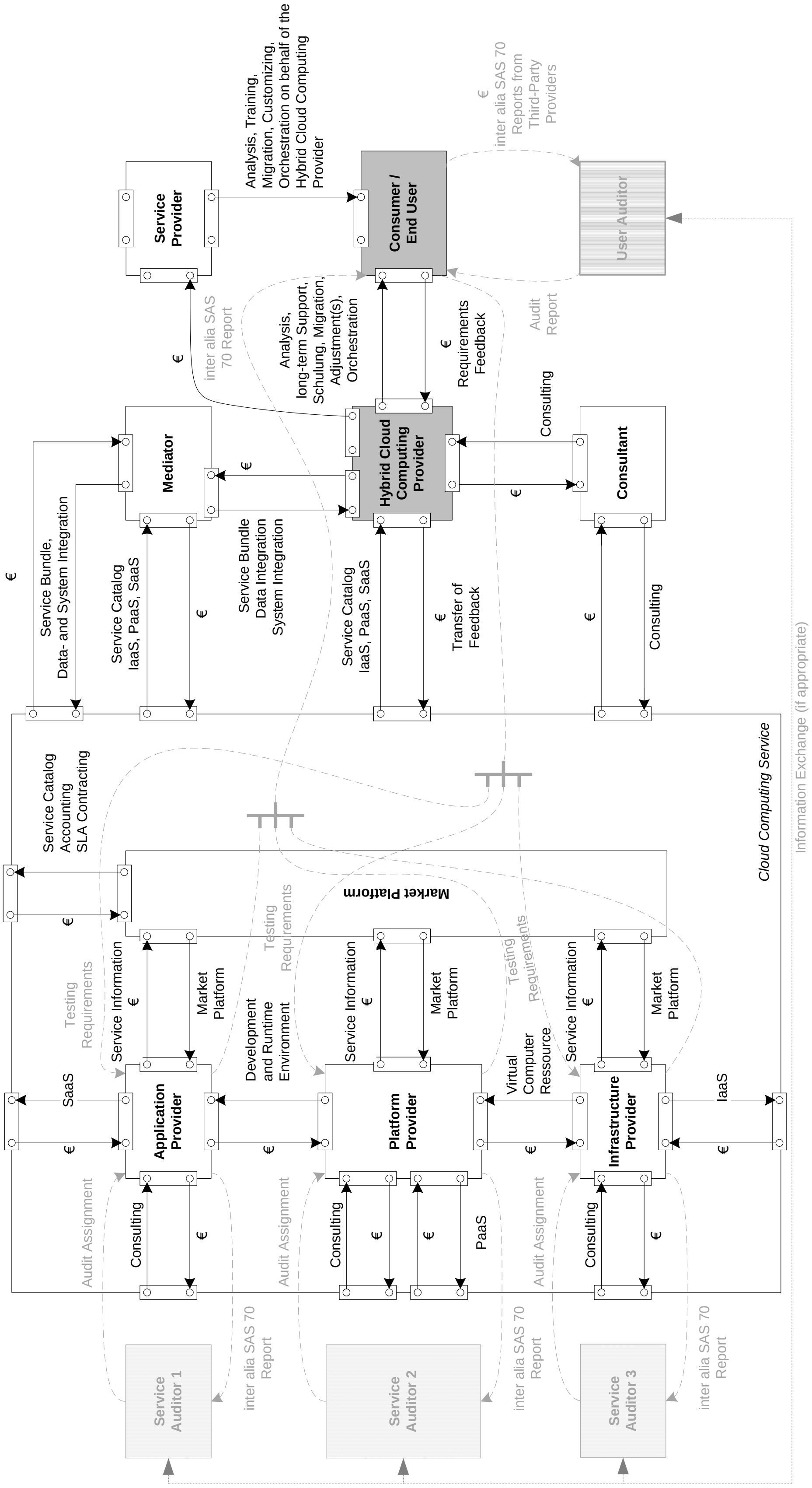

Service Provider
Analysis, Training, Migration, Customizing, Orchestration on behalf of the Hybrid Cloud Computing Provider
Consumer / End User
€ inter alia SAS 70 Reports from Third-Party Providers
User Auditor
inter alia SAS 70 Report
€
Analysis, long-term Support, Schulung, Migration, Adjustment(s), Orchestration
€ Requirements Feedback
Audit Report
Consulting
Mediator
Hybrid Cloud Computing Provider
Consultant
€
Service Bundle, Data- and System Integration
Service Catalog IaaS, PaaS, SaaS
Service Bundle Data Integration System Integration
Transfer of Feedback
Consulting
Service Catalog Accounting SLA Contracting
Market Platform
Cloud Computing Service
Information Exchange (if appropriate)
Testing Requirements
Service Information
Development and Runtime Environment
Virtual Computer Ressource
SaaS
IaaS
PaaS
Application Provider
Platform Provider
Infrastructure Provider
Audit Assignment
Service Auditor 1
Service Auditor 2
Service Auditor 3

Fig. 5: Generic Cloud Computing Market for the Development of Hybrid Cloud Computing Services (Böhm et al. 2010; Knolmayer 2007; Leimeister et al. 2010; Walterbusch & Teuteberg 2012) (Walterbusch, Truh, et al. 2014).

For delivery of hybrid cloud computing services, many service providers are closely intertwined. In particular, the essential characteristics of cloud computing, *on-demand self-service*, *measured service* (Mell & Grance 2011) and *pay-as-you-go* (Armbrust et al. 2010), make it possible for hybrid cloud computing providers to exchange service providers within the cloud computing supply chain or supply chain network (see *Fig. 5*) without informing the customer, who remains unknowing and unaware (Walterbusch & Teuteberg 2012). Although the customers make a contract with one hybrid cloud computing provider, they should know all involved upstream service providers, their provided services, and their security mechanisms (*stakeholder management, missing transparency/unknown service providers*). Any changes to the supply chain (network) should be communicated to the customer (Pearson & Benameur 2010; Walterbusch & Teuteberg 2012). (Walterbusch, Truh, et al. 2014)

3.3 Total Cost of Ownership

As shown in *Fig. 5*, the economic dimension of costs plays a fundamental role for the adoption of a cloud computing service. Furthermore, one result of the serious game (see Sec. 3.1) was that costs have a positive effect on a (potential) user's trust in a cloud computing provider (Walterbusch et al. 2013b). Consequently, in the paper titled *Evaluating Cloud Computing Services from a Total Cost of Ownership Perspective* (Walterbusch et al. 2013a), the costs of a given cloud computing service, including the operation costs, are described in detail following a TCO approach (Walterbusch et al. 2013a). To rigorously develop the TCO model, the common requirements for TCO models – *transparency*, *applicability*, *variability*, *comparability*, *decision support* and *status-quo* – were satisfied (Ellram & Siferd 1993; Becker et al. 2010; Ellram 1994; Ellram & Siferd 1998). The focus of the formal model is the systematic identification and calculation of cost factors across the entire cloud computing life cycle, as shown in *Fig. 6*. (Walterbusch et al. 2013a)

Fig. 6: Cloud Computing Life Cycle (Chaudhury et al. 1995; Lammers 2004; Schlaak et al. 2008) (Walterbusch et al. 2013a).

Assumptions were made to simplify the model construction, to assist in meeting the requirement of *applicability* and to focus on significant information and cost types, e.g., *internal IT infrastructure for the Internet connection and client PCs are available* and *a change of a service provider corresponds to the first adoption of a cloud computing service* (Walterbusch et al. 2013a). The cost structure and identification of cost types were created on the basis of real cloud computing services and a systematic literature review.

Life Cycle	Cost Type	Description
Initiation	Strategic Decision, Selection of Cloud Computing Services and Cloud Types (Aggarwal & McCabe 2009; Ellram 1995; Li et al. 2009; Becker et al. 2010)	Strategic sourcing decision: as-is analysis of the IT infrastructure and business applications, application of decision tools, choice of cloud computing service type (IaaS, PaaS, SaaS or combinations thereof), choice of cloud type (public, private or hybrid), and definition of service requirements (hardware configuration for IaaS, programming language support for PaaS and functionalities for SaaS)
Evaluation	Evaluation and Selection of Service Provider (David et al. 2002; Kondo et al. 2009; Ellram 1995; Aggarwal & McCabe 2009; Becker et al. 2010)	Search process for providers that offer the desired service based on the previously defined requirements
		Service evaluation and analysis: evaluation of the functionalities of cloud computing services and identification of the best alternative
		Evaluation of the provider and SLA analysis: determination of the provider's reputation, analysis of the SLAs (quality of service), and analysis of the security requirements (data recovery)
	Service Charge (Ellram 1995; Aggarwal & McCabe 2009; Li et al. 2009; Becker et al. 2010)	Pricing schemes vary depending on the service type and the provider. The service charge is calculated on the basis of the pricing schemes
Transition	Implementation, Configuration, Integration and Migration (David et al. 2002; Aggarwal & McCabe 2009; Ellram 1995)	Implementation and configuration of the service, including, e.g., access authorizations (creating groups and users rights)
		Integration into or merging with other systems and business processes. This includes the option of merging two clouds into a hybrid cloud
		Migration of the system (porting of data)
Operation	Support (David et al. 2002; Aggarwal & McCabe 2009; Li et al. 2009; Ellram & Siferd 1993)	Phone, email, ticket, and/or chat (instant messaging) support
	Initial and Permanent Training (Aggarwal & McCabe 2009; David et al. 2002; Ellram 1994; Kondo et al. 2009)	Internal training (by own employees) or external training (by third-party providers): user training and administrative training
	Maintenance and Modification (Ellram & Siferd 1993; Kondo et al. 2009; Li et al. 2009; Strebel & Stage 2010)	Modifying the service to guarantee operability
		Testing the service operability, configuration of settings, and tariff changes
		Monitoring and reporting: performance and cost management
		Service-level management: testing whether the provider fulfills contractual obligations (aspects of service quality, e.g., availability)
	System Failure (Ellram 1995; David et al. 2002)	Lost working time
		Contract penalty for non-delivery of services
		Loss of reputation
	Backsourcing or Discarding (Ellram 1995; Li et al. 2009; Strebel & Stage 2010)	Porting data from the cloud
		Reestablishment

Tab. 5: Cost Types and Descriptions (Walterbusch et al. 2013a).

Finally, the results of four expert interviews were used to validate and extend the model. The identification approach followed a typical decision-making process, starting with a strategic decision to source a cloud computing service and ending with the back-sourcing or discarding of the service (Jayatilaka et al. 2003). *Tab. 5* presents an overview of the cost types that represent the individual phases of the decision-making process and the corresponding cost factors that are unique to each item or cost type (Ellram 1995). The four cloud computing life cycle phases (see *Fig. 6*) are annotated, whereas the phase *dissolution* is integrated into the step *operation* in terms of the cost type *Backsourcing or Discarding*. In the next step, cost factors were identified for each cost type, e.g., the cost factors *expenditure of time*, *consulting services*, and *information for decision-making* were identified for the cost types *strategic decision, selection of cloud computing services, and cloud types* (see *Tab. 5*); these represent the only step of the phase *Initiation* (cf. *Fig. 6*). To transform these results into a mathematical representation, four general equations were defined as follows (Walterbusch et al. 2013a):

$$TCO_{CCS} = \sum C^t \text{ with } t \in T$$

Eq. 1: Total Cost of Ownership of a Cloud Computing Service (Walterbusch et al. 2013a).

$$C^t = \sum C_f^t \text{ with } t \in T, f \in F$$

Eq. 2: Total Costs of a Cost Type (Walterbusch et al. 2013a).

$$C_f^t = \sum_i^n C_{f,i}^t \text{ with } i = \{1, \dots, n\}, t \in T \text{ and } f \in F$$

Eq. 3: Total Costs of a Cost Type for a Given Period (Walterbusch et al. 2013a).

$$C_{f,i}^t = a_{f,i}^t * p_{f,i}^t$$

Eq. 4: Costs of a Cost Factor in a Given Period (Walterbusch et al. 2013a).

where

TCO_{CCS}: TCO of a cloud computing service

t: cost type

T: the set of all cost types t

f: cost factor

F: the set of all cost factors f

C^t: total costs of cost type t

C_f^t: total costs of cost factor f of cost type t

$C_{f,i}^t$: costs of cost factor f of cost type t in period i

$a_{f,i}^t$: consumed or required quantity of a resource in period i of cost factor f of cost type t in period i

$p_{f,i}^{t}$: price of consumed or required quantity of a resource in period i of cost factor f of cost type t in period i

With these general equations (*Eq. 1* through *Eq. 4*), the formal model was built and evaluated. The evaluation was threefold: it consisted of a case study, a conceptual evaluation and a technical evaluation. For the purpose of the technical evaluation, a web-based, system-independent TCO software tool was implemented; this tool made the formal TCO model of cloud computing services easily applicable.[21] With the TCO software tool, the decision-maker can calculate the TCO for a given cloud computing service and benchmark the result using all other datasets in the database. (Walterbusch et al. 2013a)

3.4 Trust

As previously remarked, in cloud computing, customers transfer (sensitive) data to a cloud computing provider. According to the definition of trust from Mayer et al. (1995), giving trust is a conscious decision to be vulnerable to the actions of another party that involves taking risks based on the expectations that the other party will perform a particular action, even though the trustor is not able to monitor these actions. Therefore, because a customer depends on a provider's actions, which involves risks that cannot all be counteracted by control mechanisms or incentives, trust in a cloud computing provider is essential (Walterbusch et al. 2013b). Because there is no consensus regarding the definition of trust in the literature, but rather a plethora of definitions, in the paper *How Trust is Defined: A Qualitative and Quantitative Analysis of Scientific Literature* (Walterbusch, Gräuler, et al. 2014), the similarities and differences of 121 trust definitions, especially from the IS discipline and within disciplines, spanning over 50 years of research were studied. The research questions were the following: (i) *Which terms are commonly used in trust definitions?* (ii) *Which word clusters are most frequently used in trust definitions?* (iii) *Which word clusters exhibit a high co-occurrence with other word clusters?* (iv) *Which definition of trust covers most of the identified word clusters?* (Walterbusch, Gräuler, et al. 2014)

Even though trust is viewed as a social construct (Dahlsrud 2006; Berger & Luckmann 1966), and, as such, it is impossible to derive an unbiased definition, the differences and similarities among the definitions were studied. First, based on the works by Castaldo (2002),

[21] The TCO software tool can be found on http://www.cloudservicemarket.info/tools/tco.aspx (accessed February 5, 2015).

Rousseau et al., (1998) and McKnight et al. (2002), a thorough systematic literature review was performed, resulting in 121 definitions of trust. Second, the definitions were pre-processed following Sidorova et al. (2008) using *QDA Miner* and its extension *WordStat* (Provalis Research, Montreal, Canada). Third, a QDA was conducted (Ryan & Bernard 2000). *Tab. 6* lists the most commonly used terms in trust definitions. (Walterbusch, Gräuler, et al. 2014)

#	Term	Frequency	No. of Cases	% of Cases	#	Term	Frequency	No. of Cases	% of Cases
1	EXPECT	82	58	47.9 %	11	PARTNER	29	20	16.5 %
2	DEFIN	43	41	33.9 %	12	RELI	20	20	16.5 %
3	PARTY	64	36	29.8 %	13	EXCHANG	22	18	14.9 %
4	ACTION	47	29	24.0 %	14	PERSON	32	17	14.0 %
5	VULNER	31	28	23.1 %	15	INDIVIDU	23	14	11.6 %
6	BELIEF	33	27	22.3 %	16	SITUAT	17	14	11.6 %
7	CONFID	32	27	22.3 %	17	HOLD	14	14	11.6 %
8	BEHAVIOR	25	21	17.4 %	18	INVOLV	14	11	9.1 %
9	RISK	25	21	17.4 %	19	GROUP	14	9	7.4 %
10	ACT	22	21	17.4 %	20	GOOD	16	8	6.6 %

Tab. 6: 20 Most Commonly Used Terms in Trust Definitions (*n=121*) (Walterbusch, Gräuler, et al. 2014).

In the next step, word clusters were derived. To determine the usage of each word cluster (Dahlsrud 2006), the number of citations to each definition that referenced each respective word cluster (obtained from Google Scholar) was summed (*Eq. 5*). This *cluster score* indicates the number of citations of definitions that contain a word from the respective cluster. It was then divided by the total number of references for all definitions (*Eq. 6*). The resulting *cluster ratio* indicates the relative usage of a cluster among all citations in the analysis. (Walterbusch, Gräuler, et al. 2014)

$$CS_i = \sum_{j=1}^{x} F_{Def_{ji}}$$

Eq. 5: Cluster Score (Walterbusch, Gräuler, et al. 2014).

$$CR_i = \frac{CS_i}{\sum_{k=1}^{y} F_{Def_k}}$$

Eq. 6: Cluster Ratio (Walterbusch, Gräuler, et al. 2014).

where

CS_i: Cluster score for word cluster i

CR_i: Cluster ratio for word cluster i

$F_{Def_{ji}}$: Frequency count for definition j categorized in word cluster i

F_{Def_k}: Frequency count for definition k

x: Total number of definitions categorized in word cluster i

y: Total number of definitions in the analysis

The results of this analysis are shown in *Tab. 7*, including the name of the cluster, its associated keywords[22], the number of definitions in which this cluster is applied, the cluster score and the cluster ratio. The results are sorted in descending order of cluster ratio. (Walterbusch, Gräuler, et al. 2014)

Cluster	Keywords	Frequency	Cluster Score	Cluster Ratio
subject	A, actor, agent*, another, B, company, companies, communit*, consumer*, customer*, entity, entities, firm*, group*, individual*, it, member*, one, oneself, organization*, organisation*, other*, partner*, party, parties, people, person*, provider, salesperson*, supplier*, target_of_trust, thing*, trustee*, truster*, trustor*, us, who*, X, Y, you	116	176,900	.947
expect	expect*	58	86,547	.463
action	act*, behaviour*, behavior*, behave*, behaving	58	75,869	.406
exchange	exchange*	18	62,131	.333
will	will	52	59,654	.319
rely	rely, reliable, reliance, relie*, reliability, relying, depend*, dependency	40	59,226	.317
confident	confident, confidence	27	48,416	.259
belief	belief*, believ*, faith*, good-faith*	33	41,940	.224
fulfill	fulfill*, commit*	16	35,108	.188
willingness	willing*	23	33,192	.178
based	based	14	32,707	.175
obligation	obligation*, obligate*, duty, promise*	15	32,188	.172
relationship	relationship*, inter-organizational, inter-organisational, inter-personal, inter-group, interorganizational, interorganisational, interpersonal, intergroup	17	28,636	.153
take	take*, took, taken, taking, accept*	21	27,709	.148
outcome	outcome*, result*, perform*	17	27,510	.147
vulnerable	vulnerable, vulnerability	21	24,883	.133
competent	competen*, capabilit*, abilit*, able, aptitude*	13	21,483	.115
integrity	integrity, moral*, ethical*	7	20,329	.109
time	time*, timing, delay, future, past, temporal, long-term, short-term, term, period, day, week, month, year	15	18,965	.102
exploit	exploit*, violate*, violation*, opportunistic*, opportunism*	19	18,759	.100
control	control*, monitor*	8	17,536	.094
risk	risk*	21	17,454	.093
honest	honest*	5	16,356	.088
word	word*	10	15,996	.086
positive	positive*	13	15,500	.083
would	would	4	15,243	.082
intention	intention*, intent*, intend*, motive*	11	14,504	.078
benevolence	benevolen*, good-will, goodwill, good_will	15	14,491	.078
negative	negative*	9	13,332	.071
held	held*	13	12,622	.068
involve	involve*, involving	11	10,392	.056
assume	assume*, assumption*, assuming	3	9,507	.051
mutual	mutual, mutually, reciprocity, reciprocal	7	6,649	.036
cooperate	cooperate*, cooperation*, coordination*	5	6,353	.034
decide	decide*, decision*	3	6,265	.034
attitude	attitude*	8	6,163	.033

Tab. 7: Word Clusters, Cluster Scores and Cluster Ratios (*n=121*) (Walterbusch, Gräuler, et al. 2014).

[22] An asterisk indicates a wildcard character, e.g., *expect** will include the terms *expects, expectation, expecting, and expectancy*.

Based on these findings, a hierarchical cluster analysis was conducted. To perform the analysis, Jaccard's coefficient[23] (*Eq. 7*) was calculated for every two clusters A and B. (Walterbusch, Gräuler, et al. 2014)

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

Eq. 7: Jaccard's Coefficient (Walterbusch, Gräuler, et al. 2014).

where

$A \cap B$: Size of the intersection of the clusters A and B

$A \cup B$: Size of the union of the clusters A and B

with

$J(\emptyset, \emptyset) = 1$ and $0 \leq J(A,B) \leq 1$

The results of the hierarchical cluster analysis can be reviewed in the dendrogram shown in *Fig. 7*. The figure features an agglomerative approach, meaning that each observation starts in its own cluster on the left and, according to Jaccard's coefficient, is merged with others on the right. (Walterbusch, Gräuler, et al. 2014)

The analysis indicates that many definitions of trust are available. Nonetheless, even when they apply different terms and phrases, these definitions (more or less) use the same word clusters. It is common practice for authors to synthesize (parts of) existing definitions that they find most relevant and applicable rather than defining a term such as trust anew for every research endeavor. In this context, the definition of trust by Whitener et al. (1998), which uses a total of 13 clusters (*expect*, *fulfill*, *involve*, *control*, *action*, *belief*, *benevolence*, *vulnerable*, *will*, *willingness*, *outcome*, *rely*, and *risk*) and thus makes use of the most of the word clusters identified from all 121 definitions, can be cited:

> *"First, trust in another party reflects an expectation or belief that the other party will act benevolently. Second, one cannot control or force the other party to fulfill this expectation – that is, trust involves a willingness to be vulnerable and risk that the other party may not fulfill that expectation. Third, trust involves some level of dependency on the other party*

[23] Jaccard's coefficient is a measure that is commonly used in information retrieval as a measure of association (Salton & McGill 1983). Using this measure, the coefficient of co-occurrence of two clusters or groups of clusters can be determined. The higher the coefficient, the more often the two clusters appear together (Walterbusch, Gräuler, et al. 2014).

so that the outcomes of one individual are influenced by the actions of another.” (Whitener et al. 1998)

However, because the applied definition of trust is always dependent on the respective researcher’s point of view and application domain, this definition cannot be regarded as the best definition of trust for all applications (Walterbusch, Gräuler, et al. 2014).

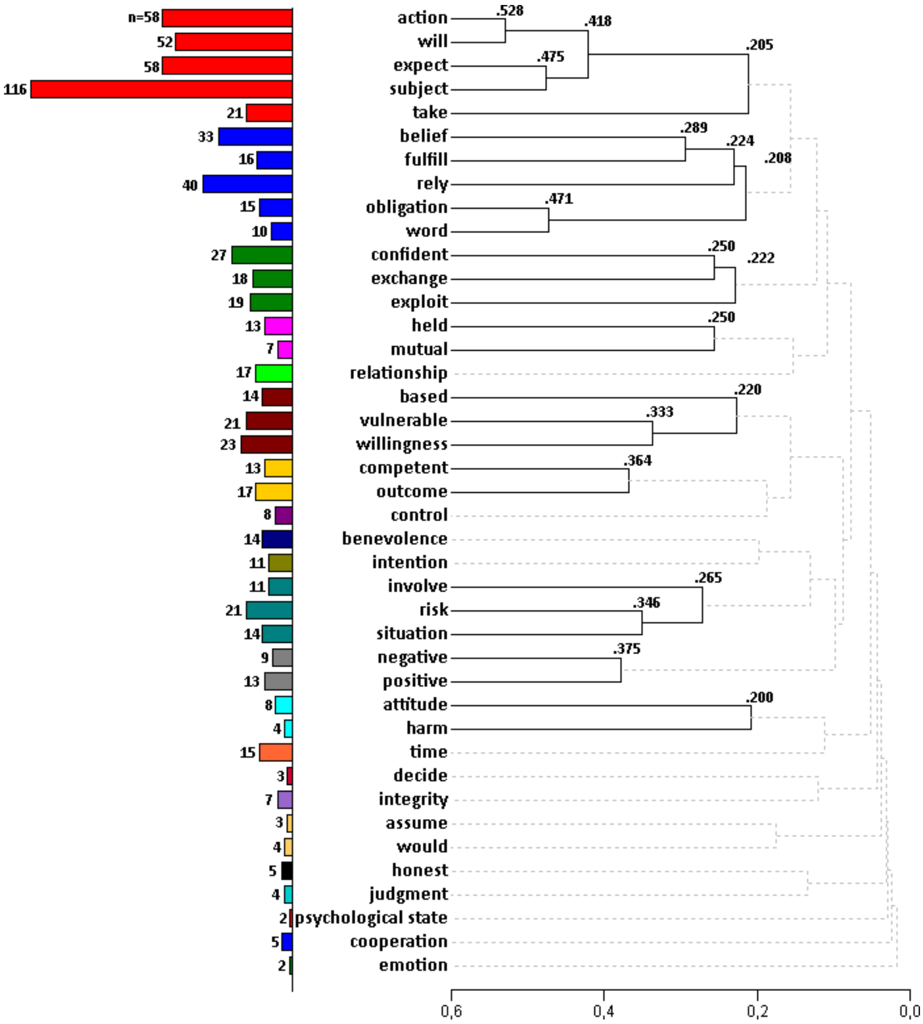


Fig. 7: Hierarchical Cluster Analysis (*Jaccard’s Coefficient* ≥ *.2*) (Walterbusch, Gräuler, et al. 2014).

3.5 Disruptive Events

In the serious game (see Sec. 3.1), it was determined that affectedness, in terms of a personal negative experience with a cloud computing provider, has a negative effect on trust in the provider. Consequently, in the paper whose title translates to *Data Losses and Disruptive Events in Cloud Computing: A Quantitative Analysis of Service Level Agreements, Disruptive Events and Users’ Reactions* (Walterbusch & Teuteberg 2014a), disruptive events in cloud computing were investigated. To reveal unique insights into the holistic image of disruptive events, SLAs for 29 services offered by 16 providers contained in *Garnter's Magic Quadrant for Public Infrastructure as a Service* (Leong & Chamberlin 2011) were analyzed in depth. Similar to the approach used in paper D (see Sec. 3.4), the analysis followed a specific, pre-defined procedure that satisfied the prerequisite of a rule-governed and transparent approach (i.e., it is intersubjectively reproducible), and, based on a text-analytical approach, interpreted the sources (in this case, the SLAs) in the broadest sense. *Tab. 8* presents the absolute frequencies of the word stems that occurred in the 24 SLAs of the identified providers. The data indicated that downtime is the most frequently mentioned disruptive event; in contrast, data loss, for example, occurs relatively infrequently. Other topics found in the list of word stems of the respective SLAs are service credit[24] (*CREDIT*), accounting (*PERIOD, FEE, BILL, MONTHLI*), disruptive events in general (*FAILUR*), and availability[25] (*AVAIL, DOWNTIM, 99, HOUR, 100*). (Walterbusch & Teuteberg 2014a)

#	Word	Frequency	Occurrence in records	#	Word	Frequency	Occurrence in records
1	SERVIC	570	96 %	11	AGREEM	114	92 %
2	CREDIT	393	84 %	12	PROVID	112	68 %
3	CLOUD	332	76 %	13	INCLUDE	110	96 %
4	CUSTOM	297	64 %	14	LEVEL	110	96 %
5	SERVE	185	76 %	15	DOWNTIM	100	68 %
6	NETWORK	159	76 %	16	99	97	64 %
7	FAILUR	145	76 %	17	HOUR	94	56 %
8	PERIOD	123	68 %	18	BILL	93	68 %
9	AVAIL	118	96 %	19	100	90	84 %
10	FEE	117	76 %	20	MONTHLI	88	76 %

Tab. 8: Absolute Frequency of Word Stems in the Service-Level Agreements (*n=24*) (Walterbusch & Teuteberg 2014a).

The two-dimensional (2D) concept map[26] depicted in *Fig. 8* provides an overview of how often a word stem occurs and which word stems are used in connection with one another. The word stems *PROBLEM, CAUSE, REASON, EQUIP, SOFTWAR, HARDWAR*, and *ACCESS* are frequently used in paragraphs that discuss disruptive events. The terms *hardware* and *software*

[24] The customer receives a service credit in case of a failure, e.g., if the availability falls below the contractually committed level.

[25] The safety target availability (*AVAIL*) implies that a cloud computing service is accessible and can be used by an authorized person at any given time (Lampe et al. 2012; Zissis & Lekkas 2012). It refers to all cloud computing service models (IaaS, PaaS and SaaS) but especially to the provision of computing resources and network capacity attributed to IaaS. The internal or external cloud provider, which refers to on-premises or off-premises in terms of the cloud computing deployment models of the private, public or hybrid cloud, has to ensure access to and transmission of data at all times, even in the scenario of a potential failure of the system because of a disruptive event (Zissis & Lekkas 2012; Durkee 2010; Armbrust et al. 2010).

[26] The 2D concept map is the visual representation of a dendrogram, in which each word stem is represented as a colored bubble. The size of a bubble indicates the observed frequency of the corresponding word stem, and the distances between bubbles indicate how likely the corresponding word stems are to appear together (Provalis Research 2005; Provalis Research 2010).

problems indicate that disruptive events are only represented in general, i.e., no examples (e.g., lost or stolen data) are given. Availability, the most prominent part of the SLAs, which is directly connected with the disruptive event of a downtime, is treated in a separate paragraph. Other identified clusters can be attributed to the topics of financial reporting (e.g., *FEE, BILL, MOTHLI, PERIOD*), maintenance (e.g., *SCHEDUL*, *MAINTEN*, *EXCLUD*), monitoring (e.g., *PERFORM*, *MEASUR*, *NETWORK*, *LATENC*, *LOSS*, *PACKET*, *CURRENT*), and support (e.g., *OPER*, *SYSTEM*, *APPLIC*, *SUPPORT*, *ENVIRON*, *VIRTUAL*, *MANAG*).[27] (Walterbusch & Teuteberg 2014a)

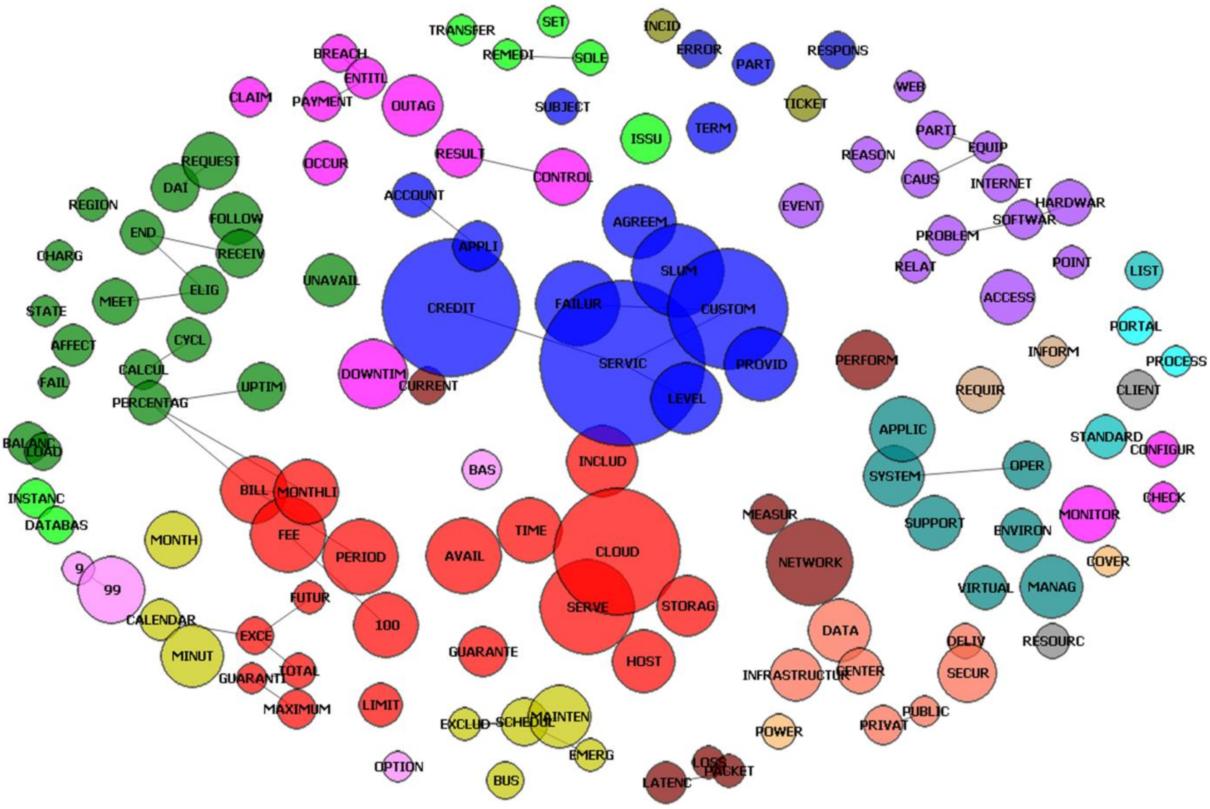


Fig. 8: 2D Concept Map of Word Clusters in Service-Level Agreements (*n=24*) (Walterbusch & Teuteberg 2014a).

Including the contractual content in the SLAs, certain disruptive events stand out. Some of these events occurred because of natural phenomena, such as a blackout caused by a storm, and the remainder of the causes of disruptive events can be categorized as force majeure (e.g., from a series of unfortunate events), attacks from outside (e.g., distributed denial of service (DDoS)

[27] The findings are consistent with the qualitative analysis of SLAs conducted by Stankov et al. (2012). In contrast with their research approach, in the present work, a quantitative approach was employed and, in addition to their findings, *(i)* the word stems used to describe each subject area within the SLAs, *(ii)* their frequency of occurrence and *(iii)* their co-occurrence were determined, as shown in *Fig. 8*.

attacks), or human errors (e.g., misconfiguration of the routing during the migration of multiple data centers). In addition, functionality disorders (e.g., problems adding virtual servers via the interface), temporary and even irreversible data losses (e.g., from mistakes during a network upgrade), inconsistencies (e.g., a software error deletes parts of the backup), and announcements of vulnerability to hacking attacks (e.g., a vulnerability to cross-site-scripting (XSS) attacks) are other known disruptive events. (Walterbusch & Teuteberg 2014a)

Next, users' reactions to disruptive events were analyzed. Posts (*tweets*) on the microblogging service Twitter were used to analyze how users of cloud computing services reacted to disruptive events. Twitter was chosen because the length of a single post is limited to 140 characters; consequently, users must express themselves concisely. The data for the analysis were collected and exported utilizing Brandwatch (Brighton, England).[28] *OUTAGE* is the word stem that was mentioned most frequently: it was included in 86.1 % of all identified tweets (see *Tab. 9*). Furthermore, the word stem *DOWNTIME* occurred relatively frequently. The affected data (*DATA, AFFECT*), the cause of the disruptive event (*POWER, ISSUE*), and the duration (*DAY, TIME, TODAY*) are other topics that were identified. (Walterbusch & Teuteberg 2014a)

#	Word	Frequency	Occurrence of records
1	OUTAGE	8,348	86.1 %
2	CLOUD	6,249	55.6 %
3	SERVICE	1,504	14.6 %
4	DOWNTIME	1,184	12.4 %
5	WEB	787	8.1 %
6	COMPUTE	654	6.7 %
7	DATA	522	4.3 %
8	AFFECT	515	5.5 %
9	SITE	483	4.7 %
10	ISSUE	411	4.2 %

#	Word	Frequency	Occurrence of records
11	POWER	410	4.2 %
12	DAY	367	3.5 %
13	HOST	364	3.4 %
14	TIME	360	3.0 %
15	NEWS	327	3.3 %
16	SERVE	325	2.9 %
17	POST	312	3.0 %
18	CUSTOMER	310	2.9 %
19	TODAY	307	3.1 %
20	LEARN	303	3.2 %

Tab. 9: Absolute Frequency of Word Stems of Users' Reactions on Twitter (*n=9,110*) (Walterbusch & Teuteberg 2014a).

Because of the strength of the connection of the terms (see *Fig. 9*), the relation between the nodes *SHOW* and *RISK* is clearly visible (e.g., "*Amazon EC2 outage impacts on Foursquare, Hootsuite etc [sic] show risks of the #cloud*"). Other topics are requests for apologies and explanations (*APOLOGIZE, EXPLAIN*), accusation (*BLAME*), current information about the disruptive events (*STATUS, UPDATE*), and the extent, specifically related to the availability zones used by, e.g., Amazon Web Services (*AVAILABILITY, ZONE*): *"The last big AWS outage made*

[28] All posts (*tweets*) sent via the network can be searched by accessing Twitter's *Firehose* application programming interface (API); Brandwatch (Brandwatch 2015) provides access to *Firehose*.

it abundantly clear that you need to distribute across availability zones […]“). (Walterbusch & Teuteberg 2014a)

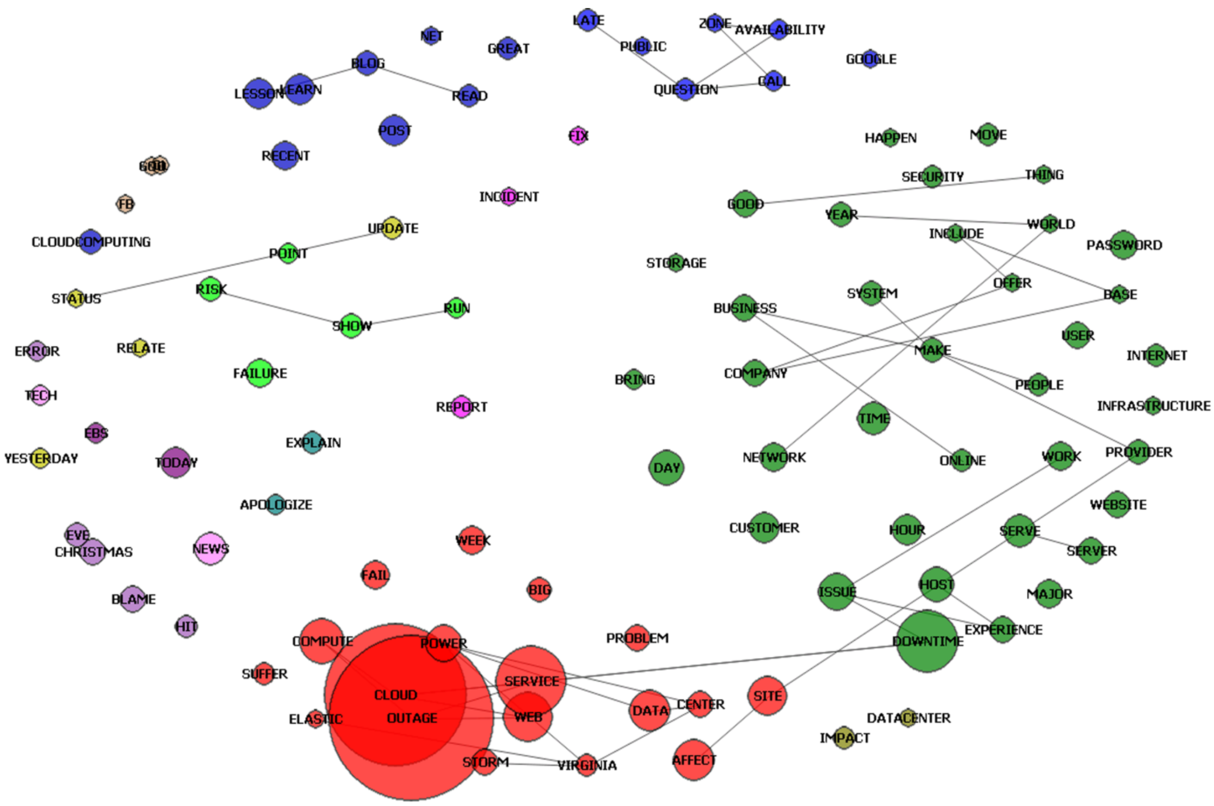


Fig. 9: 2D Concept Map of Users’ Reactions on Twitter (*n=9,110*) (Walterbusch & Teuteberg 2014a).

3.6 Shadow IT

In the papers discussed above, the factors that influence the adoption of cloud computing services were explored and analyzed under the assumption that the adoption of a cloud computing service is a conscious decision. Because of users’ growing acceptance of cloud computing services that can be used free of charge and independently of location from any (mobile) device, and thereby synchronizing data among various devices (Worthen 2007; King 2012), cloud computing services may be used within companies by employees without management’s permission or even its knowledge. Consequently, cloud computing services may be used by employees without the appropriate decision-makers having made a decision for or against the adoption of these services. Therefore, in the paper whose title translates to *Shadow-IT: Implications and Recommendations for Mobile Security* (Walterbusch, Fietz, et al. 2014), the following research questions were addressed: (i) *What are the reasons for the use of cloud services and the resulting shadow IT from an employee's perspective?* (ii) *How can a company counteract unauthorized usage of cloud services?* (iii) *What are the opportunities and risks associated with cloud computing in the form of shadow IT?* These questions were answered using a systematic literature review, expert interviews, and a vignette study. (Walterbusch, Fietz, et al. 2014)

Starting with the first research question, based on a literature review, it was determined that one reason that employees use cloud computing services without permission is that they use cloud computing services in their daily private lives and thus want to obtain the same advantages in their work lives also (Rentrop & Zimmermann 2012). Furthermore, employees do not always follow guidelines, if there are any in place at all, because they do not agree with them or do not see the benefits of them (Behrens 2009). In some cases, employees do not know that there are guidelines regarding the usage of shadow IT (Silvius & Dols 2012). (Walterbusch, Fietz, et al. 2014)

In March 2013, ten expert interviews were conducted to determine the status quo of cloud computing services in conjunction with shadow IT in companies and to identify the resulting risks. These risks are listed in *Tab. 10*.

Risk(s)	**Description**	**Expert #**
Stolen Data/Corporate Espionage	Data stored in the cloud may be stolen via unauthorized third-party access. Also important are the threatening inherent damages to the reputations of the companies.	1, 3, 4, 6, 8, 9, 10
Malware/Spyware	Because the cloud computing services employed are not subject to the maintenance and update cycles of the local IT department, security vulnerabilities can arise from shadow IT. Additionally, malicious code can be attached to downloaded software.	1, 3, 5, 6, 9
Missing Backups	Because the use of cloud services is unauthorized, it is unacknowledged, and the cloud systems are not integrated into the security system of the company; therefore, periodic backups of the *cloudsourced* data do not occur.	1, 2, 6, 8
Data Location	Because of the global nature of cloud computing services, the user is unaware of where the data are stored and who has access to them. This can lead to data protection problems, especially when sensitive, personalized customer data are outsourced to the cloud. Furthermore, it is not necessarily known whether and where (on the customer side or on the provider side) data encryption occurs.	6, 7, 8
Loss of Compatibility/Inside Knowledge	The use of local SaaS solutions implies that an employee who outsources data to the cloud has inside knowledge. Moreover, the data stored in the cloud may no longer be compatible with company data because of proprietary file formats.	5

Tab. 10: Risks That Arise from the Usage of Unauthorized Cloud Computing Services (Walterbusch, Fietz, et al. 2014).

However, the unauthorized use of cloud computing services also creates opportunities. The positive effects most frequently mentioned in the expert interviews are the employees' increased effectiveness and the potential for innovation. There may be an improvement in the quality of work and employees are more likely to accept the employed systems (Behrens 2009; Rentrop & Zimmermann 2012). Moreover, detection of a cloud computing service used without authorization offers its own advantages. The use of an unauthorized cloud computing service may imply that the involved employees have an unmet need because, e.g., the corporate IT systems are inadequate; thus, the employees close the gap between their requirements and the actual provided IT systems themselves (Jones et al. 2004). Consequently, the IT department or management can use this gained knowledge to improve the corporate IT landscape, thus positively impacting the company's effectiveness (Jones et al. 2004). (Walterbusch, Fietz, et al. 2014)

Based on the findings from the literature and expert interviews, a vignette study was conducted, as described in *Tab. 11*. (Walterbusch, Fietz, et al. 2014)

Matthew (20 years old, student and employee in a small IT consulting firm) is at a party and wants to leave his jacket at the wardrobe, but unfortunately the wardrobe is already closed. He decides to put the jacket in a corner, it'll be alright. When he comes back from the dance floor, his jacket is gone. He checks his trouser pockets and realizes that his phone was in one of the inside pockets of his jacket. The next morning, Matthew immediately blocks his subscriber identity module (SIM) card. During the call with the mobile service provider, it occurred to him that he synchronized his employer's sensitive data using a cloud service, so that the latest results were available from any device (smartphone, laptop, tablet, desktop PC, and so on). Furthermore, he also synchronized his employer's email account on the smartphone. Because Matthew thought that unlocking his smartphone via gesture control was too annoying, he refrained from doing it. The passwords to the cloud services were stored for convenience, so that he did not have to always type them in again on the small smartphone keyboard. Consequently, the alleged thief now has access to all the company data Matthew had access to and also to his emails.   Put yourself in the position of Matthew. What do you think about this disruptive event – please write down everything that goes through your head. Among others, answer the following questions: • What happens to you? How do you feel? • How do you react in this situation? Do you inform your employer? If yes, why? If not, why not? • Which consequences do you expect?

Tab. 11: Vignette Study (Walterbusch, Fietz, et al. 2014).

In the following, the key findings (namely the employees' emotional state, their actions towards the employer, and their respective motives) that could be extracted from the 211 complete responses to the vignette will be elaborated. As depicted in *Tab. 12*, 165 total participants described their emotional state (multiple responses were allowed). Most participants felt embarrassed, blaming themselves for the naivety and carelessness that enable them to first, store internal company data unsecured on their smartphone and second, to lose this device. It was embarrassing for the participants, especially because they "*do not only harm themselves, but the entire company*". These feelings could result in concealment of the loss of the phone and the company's internal data. Furthermore, a quarter of all participants described the emotional states of helplessness and panic; they simply did not know how to react in such a situation. (Walterbusch, Fietz, et al. 2014)

Emotion	Percentage
embarrassing; stupid; bad	43.64 %
helpless; panic; desperate	26.06 %
angry; furious	24.24 %
fearful; uncertain	20.00 %
annoyed; hateful	20.00 %

Tab. 12: Employees' Emotional State When Losing a Smartphone on which Sensitive Company Data Had Been Synchronized (*n=165, Multiple Responses Allowed*) (Walterbusch, Fietz, et al. 2014).

Tab. 13 indicates how the participants would react; the range goes from *inform the superiors immediately* about the incident to *providing no information*. The difference between *inform immediately* and *inform soon* is that in the case of informing the superior *soon*, the employee wants, e.g., "*[…] to sleep on it for a night*". However, delays in reporting increase the threat to the company because the alleged thief has most likely already accessed sensitive data. Approximately 60 % of the respondents would immediately inform their employer about the loss of the smartphone. Approximately 7 % would inform the employer later, when all options (e.g., changing the password or blocking the cloud computing services) were exhausted. Only one participant would not inform the company at all because he or she thinks, "*Probably the thief cannot use the company's data and consequently will ignore it*". (Walterbusch, Fietz, et al. 2014)

Action	Percentage
inform immediately	59.72 %
inform soon	30.33 %
inform later	6.64 %
withhold information or lie	2.37 %
no information	0.47 %

Tab. 13: Employees' Actions Toward Their Employer When Losing a Smartphone on which Sensitive Company Data Had Been Synchronized (*n=211*) (Walterbusch, Fietz, et al. 2014).

3.7 Sustainability

In the previous papers, the economic perspective on the adoption of cloud computing services prevailed, especially in the exploration that used the simplified cloud computing market presented in paper A, the description of the cloud computing market and the corresponding value flows in paper B and the formal TCO model in paper C. In paper G, titled *A Decision Model for the Evaluation and Selection of Cloud Computing Services: A First Step Towards a More Sustainable Perspective* (Walterbusch et al. 2015), the focus shifted towards sustainability. By applying a combination of deductive and inductive steps to reveal the core characteristics of cloud computing services and their economic, environmental and social impacts, which are subsumed under the term *sustainable information systems management*[29], a realistic decision

[29] The definition of sustainability, which is also known as the triple-bottom-line concept (corporate sustainability) and consists of economic, ecological and social pillars, is used (Elkington 1998). The primary focus is IT; thus, the three interdependent perspectives are integrated and balanced in the realm of IT, thereby resulting in the term sustainable information systems management (Schmidt et al. 2009). (Walterbusch et al. 2015)

model for evaluation and selection of cloud computing services was formulated. The corresponding research question (Watson & Chen 2010) was as follows: *Which information regarding cloud computing services must be integrated into a formal decision model to increase their sustainable application?* (Walterbusch et al. 2015)

Using a systematic literature review, a research gap about economic models for sustainable cloud computing was identified. Next, the focus was on the theoretical background of the model (see *Tab. 2*), and its requirements were discussed, as indicated in *Tab. 14*. (Walterbusch et al. 2015)

Model Element	Requirement/Characteristic	References
IT Service Costs		
	Pricing Model (Pay-Per-Use, Subscription Basis per User and/or per Month)	Anandasivam & Premm (2009), Lehmann & Buxmann (2009), Lehmann et al. (2010), Armbrust et al. (2010)
Negotiation Costs		
	License and SLA Negotiation: Quantity, Quality, Discount, Contract Length	Ellram & Siferd (1993), Pueschel & Neumann (2009), Martens et al. (2011)
Evaluation Costs		
	Selection and Evaluation of Cloud Computing Services	Weinhardt et al. (2009), Armbrust et al. (2010)
	Quality of Service (availability, response time, certificates, security, auditability, carbon emissions)	Cagnin et al. (2005), Weinhardt et al. (2009), Armbrust et al. (2010)
	Estimation of Cost Parameters	McKeen & Smith (2010), Ellram & Siferd (1993)
Coordination Costs *[1]		
	SLA Management	Talukder et al. (2010), Armbrust et al. (2010)
	Renegotiation (Up- and Downscaling)	Ellram & Siferd (1993), McKeen & Smith (2010), Talukder et al. (2010), Armbrust et al. (2010)
	Administration (Aligning Corporate, Sustainability and IT Strategy)	Ellram & Siferd (1993), McKeen & Smith (2010), DiMaggio & Powell (1983)
Adoption Costs		
	Integration Costs, Interoperability, API Adjustment	Talukder et al. (2010)
	Consulting Services	Leimeister et al. (2010), Böhm et al. (2010)
Maintenance Costs		
	Data Transfer	Armbrust et al. (2010)
	Energy	Cagnin et al. (2005), McKeen & Smith (2010), Osch & Avital (2010), Vykoukal (2010), Hedwig et al. (2009)
	Personnel	Ellram & Siferd (1993)
	Security	Gupta et al. (2008), Ramireddy et al. (2010)
Agency Costs[a]		
	Monitoring	Leimeister et al. (2010)
	Performance Management	Talukder et al. (2010), Durkee (2010)
Environmental Costs[a]		
	Reverse Logistics	Elkington (1998), Hazen et al. (2010), Osch & Avital (2010), Mann et al. (2009)
	Carbon Emission	Cagnin et al. (2005), Subramanian et al. (2010), Vykoukal (2010), Hedwig et al. (2009)
Social Costs[a]		
	Training for Redeployment	Elkington (1998), Cagnin et al. (2005), Fink & Neumann (2007)
*[1] Factors that support sustainable decision-making.		

Tab. 14: Requirements and Model Elements (Walterbusch et al. 2015).

Similar to the TCO approach (see Sec. 3.3), equations for the calculation of the individual model elements (see *Tab. 14*) were derived. For the purpose of performing a simulation, the decision model was implemented with the help of @Risk[30] (Palisade Corporation, Ithaca, New York, USA), an add-in for Microsoft Excel. The reasons for which a simulation study was conducted are twofold. First, a deeper comprehension of the decision model was desired. Second, the simulation was used to validate the practicability of the model. (Walterbusch et al. 2015)

The @Risk tool was used because there are several parameters included in the model that are subject to estimates and, therefore, the use of statistical distributions simplifies the application of the model. Furthermore, the problem of spurious accuracy can be counteracted using distributions. A stochastic technique, a Monte Carlo simulation, was applied. To create different possible scenarios of a problem within a Monte Carlo simulation, random values from given distributions are selected (Conrad 2005). An overview of the simulation model and the exemplified distributions is shown in *Fig. 10*. The following case was simulated[31]: a company intends to outsource storage capacity using IaaS. There are three services available from three different providers. The amount of storage is measured in gigabytes, follows a normal distribution $N(150; 15)$, and increases 10 % each period over a duration of five periods, where a period equals one billing year. (Walterbusch et al. 2015)

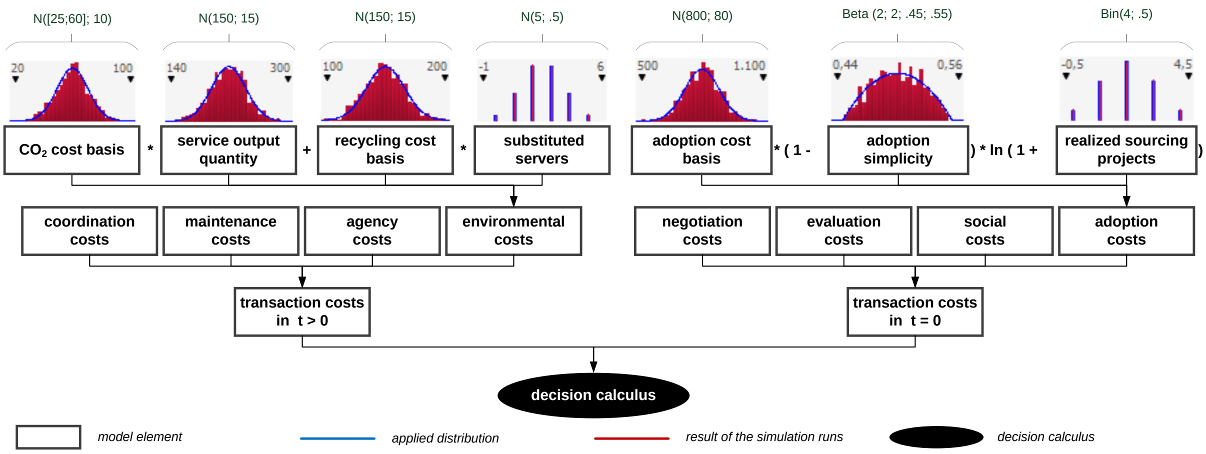


Fig. 10: Overview of the Simulation Model and the Distributions (Walterbusch et al. 2015).

In the case study, two scenarios were analyzed: *(i)* the complete model, including variables and parameters that pertain to sustainability, was simulated; *(ii)* only those parts of the model regarding economics were simulated, thus disregarding the aspect of sustainability. Using a

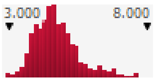
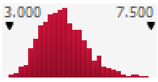
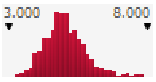
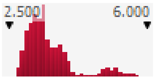
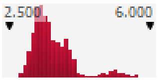
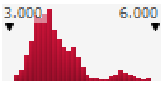
[30] @Risk supports the generation of statistical distributions instead of a single data input and a single data output. Further information can be found at http://www.palisade.com/risk/ (accessed February 2, 2015).

[31] The case study represents a realistic scenario that resulted from a review of the literature (C. Riedl et al. 2010) and from industry workshops that were conducted on the topic of cloud computing and sustainable information systems management.

Monte Carlo simulation, 1,000 iterations were conducted, resulting in the distributions presented in *Tab. 15*. In the first scenario, i.e., including all economic, ecologic and social factors, Provider 2 offers the best fitting solution because the mean, the 5 %-quantile and the 95 %-quantile exhibit the lowest values and the distribution has the lowest skewness. (Walterbusch et al. 2015)

The second scenario, i.e., including only the economic focus, results in Provider 1 offering the best service because it exhibits the lowest minimum, maximum, mean and median values and the lowest value for the 5 %-quantile. (Walterbusch et al. 2015)

To gain a better understanding of the model mechanism, a sensitivity analysis of the final results was conducted by applying Spearman's rank correlation coefficient ρ to each of the six scenarios. Summarizing, a balanced result was indicated by the sensitivity analysis, thus emphasizing the importance of the sustainability parameters contained in the model. (Walterbusch et al. 2015)

Scenario/Provider		Graph	Min	Max	Mean	Median	5 %	95 %	Estimated Distribution[32]	Skewness[33]
Sustainability	1		3.123	7.571	4.797	4.699	3.841	6.225	$LogN(2748.7; 705.38)$[34]	0.858
	2		3.205	7.329	4.772	4.731	3.829	5.863	$LogN(3811.1; 631.12)$[34]	0.471
	3		3.446	7.710	5.102	5.042	4.133	6.297	$LogN(3548.1; 649.82)$[34]	0.620
Economic	**1**		2.817	5.715	3.550	3.433	2.988	4.931	$PearsonV(5.9413; 5163.7)$[35]	1.769
	2		2.874	5.633	3.632	3.528	3.127	4.370	$PearsonV(8.3411; 8166.8)$[35]	1.686
	3		3.237	5.837	4.002	3.897	3.479	5.152	$PearsonV(9.011; 9484.4)$[35]	1.528

[32] The verification of the estimation was conducted using a chi-square test. For the first scenario (*Sustainability*), the values ranged from 19.2 to 46.3. For the second scenario (*Economic*), the chi-square test resulted in values that ranged from 85.5 to 135.8.

[33] All results were skewed right (> 0), thereby indicating that values lower than the arithmetic mean occurred more frequently than values greater than the arithmetic mean. The skewness of the distributions was greater in the second scenario than in the first scenario.

[34] The log-normal distribution $(X \sim LogN(\mu; \sigma^2))$ ranges from 0 to ∞, and the logarithm of a random variable is normally distributed (Grove & Coddington 2005).

[35] The Pearson type-V distribution (inverse gamma distribution) generally has a shape parameter α, a scale parameter β and a location parameter γ, i.e., $PearsonV(\alpha; \beta; \gamma)$ where $\alpha > 0$ and $\beta > 0$ (Grove & Coddington 2005). This distribution is usefully applied if the minimum is certain and the maximum is unbounded.

Tab. 15: Simulation Results (in Euro) (Walterbusch et al. 2015).

3.8 Information Asymmetry

Motivated by the findings of the serious game (see Sec. 3.1) that information about a provider has a positive effect on a potential user's trust in the provider, in the paper titled *"May I help You?" Increasing Trust in Cloud Computing Providers through Social Presence and the Reduction of Information Overload* (Walter et al. 2014), the impact of information presentation was investigated, and the corresponding effects on a user's trust and intentions to adopt the cloud computing service were explained. Therefore, the emphasis was on the importance of communication in fostering trust in cloud computing providers (Garrison et al. 2012; Khan & Malluhi 2010; Öksüz 2014), and the technological requirements of cloud computing services were completely omitted (Yang & Tate 2012). With respect to communication regarding cloud computing environments, bridging information asymmetry and enhancing transparency are of high importance (Walter et al. 2014). In particular, cloud computing providers must adequately inform their current and prospective users about data storage locations, security mechanisms, and privacy practices (Garrison et al. 2012; Khan & Malluhi 2010). These data can usually be found in the SLAs (Stankov et al. 2012; Walterbusch & Teuteberg 2014a). The corresponding research questions were the following (i) *Does the implementation of assistive website elements have an impact on the ease of searching for relevant information in cloud computing providers' SLAs and privacy policies?* (ii) *Do users have a different perception of human warmth/social presence when using an assistive website element?* (iii) *Does the inclusion of assistive website elements on a cloud computing provider's website influence a (potential) user's trust in the cloud computing provider?* (Walter et al. 2014)

Based on a thorough discussion of the theoretical background, the hypotheses presented in *List 2* were derived.

H1 As a user's *(perceived) trust* in a cloud computing provider increases, the *intention to use* a cloud computing service from that cloud computing provider increases (Walterbusch et al. 2013b; Gefen et al. 2003).

H2 Providing assistive website elements (such as a search box or a social recommendation agent) to help users find relevant information in SLAs and privacy policies reduces a user's level of *(perceived) information overload* (Eppler & Mengis 2004; Schneider 1987; Swain & Haka 2000; Owen 1992; Tegenbos & Nieuwenhuysen 1997; Berghel 1997).

H3 Providing assistive website elements (such as a search box or a social recommendation agent) to help users find relevant information in SLAs and privacy policies increases a user's *(perceived) control* over the search activity (Eppler & Mengis 2004).

H4 As a user's *(perceived) information overload* when searching for relevant information in SLAs and privacy policies decreases, the *(perceived) ease of use* increases (Eppler & Mengis 2004; Schneider 1987; Swain & Haka 2000; Owen 1992).

H5 As a user's *(perceived) control* when searching for relevant information in SLAs and privacy policies increases, the *(perceived) ease of use* also increases (Lee & Benbasat 2011; Eppler & Mengis 2004).

H6 As a user's *(perceived) ease of use* increases, a user's *(perceived) trustworthiness* of a cloud computing provider also increases (Milne & Culnan 2004).

H7 Providing a social recommendation agent in SLAs and privacy policies will increase users' *(perceived) social presence* (Qiu & Benbasat 2009; Chattaraman et al. 2012; Short et al. 1976; Cyr et al. 2009).

H8 As a user's *(perceived) social presence* when searching for relevant information in SLAs and privacy policies increases, the *(perceived) trustworthiness* of the cloud computing provider also increases (Walter et al. 2013; Cyr et al. 2009; Hess et al. 2009; Qiu & Benbasat 2009).

List 2: Hypotheses (Walter et al. 2014).

An experiment was designed to verify the hypotheses in *List 2*. In accordance with the research questions, the effects of two assistive website elements (a search box with autocomplete functionality and a social recommendation agent) embedded into a cloud computing provider's SLAs and privacy policy were examined separately. In addition to these two experimental conditions, a condition in which the information was presented as text only was used as a control. Using both analyses of variances (ANOVA) and analyses of means (t-test), hypotheses H2, H3, and H7 were confirmed (see *List 2*). Using a partial least squares analysis, hypotheses H1, H4 through H6, and H8 were confirmed (see *List 2*). The corresponding logical explanatory model is shown in *Fig. 11*. (Walter et al. 2014)

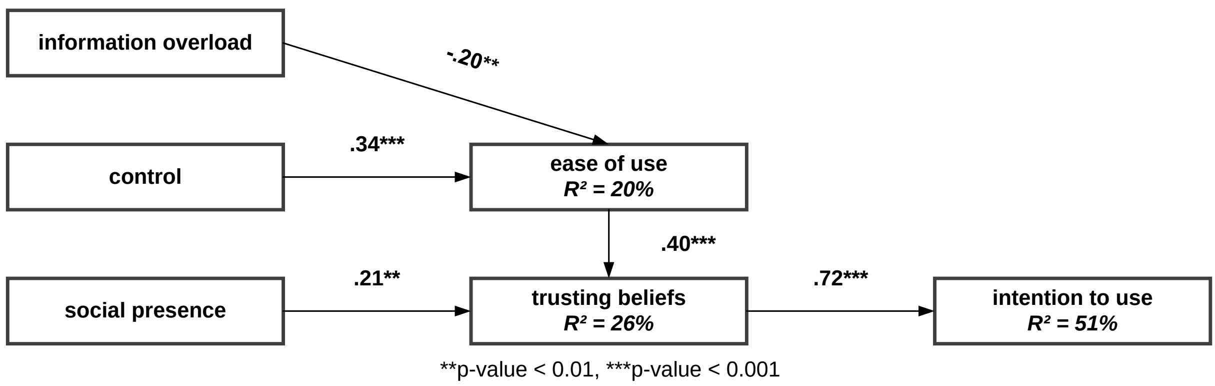


Fig. 11: Logical Explanatory Model (*n=193*) (Walter et al. 2014).

In summary, the results indicated that embedding assistive website elements (search boxes or social recommendation agents) into cloud computing providers' SLAs and privacy policies positively influences the perceived trustworthiness of a cloud computing provider by reducing perceived information overload and increasing perceived control. Furthermore, especially in the case of a social recommendation agent, embedding an assistive web element increases the perceived social presence. Moreover, a user's trust in a provider positively influences his or her intention to adopt a cloud computing service from the provider. All hypotheses (see *List 2*) have been verified. (Walter et al. 2014)

3.9 Research Agenda & Proposed Research Methods

As shown in *Fig. 2*, the previous research contributions (see Secs. 3.1 through 3.8) were ultimately combined to create a research agenda for the exploration, analysis, description and explanation of trust in the realm of cloud computing titled *Towards an Understanding of the Formation and Retention of Trust in Cloud Computing: A Research Agenda, Proposed Research Methods and Preliminary Results* (Walterbusch & Teuteberg 2014b). The corresponding research questions were the following: (i) *What factors influence trust (in the area of cloud computing)?* (ii) *In which way do these factors influence trust? Is there a hierarchal or even dependent order?* To explore the *influencing* and *influenced* facets of the term trust, analyze them in detail, describe them in detail and explain their dependencies, analyses at different levels are necessary (Pearson & Benameur 2010). Because of (a) *the many different forms* (Josang et al. 2007) and (b) *the difficult conceptualization* (Gefen & Straub 2003) of trust, it is ambitious to attempt to develop a holistic definition of trust that covers all of the dynamic and multifaceted subtleties. Because of the multitude of service and deployment models in cloud computing environments (Mell & Grance 2011), the conceptualization of trust in the realm of cloud computing is particularly complex. Consequently, a mixed-methods approach was proposed. This approach consisted of the research methods literature review, laboratory experiments, semi-structured expert interviews, surveys, vignettes and (retrospective) thinking aloud complemented by NeuroIS. The research approach was divided into the following five steps: (i) *observation & induction*, (ii) *formulation of hypotheses*, (iii) *data collection*, (iv) *verification & adaption*, and (v) *design and evaluation*, as shown in *Fig. 12*. This research approach has the power to verify existing theories regarding the subject (see *Tab. 3*) and provides the possibility for development of new theories, e.g., using NeuroIS. (Walterbusch & Teuteberg 2014b)

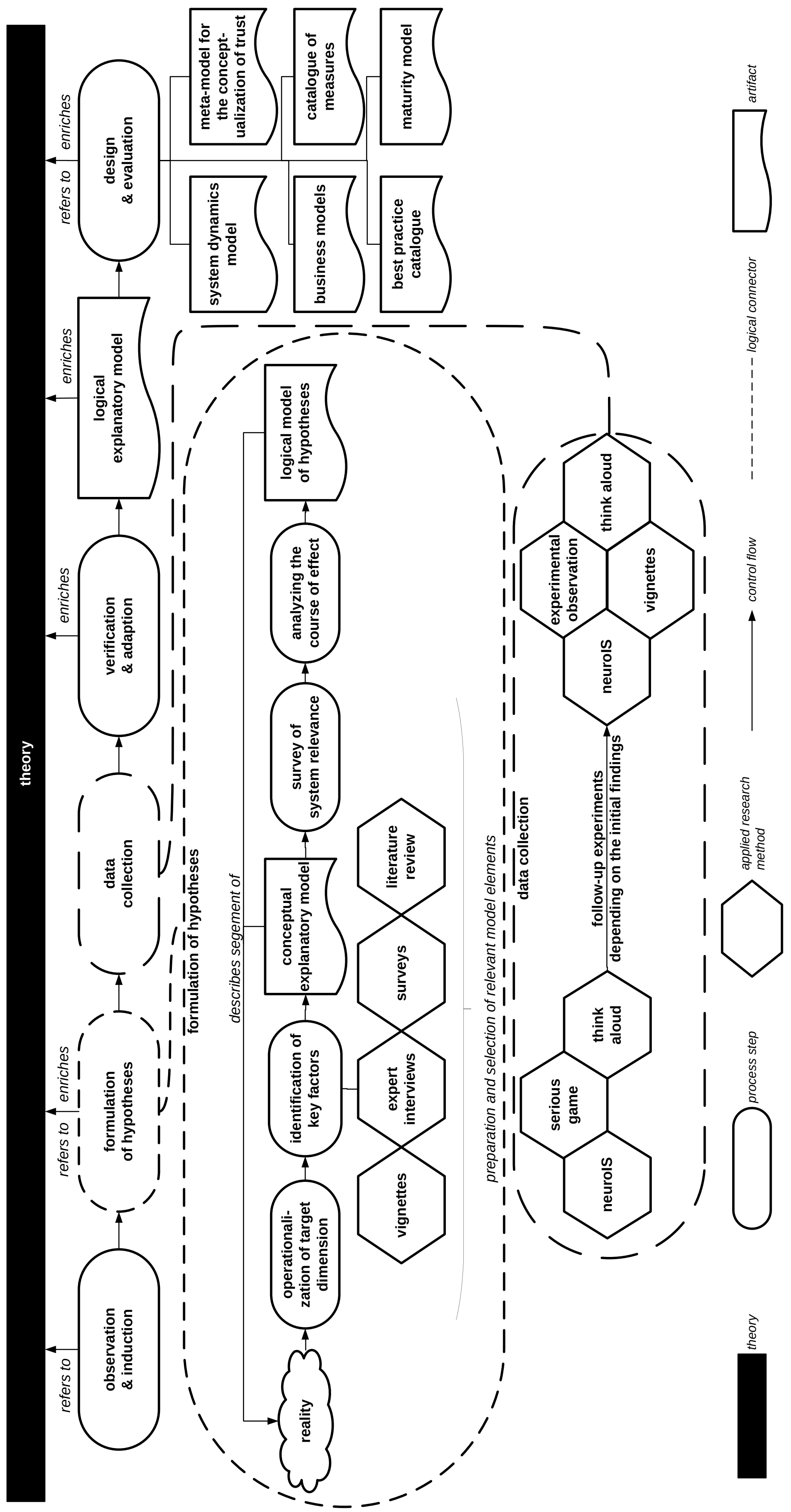

theory
refers to
enriches
observation & induction
formulation of hypotheses
data collection
verification & adaption
logical explanatory model
design & evaluation
system dynamics model
meta-model for the concept-ualization of trust
business models
catalogue of measures
best practice catalogue
maturity model
formulation of hypotheses
describes segement of
reality
operationali-zation of target dimension
identification of key factors
conceptual explanatory model
survey of system relevance
analyzing the course of effect
logical model of hypotheses
vignettes
expert interviews
surveys
literature review
preparation and selection of relevant model elements
data collection
neuroIS
serious game
think aloud
follow-up experiments depending on the initial findings
neuroIS
experimental observation
vignettes
think aloud
theory
process step
applied research method
control flow
logical connector
artifact

Fig. 12: Methodology (Walterbusch & Teuteberg 2014b).

4 Discussion

4.1 Implications

4.1.1 Implications for Research

Because this doctoral thesis is a cumulative dissertation, the research contributions contained herein build upon one another, thereby closing research gaps identified in preceding papers. Therefore, a mixed-methods approach was chosen. The main theme is the exploration, description, analysis, and explanation of the factors that influence the adoption of cloud computing services from different perspectives. Consequently, the implications for research are the results of the individual research contributions contained in this cumulative dissertation. A plethora of factors influence the adoption of cloud computing. This thesis offers an overview of the large variety of divergent factors. Each of these factors was investigated from a certain point of view, e.g., information asymmetry was investigated from the perspective of the various manners in which information is presented. By applying other points of view, further insights are possible. Therefore, these insights are not only relevant in the cloud computing context but also in other domains, e.g., the results from research on trust in cloud environments can be generalized to trust in IT outsourcing or transferred to e-commerce contexts. Consequently, the following detailed implications for research based on each individual study must be viewed as starting points for further research regarding the relevant factor(s).

The starting point is paper A (see Sec. 3.1), which explored various factors that influence the adoption of cloud computing. It was determined that trust plays a major role; consequently, trust was generally described in paper D (see Sec. 3.4). Furthermore, an analysis from various points of view along the entire value chain, which consists of user companies, mediators and providers, was required; this analysis was presented in paper B (see Sec. 3.2). A typical trust process that is determined by an incident increasing or decreasing the level of trust was identified. These incidents, i.e., disruptive events, were studied in the work presented in paper E (see Sec. 3.5). These general insights were then used to formulate hypotheses, which were statistically tested via a serious game. It was demonstrated that a customer's risk aversion, his or her personal affectedness, a provider's reputation, information about the provider and the cost of a cloud computing service influence the trust in a mediator or provider in a cloud environment, which in turn has a significant influence on a prospective user's intention to adopt a cloud computing service. These factors, except for attitudes (e.g., risk aversion or disposition to trust), were then described and analyzed in detail. Personal affectedness in cloud computing was presented in paper E (see Sec. 3.5) by analyzing disruptive events, whereas a formal model that addressed the factor costs was developed and presented in paper C (see Sec. 3.3). A provider's reputation in terms of his or her means to overcome information asymmetry was explained in paper H (see Sec. 3.8). Additionally, the factors shadow IT and sustainability were described and analyzed. All of the papers B through I (see Secs. 3.2 through 3.8) contain further implications for research, which are as manifold as the factors regarded and shall be presented below.

In paper B (see Sec. 3.2), a generic model of the cloud computing market to be used for the development of hybrid cloud computing services was presented. As the research and development of the cloud computing paradigm matures, the model must be adapted to changes in the market, e.g., the entry of yet unknown stakeholders. It also requires a clarification of the composition of the pricing for a hybrid cloud computing provider, i.e., how the value of the provider's service is calculated or assessed monetarily. Moreover, every stakeholder of a supply chain network should know which part of the network provides which service(s). Additionally, the model represents a generic cloud computing market, which makes it necessary to more closely analyze possible hybrid service bundles that consist of a cloud computing service and an additional service. Based on the generic model, its dependence on the respective service (IaaS, PaaS and SaaS) and the deployment model (public, private, community and hybrid cloud), more specific cloud computing market models can be developed (Mell & Grance 2011). (Walterbusch, Truh, et al. 2014)

Based on the results presented in paper C (see Sec. 3.3), gathering the TCO assessment data based on the TCO model presented and analyzing them statistically to better understand decision-making in cloud computing was recommended. An analytic hierarchy process (AHP) for the evaluation of the quality of several services can be included and compared with the results of the TCO model (Saaty 1980). In addition, the research results suggest several new areas that have not yet been extensively discussed in the scientific literature. Although current scientific work continues to focus on the risk and security aspects of cloud computing, an approach that combines the risk and security aspects using a TCO approach is missing. Additionally, benefits management can be explored, e.g., using cost-benefit analyses (Kondo et al. 2009) in real world scenarios, thereby revealing additional insights about economic and managerial success factors in cloud computing. (Walterbusch et al. 2013a)

Regarding paper D (see Sec. 3.4), the need for a holistic and interdisciplinary definition of trust must be put into perspective. As the analysis demonstrated, existing trust definitions essentially use the same word clusters. Consequently, it is legitimate for researchers to define trust separately for each research endeavor while still relying on established definitions of trust. The presented results can aid researchers in finding and devising a fitting definition of trust while ensuring that no commonly accepted word clusters are omitted. Additionally, the common view regarding trust and its comprising constructs, determined, e.g., by means of coding, may be open to changes, extension or even realignment. The need for changes, extension or realignment may be caused by new insights gained from the application of innovative research methods, e.g., NeuroIS (Dimoka et al. 2012). The existing definitions try to describe trust on the basis of multi-item scales, which are subject to many biases, e.g., subjectivity bias, desirability bias or demand effects (Dimoka et al. 2012), and may not be sufficient to identify all dependencies of and influences on the complex construct of trust. Consequently, the unbiased exploration of the establishment, maintenance and loss of trust should be continued (see paper I). (Walterbusch, Gräuler, et al. 2014)

In the analysis of disruptive events presented in paper E (see Sec. 3.5), it was found that the causes for and results of disruptive events can take many forms. Whereas the causes for disruptive events are force majeure, human failure and announcements of vulnerability to hacking attacks, the results of disruptive events are downtimes, functionality disorders, temporary and irreversible data losses, data inconsistencies and (hacking) attacks. Because of the unpredictable character of disruptive events, the data must be stored redundantly with different providers, rather than using the same basic cloud provider or relying on one another in terms of a supply chain value network (see *Fig. 5*), to guarantee an availability of one hundred percent. Because saving data redundantly with two providers implies costs for two providers and the inclusion of a switch, data should be saved manually in a virtual location and then automatically mirrored at both providers. The switches for different cloud computing services must be designed, implemented, and evaluated in terms of their usability and response times. There is also a need to research suitable communication strategies for each of the identified disruptive events. Although cloud computing providers offer service credits to their customers if the availability falls below the contractually assured threshold, the analysis presented in paper E demonstrated that there is still a need to address disruptive events effectively and via multiple channels. (Walterbusch & Teuteberg 2014a)

The findings presented in paper F (see Sec. 3.6) indicate various starting points for further research. In terms of prevention of shadow IT, there is a need for suitable measures to raise the awareness of employees, e.g., brochures, email notifications, and single or periodic workshops, regarding the risks of the unauthorized usage of shadow IT in general and cloud computing services in particular. With respect to the detection of shadow IT in use within a company, a best practices model for the identification of shadow IT must be developed and evaluated. Future research should focus on frameworks and security mechanisms to integrate shadow IT into the existing corporate IT infrastructure.

In paper G (see Sec. 3.7), a formal decision model for the evaluation and selection of cloud computing services was presented. This formal model contains a certain degree of flexibility, e.g., the addition or omission of certain cost factors is possible. However, it might not be applied by decision-makers as easily as, e.g., a web-based software tool can be (see paper C). It was not the objective of the study to deliver a theoretical solution for the model, but this could be undertaken in further research studies, e.g., using a genetic algorithm[36]. Moreover, the model concentrates on adopting a cloud computing service solely from one provider, thereby completely eliminating multi-sourcing. Further research regarding cloud computing service portfolios and issues such as risk distribution may provide valuable new insights. Based on these findings, the model may be extended by including quality and security measures. The published study implies that integrating sustainable factors into a decision-making process concerning *cloudsourcing* is of high relevance, thus highlighting the connection between sustainable development and IT. The question to be answered is the following: how can ecological, social and economic goals be integrated into one holistic model? Because the study employed an economic approach and included monetized social and ecologic factors, a more holistic approach may be found. (Walterbusch et al. 2015)

The results presented in paper H (see Sec. 3.8) confirm the importance of trust as a major factor that influences the adoption of cloud computing. It was determined that a provider's willingness and efforts to bridge the information asymmetry between users and the provider is observed as a benevolent act that is rewarded with higher levels of trust from users. Therefore, a user's intention to adopt cloud computing depends on actual security improvements and also on the adequate provision of information regarding security. Consequently, research should focus on various methods of information provision and their improvement, e.g., certificates that

[36] Genetic algorithms compare different solutions of particular individuals and evaluate their fitness to create a new generation (Silver 2004).

summarize information to improve the comprehensibility of (complex) dependencies. With respect to the implemented assistive website elements, i.e., the search box and the social recommendation agent, these tools need to be improved in terms of appearance (e.g., humanoid[37]), functionality (e.g., detection of spelling errors and application of machine learning algorithms), and usability (e.g., provide an overview of the ten most frequently asked questions (FAQs)) to achieve the best possible effect. (Walter et al. 2014)

The results of papers A through H (see Secs. 3.1 through 3.8) were implicitly or explicitly joined in the research agenda proposed in paper I (see Sec. 3.9). The research agenda ultimately emphasized the importance of further research regarding trust in cloud computing environments. Future research studies are recommended to apply the mixed-methods approach used herein. Additionally, the presented model constructs and theories presented herein (see *Tab. 2*) must be refined. The empirical findings must be translated into adequate artifacts, e.g., a system dynamics model, new business models or recommendations for action, for cloud computing users and providers alike. (Walterbusch & Teuteberg 2014b)

4.1.2 Implications for Practice

As with the implications for research (see Sec. 4.1.1), the implications for practice are results of the individual research contributions of this cumulative dissertation.

With respect to the exploration via a serious game presented in paper A (see Sec. 3.1), the presented results are highly valuable for decision-makers in cloud computing and also for understanding the market mechanisms. Proactive recommendations for mediators and providers can be deduced from the statistical results; these recommendations were presented and further discussed in paper I (see p. 51). Additionally, the results offer interesting insights for customers, e.g., which aspects to consider during a provider selection process. (Walterbusch et al. 2013b)

In paper B (see Sec. 3.2), the processes for adding hybrid value to cloud computing services and a model for the generation of hybrid cloud computing services were developed and validated. Both cloud computing providers and customers benefit from insights into regulatory aspects during the planning of a hybrid cloud computing service. Additionally, the implementation and support phases were thoroughly discussed. The results can also aid cloud computing providers in aligning their service strategically, determining an adequate price for their service

[37] In 1970, Masahiro Mori proposed the hypothesis "*[...] that a person's response to a humanlike robot would abruptly shift from empathy to revulsion as it approached, but failed to attain, a lifelike appearance*", which is known as the uncanny valley theory (Mori et al. 2012). This theory originally targeted robots but has, inter alia, been extended to social recommendation agents.

and monitoring their service. Moreover, several risks of hybrid cloud computing services that apply for both providers and customers were discussed. (Walterbusch, Truh, et al. 2014)

With respect to the analysis of relevant cost types and factors of cloud computing services, paper C (see Sec. 3.3) is an important pillar of decision-making in cloud computing management. The TCO model was presented in the form of a mathematical model and implemented on a publicly available website. During the research process, it was determined that the evaluation and selection process of cloud computing services is frequently conducted ad-hoc and, therefore, lacks a systematic approach. The presented TCO model and its application raised the awareness of the indirect and hidden costs in cloud computing. Nevertheless, the approach followed should be regarded as one part of a comprehensive IT cost management scheme and as an additional method to evaluate cloud computing services. In terms of a more sustainable view regarding the decision to adopt a cloud computing service, paper G (see Sec. 3.7) must also be mentioned. (Walterbusch et al. 2013a)

As stated and cited in paper D (see Sec. 3.4), there is no consensus regarding the definition of trust, neither interdisciplinary nor within the IS literature. Nonetheless, as the analysis demonstrated, existing trust definitions generally employ the same word clusters. The presented results aid practitioners in finding and devising a definition of trust while ensuring that no commonly accepted word clusters are omitted. The results directly enable practitioners to phrase trust-building statements more efficiently and more holistically. Using the previous example, trust-building statements should be used by an IT outsourcing provider to communicate how it will meet the customers' expectations regarding handling the outsourced data or processes. In other words, when cloud computing providers use the word trust on their websites, they should address the commonly accepted word clusters such as *subject* and *expectations*. (Walterbusch, Gräuler, et al. 2014)

The results of paper E (see Sec. 3.5) yielded the following recommendations for action (Walterbusch & Teuteberg 2014a).

Recommendations for cloud computing providers

1. When formulating SLAs, be sure to address the commonly used word stems, clusters and subject areas also covered by the market leaders, challengers, visionaries and niche players, as presented in the results.

2. Pay attention when formulating the *service credit* section in your SLAs. Exclude service credit in the case of disruptive events caused by factors outside of reasonable control, e.g., force majeure.
3. In the case of a disruptive event, an honest communication strategy should be in place to inform stakeholders. The questions to be answered are primarily the following: *What* happened? *Who* is affected? *When* did it take place? *Where* did it take place? *Why* did it happen? Additionally, the following question should be answered: *How* long will it take to get back to normal operation? The customers need to be informed about which conclusions have been drawn and what steps are being taken to prevent future service disruptions for the same or similar reasons.

Recommendations for cloud computing users

1. Because social networks, e.g., Twitter, contain openly accessible data that reflect a diverse sample of public opinion concerning various cloud computing providers, cloud computing users should review these data before deciding on a specific service and/or provider.
2. Prior to concluding a contract, customers should check the cloud computing provider's SLAs for the subject areas covered. If the service provider fails to address at least the subject areas identified in the present research results, e.g., availability, service credit and failures, it should be considered a negative signal. Customers should pay close attention to the percentage of availability, the corresponding service credit and the generic descriptions of possible disruptive events.
3. Customers should be aware of any exclusion from service credit, e.g., force majeure or planned maintenance. Additionally, the amount of service credit should be considered. Whereas the service credit should directly compensate for, e.g., the unavailability, the service credit may not compensate for the indirect potential harm to the customer's business and his or her or his or her customers' data.
4. In terms of risk diversification, especially with respect to availability, it is recommended to save one's data redundantly with different cloud providers. It is important not only to choose different availability zones but also to pay attention that the chosen providers do not use the same basic cloud provider as their fall-back provider, thereby preventing a single point of failure (see *Fig. 5*).

The results of paper F (see Sec. 3.6) indicate that the main problem with shadow IT is not the technical implementation of countermeasures, e.g., a comprehensive local and mobile identity and access management system, but rather the underlying strategy employed by management. Many approaches have been proposed to address unauthorized usage of cloud computing services; however, it is essential that such usage is addressed proactively and to achieve a strategic goal. The integration of cloud computing services in conjunction with shadow IT can result in increasing efficiency and productivity, reduced operating costs, minimized risks, flexibility and increased employee satisfaction. However, these advantages can only be achieved if the specified guidelines are not too restrictive and the potential risks, e.g., loss of mobile devices, malware, hacking and industrial espionage, are addressed adequately. Further implications for practice presented in paper F (see Sec. 3.6) include recommendations for action, which are presented below (Walterbusch, Fietz, et al. 2014).

Conduct an employee survey to identify the status quo

1. The aim is to identify the status quo of shadow IT, to obtain an overview, to obtain control over the (mobile) devices, programs, applications, and cloud computing services used in the company, and to determine the effected processes and outsourced data, such that they can be secured. Surveys of the employees, e.g., key users, single departments or the entire staff, or individual and group discussions are appropriate measures to identify employees' unmet needs or requirements and to assess the current usage of unauthorized cloud computing services. After identification, the company can choose between the following two possible solutions to bridge the IT gap: improve the existing IT systems, e.g., with new functionalities and software, or integrate frequently used cloud computing services into the company's IT governance.

Set up a company-wide cloud security strategy

2. A stringent, company-wide cloud computing strategy should be developed. It should clearly state whether cloud computing services are banned, limited or generally allowed within the company. In advance, the company has to critically examine the legal requirements, corporate internal and external consequences, potential risks and countermeasures for all three alternatives. Depending on the size of the company, the integration of a *chief cloud officer* or *chief mobile officer* in the organizational structure could be part of the

strategy. As soon as the corporate management has derived a strategy, it should be communicated to the employees.

Setup IT security guidelines, especially with respect to shadow IT

3. Companies should issue guidelines regarding the use of cloud computing services, including how to encounter possible risks, mandatory courses of action in case of the loss of a mobile device and the consequences of violations.

Raise awareness among employees and proactively address the topic of cloud computing services in conjunction with shadow IT

4. A proactive response, regardless of the chosen strategy (ban, limit or generally allow cloud computing services), is desirable. Employees can be made aware, e.g., by means of brochures or periodic employee trainings. In the case of permission to use cloud computing services (Bring Your Own Cloud (BYOC)), employees should be taught about safe handling of data, and a clear definition of the data to be stored in the cloud should be given, e.g., because of legal requirements, no customer or personalized data should be stored in the cloud. In the case in which the use of shadow IT is not encouraged but tolerated, the employees should be made aware of the potential risks and consequences of their direct actions. In the case of prohibition of the use of cloud computing services, it is imperative to openly communicate the consequences for infringements. Additionally, employees should be given opportunities to inform the IT department of any unmet needs.

Probe Bring Your Own Device (BYOD)

5. BYOD allows the employees to access company data through private (mobile) devices. These devices might be integrated into the company's internal IT infrastructure. The associated benefits are, inter alia, cost reductions or avoidances because there is no need to purchase mobile devices owned by the company. Increased productivity and the inherent operational simplicity are further advantages. Disadvantages include the possibility that the corporate network can be attacked by infected applications and other security vulnerabilities of the mobile devices. Furthermore, because of the high degree of heterogeneity (various operating systems, different versions and manufacturers' offshoots), BYOD creates a complex IT landscape, and security mechanisms must be expanded accordingly. A

potential increase in productivity may be outweighed by the high initial and ongoing operating expenses.

The decision model presented in paper G (see Sec. 3.7) supports decision-makers in structuring their decision process and provides a basis for justifying their decision. However, during the identification of realistic values for parameters, such as power consumption per gigabyte, it was found that providers are reluctant to provide companies with information. Nonetheless, some providers occasionally provide environmental information to their customers in the form of sustainability reports. The model goes beyond such measures by making a first step towards the introduction of sustainable management of cloud computing services. Regardless, the primary purpose of the research was not to present a decision model but rather to argue that companies must consider more dimensions than only the economic values in the evaluation and selection of cloud computing services. Generally speaking, the decision model is a means to an end: it makes the first step towards more sustainable usage by clarifying the relevance of integrating sustainable factors into a decision-making process concerning *cloudsourcing*.

Regarding the implications of the research presented in paper H (see Sec. 3.8), the results imply that a provider should implement certain security measures to enhance the security of the cloud computing infrastructure and should also adequately communicate the implemented measures, e.g., via assistive website elements, to gain potential users' trust. Furthermore, the perceived trustworthiness of a cloud computing provider depends on *what* information is provided and also on *how* the information is communicated. The findings demonstrate that the easier it is for users to find relevant information, the more they will trust a cloud computing provider. That is, the information should be *pushed* by cloud computing providers, e.g., text-based, and the users should also be able to *pull* the information they want, e.g., by providing appropriate search functionalities, summarizing FAQs, and providing further contact information in the case that questions cannot be answered. Consequently, cloud computing providers should invest some effort in educating users about critical information in such a manner that they can more easily pull the needed information and understand it. For example, cloud computing providers may utilize visualizations to improve the comprehensibility of (complex) interdependencies such as encryption mechanisms. Equally, other methods that make the offered cloud computing services more transparent are conceivable, e.g., augmentation of SLAs. (Walter et al. 2014)

The statistical results of paper A (see Sec. 3.1) provide the data upon which the proactive recommendations for mediators and providers presented in paper I (see Sec. 3.9) were based. These implications are of interest for both cloud computing providers and users. They provide insights into the providers' behavior, and users can obtain a *feel* for which factors to consider in a provider selection process. In the following, recommendations and short justifications based on the experiment's results are given (Walterbusch & Teuteberg 2014b):

1. Because the decision for a particular provider holds until the test person is disappointed by the provider's services, cloud computing providers should, by all means, meet the customers' expectations.
2. After a decision to use a certain provider has been made, purely negative information about this provider does not necessarily constitute a reason to switch providers. Consequently, providers should overcome information asymmetry at an early point in the business relation to gain the users' trust by, e.g., using trust-enhancing signals, such as certificates.
3. Because the test subjects in the experiment preferred a provider rather than a mediator, direct purchases of cloud computing services from the provider should be made possible.
4. During a selection process, the focus is on the cost; therefore, cloud computing providers should strive for a cost leadership strategy.
5. If the potential monetary damage in case of risk occurrence increases, the test persons' safety requirements also increase. Consequently, cloud computing providers should offer flexible pricing models and corresponding security levels for every need.
6. A user's trust in a cloud computing provider correlates with the trust in the mediator, who falls back on the provider. Consequently, both cloud computing providers and mediators should consider their dependence upon one another, irrespective if the dependence is transitive or propagative[38].

4.2 Limitations

As in any research endeavor, the mixed-methods approach has limitations. Initially, the factors to be further described, analyzed and explained were derived from the literature and expert interviews. Subsequently, their relevance was confirmed using a serious game (see paper A).

[38] Transitivity implies that if *person A* trusts *person B* and *person B* trusts *person C*, whom *person A* does not know, *person A* trusts *person C*. Propagation implies that if *person A* trusts *person B* and *person B* trusts *person C*, whom *person A* does not know, *person A* can derive some amount of trust on *person C* based on how much he or she trusts *person B* and *person B* trusts *person C* (Sherchan et al. 2013).

Nonetheless, the factors considered in this doctoral thesis are not the only factors to be considered in the context of cloud computing adoption. For example, one factor that has not been explicitly considered is technical security, including all facets, such as redundant data storage, encryption, frauds and audits. Consequently, this doctoral thesis does not claim to be the end point for research in this direction. Nonetheless, the factors identified prior to and validated during the serious game have all been described, analyzed and/or explained in the course of this doctoral thesis. Furthermore, starting from these results, additional factors, such as shadow IT and sustainability, have been considered. Consequently, this doctoral thesis is an end in itself because it answers all questions raised in paper A (see Sec. 3.1) and beyond.

Further limitations include the limitations of each research contribution contained in the mixed-methods approach. These limitations were discussed in the context of each paper; however, they are summarized below for completeness.

With respect to the papers involving experiments, questionnaires and vignettes (see papers A, F, H and I), the test subjects were primarily students. The generalizability of findings based on student samples is a controversial topic in IS (Compeau et al. 2012). The current generation of students is part of a group of digital natives, i.e., *"the generation of young people who do not remember life before the Internet, who grew up surrounded by computing technology and mobile phones"* (Kurkovsky & Syta 2010). It is likely that this generation does not perceive the risks accompanied with cloud computing to be as high as the generation of digital immigrants does. This older generation is designated as those "*who were not born into the digital world but have, at some later point in […] [life], become fascinated by and adopted many or most aspects of the new technology*" (Blair et al. 2013). Consequently, it can be expected that students are a significant part of the target population (Compeau et al. 2012). Furthermore, students do not differ significantly from others in terms of their decisions concerning technology adoption and use (Sen et al. 2006; McKnight et al. 2011); therefore, they are an adequate target sample for our studies. The experiments, questionnaires and vignettes were conducted online. Consequently, the limitations of web-based experimenting apply (Reips 2002), e.g., it cannot be ensured that all participants concentrated on the experiment, did not talk with one another or did not exchange results while the experiment was performed. (Walterbusch et al. 2013b; Walterbusch, Fietz, et al. 2014; Walter et al. 2014; Walterbusch & Teuteberg 2014b)

With respect to paper A (see Sec. 3.1), unidirectional relations in the cloud computing market were assumed; however, in reality, each relationship has bidirectional trust relations (see *Fig. 5*). Moreover, the focus was on trust given by a trustee and received by a trustor, not the reliability in the technology itself. Several factors that influence trust in cloud computing were identified, but specific methods or processes for trust formation were not particularly considered. (Walterbusch et al. 2013b)

In paper B (see Sec. 3.2), the derived model of the generic cloud computing market for the development of hybrid cloud computing services was not practically applied. Consequently, the validation by means of expert interviews is sufficient but not satisfactory. The validity of the model must be confirmed by its practical utilization. (Walterbusch, Truh, et al. 2014)

With respect to paper C (see Sec. 3.3), the limitations of the approach are primarily in the restrictive assumptions made in the derivation of the model, e.g., concerning the existing internal IT infrastructure. Because the approach strongly focuses on the evaluation of cloud computing services that are frequently provided externally, these assumptions significantly simplify the cost evaluation approach and its applicability. (Walterbusch et al. 2013a)

With respect to paper D (see Sec. 3.4), more definitions of trust could likely have been gathered. Nonetheless, the aim of the research was not to collect a comprehensive list of trust definitions but rather to analyze a significant sample of trust definitions over a large time span. A total of 121 definitions spanning over 50 years of research achieved this goal. One major limitation relates to the inclusion of CS and CR into the analysis. First, Google Scholar was used to determine the number of citations for each definition, but this method is not 100 % accurate. Second, it remains unclear whether the papers were cited for their definition of trust or for another purpose. However, because the same approach was used for every definition, consistency can be assumed. (Walterbusch, Gräuler, et al. 2014)

The results presented in paper E (see Sec. 3.5) must be considered with two limitations in mind. First, the identities of the users (e.g., private individuals, companies or even automated news accounts) who generated the Twitter data used in the analysis are unknown. Second, for the most part, no primary sources (e.g., a provider's statement on a corporate blog, social media or email) for the disruptive events discussed were identified. Additionally, some of the links on the news pages to the providers' statements are no longer available, thus making validation of these statements impossible. Consequently, the credibility of the disruptive events presented must be accepted on the basis of the secondary sources, e.g., articles on news pages. (Walterbusch & Teuteberg 2014a)

In addition to the limitation previously mentioned, i.e., that most of the test subjects were students, in the studies presented in paper F (see Sec. 3.6), the intentions indicated by the test subjects do not necessarily correspond with their actions in real situations (Ajzen et al. 2004).

However, many studies have demonstrated that participants respond to a vignette in a manner that corresponds to their behavior in real life (Hughes 1998). Accordingly, the bias between the behavioral intention and actual behavior is not substantial. (Walterbusch, Fietz, et al. 2014)

With respect to the study presented in paper G (see Sec. 3.7), one major limitation is that some undefined parameters remain because of missing empirical data. In addition to the quantitative decision calculus derived by the application of the model, decision-makers should also consider the possible strategic significance that the cloud computing service may involve for their companies and factor in qualitative factors that may be organizational, psychological, political, regulatory, or technological in nature. Admittedly, it is difficult to determine all these tangible and intangible (conflicting) factors a priori for every company, and their degree of relevance varies depending on the particular company context (Kou et al. 2014). However, by relaxing the model assumptions, decision-makers can create customized models adjusted to their needs to include qualitative factors not yet covered by the model. (Walterbusch et al. 2015)

With regard to the results presented in paper H (see Sec. 3.8), and considering the limitations concerning the student samples discussed above, the stimuli used in the experimental design, i.e., the search box with autocomplete functionality and the social recommendation agent, were designed, implemented, and filled with content according to the status quo and to the best of the authors' knowledge. Nonetheless, it could be the case that other designs, e.g., a female social recommendation agent instead of a male version, would result in more significant findings. (Walterbusch & Teuteberg 2014b)

With respect to paper I (see Sec. 3.9), the limitations of the triangulation reflect the limitations of each applied research method[39]. These limitations justify why a mixed-methods approach is favored – rather than relying on a single source of data – because data from various sources can be triangulated.

[39] Refer to the paper for a detailed discussion of the limitations of each research method.

5 Conclusions

The aim of this doctoral thesis was to explore, describe, analyze and explain the factors that influence the adoption of cloud computing. Overall, a mixed-methods analysis was applied. Based on a serious game, several factors were explored, and these factors were then described, analyzed and explained. Moreover, further factors that arose during the research process were included. As addressed in the implications for research (see Sec. 4.1.1), the factors contained in this doctoral thesis are not to be considered a complete list. Instead, the goal was to determine a common and definite set of factors that influence the adoption of cloud computing. This set of factors is ample and includes various perspectives. The included factors may not all be of relevance for every private and corporate decision-maker in cloud computing. Nonetheless, each factor discussed is of some relevance, e.g., motivated in each research contribution as well as confirmed by the reviewers involved in the double-blind review processes and the experts involved in the corresponding research endeavors. In total, there are nine research contributions within this doctoral thesis that focus on factors that influence the adoption of cloud computing services from different points of view (see Sec. 2.2) using different theories (see Sec. 2.3) and applying different qualitative and quantitative research methods (see Sec. 2.4). The framework of research contributions was divided into the phases of exploration, description and analysis, and explanation. Ultimately, all results and lessons learned were synthesized into a research agenda. This approach demonstrated that the adoption of cloud computing depends on various factors. In this doctoral thesis, the factors *cloud computing market*, *costs*, *trust*, *affectedness*, *shadow IT*, *sustainability* and *information asymmetry* were investigated. The effect of the rigorously deduced results on both research (Sec. 4.1.1) and practice (Sec. 4.1.2) were discussed. These implications demonstrated that the results in this doctoral thesis are of considerable, immediate and contemporary relevance. However, the present results do not only apply only to the context of the adoption of cloud computing but rather might also be transferred to other domains, e.g., IT outsourcing in general. As another example, overcoming information asymmetry via assistive website elements, as explained in the context of SLAs in cloud computing, might be transferred to other contexts that involve legal documents (e.g., the terms and conditions of a software product) or other contexts in which economies of scale are possible (e.g., providing customers a user manual combined with FAQs). To foster transfer of the research results, these studies have been published in well-known conference proceedings and renowned journals. By considering the multifold results, it is clearly illustrated that the present research in the field of cloud computing adoption was worth the effort. On this account, the author of this doctoral thesis hopes to encourage researchers in the field to follow this path.

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Part B: Research Contributions

Paper A

**Exploring Trust in Cloud Computing:
A Multi-Method Approach**

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Year	2013
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EXPLORING TRUST IN CLOUD COMPUTING: A MULTI-METHOD APPROACH

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Abstract. The cloud computing paradigm promises to provide flexible IT services delivered via the internet. The cost efficiency of cloud computing services is primarily enabled by a high degree of automation realized by SLAs and minor direct human interaction. In this paper, we analyze eight expert interviews to identify and discuss the different levels of trust from an end-user perspective (trust in mediator and provider) that are prevalent in cloud computing and the primary drivers influencing trust. Then, we use the findings to postulate hypotheses that we subsequently verify by means of a serious game. We discover risk aversion, information, disposition of trust, affectedness, reputation and costs to be important factors influencing trust in cloud computing mediators or providers. Furthermore, by analyzing the descriptive statistics gathered through the serious game, we formulate further hypotheses.

Keywords. Trust, Cloud Computing, Interviews, Experiment, Serious Game, Customer Behavior.

Paper B

Hybride Wertschöpfung durch Cloud Computing
(*translation: Hybrid Value Added in Cloud Computing*)

Authors	Walterbusch, M.; Truh, S.; Teuteberg, F.
Year	2014
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Hybride Wertschöpfung durch Cloud Computing

Marc Walterbusch, Stefan Truh, Frank Teuteberg

Abstract. Ziel des Beitrags ist es, ein generisches Modell für die Entwicklung von hybriden Cloud Computing Services auszuarbeiten. Weitergehend wird auf Besonderheiten und Risiken eingegangen, so bspw. die volle Abhängigkeit vom hybriden Cloud Computing Anbieter. Es wird eine konstruktivistische Vorgehensweise gewählt. Weitergehend stellen wir das Wertschöpfungsnetzwerk vor, dessen Mittelpunkt der hybride Cloud Computing Anbieter darstellt. Es wird klar, dass an der Leistungserstellung viele Akteure beteiligt sind, die dem Leistungsbezieher nicht zwangsläufig alle bekannt sind. Da im Cloud Computing allerdings (sensible) Unternehmensdaten oder komplette Prozesse ausgelagert werden, sollten dem Leistungsbezieher alle an der Leistungserstellung beteiligten Akteure bekannt sein. Auch stellt sich heraus, dass sich die Preisfindung für die individuelle Leistung des hybriden Cloud Computing Anbieters durchaus schwierig gestaltet, da die Beratungsleistung monetär zu bewerten ist.

Paper C

Evaluating Cloud Computing Services from a Total Cost of Ownership Perspective	
Authors	Walterbusch, M.; Martens, B.; Teuteberg, F.
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Outlet	Management Research Review, Vol. 36, Iss. 6, p. 613-638
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Evaluating cloud computing services from a total cost of ownership perspective

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Purpose. Start-up companies in particular can benefit from cloud computing services because frequently they do not operate an internal IT infrastructure. The purpose of this paper is to present a total cost of ownership (TCO) approach for cloud computing services.

Design/methodology/approach. The authors applied a multi-methods approach (systematic literature review, analysis of real cloud computing services, expert interviews, and case study) for the development and evaluation of a formal mathematical TCO model.

Findings. It was found that decision processes in cloud computing are conducted ad hoc and lack systematic methods. The presented method raises the awareness of indirect and hidden costs in cloud computing.

Research limitations/implications. Some restrictive assumptions were made. For example, cost types that focus on an existing internal IT infrastructure were hidden. Future research can combine risk and security aspects using a TCO approach. Additionally, benefits management in cloud computing is another new research field that can be explored using a cost-benefit analyses.

Practical implications. The analysis of relevant cost types and factors of cloud computing services is an important pillar of decision-making in cloud computing. This software tool allows for an easy application of the TCO model with reasonable effort.

Originality/value. The paper provides an evaluated mathematical model for the calculation of the TCO of cloud computing services. With this tool, decision-makers are able to decide whether outsourcing to the cloud is monetarily attractive; in particular, whether the costs associated with cloud computing services are lower than using the pre-existing infrastructure.

Keywords. Computing, Information technology, Outsourcing, Costs, Cloud computing, Total cost of ownership, Pricing, Case study, Analytical model

Paper D

How Trust is Defined: A Qualitative and Quantitative Analysis of Scientific Literature

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How Trust is Defined:
A Qualitative and Quantitative Analysis of Scientific Literature

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Abstract. We are confronted with situations requiring trust in business contexts and in our everyday lives. In the literature, there is no consensus on a single definition of trust, resulting in a plethora of definitions. Determining what trust means conceptually, regardless whether adopting a organizational, managerial, psychological, social or cultural perspective, requires great effort. The purpose of this research is not to collect a comprehensive list of trust definitions, but to study their similarities and differences, especially within the IS discipline and between disciplines over a large time span. This objective has been achieved with a total of 121 definitions spanning over 50 years of research. Our results aid researchers in finding and devising a fitting definition of trust for their research, while ensuring that no commonly accepted word clusters are omitted. Furthermore, our research enables practitioners to phrase trust-building statements more efficiently and more holistically.

Keywords. Trust, Definition, Analysis, Qualitative Research, Quantitative Research, Social Construction

Paper E

Datenverluste und Störfälle im Cloud Computing: Eine quantitative Analyse von Service Level Agreements, Störereignissen und Reaktionen der Nutzer
(*translation: Data Losses and Disruptive Events in Cloud Computing: A Quantitative Analysis of Service Level Agreements, Disruptive Events and Users' Reactions*)

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Datenverluste und Störfälle im Cloud Computing: Eine quantitative Analyse von Service Level Agreements, Störereignissen und Reaktionen der Nutzer

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Abstract. Ziel des Beitrags ist es, das Themenfeld der Störereignisse im Cloud Computing explorativ zu untersuchen. Hierfür werden zunächst die vorherrschenden Service Level Agreements diverser Cloud Computing Anbieter quantitativ analysiert. Weitergehend werden die prägnantesten Störereignisse im Cloud Computing samt Erläuterung der Ursache und des Ausmaßes vorgestellt. Im Anschluss erfolgt eine quantitative Exploration der Reaktionen von Twitter-Nutzern auf diverse Störereignisse im Cloud Computing. Wir kommen u. a. zu dem Ergebnis, dass die häufig in den Service Levels Agreements verankerte Gutschrift im Falle eines Störereignisses nicht ausreicht, um die Nutzer von Cloud Computing Services zufriedenzustellen. Vielmehr erwarten die Nutzer eine transparente Stellungnahme inkl. vollständiger Aufklärung zur Ursache der jeweiligen Störereignisse. Auffällig ist zudem, dass viele der Anbieter eine geeignete Kommunikationsstrategie vermissen lassen.

Paper F

Schatten-IT: Implikationen und Handlungsempfehlungen für Mobile Security
(*translation: Shadow-IT: Implications and Recommendations for Mobile Security*)

Authors	Walterbusch, M.; Fietz, A.; Teuteberg, F.	
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Schatten-IT: Implikationen und Handlungsempfehlungen für Mobile Security

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Abstract. Die Gefahren, die von Schatten-IT ausgehen, ändern sich durch die größer werdende Akzeptanz der Anwender von Cloud Computing Services, die ortsunabhängig, jederzeit und von jedem (mobilen) Endgerät genutzt werden können. Auf der Basis von Experteninterviews und einer Vignetten-Studie zeigt der vorliegende Beitrag auf, dass es nicht an der technischen Umsetzung mangelt, Schatten-IT zu unterbinden, sondern eine geeignete unternehmensinterne Strategie, die auch das Mobile Device Management umfasst, vermisst wird. Hierzu werden entsprechende Handlungsempfehlungen aus den Ergebnissen abgeleitet.

Keywords. Schatten-IT, Cloud Computing, Mobile Security

Paper G

A Decision Model for the Evaluation and Selection of Cloud Computing Services: A First Step Towards a More Sustainable Perspective

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A Decision Model for the Evaluation and Selection of Cloud Computing Services: A First Step Towards a More Sustainable Perspective

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Abstract. In this paper, we present a decision model for evaluating and selecting cloud computing services. A strong focus is the economic, environmental and social perspectives that are subsumed under the term 'sustainable information systems management'. The model supports decision-makers in comprehensively evaluating relevant cost types. We seek to formulate a realistic model by applying a combination of deductive and inductive steps to reveal the core characteristics of cloud computing services and their economic, environmental and social impacts. For the construction of the pricing model and the determination of carbon emission costs, we adapted several theoretical and practical sources. The quality of the model is confirmed on the one hand by expert interviews and on the other hand by the outcomes of a simulation study including two scenarios and a statistical evaluation. The presented research results clarify the need to consider more than the economic dimension alone, i.e., to include factors and attributes of sustainable information systems management, in evaluating and selecting cloud computing services.

Keywords. Cloud computing; decision model; mathematical model; sustainability; simulation study.

Paper H

"May I help You?" Increasing Trust in Cloud Computing Providers through Social Presence and the Reduction of Information Overload

Authors	Walter, N.; Öksüz, A.; Walterbusch, M.; Teuteberg, F.; Becker, J.
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"May I help You?" Increasing Trust in Cloud Computing Providers through Social Presence and the Reduction of Information Overload

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Abstract. Despite the potential benefits of cloud computing (CC), many (potential) users are reluctant to use CC because they have concerns about data security and privacy. Moreover, the perceived social distance to CC providers can increase risk perceptions. Therefore, gaining users' trust is a key challenge for CC providers. The results of our online experiment confirm that the intention to use CC services is highly dependent on a user's assessment of a provider's trustworthiness. We show that embedding two different assistive website elements (search box and a social recommendation agent) into CC providers' SLAs and privacy policies positively influences the perceived trustworthiness of a CC provider by reducing perceived information overload and increasing perceived control and social presence. Therefore, in addition to improving security, CC providers also must communicate trust-critical information and facilitate the search process for that information to be perceived as trustworthy.

Keywords. Trust, cloud computing, information overload, social presence, social recommendation agent, search box, assistive website elements, service-level agreements, privacy policies

Paper I

Towards an Understanding of the Formation and Retention of Trust in Cloud Computing: A Research Agenda, Proposed Research Methods and Preliminary Results

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Towards an Understanding of the Formation and Retention of Trust in Cloud Computing: A Research Agenda, Proposed Research Methods and Preliminary Results

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Abstract. This research presents a constitutive, mixed-methods approach to identify trust-influencing and trust-influenced factors in cloud computing, which should lead to a fundamental understanding of the formation and retention of trust in cloud computing. In cloud computing, sensitive data and entire processes are transferred and outsourced to the cloud provider, without necessitating face-to-face communication with a sales assistant. We find the research methods of literature review, laboratory experimental research, semi-structured expert interviews, surveys, vignettes, and (retrospective) thinking aloud complemented by neuroscientific methods to be suitable to reach the target set. Because vignettes, thinking aloud and neuroscientific methods are underrepresented or relatively new to the information systems domain, we place emphasis on these contributions. Our mixed-methods approach has the ability to verify, reaffirm, and refine theories affected by cloud computing and to create new ones. Based on the findings of this research, recommendations for actions and implications for users and providers can be deduced. Because we rely on triangulation of the data set, the limitations of the entire approach reflect the limitations of each applied research method. Preliminary results indicate that 76 % of cloud users focus primarily on data security, whereas 58 % name the price of a certain cloud computing service to be relevant to provider selection.

Keywords. cloud computing, trust, laboratory experiment, behavioral science, online trust, empirical research, mixed-method analysis