Inauguraldissertation zur Erlangung des akademischen Grades eines
Doktors der Wirtschaftswissenschaften
des Fachbereichs Wirtschaftswissenschaften
der Universität Osnabrück

Finanz- und sozio-technische Auswirkungen von Cloud Computing: Anwendungsszenarien und multiperspektivische Analysen aus Sicht der nutzenden Unternehmen

Vorgelegt von

Diplom-Kaufmann Andreas Jede

Osnabrück, Mai 2016

Dekan
Professor Dr. Joachim Wilde

Referenten
Professor Dr. Frank Teuteberg
Professor Dr. Uwe Hoppe

Datum der Disputation
23.05.2016

Vorwort

Die vorliegende Dissertation entstand über einen Zeitraum von rund drei Jahren und wurde im Januar 2016 fertiggestellt. In diesem Zeitraum war ich als externer Doktorand am Fachgebiet Unternehmensrechnung und Wirtschaftsinformatik (UWI) am Institut für Informationsmanagement und Unternehmensführung (IMU) an der Universität Osnabrück tätig. In den nachstehenden beiden Abschnitten möchte ich die Gelegenheit nutzen, all denen meinen Dank auszusprechen, die zum Gelingen dieser Arbeit einen wertvollen Beitrag geleistet haben.

Beginnend mit der Unterstützung fachlicher und wissenschaftlicher Natur gilt großer Dank meinem Doktorvater, Herrn Professor Dr. Frank Teuteberg, der meine Betreuung übernommen und durch seine intensive und individuelle Förderung maßgeblich zur Entstehung dieser Arbeit beigetragen hat. Vor allem die inhaltliche Unterstützung, das konstruktive und sehr zeitnahe Feedback sowie die offene und ehrliche Kommunikation sind während der gesamten drei Jahre sehr hilfreich gewesen. Des Weiteren danke ich Herrn Professor Dr. Uwe Hoppe für die Übernahme des Korreferats sowie Frau Marita Imhorst für die zahlreichen Lektorate und wertvollen Anmerkungen, die dazu beigetragen haben, die entwickelten Forschungsbeiträge zu verbessern. Weiterhin gilt großer Dank meinen Kollegen Volker Frehe und Dr. Marc Walterbusch, die stets bereit waren, meine Forschungsbeiträge kritisch zu hinterfragen, wertvolle Anregungen zu geben, zur Verfügung stehende Anwendungssysteme zu erklären oder auch organisatorische Themen zu übernehmen.

Im Hinblick auf mein privates Umfeld bedanke ich mich bei meiner Familie und meinen Freunden, die mich in den vergangenen drei Jahren moralisch unterstützt haben und meine oftmalige Abwesenheit mit Verständnis aufgenommen haben. Besonderer Dank gilt meinen Eltern, die erst die Voraussetzungen für mein Studium und diese Dissertation schufen. Schließlich gilt meine tiefste und größte Dankbarkeit meiner lieben Frau Olga, die mich von Beginn an in diesem Vorhaben uneingeschränkt unterstützt hat und fortwährend an mich und den Erfolg meiner Arbeit geglaubt hat. Ich danke ihr für ihre verständnisvolle Begleitung in dieser Zeit und dafür, dass sie mir bei den Dingen des Alltags den Rücken freigehalten hat.

Hannover, Januar 2016

Andreas Jede

Inhaltsverzeichnis

Hinweise zum Aufbau des Dokuments **3**

Teil A **4**

Abkürzungsverzeichnis **5**

Abbildungsverzeichnis **6**

Tabellenverzeichnis **6**

1 Einleitung **7**

1.1 Ausgangssituation und Motivation 7

1.2 Zielsetzung und Aufbau der Arbeit 9

2 Einordnung der Beiträge **10**

2.1 Forschungsplan 10

2.2 Gesamtforschungsprozess 12

2.3 Publikation der Beiträge 14

3 Zusammenfassung der Forschungsergebnisse **16**

3.1 Überblick 16

3.2 Beitrag 1: Forschungsstand zum CC-Einsatz im SCM 16

3.3 Beitrag 2: Konzeptionelles Vorgehensmodell für Dokumenten-basierte Referenzmodellierung 18

3.4 Beitrag 3: Referenzmodell für CC-basierte SCM-Prozesse 20

3.5 Beitrag 4: Finanz-technische Bewertung der Vorteilhaftigkeit von Cloud-Lösungen 21

3.6 Beitrag 5: Evidente Ausfallrisiken im CC-Markt 23

3.7 Beitrag 6: Adäquate Bewertung von Terminierungsoptionen bei CC-Services 25

3.8 Beitrag 7: Sozio-technische Einflüsse von CC auf die IT-Mitarbeiter der nutzenden Unternehmen 27

3.9 Beitrag 8: Sozio-technische Einflüsse von CC auf die IT-Mitarbeiter und andere Endnutzer der nutzenden Unternehmen 29

4 Diskussion **30**

4.1 Implikationen für Theorie und Praxis ... 30
4.2 Limitationen ... 33

5 Fazit ... 35

Literaturverzeichnis ... 36

Eidesstaatliche Erklärung (Hilfsmittel) ... 45

Eidesstaatliche Erklärung (entgeltliche Hilfe) ... 46

Teil B ... 47

1 Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review ... 48

2 Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application ... 102

3 Towards Cloud-based Supply Chain Processes: Designing a Reference Model and Elements of a Research Agenda ... 146

4 Investigating Preconditions for a Financially Advantageous Cloud Usage 174

5 Evidente Ausfallrisiken im Cloud-Markt – Eine quantitative Analyse der Finanzberichte von Anbietern ... 196

6 Valuing the Advantage of Early Termination: Adopting Real Options Theory for SaaS ... 214

7 Looking Behind the Stage: Influence and Effect of Software-as-a-Service on Socio-Technical Elements in Companies ... 229

8 Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data 265

Hinweise zum Aufbau des Dokuments

Die vorliegende Dissertation ist in zwei Teile gegliedert. In Teil A wird zunächst das Forschungsvorhaben theoretisch und praktisch erläutert. Darauf aufbauend wird das zugrunde liegende Forschungsdesign erläutert und die einzelnen Forschungsbeiträge werden in den Gesamtkontext eingeordnet. Somit stellt Teil A den Forschungsrahmen dar, der durch den Teil B im Detail gefüllt wird. Damit einhergehend bildet Teil A ein eigenständiges Dokument mit separaten Verzeichnissen zu Beginn und einer Referenzliste am Ende.

Teil B enthält die Forschungsbeiträge inklusive deren Anhänge. Die Formatierungen der einzelnen Beiträge sowie die Zitationsstile basieren auf den unterschiedlichen Vorgaben der jeweiligen Publikationsorgane, in denen sie publiziert wurden. Die Quellenverweise innerhalb der Beiträge in Teil B beziehen sich auf das Literaturverzeichnis des jeweiligen Artikels.

Teil A

Abkürzungsverzeichnis

Abb.	Abbildung
ABDC	Australien Business Dean Council
BPM	Business Process Modeling
CC	Cloud Computing
ERM	Entity Relationship Model
FF	Forschungsfrage
i.d.R.	in der Regel
IaaS	Infrastructure-as-a-Service
IT	Informationstechnologie
ITIL	Information Technology Infrastructure Library
KPI	Key Performance Indicator
MDS	Multidimensionale Skalierung
NBW	Nettobarwert
NIST	National Institute of Standards and Technology
RMR	Reference Model Requirement
SaaS	Software-as-a-Service
SOA	Service-orientierte Architekturen
SCM	Supply Chain Management
Tab.	Tabelle
TCO	Total Cost of Ownership
UML	Unified Modeling Language
VHB	Verband der Hochschullehrer der Betriebswirtschaft
WKWI	Wissenschaftliche Kommission Wirtschaftsinformatik

Abbildungsverzeichnis

Abb. 1: Forschungsplan 12
Abb. 2: Gesamtüberblick der Beiträge..... 14
Abb. 3: Einordnung der Forschungsbeiträge in den CC-Lebenszyklus (in Anlehnung an Conway und Curry, 2012) 16
Abb. 4: Forschungsmethodik des Beitrags 3 (Jede und Teuteberg, 2016b)..... 20
Abb. 5: Vergleichsrechnung CC und On-Premise (Jede und Teuteberg, 2016c)..... 23
Abb. 6: Multidimensionale Skalierung (MDS) der Jahresabschlüsse von CC-Anbietern (Jede und Teuteberg, 2015b)..... 25
Abb. 7: Beispiel einer vorzeitigen Terminierung (Jede und Teuteberg, 2016d)..... 26
Abb. 8: Forschungsmodell des Beitrags 7 (Jede und Teuteberg, 2015c)..... 28
Abb. 9: Methodentriangulation im Beitrag 8 (Jede und Teuteberg, 2016e) 30

Tabellenverzeichnis

Tab. 1: Beiträge und Ratings im Überblick..... 15
Tab. 2: Angewandte Forschungsmethoden (Jede und Teuteberg, 2015a) 17
Tab. 3: Anforderungen für die Referenzmodellierung (Jede und Teuteberg, 2016a)..... 19

1 Einleitung

1.1 Ausgangssituation und Motivation

Die herausragende Bedeutung der Informationstechnologie (IT) für die Wertschöpfungskette der nutzenden Unternehmen[1] begründeten Porter und Millar (1985) bereits Mitte der 1980er Jahre. Auch nach heutigem Verständnis ist die IT ein elementarer Erfolgsfaktor beim Streben der Unternehmen nach Transparenz und Flexibilität (Bardhan et al., 2010; Steinfield et al., 2011). Mit Service-orientierten Architekturen (SOA), die von diversen Anbietern stammen können, wurden die technischen Voraussetzungen geschaffen, komplette Services aus gekapselten Funktionen ortsungebunden jederzeit bereitzustellen. Basierend auf SOA bildete sich Ende des letzten Jahrzehnts das Paradigma „Cloud Computing“[2] (CC) heraus. Vor allem für die dezentrale Natur von globalen agierenden Unternehmen bietet CC signifikante Vorteile. Die IT-Prozesse gewinnen unter anderem durch Skalierbarkeit und Virtualisierung an Stabilität und Flexibilität (Hoberg et al., 2012).

Der aktuelle Forschungsstand zum Themengebiet CC befindet sich jedoch sowohl in der Theorie als auch in der Praxis im Frühstadium (Marston et al., 2011; Fremdt et al., 2013). Es herrscht allerdings allgemeiner Konsens, dass dem CC-Konzept sowohl eine finanzielle Tragweite, erwähnt seien hier beispielhaft das sinkende Anlagevermögen oder Kostenvorteile, als auch eine informationstechnische Tragweite attestiert werden (Marston et al., 2011). Derzeit sehen potentielle Unternehmen, die beide Aspekte bei Selektion, Adaption, Nutzung und ggf. Rückführung vereinen müssen, einem undurchsichtigen Gebilde von CC-

---

[1] Im Duden sind die Begriffe Unternehmen, Firma und Betrieb Synonyme. Für Gutenberg (1958, S. 381 ff.) ist ein Unternehmen durch drei konstitutive Merkmale gekennzeichnet: das Prinzip des Privateigentums, das Autonomieprinzip (Selbstbestimmung des Wirtschaftsplans) und das erwerbswirtschaftliche Prinzip.

[2] Das National Institute of Standards and Technology (NIST) definiert CC wie folgt (Mell und Grance, 2011): „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”. Ferner unterscheidet die Literatur zwischen drei „as a Service“-Modellen (Hoberg et al., 2012; Martson et al., 2011): Infrastructure, Platform und Software (IaaS, PaaS, SaaS). Desweiteren existieren vier CC-Ausprägungen (Hoberg et al., 2012; Martson et al., 2011): Beim „Public CC“ stellt ein externer Anbieter seine Services über das Internet zur Verfügung. Beim „Private CC“ werden die Services hingegen unternehmensintern angeboten, was implizit einen notwendigen, eigenen CC-Betrieb voraussetzt. „Community CC“ ist relevant, falls eine Gruppe von Unternehmen, die gemeinsame Interessen verfolgt und vergleichbare Sicherheitsstandards pflegt, den CC-Betrieb eigenständig kontrollieren will. Schließlich werden beim „Hybrid CC“ (Kombination aus Private/Public CC) sensible Informationen intern abgegrenzt und unkritische Services und Daten in die Obhut eines externen Anbieters übertragen.

Möglichkeiten und -Auswirkungen entgegen (Wind et al., 2012). Die Mehrzahl wissenschaftlicher Veröffentlichungen fokussiert bislang insbesondere die technischen Aspekte (Hoberg et al., 2012; Leimeister et al., 2010). Interdisziplinäre Handlungsempfehlungen für spezifische Unternehmensbereiche, wie z. B. für das „Supply chain management“ (SCM), sind rar (Hoberg et al., 2012; Cegielski et al., 2012).

Zur Lösung dieser mehrdimensionalen Problematik kann eine Kombination aus standardisierten Referenzmodellen, etablierten Formalmodellen und analytischen Methoden zweckdienlich sein. Diese Modelle und Methoden sollten neben der IT-Perspektive auch finanz[3]- und sozio-technische[4] Elemente integrieren und gegeneinander abgleichen (Marston et al., 2011). Ein derart ausgestalteter Ordnungsrahmen kann zum einen höhere Transparenz hinsichtlich bestehender und bevorstehender Unternehmensdependenzen sowie -interdependenzen[5] hervorbringen und zum anderen Wertschöpfungsketten bereichern. Dabei impliziert die beschriebene Vielfältigkeit der Auswirkungen von CC auf die nutzenden Unternehmen, dass ein solcher Ordnungsrahmen die unterschiedlichen Phasen im Lebenszyklus (z. B. Selektion, Adoption und Nutzung) von CC berücksichtigen sollte.

Die bisher beschriebene Ausgangssituation stellt im Grunde ein sehr breites Forschungsfeld dar, welches zum Zwecke einer strukturierten Arbeit weiter spezifiziert werden muss. Dabei gilt die Motivation im Sinne einer multiplen Betrachtungsweise vor allem drei Untersuchungsbereichen: (i) Anwendungsmöglichkeiten von CC im Bereich von SCM[6], (ii) finanz-

[3] In dieser Dissertation wird unter „finanz-technischen“ Analysen die ganzheitliche kaufmännische Untersuchung von IT-Produkten und Dienstleistungen verstanden. Dabei werden nicht nur die direkten finanziellen Aspekte berücksichtigt (z. B. Preis der Software), sondern auch indirekte Aspekte, die sich aus dem Bereitstellungsmodell CC ergeben und eine Unterscheidung zu traditionellen IT-Systemen zwingend erfordern (z. B. Nutzungsdauer, Nutzungsmengen, Terminierungsoptionen). Diesem Verständnis nach sind finanz-technische Analysen dem IT-Controlling (Gadatsch und Meyer, 2013) zuzuordnen. Damit wird eine klare Abgrenzung zum Wort „finanztechnisch“ geschaffen, die der Duden als „die methodischen, verfahrensmäßigen, organisatorischen Äußerlichkeiten des Finanzwesens“ definiert.

[4] Sozio-technische Verbindungen bestehen aus zwei abhängigen Subsystemen – dem technischen Subsystem (Technologien und Aufgaben) und dem sozialen Subsystem (Menschen und soziale Strukturen).

[5] Während Dependenzen einseitige Abhängigkeitsbeziehungen darstellen, führen Interdependenzen zu wechselseitigen Abhängigkeitsbeziehungen (Rinaldi et al., 2001).

[6] Cooper et al. (1997) definieren SCM als „the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders”. Mentzer et al. (2001) differenzieren beim SCM zwischen drei konstitutiven Verrichtungsebenen und definieren SCM wie folgt: „a set of … entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.” Neuere SCM-Ansätze (z. B. Elkington, 2004; Cegielski et al., 2012) betonen die herausragende Bedeutung von Nachhaltigkeit im SCM, womit neben den operativen Prozessen und den finanziellen Auswirkungen auch die sozialen Aspekte zunehmend in den Fokus rücken.

technische Auswirkungen von CC und (iii) sozio-technische Auswirkungen auf die unternehmensinternen Anwender. Wie in den verschiedenen Literaturanalysen der Fachbeiträge (Teil B) aufgezeigt werden konnte, sind auf den jeweiligen Gebieten entsprechend konstruierte Modelle und Methoden in Wissenschaft und Praxis bisher nicht weit verbreitet.

1.2 Zielsetzung und Aufbau der Arbeit

Diese kumulative Dissertation verfolgt das Ziel, das Themengebiet CC aus Sicht der nutzenden Unternehmen multiperspektivisch zu analysieren und dabei Methoden und Modelle zu konstruieren, die die CC-Nutzung optimieren. Weiterhin werden aufbauend auf den gewonnenen Erkenntnissen Handlungsempfehlungen für Theorie und Praxis formuliert. Im Sinne eines anwendungsorientierten Verständnisses der Wirtschaftsinformatik[7] (Scheer, 2009) zielt die vorliegende Arbeit dabei auf eine Ausgewogenheit zwischen Rigorosität und Relevanz[8] ab (Glass, 2001). Die eingangs diskutierte Vielfältigkeit von CC erfordert bei der Selektion der Forschungsmethoden eine adäquate Kombination aus qualitativer und quantitativer Forschung, um die zu determinierenden Forschungsfragen aus verschiedenen Blickwinkeln bewerten zu können (Venkatesh et al., 2013). Dieser Anforderung ist in vorliegender Arbeit dahingehend Folge geleistet worden, als dass die Forschungsfragen mittels systematischer Literaturanalysen, mathematischer Modelle, semi-formaler Referenzmodelle, Fallstudien, Experteninterviews und einer Umfrage untersucht wurden.

Die weitere Struktur dieses Abschnitts (Teil A) lautet wie folgt: Das zweite Kapitel präsentiert den Forschungsplan, den Forschungsprozess sowie die einzelnen dieser Dissertation zugrunde liegenden Beiträge, die innerhalb eines Ordnungsrahmens positioniert werden. Im dritten Kapitel folgt eine kurze Zusammenfassung der Forschungsergebnisse je Beitrag. Basierend auf den Ergebnissen wird im vierten Kapitel die Synthese aller Forschungsergebnisse in Form von Implikationen und Limitationen dargestellt, bevor die Arbeit in Kapitel sechs mit einem Fazit schließt.

---

[7] Auf eine ausführliche Diskussion der Wissenschaftsdisziplin „Wirtschaftsinformatik“ sowie deren Ziele sei auf Hansen und Neumann (2005), Stahlknecht und Hasenkamp (2005) und Österle et al., (2010) verwiesen.

[8] Simon (2004) definiert Rigorosität als den Grad der Tiefe und Genauigkeit innerhalb einer etablierten Methodenforschung. Relevanz wird hingegen als der Grad der Anwendbarkeit in der Praxis verstanden.

2 Einordnung der Beiträge

2.1 Forschungsplan

Der Forschungsplan wird durch Forschungsfragen (FF) präzisiert. Die Literatur argumentiert, dass bei der Problemlösung schrittweise vorzugehen ist (Wieringa, 2010). Dabei werden komplexe Fragestellungen solange in Teilprobleme und Teilfragen zerlegt, bis die Dekomposition zu lösbaren Teilaufgaben führt (Schlitt, 2003). Entsprechend dieser Empfehlung wurden neun Forschungsfragen hergeleitet und im nachfolgenden Forschungsplan zusammengeführt. Dabei zeigt die Abb. 1, dass ausgehend von der Hauptforschungsfrage drei Teilbereiche (gemäß Kapitel 1.1) klassifiziert wurden, die wiederrum in drei Unterbereiche gegliedert sind. Den drei Teilbereichen liegt gewisser Maßen ein simplifizierter Lebenszyklus eines CC-Einsatzes zugrunde, der sich in die Phasen (i) Analyse der Anwendungsmöglichkeiten, (ii) Selektion[9] und Adoption sowie (iii) Nutzung, Anpassung und ggf. Rückführung einteilt.[10]

Im Hinblick auf den ersten Teilbereich wurde exemplarisch der vielversprechende CC-Einsatz im SCM näher untersucht. Während CC grundsätzlich für diverse Bereiche Einsatzmöglichkeiten im nutzenden Unternehmen bietet, sieht die Literatur beim CC-Einsatz im SCM erheblichen Forschungsbedarf (z. B. Cegielski et al., 2012). Auch die erzielten Ergebnisse in den Fachbeiträgen weisen auf die künftige Entwicklung einer stärkeren Verzahnung aus CC und SCM hin und zeigen ferner, dass die Praxis das Potential dieser Verknüpfung bislang noch nicht in Gänze erkannt hat und CC im SCM bisher nur ansatzweise nutzt. Somit kann der erste Teilbereich als Grundlagenforschung betrachtet werden.

Nachdem die Anwendungsmöglichkeiten analysiert wurden, steht dem Entscheider ggf. die Selektion und Adoption eines geeigneten CC-Services bevor. Dabei sind technische und finanzielle Faktoren kritisch. Wie zuvor erwähnt hat die Literatur bereits zahlreiche und wertvolle Rahmenwerke für die technischen Selektionskriterien hervorgebracht (z. B. Wind et

[9] Des Weiteren inkludiert die Selektionsphase den Einkauf von CC-Services. Eine differenzierte Betrachtungsweise der Phasen (i) und (ii), die in Form von ereignisgesteuerten Prozessketten (EPK) samt Fallstudie untersucht wurden, ist in Jede und Teuteberg (2015d) zu finden.

[10] Diese Dissertation erhebt kein Anspruch auf Vollständigkeit der beschriebenen Phasen, sondern indiziert vielmehr einen generellen Verlauf, der sich an Conway und Curry (2012) anlehnt. Für eine ausführliche Diskussion mit hohem Praxisbezug sei an dieser Stelle z. B. auf das Service-Lifecycle-Management von ITIL V3 verwiesen.

al., 2012, Hoberg et al., 2012). Die Kombination der technischen Rahmenwerke mit finanziellen Aspekten gewinnt in der Praxis zunehmend an Bedeutung, obgleich in der Forschung deutlicher Nachholbedarf vorherrscht (Marston et al., 2011). Somit widmet sich der zweite Teilbereich den finanz-technischen Kriterien. Da es sich hierbei um die Erweiterung bestehender Rahmenwerke handelt, kann dieser Teilbereich als Ergänzungsforschung bezeichnet werden.

Nach der Implementierung des CC-Services befindet sich das Unternehmen in der Nutzungsphase, in der die zuvor angenommenen Potentiale realisiert werden sollen. Mit CC-Services werden Vorteile wie beispielsweise Kosteneffizienz assoziiert, die die Entscheidungsträger immer stärker dazu bewegen, diese Technologie in Betracht zu ziehen. Dabei bleiben die nachlaufenden, organisatorischen Auswirkungen von CC-Integrationen vielfach verborgen. Der dritte Teilbereich untersucht deswegen die Einflüsse von CC auf die Radikalität der technischen und sozialen Veränderungen sowie die Auswirkung auf Arbeitszufriedenheit und -leistung von individuellen IT-Mitarbeitern und Endnutzern. Die Auswirkungen werden bislang eher argumentativ-deduktiv vermutet (z. B. Marston et al., 2011). Empirische Analysen sind hierbei rar, sodass dieser Bereich erneut als Grundlagenforschung klassifiziert werden kann.

Forschungsplan
Aggregierte Forschungsfrage   *FF: Welche finanz- und sozio-technischen Auswirkungen kann CC auf die nutzenden Unternehmen haben?*
Dekomposition in Teilforschungsfragen   *FF1: Was sind die Chancen, Risiken und Handlungsempfehlungen für den CC-Einsatz im SCM für nutzende Unternehmen?*   *FF1.1: Was sind die wichtigsten Einflussfaktoren für die Implementierung von CC im SCM?*   *FF1.2: Wie sind geeignete Referenzmodelle zu konstruieren, die Willkür vermindern und die Objektivität stärken?*   *FF1.3: Wie können die wichtigsten Elemente für den CC Einsatz im SCM im Rahmen eines Referenzmodells berücksichtigt werden?*
FF2: Welchen Einfluss haben finanz-technische Aspekte von CC für nutzende Unternehmen?   *FF2.1: Welche Auswirkungen haben Faktoren wie Kapitalkosten, Steuereffekte, Nutzungsdauern oder Nutzungsmengen auf die Vorteilhaftigkeit von CC?*   *FF2.2: Lassen sich evidente Ausfallrisiken aus den Finanzberichten der CC-Anbieter ableiten und wie können diese Risiken im CC-Selektionsprozess geeignet Beachtung finden?*   *FF2.3: Wie kann die neue Flexibilität einer vorzeitigen CC-Service-Kündigung in einem Bewertungsmodell adäquat Beachtung finden?*
FF3: Was sind die sozio-technischen Einflüsse von CC auf nutzende Unternehmen und deren Mitarbeiter?   *FF3.1: Gibt es signifikante Veränderungen bei den Aufgaben von internen IT-Mitarbeitern im Falle einer CC-Nutzung für Kerngeschäftsprozesse?*   *FF3.2: Gibt es signifikante Veränderungen bei der wahrgenommenen Leistung und Zufriedenheit von internen IT-Mitarbeitern im Falle einer CC-Nutzung für Kerngeschäftsprozesse?*   *FF3.3: Gibt es wesentliche Unterschiede zwischen den wahrgenommenen Veränderungen bei internen IT-Mitarbeitern und anderen Endnutzern im Falle einer CC-Nutzung für Kerngeschäftsprozesse?*

Abb. 1: Forschungsplan

2.2 Gesamtforschungsprozess

Die dieser Dissertation zugrunde liegenden Forschungsbeiträge durchliefen jeweils einen eigenständigen Forschungsprozess, der im Sinne der *Rigorosität* an das Forschungsvorhaben und die Forschungsfragen adjustiert ist. Bei Aggregation der spezifischen Forschungsprozesse finden sich jedoch drei grundlegenden Phasen in allen Beiträgen wieder (Jenkins, 1985; Fettke, 2006; Österle et al., 2011): (i) Problemidentifikation, (ii) Determinierung des Forschungsdesigns und Datenanalyse sowie (iii) Interpretation der Ergebnisse. Die einzelnen Beiträge sind in Abb. 2 ersichtlich.

Alle Beiträge haben einen starken Literaturbezug, indem eine systematische Literaturanalyse (Webster und Watson, 2002) und/oder Data Mining[11] durchgeführt wurden. Weiterhin sind qualitative und quantitative Methoden etwa gleich stark vertreten. Bei den qualitativen Methoden wurde neben der systematischen Literaturanalyse auch die Fallstudienforschung (Beiträge 3, 4, 6 und 8) angewandt (Palvia et al., 2003; Recker, 2013). Bei den quantitativen Methoden haben insbesondere formal-deduktive Modelle (Beiträge 4 und 6; Wilde und Hess, 2007) sowie statistische Analysen (Beiträge 5, 7 und 8; Reips, 2002) und Simulationen (Beiträge 3 und 6; Cha et al., 2008) Einzug gehalten. Werden die angewandten Methoden in das konstruktionsorientierte und das behavioristische Paradigma nach Wilde und Hess (2007) eingeteilt, so ergibt sich ebenfalls ein ausgeglichenes Bild. Während Simulationen, Referenzmodellierungen, Literaturanalysen und Formalmodelle eher den gestaltungsorientierten und ingenieurwissenschaftlich getriebenen Forschungsansätzen zugewiesen werden, dienen Fallstudien und empirische Querschnittsanalysen verhaltenswissenschaftlichen Erkenntnissen. Im Gesamtforschungsprozess, der durch die determinierten Forschungsmethoden der einzelnen Beiträge bestimmt ist, hat die Nähe zur Praxis hohen Stellenwert, wodurch der Faktor *Relevanz* adressiert werden soll.

Des Weiteren nutzen vier Beiträge allgemein anerkannte Forschungstheorien, um das Forschungsdesgin in einen theoretisch fundierten Rahmen einzubetten. Hierbei fußt der Beitrag 3 auf dem „Triple Bottom Line Concept“ (Elkington, 2004), um den Einsatz von CC im SCM unter Nachhaltigkeitsaspekten zu untersuchen. Der Beitrag 6 hingegen kombiniert den Realoptionen-Ansatz (Taudes, 1998) mit den Charakteristiken von CC, um den finanz-technischen Vorteil einer CC-Terminierung zu ermitteln. Schließlich adaptieren die Beiträge 7 und 8 die sozio-technische Systemtheorie (Venkatesh et al., 2010), damit Wahrnehmungen der Mitarbeiter auf der individuellen Ebene geeignet adressiert werden können. Eine ausführliche Darstellung von anerkannten Theorien der Wirtschaftsinformatik und deren spezifischen Einflüssen im Kontext CC-Einsatz im SCM ist in Beitrag 1 enthalten.

[11] Data Mining ist ein interdisziplinärer Teilbereich der Informatik, bei dem i. d. R. große Datenmengen Computer-basiert auf dokumentiertes Wissen überprüfen werden. Ziel ist vor allem die Extraktion von Informationen aus der Datenmenge und der Transformation in vordefinierte Strukturen, sodass neues Wissen entstehen kann (Tan et al., 2005). Für eine ausführliche Darstellung siehe Feldman und Sanger (2007).

1) Problemidentifikation	2) Forschungsdesign, Datenanalyse	3) Interpretation der Ergebnisse	
Forschungsfrage	**Forschungsmethode**	**Forschungsergebnis**	**Beitrag**
FF1.1	Systematische Literaturanalyse, Data Mining	Status Quo, offene Forschungsfragen	1
FF1.2	Systematische Literaturanalyse, Referenzmodellierung	Vorgehensmodell zur Dokumenten-basierten Referenzmodellierung	2
FF1.3	Systematische Lit.-analyse, Data Mining, Referenzmodellierung, Fallstudie, Simulation	Erklärungsmodell für CC im SCM und Handlungsempfehlungen	3
FF2.1	Formalmodell, Fallstudie	Entscheidungsmodell für Cashflow-basierte CC-Evaluation und Aufzeigen von Finanzrisiken	4
FF2.2	Systematische Literaturanalyse, statistische Analyse, Data Mining	Verständnis für Ausfallrisiken von CC-Anbietern und Handlungsempfehlungen	5
FF2.3	Systematische Literaturanalyse, Formalmodell, Simulation, Fallstudie	Entscheidungsmodell für die Bewertung der Vorteilhaftigkeit von Kündigungsrechten	6
FF3.1 & FF3.2	Systematische Literaturanalyse, Befragung, Strukturgleichungsmodell	Erklärungsmodell für Einfluss von CC auf die Wahrnehmung individueller IT-Mitarbeiter	7
FF3.3	Systematische Literaturanalyse, Befragung, Fallstudie	Erklärungsmodell für Einfluss von CC auf die Wahrnehmung diverser Mitarbeitergruppen	8

Abb. 2: Gesamtüberblick der Beiträge

2.3 Publikation der Beiträge

Die zur Anrechnung eingebrachten Beiträge durchliefen im Rahmen des Publikationsprozesses ein mehrstufiges Double-Blind-Peer-Review-Verfahren, bei dem jede Publikation von zwei bis vier externen unabhängigen Gutachtern bewertet wurde. Die Rückmeldung der Gutachter konnte somit in die jeweiligen Beiträge einfließen und ihre Qualität erhöhen. Für die Publikation der Beiträge wurden die Forschungsergebnisse auf drei internationalen hochrangigen Konferenzen und in vier[12] Journals veröffentlicht. Darüber hinaus wurden weitere Arbeiten erstellt, die nicht im Rahmen dieser Dissertation berücksichtigt werden, da sie entweder eine zu hohe thematische Distanz aufweisen und/oder sich gerade in der ersten Review-Runde befinden.

In der Tab. 1 sind die Beiträge und die Rankings der entsprechenden Publikationsorgane laut dem Verband der Hochschullehrer der Betriebswirtschaft (VHB 2015) und der Orientierungsliste der Wissenschaftlichen Kommission Wirtschaftsinformatik (WKWI 2008) aufgeführt. Weiterhin ist für drei Beiträge der 1-Year Journal Impact Factor (JIF) ersichtlich. Die Autorenreihenfolge impliziert, dass der Verfasser dieser Dissertation die wesentlichen Beiträge zu allen Forschungsarbeiten in Tab. 1 geleistet hat. Alle Publikationen wurden durch

[12] Der Beitrag Jede und Teuteberg (2016e) steht unmittelbar vor einer weiteren Annahme, sodass es aller Voraussicht nach fünf Veröffentlichungen in Journals geben wird. Siehe Fußnote 15 für weitere Details.

Herrn Prof. Dr. Teuteberg begleitet, der die inhaltliche und methodische Forschungsausrichtung durch kritische Reflexion positiv beeinflusste und mit neuen Ideen und Anmerkungen die Beiträge bereicherte. Weiterhin unterstützte Frau Marita Imhorst den Autor mit Lektoraten in allen englisch-sprachigen Beiträgen. Herr Dr. Marc Walterbusch gab hilfreiche Hinweise zum methodischen Vorgehen in den Beiträgen 7 und 8. Darüber hinaus unterstütze Herr Dr. Alexander Krüger vor allem bei den Formalmodellen der Beiträge 1, 4 und 6 durch wertvolle Anregungen.

#	Titel	Referenz	VHB	WKWI	JIF	Publikationsorgan
1	Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review	Jede und Teuteberg, 2015a[13]	C	-	-	Journal of Enterprise Information Management
2	Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application	Jede und Teuteberg, 2016a	-	B	1,352	Journal of Systems and Software
3	Towards Cloud-based Supply Chain Processes: Designing a Reference Model and Elements of a Research Agenda	Jede und Teuteberg, 2016b	C	-	0,946	International Journal of Logistics Management
4	Investigating Preconditions for a Financially Advantageous Cloud Usage	Jede und Teuteberg, 2016c[14]	-	-	-	International Journal of Accounting & Information Management
5	Evidente Ausfallrisiken im Cloud-Markt – Eine quantitative Analyse der Finanzberichte von Anbietern	Jede und Teuteberg, 2015b	C	C	-	Lecture Notes in Informatics (LNI, 2015)
6	Valuing the Advantage of Early Termination: Adopting Real Options Theory for SaaS	Jede und Teuteberg, 2016d	C	B	-	46th Hawaii International Conference on System Sciences (HICSS, 2016)
7	Looking Behind the Stage: Influence and Effect of Software-as-a-Service on Socio-Technical Elements in Companies	Jede and Teuteberg, 2015c	B	A	-	23rd European Conference on Information Systems (ECIS, 2015)
8	Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data	Jede and Teuteberg, 2016e	B	A	2,059	Business & Information Systems Engineering

Tab. 1: Beiträge und Ratings im Überblick

[13] Beitrag 1 stellt eine erweiterte Fassung des Konferenzbeitrags von Jede und Teuteberg (2014b) dar, der auf der „INFORMATIK 2014“ vorgestellt und in den „Lecture Notes in Informatics“ publiziert wurde. Lecture Notes in Informatics haben gemäß dem VHB und der WKWI ein C-Rating.

[14] Beitrag 4 basiert auf einer inhaltsähnlichen Arbeit, die zuvor in dem Journal „HMD – Praxis Wirtschaftsinformatik“ veröffentlicht wurde (Jede und Teuteberg, 2014a). HMD – Praxis Wirtschaftsinformatik hat nach dem VHB ein D-Rating und nach der WKWI ein B-Rating. Das International Journal of Accounting & Information Management hat gemäß dem Australien Business Dean Council (ABDC) ein B-Rating.

3 Zusammenfassung der Forschungsergebnisse

3.1 Überblick

Das dritte Kapitel thematisiert die Resultate der für die Dissertation in Anrechnung gebrachten Beiträge. Diese werden in Abb. 3 entlang des Lebenszyklus eines CC-Einsatzes (Breiter und Behrendt, 2009; Conway und Curry, 2012) dargestellt. Aus Gründen der Vollständigkeit sei an dieser Stelle erwähnt, dass die Beiträge nicht die jeweilige Phase in ihrer Gänze abdecken, sondern gewisse Facetten der jeweiligen Phase vertiefen und/oder erweitern. Die Zuteilung der Beiträge entlang des Lebenszyklus hilft dem interessierten Leser, die Relevanz der erzielten Forschungsergebnisse mit den jeweiligen Kernlebenszyklusphasen zu verknüpfen, obgleich einige Beiträge auch zu phasenübergreifenden Erkenntnissen führen (z. B. Notwendigkeit der Berücksichtigung von sozialen Aspekten bereits vor der Nutzungsphase). Die nachfolgenden Abschnitte behandeln die Forschungsmethoden sowie Kernergebnisse der acht Beiträge, wobei eine detaillierte Zusammenfassung aus Redundanzgründen an dieser Stellen unterbleibt, da alle Beiträge im Teil B dieser Dissertation enthalten sind.

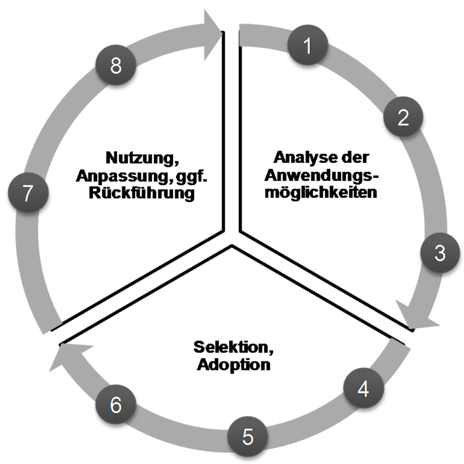


Abb. 3: Einordnung der Forschungsbeiträge in den CC-Lebenszyklus (in Anlehnung an Conway und Curry, 2012)

3.2 Beitrag 1: Forschungsstand zum CC-Einsatz im SCM

In Beitrag 1 (Jede und Teuteberg, 2015a) wurde auf Basis von 99 wissenschaftlichen Publikationen eine interdisziplinäre systematische Literaturanalyse (Webster und Watson, 2002) aus dem Zeitraum 2007-2013 durchgeführt. Zunächst wurden alle Publikationen mittels eines vordefinierten Rasters gemäß Dibbern et al. (2004) systematisch untersucht, um die wichtigsten Forschungsschwerpunkte sowie die relevanten Einflussfaktoren für die CC-Implementierung zu identifizieren. Des Weiteren wurden die Publikationen nach Forschungsmethoden, Forschungsinstitutionen, Forschungstheorien und offenen Forschungsfragen klassifiziert und kategorisiert, wodurch die Autoren erste wertvolle Rückschlüsse auf die Qualität und die Reife der theoretischen Fundierung des zuvor determinierten Forschungsgebiets ziehen konnten. Neben den skizzierten qualitativen Analysen wurden auch quantitative Vorgehensweisen angewandt, um die qualitativen Ergebnisse zu verifizieren. Dabei wurden alle Publikationen mittels „Data Mining" ausgewertet. Darüber hinaus wurde ein formales Modell zur Errechnung von Abhängigkeiten zwischen „Keywords"[15] neu entwickelt und eingesetzt. Tab. 2 enthält exemplarisch die Anzahl der Forschungsmethoden der 99 Publikationen sowie die prozentuale Verteilung derer.

Research method	**#**	**%**
Argumentative / deductive research	51	43,2
Cross sectional survey and interviews	36	30,5
Reference modeling	11	9,3
Case study	8	6,8
Simulation	6	5,1
Prototyping	5	4,2
Experiment	1	0,8

Tab. 2: Angewandte Forschungsmethoden (Jede und Teuteberg, 2015a)

Eine Unterteilung der in den Publikationen angewandten Methoden in das „konstruktionswissenschaftliche Paradigma" und das „verhaltenswissenschaftliche Paradigma" nach Wilde und Hess (2007) offenbart einen deutlichen Überhang der ersten Option. Das Verhältnis ist ein Indiz für das frühe Stadium der Forschung, da verhaltensorientierte Arbeiten das Vorhandensein von (IT-) Artefakten als Untersuchungsbasis für verhaltenswissenschaftliche Studien voraussetzen und vermehrt auf fortgeschrittenen Forschungsgebieten vorzufinden sind (Martens und Teuteberg, 2009). Weiterhin konnten die wesentlichen Beweggründe für eine CC-Implementierung im SCM untersucht werden. Dabei kommt dem Faktor Kostenreduktion die wichtigste Bedeutung zu. Aber auch SCM-spezifische Faktoren wie Flexibilitätssteigerungen, Koordinationsunterstützung und Wissensaustauch werden im Kontext mit

[15] Mit Keywords (oder Schlagwörtern/ Schlüsselwörtern) sind in dieser Dissertation vorgegebene Bezeichnungen in den Publikationen gemeint, die in einigen wenigen Wörtern auf die Beschreibung des Inhalts der Publikation hindeuten und vor allem für die Suche nach relevanten Publikationen hilfreich sind.

CC intensiv diskutiert. Die Literaturanalyse bringt zum Vorschein, dass es dem Forschungsfeld vor allem an einem gemeinsamen Verständnis für den CC-Einsatz im SCM mangelt. Verstärkt wird der Umstand durch die klare Trennung der beiden Disziplinen. Während die (Wirtschafts-) Informatikforschung technische Faktoren fokussiert, verbleibt die SCM-Forschung oftmals in allgemeinen Aussagen. Die fehlende gemeinsame Sprache sowie das Nichtvorhandensein eines organisatorischen Rahmens für CC-Prozesse im SCM stellen die Hauptforschungslücken dar und werden im weiteren Verlauf dieser Dissertation betrachtet. Auch der oftmals implizit angenommene Kostenvorteil wird in den weiteren Beiträgen kritisch untersucht.

3.3 Beitrag 2: Konzeptionelles Vorgehensmodell für Dokumenten-basierte Referenzmodellierung

Der Beitrag 2 (Jede und Teuteberg, 2016a) behandelt die Referenzmodellierung, die sich in der wissenschaftlichen und anwendungsorientierten Forschung als zweckdienlich erwiesen hat, um das Design von Informationssystemen und den entsprechenden organisatorischen Elementen auf einer aggregierten, prozessorientierten Ebene darzustellen (Frank, 2007; Thomas, 2006). Neben einem gemeinsamen Prozessverständnis fördert die Referenzmodellierung die Qualität der Prozessabläufe und kann Zeit- sowie Kostenersparnisse bei der anschließenden Detailmodellierung erwirken (Fettke und Loos, 2005).

Im Beitrag 2 wurde zunächst eine systematische Literaturanalyse im Themengebiet Referenzmodellierung durchgeführt. Im Ergebnis muss konstatiert werden, dass zahlreiche Referenzmodelle nicht ausreichend dokumentiert sind (z. B. keine Unterscheidung zwischen Konstruktions- und Anwendungsprozess) und sich von existierenden Dokumenten oftmals isolieren (von wissenschaftlichen und praktischen Publikationen, Transskripten von Experteninterviews, Einträgen in sozialen Medien etc.). Dadurch kommt es unmittelbar zur Subjektivität und eine Synthese im Forschungsgebiet wird erschwert.

Da die Referenzmodellierung als Teilbereich der Design-Science-Forschung[16] gilt (Becker et al., 2010; Vom Brocke, 2003), wurden auf Grundlage der allgemeinen Design-Science-

[16] Hevner et al. (2004) determinieren das Ziel von Design-Science wie folgt: “In the design-science paradigm, knowledge and understanding of a problem domain and its solution are achieved in the building and application of the designed artifact.”

Richtlinien spezielle Referenzmodellierungsregeln aufgestellt, die die Objektivität der Referenzmodelle stärken sollen (siehe Tab. 3). Während der Entstehungsphase des neuen Vorgehensmodells bereicherten vorbildlich dokumentierte Referenzmodelle (z. B. Krcmar et al., 2000) das Rahmenwerk. Schließlich wurden die Erkenntnisse aus den erwähnten Anforderungen sowie aus wohldokumentierten Referenzmodellverfahren konsolidiert und in die Entwicklung eines konzeptionellen Vorgehensmodell für Dokumenten-basierte Referenzmodellierung überführt. Damit können die zuvor genannten Vorteile der Referenzmodellierung noch besser realisiert werden.

Guideline from Hevner et al. (2004)	Reference model requirement (RMR)	Role	Description of reference model requirement
Problem relevance	RMR1: Problem definition	From the developer perspective	The key issue has to be investigated with its related resources, roles, responsibilities, and interrelations.
Research contributions	RMR2: Qualitative document verification	From the developer perspective	The problem of the outstanding reference models (RM) has to be set in relation to existing literature (and - if any - with existing RM) via a qualitative document analysis. It has to be clear whether the new RM aims to extend, replace, or improve already existing RMs.
Design as a search process	RMR3: Iterative construction	From the developer perspective	The new RM must be developed iteratively; through searching for solutions in related work, adopting RM, and/or proposing new ways; and, if necessary, through refinement.
	RMR4: Iterative selection	From the user perspective	The RM has to be substantiated iteratively via a search and selection process. Compared with other models, it is necessary to explain how and why the new model is accepted as a reference.
	RMR5: Iterative adaption	From the user perspective	The generic RM needs to be adapted iteratively to a company- or project-specific model. The adjustments, replacements, or extensions as well as the implementation/integration process have to be clarified in width and depth.
Research rigor	RMR6: Selection of methodologies	From the developer perspective	The new RM may have various abstraction levels and may include methods, languages, and tools, which have to be selected and adopted accordingly to the underlying issue.
Design as an artifact	RMR7: Development of sections	From the developer perspective	Due to the multifaceted nature of RMs, the new model can normally not be produced from one single source only. It rather has to be created in sections, whereby every section has to be based on preexisting knowledge gained from documents and tested for validity prior to integration into the overall RM. Only in this way it will be possible to create a viable artifact.
Design evaluation	RMR8: Knowledge-based evaluation	From the developer perspective	As a new RM always constitutes a new theory, it is necessary to evaluate the RM through an IS knowledge-oriented perspective. This may include analytical evaluations (e.g., metamodel-based evaluation (RMR8a)), and metric-based evaluation (e.g., quantitative data analysis of documents and/or transcripts (RMR8b)).
	RMR9: Empirical assessment	From the user perspective	After having applied the RM in empirical environments, the usefulness, the quality, and the effectiveness of the intermediary outcomes need to be measured with scientific methodologies.
Communication of research	RMR10: Literature enrichment	From the developer perspective	The results from RMR1 to RMR9 must adequately and scientifically be documented in a technology-oriented as well as management-oriented way.

Tab. 3: Anforderungen für die Referenzmodellierung (Jede und Teuteberg, 2016a)

3.4 Beitrag 3: Referenzmodell für CC-basierte SCM-Prozesse

Der Beitrag 3 (Jede und Teuteberg, 2016b) baut auf den Beiträgen 1 und 2 auf. Nachdem auf das Problem eines mangelnden gemeinsamen Verständnisses hingewiesen und ein konzeptionelles Vorgehensmodell für die Referenzmodellierung entwickelt wurde, widmet sich der Beitrag 3 einem Referenzmodell für den CC-Einsatz im SCM. Das Ziel des Modells ist es, Theorie und Praxis bei CC-Implementierungen im SCM zu unterstützen und Wettbewerbsvorteile aufzuzeigen. Der Beitrag wendet eine mehrdimensionale Forschungsmethode an, die sich aus einer systematischen Literaturanalyse, Data Mining, Referenzmodellierung, Simulation, und einer Fallstudie (in Form von Experteninterviews) zusammensetzt. Die Methode ist in Abb. 4 ersichtlich.

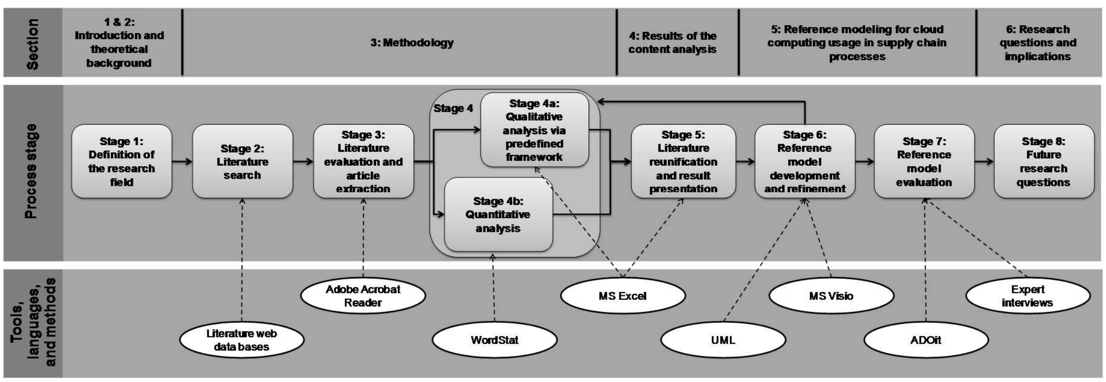


Abb. 4: Forschungsmethodik des Beitrags 3 (Jede und Teuteberg, 2016b)

Basierend auf qualitativen und quantitativen Literaturanalysen wurden zunächst die wichtigsten Erkenntnisse, Strukturen und Abhängigkeiten der Publikationen zu Elementen und zu Verbindungen zwischen den Elementen im Zusammenspiel der Bereiche CC und SCM gebündelt. Aufgrund des möglichen tiefgreifenden Einflusses von CC auf die Prozesse eines Unternehmens bedurfte es hierbei einer ganzheitlichen Unternehmensbetrachtung. Das bedeutet, dass dem Gesamtmodell einzelne Teilmodelle unterliegen. Dabei wurden folgende Teilmodelle identifiziert: 1) Strategiemodell, 2) Stakeholder-Modell, 3) Organisationsmodell, 4) Prozessmodell, 5) IT-Architekturmodell, 6) Supply-Chain-Kooperationsmodell, 7)

CC-Architekturmodell und 8) Kennzahlenmodell[17]. Für die Teilmodelle Strategie und Stakeholder wurde das Triple-Bottom-Line-Konzept[18] herangezogen. Das Referenzmodell wurde in einer partizipierenden Fallstudie angewendet und Software-gestützt simuliert. Damit konnte ein hoher Praxisbezug hergestellt werden.

Neben der Synthese der bisherigen Forschung ist eine weitere wichtige Erkenntnis des Beitrags, dass eine Unterscheidung zwischen zwei Effizienzebenen zwingend erforderlich ist, die bislang eher willkürlich diskutiert werden: Streben nach Effizienz in der IT-Ressourcennutzung (z. B. direkte IT-Kostenreduktion) und Streben nach Effizienz in der Interoperabilität. Der Vorteil des CC durch effiziente IT-Ressourcennutzung ist nicht SCM-spezifisch, sondern grundsätzlich für zahlreiche IT-Bereiche in der Unternehmensarchitektur denkbar. CC vereint dabei Ressourcen desselben Typs mit dem Ziel, diese zum einen optimal auszunutzen und damit zum anderen eine möglichst große Nachfrage zu bedienen. Der Vorteil durch Effizienz in der Interoperabilität hingegen ist SCM-spezifisch und wird im Referenzmodell entsprechend berücksichtigt. Da CC zwischen beliebig vielen Supply-Chain-Partnern als Medium fungieren kann, welches über den Datenaustausch hinaus auch die kollaborative Datenanalyse und Prozessplanung sowie die Entscheidungsfindung unterstützt, handelt es sich hierbei letztlich um Wissensaustausch.

3.5 Beitrag 4: Finanz-technische Bewertung der Vorteilhaftigkeit von Cloud-Lösungen

Wie bereits erwähnt werden mit CC finanzielle Vorteile assoziiert, die nicht nur im SCM erzielt werden können, sondern grundsätzlich in zahlreichen IT-Bereichen im nutzenden Unternehmen denkbar sind. Gemeinhin stellen Kostengesichtspunkte eines IT-Systems eine wichtige Entscheidungsgrundlage während der Selektions- und der Betriebsphase dar. Im Zusammenhang mit CC wird oftmals das Argument eines Wechsels von Investitionen zu variablen Kosten und den damit verbundenen Vorteilen einer sinkenden Kapitalbindung angeführt (z. B. Venters und Whitley, 2012). In diesem Kontext präsentieren Cloud-Anbieter vielfach undifferenzierte Beispielrechnungen, die von der finanziellen Vorteilhaftigkeit ihrer

[17] Genau genommen berücksichtigt das Referenzmodell das Teilmodell „Key Performance Indicators“ (KPI). KPI oder auch Leistungskennzahlen genannt messen in periodischen Abständen den Erfolg einer Organisation oder einer Aktivität. Für eine ausführliche Diskussion sei an dieser Stelle auf Parmenter (2010) verwiesen.

[18] Das „Triple Bottom Line Concept“ ist ein Rahmenwerk, welches einen sozialen, einen ökologischen sowie einen finanziellen Bereich berücksichtigt und somit die Nachhaltigkeit durch profit-orientierte und nicht-profit-orientierte Elemente misst (Elkington, 2004).

Lösungen zeugen. Daher setzen sich die Beiträge 4-6 mit den finanz-technischen Auswirkungen von CC auf die nutzenden Unternehmen auseinander.

Der Beitrag 4 (Jede und Teuteberg, 2016c) verweist zunächst auf die Problematik in der Literatur, dass anwendungsorientierte Publikationen für ihre Vergleichsrechnungen (CC vs. traditionelle IT-Systeme) i. d. R. den Total-Cost-of-Ownership-Ansatz (TCO) bemühen. Dabei werden gemeinhin wesentliche Faktoren wie Kapitalkosten, Steuereffekte, Nutzungsdauern oder Nutzungsmengen vernachlässigt. Ausgehend von dieser Forschungslücke wurde im ersten Schritt ein mathematisches Modell konstruiert, welches diese Faktoren integriert und eine vollständige Berechnung der Vorteilhaftigkeit ermöglicht. Im zweiten Schritt wurde das Formalmodell in eine Software überführt, die Simulationen und Szenario-Analysen ermöglicht. In einer Fallstudie wurde die Validität des Modells getestet. Der Praxis steht eine Excel-Datei zur individuellen Kalkulation zur Verfügung (Link im Beitrag enthalten).

Die Ergebnisse indizieren, dass die vielschichtigen Relationen der einzelnen Parameter zusammenhängend betrachtet werden müssen, um den Anforderungen einer vollständigen Vergleichsrechnung gerecht zu werden. Die Abb. 5 zeigt, dass sich die Vorteilhaftigkeit in starker Abhängigkeit von den einzelnen Parametern ändern kann. In der Schnittmenge sind die Nettobarwerte (NBW) identisch. Gemäß der Fallstudie wird die On-Premise Lösung mit steigender Nutzungszahl vorteilhafter. Somit werden bestehende Publikationen (z. B. Misra and Modal, 2011) dahingehend bestätigt, dass sich CC bei Kerngeschäftsprozessen unter finanz-technischen Gesichtspunkten insbesondere für kleinere Unternehmen mit geringer Nutzerzahl eignet. Der Beitrag 4 wurde zuvor in einer inhaltsähnlichen Version in einer deutschsprachigen Zeitschrift veröffentlicht (Jede und Teuteberg, 2014a). Darin ist unter anderem auf eine ausführliche Literaturanalyse sowie auf eine detaillierte Darstellung des mathematischen Modells verzichtet worden. Im Gegenzug sind die Implikationen stärker auf die praxisorientierte Leserschaft zugeschnitten worden.

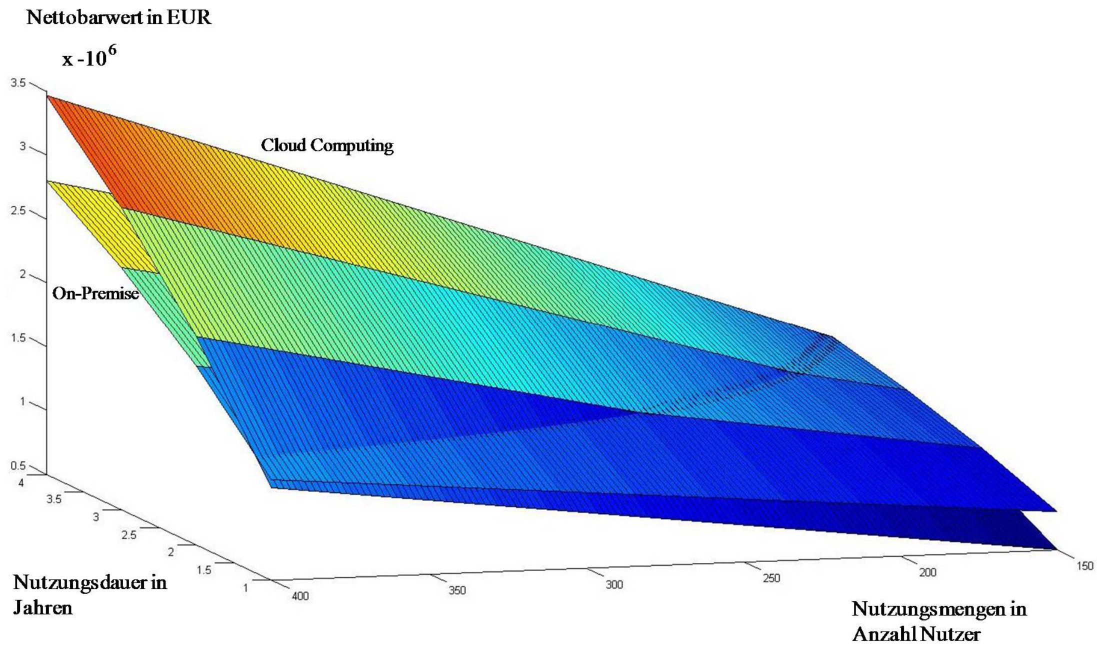


Abb. 5: Vergleichsrechnung CC und On-Premise (Jede und Teuteberg, 2016c)

3.6 Beitrag 5: Evidente Ausfallrisiken im CC-Markt

Die bisherigen Ausführungen zum CC-Einsatz indizieren eine neue Art der Abhängigkeit für nutzende Unternehmen. Wenn ein CC-Service beispielsweise innerhalb eines Supply-Chain-Netzwerks eingesetzt wird, so können sich zwischen den Netzwerkteilnehmern kritische Interdependenzen entwickeln, die einen entsprechenden Koordinationsaufwand erfordern. Darüber hinaus besteht für das nutzende Unternehmen jedoch auch eine hohe einseitige Abhängigkeit vom Cloud-Service-Anbieter und seiner Leistungsfähigkeit, die sich in Faktoren wie Zugang zu neuesten Technologien, Managementkompetenz, Zertifikate oder Sicherheitsstandards wiederspiegeln. Aber auch die Validität und Finanzkraft des CC-Anbieters sollte das nutzende Unternehmen bei der Selektion eines Services hinterfragen, da Anbieterinsolvenzen in jüngster Vergangenheit vermehrt auftraten und Ausfallrisiken somit präexistent sind. Je nach Nutzungsintensität und Bedeutung des CC-Services kann das anwendende Unternehmen erheblichen Schaden davontragen. Daher setzt sich der Beitrag 5 (Jede und Teuteberg, 2015b) mit den Ausfallrisiken im CC-Markt auseinander, bei dem die Anbieterseite durch eine steigende Vielfalt gekennzeichnet ist. Denn neben etablierten Anbietern bemühen sich vermehrt auch junge und unbekannte IT-Unternehmen um den stark wachsenden CC-Markt (Ridder, 2014).

Das methodische Vorgehen des Beitrags ist durch quantitative Methoden geprägt. Dabei wurden in einem aufwendigen Suchprozess die Jahresabschlüsse von 38 publikationspflichtigen CC-Unternehmen selektiert. Bei der Berechnung des Ausfallrisikos lehnt sich der Beitrag an das klassische Z-Faktoren-Modell von Altman (1968) an. Dem Modell nach wird mithilfe der multivariaten, linearen Diskriminanzanalyse ein Z-Faktor der zu beurteilenden Unternehmen parametrisiert und mit einer voraussichtlich solventen Alternativgruppe verglichen (Bestimmung des Signifikanzniveaus). Des Weiteren dienten die Jahresabschlüsse als Basis für eine quantitative Inhaltsanalyse. Hiermit wurde untersucht, welche Risikoarten sich aus der Linguistik der Jahresabschlüsse ableiten lassen.

Bei den statistischen Ergebnissen zeigen die Durchschnittswerte der CC-Unternehmen erhebliche Insolvenzrisiken, da die unteren Grenzwerte der Z-Faktoren deutlich unterschritten wurden. Zwar gibt es auch bei den CC-Anbietern „gesunde" Unternehmen, diese sind jedoch in der Minderheit. Das Grundproblem der Anbieter in der Probe ist, dass diese kaum gewinnbringend wirtschaften und somit stark vom „Wohlwollen" ihrer Investoren abhängig sind. Bei der quantitativen Inhaltsanalyse wurde das Verfahren der multidimensionalen Skalierung (MDS) angewandt. Die Größe der Kreise in Abb. 6 korrespondiert mit der Worthäufigkeit. Die Nähe zwischen den Kreisen steht in Relation zur Häufigkeit des gemeinsamen Auftretens von Wörtern. Demnach wird das Thema Risiko derzeit vor allem im Zusammenhang mit *Kreditrisiken* und *Zinsrisiken* verbunden (siehe obiger Bereich in der Abb. 6), was die zuvor präsentierten Ergebnisse bestätigt. Im Falle einer Insolvenz ist völlig unklar, wie sich die Daten vor unberechtigtem Zugriff schützen lassen oder effizient zu anderen CC-Anbieter transferiert werden können, damit der IT-gestützte Geschäftsprozess fortgesetzt werden kann. Hervorzuheben ist die aktuelle Praxisrelevanz des Beitrags, da die Datengrundlage aus den Jahresabschlüssen des Jahres 2014 stammt.

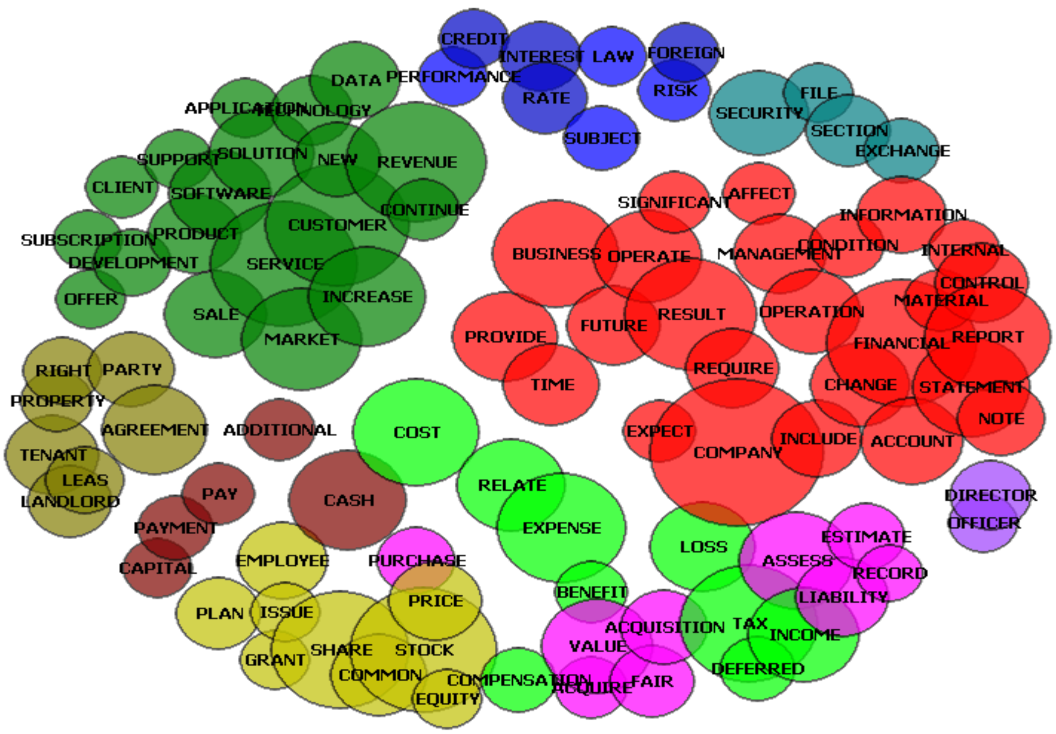


Abb. 6: Multidimensionale Skalierung (MDS) der Jahresabschlüsse von CC-Anbietern (Jede und Teuteberg, 2015b)

3.7 Beitrag 6: Adäquate Bewertung von Terminierungsoptionen bei CC-Services

Während der Beitrag 4 die bestehende Literatur dazu anhält, die Bewertungen von CC-Services vollständiger und ganzheitlicher zu gestalten (z. B. Nutzungsmengen, Nutzungsdauern zu inkludieren) und der Beitrag 5 auf die Ausfallrisiken von CC-Anbietern sowie auf die Auswirkungen hinweist, untersucht der Beitrag 6 (Jede und Teuteberg, 2016d) eine neue Berechnungsdimension in der finanz-technischen Beurteilung von CC-Services. In der Wirtschaftsinformatikliteratur sind klassische Methoden wie der NBW für die Bewertung von IT-Lösungen vorherrschend. Im Gegensatz zu traditionellen IT-Systemen (z. B. On-Premise Lösungen) ermöglicht CC dem nutzenden Unternehmen eine höhere Flexibilität, die darin mündet, dass Nutzer diese Services kurzfristig beziehen und wieder abstoßen können. Der Vorteil dieser Flexibilität kann mit klassischen Berechnungsmethoden nur schwerlich bewertet werden.

Daher wird im Beitrag 6 die Realoptionentheorie[19], die ursprünglich aus der Kapitalmarktforschung stammt, auf die Mechanismen des CC-Einsatzes transferiert. Vor allem der Vorteil einer vorzeitigen Terminierung, die bei traditionellen IT-Systemen nur eine geringe Relevanz hatte[20], stellt eine wichtige Forschungslücke dar.

Die Funktionsweise des Optionenansatzes ist vereinfacht in Abb. 7 ersichtlich. Zu jedem Zeitpunkt werden vorab Wertbeitrag und Kosten des IT-Systems sowie die Eintrittswahrscheinlichkeiten für zwei mögliche Umweltzustände (hoch und runter) bestimmt. Falls der NBW eines Umweltzustands negativ ist, greift die Terminierungsoption und der CC-Service wird abgestoßen, sodass der NBW der Periode null ist. Der Optionenansatz bewertet somit den NBW zu jedem Zeitpunkt, wobei i. d. R. NBW ≥ 0 gilt. Umgekehrt formuliert kann der Wert der Option niemals < 0 sein.

T=0				T=1					T=2					T=3		
Invest. Costs	Periodic costs	NPV t	Decision calc.	Periodic costs	Benefit	Sum	NPV t	Decision calc.	Periodic costs	Benefit	Sum	NPV t	Decision calc.	Periodic costs	Benefit	Sum
														-100,0	172,8	72,8
									-100,0	144,0	44,0	92,8	48,8			
														-100,0	72,0	-28,0
				-100,0	120,0	20,0	81,3	61,3								
														-100,0	72,0	-28,0
									-100,0	60,0	-40,0	-40,0	0,0			
														-100,0	30,0	-70,0
-27,7	0,0	22,9	50,6													
														-100,0	72,0	-28,0
									-100,0	60,0	-40,0	-40,0	0,0			
														-100,0	30,0	-70,0
				-100,0	50,0	-50,0	-50,0	0,0								
														-100,0	30,0	-70,0
									-100,0	25,0	-75,0	-75,0	0,0			
														-100,0	12,5	-87,5

Abb. 7: Beispiel einer vorzeitigen Terminierung (Jede und Teuteberg, 2016d)

Hinsichtlich der methodischen Vorgehensweise beginnt der Beitrag mit einer systematischen Literaturanalyse, in der vor allem verwandte empirische Arbeiten im Vordergrund stehen. Darauf basierend wird ein Binomialmodell für die Zwecke des Untersuchungsgegenstands adaptiert und in eine Software-gestützte Simulation überführt. Die Funktionsfähigkeit

[19] Der Realoptionenansatz berücksichtigt, dass sich im Verlauf eines Investitionsvorhabens das Risiko verändern kann und dass der Entscheidungsträger die Möglichkeit hat (aber nicht die Verpflichtung), darauf zu reagieren. Diese Möglichkeiten liegen beispielsweise darin, das Vorhaben abzubrechen (Taudes, 2000; Benaroch, 2002). Neben dem Binomialmodell wird vielfach auch das Black-Scholes-Modell (Black and Scholes, 1973) verwendet, um den Wert der Option zu ermitteln.

[20] Traditionelle IT ist durch eine hohe Kapitalbindung geprägt (i. d. R. durch Investitionen von Hardware und Software zum Zeitpunkt t=0). Daher wird bei unerwünschten Umweltzuständen im Zusammenhang mit traditioneller IT oftmals von „sunk costs“ gesprochen. Im Gegensatz dazu wird bei CC eine geringe Kapitalbindung angenommen, wobei die laufenden Kosten i. d. R. höher sind. Die Kosten werden beim CC entlang der Zeitachse gestreckt. Bei unerwünschten Umweltzuständen kann der CC-Service gekündigt werden und die laufenden Kosten entfallen. Für eine ausführliche Diskussion wird z. B. auf Marston et al. (2011) verwiesen.

und Aussagekraft des Modells wird mittels einer Fallstudie unter Beweis gestellt. Für die Praxis wurde eine entsprechende Excel-Datei zur individuellen Kalkulation erstellt (Link im Beitrag enthalten).

Bei einem direkten Vergleich zwischen CC und traditionellen Systemen zeigen die Ergebnisse, dass je niedriger der NBW-Abstand der beiden IT-Systeme wird, desto höher ist der implizite Vorteil einer CC-Lösung, da sich das nutzende Unternehmen unerwünschter künftiger Zustände leichter entledigen kann. Dieser Vorteil kann mit dem Optionenansatz genau ermittelt werden. Je deutlicher sich die NBWs (Wertbeitrag vs. Kosten der IT) unterscheiden, desto eher führen beide Berechnungsmethoden (nur NBW vs. Realoptionen [inklusive NBW]) zur selben Entscheidungsgrundlage.

3.8 Beitrag 7: Sozio-technische Einflüsse von CC auf die IT-Mitarbeiter der nutzenden Unternehmen

Dem Lebenszyklus des CC-Einsatzes folgend (siehe Abb. 3) untersucht der Beitrag 7 (Jede und Teuteberg, 2015c) die Einflüsse speziell auf interne IT-Mitarbeiter. Denn die relativen Vorteile einer CC-Nutzung sowie die oftmals einfache Anwendung für den Endnutzer sollten die damit einhergehenden Auswirkungen auf die interne IT-Organisation und ihre Prozesse nicht verschleiern. CC verändert die Komplexität der gesamten IT-Infrastruktur sowie der Informationsarchitektur entlang interner und externer Datenströme (Marston et al., 2011; Leimeister et al., 2010). Folglich ändern und verschieben sich auch die Aufgaben der internen IT-Organisation. Während Aufgaben wie Software-Entwicklung, -Customizing oder Server-Administration die interne IT-Organisation verlassen, gewinnen andere Aufgaben wie IT-Sicherheit oder IT-Architektur-Beratung zunehmend an Bedeutung. Vor diesem Hintergrund ist es nicht unwahrscheinlich, dass Unternehmen in Abhängigkeit vom Grad der CC-Nutzung mit weitreichenden Anpassungen bei IT-Kompetenzen und IT-Strukturen konfrontiert werden. Diesen Veränderungen könnten sie zunächst reserviert oder sogar abweisend begegnen (Bala, 2013).

Da die CC-Forschung sich nach wie vor im Frühstadium befindet, fokussieren bislang veröffentlichte Untersuchungen insbesondere Selektions- und Implementierungsprozesse (z. B. Meer et al., 2012; Gupta et al., 2013). Organisatorische Auswirkungen werden bislang eher oberflächlich und argumentativ-deduktiv diskutiert (Morgan und Conboy, 2013), obwohl gerade diese Aspekte für den CC-Erfolg oder Misserfolg entscheidend sind. Deshalb fokussiert Beitrag 7 die Auswirkungen von CC auf die Zufriedenheit und die Leistungsfähigkeit betroffener IT-Mitarbeiter. Die Problemstellung wird hierbei aus der Mikroebene (also aus der Ebene des einzelnen Individuums) analysiert. Ferner wird für die theoretische Fundierung die sozio-technische Systemtheorie[21] (Venkatesh et al., 2010; Rousseau, 1977) herangezogen. Weiterhin wurde angenommen, dass IT-basierte Kerngeschäftsprozesse komplexer sind als Unterstützungsprozesse, sodass die CC-Auswirkungen bei Kerngeschäftsprozessen deutlicher zu identifizieren sind, womit der Beitrag in der Konzeption und Umsetzung insbesondere diese weiterverfolgte.

Um den aktuellen Forschungsstand zum Themengebiet zusammenzutragen, wurde zunächst eine systematische Literaturanalyse durchgeführt. Anschließend wurde ein Forschungsmodell samt Hypothesen konstruiert (siehe Abb. 8). Dabei stehen die beiden Endkonstrukte im Forschungsmodell für das sozio-technische Gleichgewicht. Ein Online-Fragebogen führte zu Daten von 66 internen IT-Mitarbeitern, sodass das Forschungsmodell mittels eines Strukturgleichungsmodells getestet werden konnte.

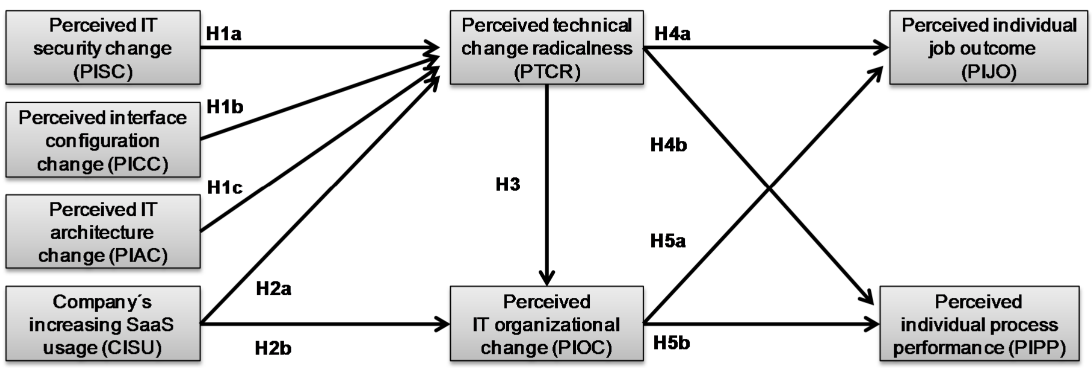


Abb. 8: Forschungsmodell des Beitrags 7 (Jede und Teuteberg, 2015c)

Im Beitrag wird gezeigt, dass sich sowohl die durch CC initiierten *Veränderungen in der IT-Sicherheit* und *IT-Infrastruktur* als auch die *Intention zur steigenden CC-Nutzung* direkt auf die *wahrgenommene Radikalität der technischen Änderungen* auswirken. Ferner wird die *Radikalität der IT-organisatorischen Änderungen* durch die *Intention zur CC-Nutzung* sowie durch die *technische Radikalität* beeinflusst. Da der Effekt durch die technische Radikalität größer ist als der Effekt durch die Intention zur CC-Nutzung, kann hierbei angenommen werden, dass die Anpassung in der IT-Organisation eher nachlaufend oder reaktiv vollzogen

[21] Ein sozio-technisches System repräsentiert im Grunde jedes Konstrukt in der Organisation, das aus zwei abhängigen Subsystemen besteht – dem technischen Subsystem (Technologien und Aufgaben) und dem sozialen Subsystem (Menschen und soziale Strukturen). Diese Subsysteme besitzen zwar unabhängige Ursprünge, aber verfolgen ein gemeinsames Ziel. Beide Subsysteme interagieren rekursiv miteinander, um durch eine gemeinsame Optimierung zum Gleichgewicht zu gelangen (Venkatesh et al., 2010).

wird. Weiterhin wirken sich die beiden Radikalitätskonstrukte, die gemeinsam als Gradmesser für die Gesamtveränderung in einer Unternehmung fungieren, negativ auf die soziale Komponente *Arbeitszufriedenheit* aus. Ferner stellten die IT-Mitarbeiter mit steigender *Radikalität der IT-organisatorischen Änderung* ein Abnehmen ihrer *subjektiven Arbeitsleistung* fest.

3.9 Beitrag 8: Sozio-technische Einflüsse von CC auf die IT-Mitarbeiter und andere Endnutzer der nutzenden Unternehmen

Der Beitrag 8 (Jede und Teuteberg, 2016e) nutzt in der quantitativen Analyse dieselbe Datenbasis wie der Beitrag 7. Die Fragestellungen werden jedoch darüber hinaus aus zwei unterschiedlichen Perspektiven betrachtet, da sich die Voraussetzungen der zwei konfrontierten Gruppen (IT-Mitarbeiter und andere Endnutzer) grundsätzlich unterschieden. Daher erfolgt im Anschluss an die quantitative Analyse eine qualitative Fallstudienuntersuchung. Diese Methode ist auch unter dem Begriff der (Daten-) Triangulation bekannt (Venkatesh et al., 2013) und in Abb. 9 dargestellt. In vier Fallstudien und acht Experteninterviews werden beide Seiten vor allem im Hinblick auf die beiden Endkonstrukte des Forschungsmodells (siehe Abb. 8) untersucht.

Die Ergebnisse der Fallstudien bestätigen zunächst die Ergebnisse der quantitativen Analyse dahingehend, als dass IT-Mitarbeiter von den Auswirkungen oftmals negativ betroffen sind und sich nicht im sozio-technischen Gleichgewicht befinden. Zeitgleich sind die Endnutzer[22], die den CC-Service für Kerngeschäftsprozesse nutzten, in den Fallstudien entweder neutral oder positiv gestimmt. Weiterhin sind die Endnutzer oftmals die Initiatoren einer CC-Einführung, sodass ein organisationaler Zielkonflikt entstehen kann. Via Meta-Inferenzen werden die qualitativen und quantitativen Ergebnisse zusammengeführt und es erfolgt eine Synthese. Eine wichtige Erkenntnis daraus lautet, dass zwingend zwischen proaktiven, reaktiven und extern-getriebenen CC-Implementierungen unterschieden werden muss, um die Auswirkungen auf die Mitarbeiter besser einschätzen zu können.

[22] Wohlwissend, dass auch IT-Mitarbeiter Endnutzer eines CC-Services sein können, wird in dieser Dissertation aus Gründen der Transparenz eine Trennung in beide Gruppen vorgenommen.

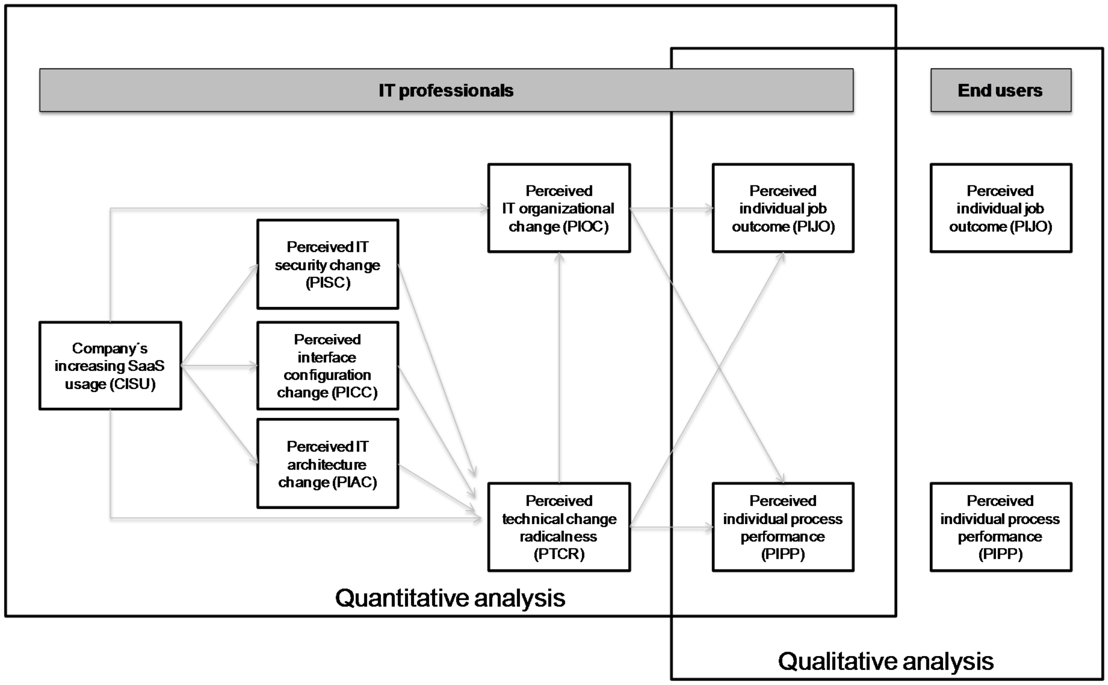


Abb. 9: Methodentriangulation im Beitrag 8 (Jede und Teuteberg, 2016e)

4 Diskussion

4.1 Implikationen für Theorie und Praxis

Die anwendungsorientierte Wirtschaftsinformatikforschung fokussiert insbesondere die Lösung praktischer Probleme, was theoretische Beiträge aber nicht ausschließt, sondern die Notwendigkeit derer sogar erfordert (Baskerville et al., 2011). In diesem Sinne bewegt sich die vorliegende Dissertation in der Schnittmenge zwischen Theorie und Praxis. Der rote Faden dieser Dissertation ist die Konzentration auf den CC-Einsatz in nutzenden Unternehmen, wenngleich die einzelnen Beiträge spezifische Ziele verfolgen. Damit einhergehend wurde im Verlauf des Forschungsprozesses hoher Wert auf eine differenzierte Betrachtungsweise gelegt. Diese schlägt sich zum einen in den multimethodischen Forschungsansätzen und zum anderen in den verschiedenen Blickwinkeln entlang des CC- Lebenszyklus nieder. Solche Methoden- und Perspektivenwechsel ringsum einen Untersuchungsgegenstand bereichern die Wirtschaftsinformatik, wenn diese an bestehende Theorien, Erkenntnisse und Ergebnisse anknüpfen (Venkatesh et al., 2013; Kornmeier, 2007, S. 92).

Der Beitrag 1 verbindet die wissenschaftlichen Disziplinen SCM und (Wirtschaft-) Informatik mittels einer systematischen Literaturanalyse. Dadurch wurde der Stand der Forschung untersucht und zeitgleich Theoriebildung forciert, indem die Einflussfaktoren für eine CC-Implementierung im SCM analysiert wurden. Für die künftige Forschung wurden wertvolle Anreize gesetzt, indem anerkannte Wirtschaftsinformatiktheorien und deren Verbindung zum Forschungsfeld analysiert wurden. Darüber hinaus ist die Keyword-basierte Forschungsmethode entwickelt worden, mit der andere Forscher beispielsweise den zeitlichen Verlauf ihres Forschungsfelds und die entsprechenden Entwicklungen anhand der Keywords in den Publikationen fortlaufend überprüfen können.

Im Beitrag 2 lag der Fokus auf der konzeptionellen Konstruktion eines Dokumenten-basierten Referenzmodells. Hierbei wurden zehn Anforderungen für Referenzmodellierung aufgestellt, die künftigen Arbeiten als Leitfaden dienen können. Das entwickelte Prozessmodell für Referenzmodellierung beinhaltet einen neuartigen Ansatz, der semi-formale Sprachen wie z. B. Entity Relationship Model (ERM), Business Process Modeling (BPM) oder Unified Modeling Language (UML) mit Data-Mining-Methoden wie Kookkurrenzrechnungen verbindet. Damit können versteckte Inhalte offengelegt und Objektivitätsbestrebungen gefördert werden.

Der dritte Beitrag im SCM-Kontext stellt der Theorie und Praxis ein Referenzmodell für den CC-Einsatz bereit, sodass ein gemeinsames Verständnis unterstützt und ein fruchtbarer Austausch zwischen den Disziplinen angeregt wird. Eine wichtige Implikation für die weitere wissenschaftliche Forschung liegt in der Feststellung, dass CC mit nachhaltigem SCM nicht nur einhergehen kann, sondern sogar bei effektivem Einsatz die Nachhaltigkeit forciert. Des Weiteren wurde eine potentielle Forschungsagenda mit entsprechenden Forschungsfragen erarbeitet, die von Wissenschaftlern als Basis für den weiteren Erkenntnisprozess genutzt werden kann.

Der Beitrag 4 verdeutlicht die komplexen Abhängigkeiten bei finanz-technischen Vergleichen zwischen traditionellen IT-Systemen und CC. Im Sinne der Transparenz ist das Zusammenspiel wichtiger Einflussfaktoren analysiert worden. Der Beitrag ermutigt die Wirtschaftsinformatiktheorie und die IT-Praxis, die Abhängigkeiten bei finanz-technischen Entscheidungen auf der Zahlungsmittelebene zu untersuchen, um die Bewertungen vollständiger auszugestalten. Die Wirkung dieser Abhängigkeiten darf von Entscheidungsträgern in nutzenden Unternehmen nicht unterschätzt werden, da ansonsten falsche Schlüsse gezogen werden können. Mit multikriteriellen Optimierungen dieser Art wird die IT-Praxis künftig noch stärker konfrontiert, wenn CC zunehmend bei Kerngeschäftsprozessen Einzug hält.

Im fünften Beitrag wird die Dimension Anbieterausfallrisiko thematisiert und es wird darauf hingewiesen, dass IT-Abteilungen künftig vermehrt gewisse Grundprinzipien aus dem Finanzwesen beherrschen müssen, wenn CC verstärkt genutzt wird. Vor allem die Kleinteiligkeit und Intransparenz des CC-Marktes erfordert in Theorie und Praxis einen interdisziplinären Austausch zwischen Ökonomie und Informatik. Bei kritischem CC-Einsatz ist ein aktives Risikomanagement inklusive Exit-Strategien und Alternativszenarien unumgänglich. Im Beitrag 5 wird die Notwendigkeit vergegenwärtigt, bestehende Rahmenwerke zur CC-Selektion um die Dimension Anbieterausfall zu erweitern.

Beitrag 6 rundet den finanz-technischen Block innerhalb dieser Dissertation ab. Mit dem Realoptionenansatz werden kapitalmarkttheoretische Annahmen auf das CC-Paradigma übertragen. Die Simulation führt zu zwei erstaunlichen Erkenntnissen. Zum einen kann es je nach Art der Services zu erheblichen Wertunterschieden zwischen den IT-Systemen kommen, die zunächst nicht offensichtlich sind. Zum anderen hat der Optionenansatz gerade bei denjenigen Vergleichsbewertungen einen hohen Nutzen, bei denen eine pure NBW-Berechnung nahe der Indifferenz liegt. Damit hilft der Beitrag, systemische Fehler der Entscheidungsträger (Kahnemann, 2007) zu mindern. Die weitere Forschung könnte den Detailgrad des determinierten Ansatzes weiter erhöhen (z. B. dynamische Wert- und Kostenentwicklungen anstatt linearer Verläufe), um noch realistischere Ergebnisse zu erzielen.

Der letzte Teilbereich (Beiträge 7 und 8) der vorliegenden Dissertation widmet sich den sozio-technischen Einflüssen von CC auf nutzende Unternehmen. Dabei wurde aufgezeigt, dass IT-Mitarbeiter die neuen Arbeitsabläufe nicht sofort internalisieren und es im besten Fall einer gewissen Zeit bedarf bis sich das sozio-technische Gleichgewicht wieder einstellt. Im schlechteren Fall sind die IT-Mitarbeiter dauerhaft im Ungleichgewicht, was sich in Unzufriedenheit niederschlägt. So kann die Gesamteffizienz der Geschäftsprozesse sogar rückläufige Entwicklungen nehmen. Eine weitere wichtige Implikation ist, dass eine intensive CC-Nutzung anspruchsvoller ist, als es der Anschein vermuten lässt, da es ein komplexes Gefüge aus gewollten, technischen und überwiegend versteckten, organisatorischen Veränderungen zu verstehen gilt. Im Zuge einer vermehrten CC-Einführung setzt ein schleichender Restrukturierungsprozess in der IT-Organisation ein. Des Weiteren vermutet die Literatur durch CC einen Innovationsschub (Marston et al., 2011), da die finanziellen Barrieren für neue Technologien sinken und Testnutzungen möglich sind. Die IT-Probanden der Studien stehen radikalen Veränderungen jedoch eher ablehnend gegenüber. Daher ist es in der derzeitigen Konstellation unwahrscheinlich, dass die erwarteten positiven Innovationsentwicklungen eintreten, da betroffene IT-Mitarbeiter ein soziales Ungleichgewicht und sinkende Leistungsfähigkeit empfinden. Entscheidungsträger sollten hier mehr Achtsamkeit und Weitblick aufbringen, um die Innovationschancen mit den IT-Strukturen in Einklang zu bringen. Im Gegensatz dazu haben Endnutzer eine positive oder neutrale Einstellung gegenüber CC. Dieses Phänomen lässt sich mit einer geringeren Radikalität bei den Veränderungen der täglichen Arbeit erklären. Die künftige Forschung könnte z. B. verschiedene Zeitpunkte nach der CC-Einführung analysieren, um die Auswirkungen auf das sozio-technische Gleichgewicht für beide Gruppen noch besser verstehen zu können.

4.2 Limitationen

Alle Beiträge dieser Dissertation fundieren auf anerkannten Forschungsmethoden, die im Sinne der Rigorosität beitragsspezifisch selektiert und angewandt wurden. Weiterhin durchliefen alle Beiträge ein anonymes mehrstufiges Begutachtungsverfahren renommierter Publikationsorgane, bei dem externe Gutachter die Beiträge auf Rigorosität überprüften. Dennoch beinhalten die Beiträge methoden-spezifische und inhaltliche Limitationen, die bei der Interpretation der Forschungsergebnisse zu berücksichtigen sind. Darüber hinaus können diese Limitationen künftigen Arbeiten als Ausgangspunkt dienen. Die Limitationen der einzelnen Beiträge sind gemäß einer ordentlichen Forschungsarbeit jeweils detailliert in Teil B dieser Dissertation beschrieben. Das Ziel dieses Abschnitts ist es vielmehr, die Limitationen auf einer aggregierten Ebene zu diskutiert. Diese Ebene setzt sich aus den zuvor diskutierten drei Teilbereichen zusammen: (i) Anwendungsmöglichkeiten von CC im Bereich von SCM, (ii) finanz-technische Auswirkungen und (iii) sozio-technische Auswirkungen.

Im ersten Teilbereich erfolgt eine Migration zweier Forschungsgebiete. Dabei besteht die Möglichkeit, dass nicht alle relevante Arbeiten in der Selektionsphase mittels Keywords gefiltert wurden. Die drei Ursachen hierfür können in der Unvollständigkeit der definierten Keywords, in alternativen Begriffsbezeichnungen in den Artikeln sowie in der Begrenzung auf vorab festgelegte Publikationsorgane liegen. Darüber hinaus können auch weitere Forschungsgebiete (z. B. Produktionstechnik) zur Schnittmenge SCM-CC hinzugefügt werden, um die Erkenntnisse zu bereichern. Hinsichtlich der Referenzmodellierung muss die allgemein gültige Limitation der Subjektivität angeführt werden, da bei der Entwicklung neuer IT-Artefakte der subjektive Einfluss des Modellierers nie vollends ausgeschlossen werden kann (Pfeffers et al., 2008). Das Ausmaß gerade dieser Limitation wird durch die neuartige Verknüpfung der Referenzmodellierung mit Methoden des Data Mining reduziert.

Der finanz-technische Teilbereich bedient sich mathematischer und statistischer Methoden, um die jeweiligen Gegebenheiten quantifizieren zu können. Die wichtigste Limitation in diesem Teilbereich stellt die Bewertung qualitativer Faktoren dar. Die Entscheidungsfindung erfolgt in der Realität auf mehrdimensionaler Basis. Das bedeutet, dass neben technischen und finanziellen Aspekten beispielsweise auch organisationale, soziale, politische oder psychologische Motive eine tragende Rolle spielen können. Die Quantifizierung all dieser Aspekte gestaltet sich für gewöhnlich relativ schwer, womit auch die Berücksichtigung derer in Vergleichsmodellen und Investitionsentscheidungen immer kritisch zu hinterfragen sind. Auch die Marktdynamik, die derzeit im CC-Markt vergleichsweise hoch ist, kann einen starken Einfluss auf nicht-monetäre und weiche Faktoren ausüben, sodass die rein finanztechnische Betrachtung zu verzerrenden Ergebnissen führen kann. Daher weisen alle drei Beiträge (Nr. 4, 5 und 6) bei der Entscheidungsfindung auch auf die Notwendigkeit hin, finanzielle und technische Einflussgrößen um weitere wesentliche Aspekte zu ergänzen. Dennoch bieten die Beiträge in diesem Teilbereiche wesentliche neue Erkenntnisse für strategische Langzeitentscheidungen.

Auch im dritten Teilbereich müssen einige Limitation beachtet werden. So besteht das Sample in den quantitativen Analysen ausschließlich aus deutschsprachigen Probanden. Obwohl das Sample in seinen Charakteristika stark diversifiziert ist, können die Ergebnisse nicht direkt auf andere Regionen übertragen werden, da regionale und kulturelle Unterschiede auch andere Empfindungen und Haltungen hervorrufen können. Daher sollten künftige Forschungsarbeiten Umfragen in anderen Regionen oder breiter angelegte Umfragen durchführen. Das würde Quervergleiche ermöglichen und tiefere Einblicke in die die soziotechnischen Interaktionen gewähren. Wie bereits erwähnt liegt eine weitere Limitation im Design der beiden Studien, da diese als Querschnittsstudien entlang diverser Industrien, Positionen und IT-Rollen angelegt sind und somit nur eine Zeitpunktbetrachtung zulässt. Eine Longitudinalstudie, die spezifische Gruppen und/oder Situationen untersucht, könnte möglicher Weise bessere Erklärungen zu Ursachen und Konsequenzen von Mitarbeiterempfindungen zutage bringen. Des Weiteren unterscheiden die Studien nicht zwischen den unterschiedlichen Zeitpunkten nach der CC-Einführung. Obwohl CC ein recht neues Paradigma darstellt und somit angenommen werden kann, dass sich nahezu alle Unternehmen auf unbekanntem Terrain begeben, haben frühere Studien gezeigt, dass Erfolge neuer IT-Systeme oftmals mit einer Zeitverzögerung eintreten (Sykes et al., 2014). Jedoch sind auch die kurzfristigen Wahrnehmungen entscheidend. Denn wenn es Unternehmen nicht gelingt, das Ausmaß diverser Empfindungen richtig einzuschätzen und Handlungen abzuleiten, dann können individuelle Reaktion und Handlung zum langfristigen Misserfolg von CC-Prozessen führen.

5 Fazit

In der zugrunde liegenden Dissertationsschrift wurde der CC-Einsatz in nutzenden Unternehmen entlang des CC-Lebenszyklus untersucht. Die erzielten Forschungsergebnisse folgten einem Multimethodenansatz, bei dem sowohl qualitative als auch quantitative Verfahren inkludiert wurden. Dabei wurden die drei betrachteten Teilbereiche, die ein qualifiziertes IT-Management allesamt abdecken sollte, auf Grundlage aktueller Arbeiten als Kernforschungsfelder für den CC-Einsatz identifiziert. Im *Sinne des Relevanzprinzips* wurde darüber hinaus ausgeführt, wie Entscheidungsträger durch die Ergebnisse der Beiträge unterstützt werden können und welche unternehmerischen Potentiale und Risiken CC bietet. Zusammenfassend kann festgehalten werden, dass kritische und relevante Fragestellungen aus der IT-Praxis mit anerkannten wissenschaftlichen Methoden und etablierten Theorien untersucht wurden (*in Sinne der Rigorosität*), wobei die anwendungsorientierten Erkenntnisse sowohl für die Praxis als auch die Wissenschaft förderlich sind. Diese Dissertation erhebt aber keinen Anspruch darauf, dass die determinierten Teilbereiche und deren Ergebnisse sämtliche Probleme beim CC-Einsatz lösen können. Obgleich es offensichtlich ist, dass das recht junge Forschungsgebiet auch künftig intensiven Untersuchungen unterliegen wird, um Entscheidungsträger noch besser unterstützen zu können. In den einzelnen Beiträgen dieser Dissertation werden daher künftige Forschungsbedarfe strukturiert aufgezeigt.

Literaturverzeichnis

Altman, E.I. (1968). “Financial ratios, discriminant analysis and the prediction of corporate bankruptcy.” The journal of finance, 23(4), 589–609.

Bala, H. (2013). “The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation.” Journal of Operations Management, 31(6), 450–473.

Baskerville, R., Lyytinen, K., Sambamurthy, V., Straub, D. (2011). “A response to the design-oriented information systems research memorandum.” European Journal of Information Systems, 20(1), 11–15.

Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R.J., Sougstad, R. (2010). “An interdisciplinary perspective on IT services management and service science.” Journal of Management Information Systems, 26(4), 13–64.

Becker, J., Beverungen, D.F., Knackstedt, R. (2010). “The challenge of conceptual modeling for product–service systems: status-quo and perspectives for reference models and modeling languages.” Information Systems and e-Business Management, 8(1), 33–66.

Benaroch, M. (2002). “Managing information technology investment risk: a real options perspective.” Journal of Management Information Systems, 19(2), 43–84.

Black, F., Scholes, M. (1973). “The pricing of options and corporate liabilities.” Journal of Political Economy, 81(3), 637–654.

Breiter, G., Behrendt, M. (2009). “Life cycle and characteristics of services in the world of cloud computing.” IBM Journal of Research and Development, 53(4), 3:1–3:8.

Cegielski, C.G., Jones-Farmer, L.A., Wu, Y., Hazen, B.T. (2012). “Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach.” International Journal of Logistics Management, 23(2), 184–211.

Cha, H.S., Pingry, D.E., Thatcher, M.E., (2008). “Managing the Knowledge Supply Chain: An Organizational Learning Model of Information Technology Offshore Outsourcing.” Management Information Systems Quarterly, 32(2), 281–306.

Conway, G., Curry, E. (2012). “Managing Cloud Computing: A Life Cycle Approach.” In: 2nd International Conference on Cloud Computing and Services Science (CLOSER 2012), Porto.

Cooper, M.C., Lambert, D.M., Pagh, J.D. (1997). “Supply chain management: more than a new name for logistics.” The International Journal of Logistics Management, 8(1), 1–13.

Dibbern, J., Goles, T., Hirschheim, R., Jayatilaka, B. (2004). “Information systems outsourcing.” ACM SIGMIS Database, 35(4), 6–102.

Elkington, J. (2004). “Enter the Bottom line.” In: Henriques, A., Richardson, J., (Hrsg.), The Triple Bottom Line, Earthscan, London, UK.

Feldman, R., Sanger, J. (2007). “The Text Mining Handbook.” Cambridge University Press.

Fettke, P. (2006). “State-of-the-Art des State-of-the-Art: Eine Untersuchung der Forschungsmethode “Review” innerhalb der Wirtschaftsinformatik.” Wirtschaftsinformatik, 48(4), 257–266.

Fettke, P., & Loos, P. (2005). “Der Beitrag der Referenzmodellierung zum Business Engineering.” HMD-Praxis der Wirtschaftsinformatik, 241, 18–26.

Frank, U. (2007). “Evaluation of reference models.“ In: Fettke, P., Loos, P. (Hrsg.) Reference modeling for business systems analysis, Idea Group, Hershey, 118–139.

Fremdt, S., Beck, R., Weber, S. (2013). “Does Cloud Computing Matter? An Analysis of the Cloud Model Software-as-a-Service and Its Impact on Operational Agility.” Proceedings of the 46th Hawaii International Conference on in System Sciences (HICSS), Hawaii.

Gadatsch, A., Mayer, E. (2013). “Masterkurs IT-Controlling.” 5. Auflage, Vieweg, Wiesbaden.

Glass, R.L. (2001). “Rigor vs. Relevance: A Practitioner‘s Eye View of an Explosion of IS Opinions.” Communications of the Association for Information Systems, 6(1), 8–12.

Gupta, P., Seetharaman, A., Raj, J. R. (2013). “The usage and adoption of cloud computing by small and medium businesses.” International Journal of Information Management, 33(5), 861–874.

Gutenberg, E. (1958). “Grundlagen der Betriebswirtschaftslehre, Band 1, Die Produktion.” Springer, Berlin.

Hansen, H.R., Neumann, G. (2005). “Wirtschaftsinformatik.” 9. Auflage, Lucius & Lucius, Stuttgart.

Hevner, A.R., March, S.T., Park, J., Ram, S. (2004). “Design Science in Information Systems Research.” Management Information Systems Quarterly, 28(1), 75–105.

Hoberg, P., Wollersheim, J., Krcmar, H. (2012). “The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing.” Proceedings of the 18th American Conference on Information Systems (AMCIS), Seattle.

Jede, A., Teuteberg, F. (2014a). “Bewertung der Vorteilhaftigkeit von Cloud-Services anhand eines Cashflow-Vergleichs.“ HMD - Praxis der Wirtschaftsinformatik, 51(5), 698–707.

Jede, A., Teuteberg, F. (2014b). “Cloud-gestützte Supply-Chain-Architekturen – Entwicklung eines Referenzmodells auf Basis einer systematischen Literaturanalyse.“ Proceedings zur INFORMATIK 2014, 44. Jahrestagung der Gesellschaft für Informatik e.V. (GI), Stuttgart, Lecture Notes in Informatics (LNI).

Jede, A., Teuteberg, F., (2015a). “Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review.” Journal of Enterprise Information Management, 28(6), 872–904.

Jede, A., Teuteberg, F., (2015b). “Evidente Ausfallrisiken im Cloud-Markt – Eine quantitative Analyse der Finanzberichte von Anbietern.“ Proceedings zur INFORMATIK 2015, 45. Jahrestagung der Gesellschaft für Informatik e.V. (GI), Cottbus, Lecture Notes in Informatics (LNI).

Jede, A., Teuteberg, F., (2015c). “Looking Behind the Stage: Influence and Effect of Software-as-a-Service on Socio-technical Elements in Companies.” Proceedings of the 23rd European Conference on Information Systems (ECIS), Münster.

Jede, A., Teuteberg, F. (2015d). “Managing the Cloud Procurement Process – Findings from a Case Study.” Proceedings of the International Conference on Business Process Management (ICBPM), London.

Jede, A., Teuteberg, F. (2016a). “Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application.” Journal of Systems and Software, 111(1), 254–269.

Jede, A., Teuteberg, F., (2016b). “Towards Cloud-based Supply Chain Processes: Designing a Reference Model and Elements of a Research Agenda.” International Journal of Logistics Management, 27(2), 438–462

Jede, A., Teuteberg, F., (2016c). “Investigating Preconditions for a Financially Advantageous Cloud Usage.” International Journal of Accounting & Information Management, 24(2), 116–134.

Jede, A., Teuteberg, F., (2016d). “Valuing the Advantage of Early Termination: Adopting Real Options Theory for SaaS.” Proceedings of the 49th Hawaii International Conference on Systems Science (HICSS), Hawaii.

Jede, A., Teuteberg, F., (2016e). „Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data.” Business & Information Systems Engineering, 58(3), 161–176.

Jenkins, A. M. (1985). Research Methodologies and MIS Research. In: Mumford, E. (Hrsg.), Research Methods in Information Systems (S. 103–117). North-Holland.

Kahneman, D. (2003). “Maps of bounded rationality: Psychology for behavioral economics.” American Economic Review.” 93(5), 1449–1475.

Kornmeier, M. (2007). “Wissenschaftstheorie und wissenschaftliches Arbeiten: eine Einführung für Wirtschaftswissenschaftler.” Physica-Verlag, Heidelberg.

Krcmar, H., Dold, G., Fischer, H., Strobel, M., Seifert, E. K., Scheide, W., (2000). “Informationssysteme für das Umweltmanagement. Das Referenzmodell ECO-Integral.” Oldenbourg, München, Wien.

Leimeister, S., Boehm, M., Riedl, C., Krcmar, H. (2010). “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks.” Proceedings of the 18th European Conference on Information Systems (ECIS), Pretoria.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., Ghalsasi, A. (2011). “Cloud computing – The business perspective.” Decision Support Systems, 51(1), 176–189.

Martens, B., Teuteberg, F. (2009). “Why Risk Management Matters in IT Outsourcing - A Systematic Literature Review and Elements of a Research Agenda.” Proceedings of the 17th European Conference on Information Systems (ECIS), Wien.

Meer, D.V., Dutta, K., Datta, A. (2012). “A cost-based database request distribution technique for online E-commerce applications.” Management Information Systems Quarterly, 36(2), 479–507.

Mell, P., Grance T. (2011). “The NIST definition of cloud computing.” Online verfügbar: http://predeveloper.att.com/home/learn/enablingtechnologies/The_NIST_Definition_of_Cloud_Computing.pdf (Abruf am 26. Oktober 2015).

Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G. (2001). “Defining supply chain management.” Journal of Business logistics, 22(2), 1–25.

Morgan, L., Conboy, K. (2013). “Factors affecting the adoption of cloud computing: an exploratory study.” In: Proceedings of the 21st European Conference on Information Systems, Utrecht.

Misra, S.C., Mondal, A. (2011). “Identification of a company’s suitability for the adoption of cloud computing and modelling its corresponding Return on Investment.” Mathematical and Computer Modelling, 53(3), 504–521.

Österle, H., Becker, J., Frank, U., Hess, T., Karagiannis, D., Krcmar, H., Loos, P., Mertens, P., Oberweis, A. Sinz, J.E. (2010). “Memorandum zur gestaltungsorientierten Wirtschaftsinformatik.” In: Gestaltungsorientierte Wirtschaftsinformatik: Ein Plädoyer für Rigor und Relevanz, H. Österle, R. Winter und W. Brenner (Hrsg.), Infowerk, Nürnberg.

Palvia, P., Mao, E., Salam, A.F., Soliman, K.S. (2003). “Management information systems research: what's there in a methodology?.” Communications of the Association for Information Systems, 11(1), 289–309.

Parmenter, D. (2010). “Key performance indicators: Developing, implementing, and using winning KPIs.” 2nd ed., John Wiley & Sons, Hoboken.

Peffers, K., Tuunanen, T., Rothenburger, M.A., Chatterjee, S. (2007). “A design science research methodology for information systems research.” Journal of Management Information Systems, 24(3), 45–77.

Porter, M.E., Millar, V.E. (1985). “How Information gives you Competitive Advantage.” Harvard Business Review, 63(4), 149–160.

Recker, J., (2013). “Scientific Research in Information Systems: A Beginner’s Guide.” Springer, Berlin, Heidelberg.

Reips, U.D., (2002). “Standards for Internet-Based Experimenting.” Experimental Psychology, 49(4), 243–256.

Ridder, F. (2014). “Gartner Survey Shows One in Four German CIO Respondents Have Adopted Cloud and More Plan to Increase Cloud Investments.” Online verfügbar: http://www.gartner.com/newsroom/id/2731417 (Abruf am 07.02.2015).

Rinaldi, S.M., Peerenboom, J.P., Kelly, T.K. (2001). “Identifying, understanding, and analyzing critical infrastructure interdependencies.” IEEE Control Systems Magazine, 21(6), 11–25.

Rousseau, D.M. (1977). “Technological differences in job characteristics, employee sat-isfaction, and motivation: a synthesis of job design research and socio technical systems theory.” Organizational Behavior and Human Performance, 19(1), 18–42.

Scheer, A.W., (2009). “Wirtschaftsinformatik zwischen Wissenschaft und Unternehmertum.” Wirtschaftsinformatik, 51(1), 88–93.

Schlitt, M. (2003). “Grundlagen und Methoden für Interpretation und Konstruktion von Informationssys-temmodellen.“ (Dissertation). Universität Bamberg

Simon, S.J. (2004). “Rigor Vs. Relevance: Why Can‘t We All Just Get Along?.” Journal of Information Science and Technology, 1(1), 1–11.

Stahlknecht, P., Hasenkamp, U. (2005). “Einführung in die Wirtschaftsinformatik.” 11. Auflage, Springer, Berlin.

Steinfield, C., Markus, M.L., Wigand, R.T. (2011). “Through a glass clearly: standards, architecture, and process transparency in global supply chains.” Journal of Management Information Systems, 28(2), 75–108.

Sykes, T., Venkatesh, V., Johnson, J. (2014). “Enterprise system implementation and employee job performance: Understanding the role of advice networks.” Management Information Systems Quarterly, 38(1), 51–72.

Tan, P.N., Steinbach, M., Kumar, V. (2005). “Introduction to Data Mining.” Addison-Wesley, Boston, MA.

Taudes, A. (1998). “Software growth options.” Journal of Management Information Systems, 15(1), 165–185.

Taudes, A., Feurstein, M., Mild, A., (2000). “Options analysis of software platform decisions: a case study.” Management Information Systems Quarterly, 24(2), 227–243.

Thomas, O. (2006). “Understanding the term reference model in information systems research: history, literature analysis and explanation.” In: Business Process Management Workshops, Springer, Heidelberg, Berlin, 484–496.

Venters, W., Whitley, E.A. (2012). “A critical review of cloud computing: researching desires and realities.” Journal of Information Technology, 27(3), 179–197.

Vom Brocke, J. (2003). “Referenzmodellierung: Gestaltung und Verteilung von Konstruktionsprozessen.“ Logos, Berlin.

Webster, J., Watson, R.T. (2002). “Analyzing the past to prepare for the future: Writing a literature review.” Management Information Systems Quarterly, 26(2), pp. xiii–xxiii.

Wieringa, R., (2010). “Relevance and problem choice in design science.” In: Winter, R., Zhao, J.L., Aier, S., (Hrsg.), Global Perspectives on Design Science Research, Springer, Berlin.

Wilde, T., Hess, T., (2007). “Forschungsmethoden der Wirtschaftsinformatik: Eine empirische Untersuchung.” Wirtschaftsinformatik, 49(4), 280–287.

Wind, S., Repschlaeger, J., Zarnekow, R. (2012). “Towards a Cloud Computing Selection and Evaluation Environment for Very Large Business Applications.” Proceedings of the 18th American Conference on Information Systems (AMCIS), Seattle.

Venkatesh V., Bala H., Sykes T. (2010). “Impacts of information and communication technology implementations on employees’ jobs in service organizations in India: a multi-method longitudinal field study.” Production and Operations Management, 19(5), 591–613.

Venkatesh V., Brown S.A., Bala H., (2013). “Bridging the Qualitative – Quantitative Devide: Guidelines for Conducting Mixed Methods Research in Information Systems.” Management Information Systems Quarterly, 37(1), 21–54.

Eidesstaatliche Erklärung (Hilfsmittel)

Hiermit erkläre ich, dass ich meine Dissertation zur Erlangung des akademischen Grades eines Doktors der Wirtschaftswissenschaften des Fachbereichs Wirtschaftswissenschaften der Universität Osnabrück ohne unzulässige Hilfe Dritter angefertigt und die benutzten Hilfsmittel vollständig und deutlich angegeben habe.

Osnabrück, den 20. Januar 2016

Andreas Jede

Eidesstaatliche Erklärung (entgeltliche Hilfe)

Hiermit erkläre ich, dass ich keine entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten (Promotionsberatern oder anderen Personen) in Anspruch genommen habe und niemand von mir geldwerte Leistungen für Arbeiten erhalten hat, die im Zusammenhang mit dem Inhalt der Dissertation stehen.

Osnabrück, den 20. Januar 2016

Andreas Jede

Teil B

Beitrag Nr. 1	
Titel	Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	Journal of Enterprise Information Management
DOI	http://dx.doi.org/10.1108/JEIM-08-2014-0085

Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review

Andreas Jede & Frank Teuteberg

Abstract

- **Purpose:** There are cloud computing (CC) services available for various applications within supply chain management (SCM) processes and related enterprise information systems. These services offer, for example, consistent global networking platforms and shared real-time information. Furthermore, they enable quick decision-making and ensure efficiency, which may strengthen competitive advantages as to digital processes within the supply chain. However, research lacks a paper that systematically analyzes the interrelation between CC and SCM in detail and aims to become a reference point in the intersection of both research fields. Moreover, the purpose of this paper is to gain a deep understanding of the current state of research and to identify future research challenges.
- **Design/Methodology/Approach:** This paper provides a cross-discipline systematic literature review from the research perspectives of information systems and SCM. 99 papers have been investigated by combining qualitative and quantitative content analysis. As a side effect we developed a new methodological framework for conducting comprehensive literature reviews that could be applied by future research.
- **Findings:** We discover the most important influence factors for CC implementations in supply chain processes and pay special attention to major issues, research methods, applied theoretical concepts, and geographical differences. Until now, SCM research in the realm of CC usage is still in its infancy both in theory and practice.
- **Research Limitations/Implications:** Possibly not all of the relevant papers have been filtered during the paper selection phase. The findings of the literature review and the conceptual framework identifying different areas of concern are believed to be useful for future research to obtain an overview of the evolution of CC in supply chain processes.
- **Originality/Value:** To the best of our knowledge, there is no systematic literature review that consistently focuses CC usage within supply chain processes while integrating strategic aspects. Additionally, we constructed and applied a unique keyword analysis.

Keywords: Systematic Literature Review, Content Analysis, Cloud Computing, Supply Chain Management,

1 Introduction and motivation

Already in the mid-1980s, Porter and Millar (1985) justified the outstanding importance of information technology (IT) for the value chain and thus for SCM. Even today, IT is essential for information visibility and flexibility along the entire supply chain (SC), supporting SC integration (Cegielski et al., 2012; Steinfield et al., 2011). With the introduction of traditional enterprise resource planning (ERP) systems, it was noted that they have limited progress for SCM (Akkermans et al., 2003). They are lacking in providing effective SCM support especially due to their insufficient functionality in cross-organizational flows as well as their closed non-modular system architectures, and their inflexibility in ever-changing SC needs. With service-oriented architectures (SOA), which may originate from various vendors, the technical conditions have been created in order to provide complete services from encapsulated functions at any location and any time (Bardhan et al., 2011). Based on SOA, at the end of the last decade, the paradigm of "cloud computing" has emerged. CC offers significant advantages particularly for the decentralized and loosely coupled nature of global SCs, due to the fact that IT processes are becoming more and more stable and flexible, e.g., through scalability and virtualization (Bharadwaj et al., 2013; Hoberg et al., 2012; Pereira, 2009).

Looking at the provider side, SAP (www.sap.com), for example, already offers eight different CC services for SC related IT-processes like B2B trading, procurement, and information interchange. According to its own statement, GT Nexus (www.gtnexus.com) has the biggest CC-based global SC network that is accessed by more than 25.000 organizations including reputable firms like Hewlett & Packard, Procter & Gamble, and United Parcel Service. Beyond, eBuilder (www.ebuilder.com) represents an example of an order fulfillment service specialist that provides CC services for inbound, outbound, distribution, and reverse logistics and is used by organizations like DHL, Volvo, and the Swedish tax agency.

Cooper et al. (1997) define SCM as “the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders”. In parallel to material flows and cooperation, a demand-oriented intra- and inter-organizational information supply is needed. Thus the challenge lies in selecting, adapting, and using suitable IT solutions. Here is the starting point of CC. The National Institute of Standards and Technology (NIST) defines CC as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2011). But CC does not represent a new technology. Rather, it stands for a new paradigm for IT processes (Youseff et al., 2008) by consistently linking individual, existing technologies (Leimeister et al., 2010). The majority of the research literature distinguishes between three service models (Hoberg et al., 2012; Mell and Grance, 2011): “Infrastructure as a Service (IaaS)“, ”Platform as a Service (PaaS)“, and “Software as a Service (SaaS)“.

We are motivated by the fact that the obviously existing advantages of CC usage at SC processes lack a profound theoretical basis, since the current research is at an early stage in both theory and practice (Marston et al., 2011). There is, however, a general consensus that CC has an IT scope on the one side and commercial administration relevance on the other side (Marston et al., 2011). Currently, companies that need to combine these two aspects at the phases of selection, adaptation, usage, and possibly transition out, see themselves confronted with a confusing amount of CC options and concepts (Wind et al., 2012). So far, the majority of scientific publications focus especially on the technical aspects (Böhm et al., 2010; Fremdt et al., 2013). Interdisciplinary recommendations for specific strategic business areas (Hoberg et al., 2012), such as SCM (Blau et al., 2009; Leimeister et al., 2010), are scarce. Further, scientific literature needs to focus more on relevant implementation factors and the strategic influence of CC in organizations (Marston et al., 2011).

Since CC offers significant advantages regarding stability and flexibility particularly for the decentralized and loosely coupled nature of global SCs and for big data analytics in SCs, we carried out a systematic literature analysis. We are driven by the motivation to reunite the existing research on CC and SCM and to uncover more research gaps in literature by quantitative and qualitative data analysis. Further, our review fulfills the requirements for investigating CC in more an inter-disciplinary context (Bardhan et al., 2010) by moving in the intersection of the science disciplines information systems (IS) and SCM. Herein, this paper focuses on efficiency related influence factors and intends to support the establishment of the needed research basis. The following research questions (RQ) will be addressed:

- ***RQ1:*** *What are the currently discussed (region-specific) core research topics with regard to CC in the realm of SCM?*
- ***RQ2:*** *How are these topics connected to the most important and efficiency-related influence factors for adopting CC within the SC?*

The paper is built up as follows: After the introduction, the methodology of the literature analysis is described in the second section. The results from the literature review are presented and discussed in section three. The paper closes with a conclusion in section four.

2 Methodology

This paper is based on the method of a systematic literature analysis, which has proven useful for the identification of the respective current status in scientific research (Fettke, 2006; Levy and Ellis, 2006). Furthermore, we followed the framework of Dibbern et al. (2004) during the classification phase of the individual paper. Based on the framework (cf. table 1), we pursued a systematic knowledge building that is strictly linked to the published articles. The execution of the analysis is closely related to the five-stage model of Fettke (2006). Both, the framework by Dibbern et al. (2004) as well as the model by Fettke (2006) constitute valuable and well-known methodologies in the context of systematic literature analyses. The five-stage model consists of issue description and definition of the research field, literature search, literature evaluation, literature analysis, and interpretation. For the keyword based literature search at the 2nd stage, we considered 33 top rated IS journals and 31 top rated SCM journals, that were derived from selected journal rankings. While IS research is covered by the rankings of the “Association for Information Systems” and

“Wirtschaftsinformatik”, the ranking “Transport, Logistics and SCM” of the University of Sydney is, according to our knowledge, the most comprehensive one in the field of SCM. In addition, four high quality IS conferences (i.e. ICIS, ECIS, AMCIS, and WI) expanded the selection. Herein, we identified 63 relevant papers. These papers served as basis for forward and backward search and led to additional 36 papers. Hence, the total number of considered papers amounts 99 (cf. appendix table I for details of the applied five-stage model, table II for the selected journals and conferences, and table III for the used keywords).

Table 1 Framework of analysis

Phase	Stage	Research question / content	Section
Motivation	Why?	Why CC within the SC?	1
Scope, applied methods, and theories	What? How? Which?	What are the descriptive statistics of the research field?	3.1
		What are the major research topics?	3.2
		Do IS and SCM research view the underlying topic differently?	3.3
		What are the interrelations of the most discussed terms?	3.3
		What are the main influence factors for CC implementation?	3.3
		What are the empirically tested preconditions across various regions?	3.4
		Which research methods were used?	3.5
Implications	Outcome	What are the implications for theory and practice?	4

During the literature search phase within the 63 journals and four conferences, we identified four papers that also applied a literature review in content related topics. These papers are listed in table 2. They are sorted by the criteria: considered “Period”, number of “Papers”, “Research Questions”, and “Results”. Our work distinguishes from the existing scientific literature for the following reasons. To our knowledge, there is up to date no systematic analysis of the literature that consistently focuses the CC usage within SC processes (while integrating strategic aspects). Three of the stated references that conduct a literature review on CC as well have strong information system focus and a minor meaning for SCM research (Hoberg et al., 2012; Salleh et al., 2012; Fremdt et al., 2013). Contrary, the forth paper by Giminez and Lourenco (2008) has a strong SCM regard but deals with pre-CC online solutions (and hence older publications). In addition, we present the most important influence factors for CC implementation in SCM by evaluating them qualitatively as well as quantitatively. Compared with the three actual reviews on CC, the focus on business processes in this literature sample is even higher due to considering SCM research, which normally addresses processes at economic-driven industries and companies, where business process thinking and acting is a primal principle.

Table 2 Related articles

Reference	Period	Papers	Research questions	Results
Hoberg et al., 2012	1952 to 2011	60	What are the relevant aspects in the CC paradigm and how are these aspects characterized in the science literature?	Findings are compiled in four dimensions: General CC properties, determinants that influences CC adoption, required governmental regulations, and impact on entrepreneurship.
Giminez and Lourenco, 2008	1995 to 2005	174	Which business processes benefit most from the internet?	Competitive advantages for companies arise in particular in the electronic procurement process, the order fulfillment process and the information flow.
Salleh et al., 2012	-	45	Which companies benefit from a CC enterprise system?	In particular, small and medium-sized companies benefit most from CC because of low investments and limited IT resources.
Fremdt et al., 2013	2007 to 2011	28	How does CC affected operational agility?	"SaaS" based processes improve operational agility, but not immediately, e.g., through improved ERP and process support systems.

3 Literature analysis and synthesis

The findings of this study are presented under different subsections. Each of the five subsections discusses the findings in relation to a particular topic. The topics are as follows: descriptive statistics (Section 3.1), most important keywords (Section 3.2), quantitative content analysis (Section 3.3), implications from the regions (Section 3.4), and applied research methods (Section 3.5).

3.1 Descriptive statistics

The analysis of publishing outlets (cf. table 3) on the underlying research topic indicated that relevant papers have been published more often on conferences like *AMCIS* (#12), *ECIS* (#7), and *ICIS* (#3). Moreover, the journals *Decision support systems* (#8) and *International journal of information systems* (#6) published a remarkable amount as well and enriched the research field more than other journals. However, 39 journals published just one article (not shown in table 3). In total, 55 different sources were used for publishing the identified 99 articles (every percentage in table 3 is from the total range of 99 articles).

Table 3 Source of publication

Journal / Conference	#	%
American conference on information systems	12	12.1
Decision support systems	8	8.1
European conference on information systems	7	7.1
International journal of information management	6	6.1
Communications of the ACM	3	3.0
International conference on information systems	3	3.0
Information systems research	3	3.0
Journal of management information systems	3	3.0
Pacific conference on information systems	3	3.0
Transactions on intelligent transportation systems	2	2.0
International journal of physical distribution & logistics management	2	2.0
International journal of production economics	2	2.0
Journal of operations management	2	2.0
Management information systems quarterly	2	2.0

Further, we tried to figure out the most prolific authors publishing cloud computing papers in the realm of supply chain management. In table 4, it is visible that Alexander Benlian and Haluk Demirkan both contributed four research papers followed by Benjamin T. Hazen, Helmut Krcmar, Holger Schrödl, Jörg Leukel, and Stephan Olariu with three papers each. 21 authors published two papers. The overall analysis indicated that the topic has generally a wide author basis with 219 various researchers (every percentage in table 4 is from the total range of 219 authors).

Table 4 Authors ranking

Name	#	%
Alexander Benlian	4	1.6%
Haluk Demirkan	4	1.6%
Benjamin T. Hazen	3	1.2%
Helmut Krcmar	3	1.2%
Holger Schrödl	3	1.2%
Joerg Leukel	3	1.2%
Stephan Olariu	3	1.2%

Ali Syed Imran	2	0.8%
Benjamin Fabian	2	0.8%
Casey G. Cegielski	2	0.8%
Charles Steinfield	2	0.8%
Christoph Dorsch	2	0.8%
Oliver Günther	2	0.8%
Henning Baars	2	0.8%
Hing Kai Chan	2	0.8%
Jonas Repschlaeger	2	0.8%
Kieran Conboy	2	0.8%
Lorraine Morgan	2	0.8%
M. Lynne Markus	2	0.8%
Markus Böhm	2	0.8%
Rolf T. Wigand	2	0.8%
Rüdiger Zarnekow	2	0.8%
Stefan Bensch	2	0.8%
Stefan Wind	2	0.8%
Stefanie Leimeister	2	0.8%
Subhajyoti Bandyopadhyay	2	0.8%
Thomas Hess	2	0.8%
Yun Wu	2	0.8%

In addition, we were interested in the frequency of publications per year. Hence, we analyzed articles from the years 2007 to 2013, since the term “Cloud Computing” appeared in scientific literature for the first time in 2007. Table 5 presents the frequency of research papers published along the underlying years. The rapidly increasing amount of papers indicated the growing interest for the topic and there are no early symptoms for a break of the general trend.

Table 5 Publication per year

Year	#	%
2007	0	0,0
2008	2	2.0
2009	5	5.1
2010	15	15.2
2011	19	19.2
2012	22	22.2
2013	36	36.4

In order to get a geographic overview of the underlying topic, we analyzed the number of the publications per country based on the selected sample that exclusively contains papers in English language. The decisive factor herein is the institution of a paper's first author. The corresponding values are shown in table 6. Our findings suggest that literature is dominated by two countries, namely the USA and Germany, since 58.6% of all papers originate in these countries. Comparing the two countries in detail, Germany is recognized as one of the leading nations in SCM and transportation research. And some authors argue that SCM is Germany's secret to its economic success (BME, 2013; Böhmer, 2005; PWC, 2011; Wagner, 2008). The USA is ahead of the other nations with regard to practical CC implementation experience. Additionally, the NIST published a CC roadmap in order to provide technical leadership for the USA (Hogan et al., 2011).

Table 6 Institution affiliation according to country

Year	#	%
Germany	29	29.3
USA	29	29.3
China incl. Hong Kong	10	10.1
UK	8	8.1
Australia	3	3.0
Swiss	3	3.0
Korea	2	2.0
Netherlands	2	2.0

Saudi Arabia	2	2.0
Belgium	1	1.0
Canada	1	1.0
Iran	1	1.0
Kuwait	1	1.0
New Zealand	1	1.0
Poland	1	1.0
Portugal	1	1.0
Singapore	1	1.0
South Africa	1	1.0
Spain	1	1.0
Turkey	1	1.0

3.2 Keyword analysis

Generally, scientific journals and conferences require keywords within the submitting process, which encapsulate and represent the fundamental content of the underlying paper. Therefore, we took into account just the keywords of the selected papers in order to get a better understanding for the main research topics and issues in the conjoint field of CC and SCM. In particular, we were interested in the interconnection of the keywords. First, we will explain the underlying methodology of the keyword analysis and thereafter the outcome.

In 10 of the publications there were no keywords. In the remaining 89 papers, we found 472 keywords in total, which means an average of 5.3 keywords per paper. Given this starting point, we executed four clustering stages with the aim to aggregate the data content and reduce the total amount. In the first stage, we standardized the different variants of spelling, namely upper and lower case letters, hyphens, as well as separate, and compound words (e.g., “Service-oriented”, “service-oriented”, and “service oriented”). At this grammatical stage, we reduced the amount to 325 keywords. In the next stage, we unified keywords with the same meaning, and wrote abbreviations in full (e.g., “SCM” and “Supply Chain Management”, or “Cloud” and “Cloud Computing”). Thereby, the number of keywords decreased to 261. The third stage covered the highest analytical work load, as we merged keywords of the same content (e.g., “inter-firm”, “inter-company”, “inter-operation”, “inter-organization”) or (“Logistics Management”, “Supply Chain Management”, “Supply Network Management”). At this stage, we had to check the deeper meaning of ambiguous keywords in the corresponding papers’ content. Within the third stage, our clear intention was to reduce the keywords to a well-manageable quantity. Therefore, we also grouped closely related words and marked them with “&” (e.g. “Coordination & Collaboration”). Furthermore, we grouped specific research theories, which all were stated as single keywords, to one general term, and we did the same with the research methodology keywords. Thus, we aggregated the keywords to 62. During the final stage, which served as a kind of filter, we deleted all keywords with just one or two occurrences as we deduced a minor relevance for our analysis (e.g. "Durable Goods", "Consumerization"). As a result, the four-stage clustering process led to a relevant amount of 47 keywords.

In the following step, we traced back the 47 defined keywords to their initial papers and positions and built a tool based on MS Excel that counted the amount of every emerging keyword combination. The underlying algorithm for the tool is described in the following:

(1) Let us assume that we are given a random sample of I scientific papers. Our goal is to perform a keyword classification of the sample, which is assumed to be based only on the keywords of the papers. In the following, we explain the employed classification method in detail.

(2) We assume that the set of all N_i keywords $p_j^{(i)}, 1 \leq j \leq N_i$, related to the i-th paper is denoted by:

$$M_i := \{p_1^{(i)}, p_2^{(i)}, \ldots, p_{N_i}^{(i)}\}.$$

In particular, the keywords are assumed to be alphabetically ordered, which we symbolically express by the following relations:

$$p_j^{(i)} <_{\text{ABC}} p_{j+1}^{(i)} \quad \forall\, i \in \{1, \ldots, I\}, j \in \{1, \ldots, N_i - 1\}.$$

(3) For the classification, we consider the set T_i of all possible 2-tuples, that can be created from the elements of M_i, and where the 2-tuple elements are alphabetically ordered, i.e.:

$$T_i := \left\{\left(p_j^{(i)}, p_k^{(i)}\right) \middle| 1 \leq j, k \leq N_i, j < k\right\}.$$

(4) The alphabetical order of the 2-tuple elements simplifies the classification by providing an unambiguous representation for each combination of two keywords.

(5) In a next step, we create the disjoint union T of all 2-tuple sets T_i, which is defined as follows:

$$T := \coprod_{i=1}^{I} T_i := \bigcup_{i=1}^{I} \{(t, i) \mid t \in T_i\}.$$

In particular, an element of T consists of a keyword 2-tuple and the respective paper index.

(6) The motivation behind the look at the disjoint union of all keyword 2-tuples is to have the possibility to count the occurrence of all possible 2-tuples within the underlying paper sample. In particular, the number of occurrences of a 2-tuple (p, q) with $p <_{\text{ABC}} q$ is determined by the number $C_{p,q}$ of elements of the following set:

$$T^{(p,q)} := \{\, (t, i) \in T \mid t = (p, q) \,\},$$

where

$$C_{p,q} := \left|T^{(p,q)}\right|.$$

These numbers of occurrences of certain keyword 2-tuples provide coarse information about which topics are addressed in which context and to what extent by the papers within the sample.

(7) To better illustrate relevance of the addressed topics, it is reasonable to first sort all the N pair-wise different keywords of the paper sample according to the total number of keyword 2-tuples they occur in. The total number L_p of keyword 2-tuples, in which a certain keyword p occurs, is given by

$$L_p := \sum_{q >_{\mathrm{ABC}} p} C_{p,q} + \sum_{q <_{\mathrm{ABC}} p} C_{q,p}.$$

Hence, the sorted keywords, which shall here be denoted by $p_j, 1 \leq j \leq N$, satisfy the following condition:

$$L_{p_j} > L_{p_{j+1}} \quad \forall\, 1 \leq j \leq N-1.$$

Second, the numbers of occurrences of certain keyword 2-tuples may be normalized by the total number C of occurrences of all keyword 2-tuples:

$$C := \sum_p \sum_{q >_{\mathrm{ABC}} p} C_{p,q}.$$

The resulting relative numbers of occurrence may then be arranged in the matrix

$$\mathbf{A} := \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & A_{p_{N-1},p_N} \\ 0 & 0 & \therefore & \therefore & \vdots \\ 0 & 0 & A_{p_2,p_3} & \dots & A_{p_2,p_N} \\ 0 & A_{p_1,p_2} & A_{p_1,p_3} & \dots & A_{p_1,p_N} \end{bmatrix},$$

whose elements are defined by

$$A_{p_j,p_l} := \begin{cases} C_{p_j,p_l}/C, & \text{if } p_j <_{\mathrm{ABC}} p_l \\ C_{p_l,p_j}/C, & \text{else} \end{cases}.$$

The matrix **A**, together with the labels of the rows of columns, finally provides a possible keyword classification of the paper sample. In particular, the labels of the more upper rows indicate the most relevant topics by means of the respective keywords. The matrix elements indicate the relative relevance of topic combinations.

It becomes apparent in figure 1 that SCM sets up on specific advantages that CC claims to offer. This type of advantages is related to "***Coordination & Collaboration***", "***Inter-organizational Systems***", and "***Customer Partnering Relationship***" and will be investigated deeper in the upcoming subsections. Nonetheless, the keyword analysis indicates the early phase where the underlying research field is situated, due to researchers still focus primary "IT-Adoption & Integration" and "System Selection & Evaluation". Post-implementation related factors like CC-satisfaction or non-financial success measures are mostly missing, because this presupposes the existence of broad CC-adoption experiences in theory and praxis.

We expected "CC" and "SCM" to be frequently involved in combinations, but surprisingly "Business & Economic Value" in conjunction with "Research Methodologies" had the second highest combination value with 13 hits. As stated previously, research literature investigated CC mostly from the technical lens. It seems that research is progressing onward to identify factors that may create business value (e. g., Chang and Wills, 2013; Hazen and Byrd, 2012; Hoberg et al., 2012).

Comparing the three service models, we indeed expected SaaS to be the most common model, and according to figure 1, the service model SaaS is dominating the literature sample strongly. Numerous works in the sample, although differentiating between service models, focus their research explicitly on SaaS. The overweight could possibly be justified by the fact that SaaS usually serves as a "front-end" for the end user (Huang et al., 2013; Youseff et al., 2008). Thus, compared with IaaS and PaaS, SaaS might be the only "visible" CC contact for the end user.

The terms “Research Methodologies” and “Research Theories” both belong to the top five keywords in figure 1. While the research theories will be presented in detail later on in section 3.5, in the following we will shift our focus to research methods. Table 7 provides an overview of the used methods of the sample. Since 19 of the 99 articles used two methods, the total number of methods equals 118. We identified seven different methods (Wilde and Hess, 2007), which were used for the classification of the papers.

Hence, argumentative / deductive research occurred largely in 43% of the papers. Within the cross sectional analysis, empirical surveys occurred twice as often as interviews. A further structuring of the 118 used methods into the "design science paradigm" and the "behavioral science paradigm" by (Wilde and Hess, 2007) revealed a significant surplus of 62% of the first alternative. The ratio is an indicator of the early stage of the research field, because behavioral work in general requires the presence of artifacts as a basis for investigation of behavioral science studies and is used increasingly at advanced research fields (Martens and Teuteberg, 2009). But the ratio along the underlying years (2007 to 2013) is getting more balanced and the development of the research field is visibly in progress. For example, almost half of all cross sectional analyses were published in 2013. For understanding and assessing the specific relationships within the investigated research field even better, underrepresented methods and multi-method approaches should gain more attention.

Table 7 Applied research methods

Research method	**#**	**%**
Argumentative / deductive research	51	43.2
Cross sectional survey and interviews	36	30.5
Reference modeling	11	9.3
Case study	8	6.8
Simulation	6	5.1
Prototyping	5	4.2
Experiment	1	0.8

Figure 1 Bird´s eye view on research field

Clustered Keywords	Cloud Computing	Used Research Methodologies	SCM	Used Research Theories	Management Information Systems	SaaS	Collaboration & Coordination	Business & Economic Value	IT Adaption & IT Integration	Service Oriented Architecture	Value Networks	Interorganizational Systems	Diffusion of Innovation	IT Service Market	Customer Relationships	Data Management	Risks & Opportunities	Security	SME	Internet Operations	Services Management	Selected Industries	System Selection and Evaluation	Service Level Agreements	IaaS	Information Management	IT Value & Performance	Virtualisation & Scalability	e-Procurement	EDI	Digital Business Strategy	Automotive Industry	Hybrid Systems & Networks	Enterprise Information System	PaaS	IT Outsourcing	Supply Chain Agility	Traffic Networks & Systems	Cloud Provider	RFID	Capacity Planning	e-SCM	Process Model	Demand Management	Business Intelligence	Product Service Systems	Cloud Manufacturing	Portion in % of all Combinations
Cloud Manufacturing																																																0,2%
Product Service Systems																																															0	0,4%
Business Intelligence																																														0	0	0,4%
Demand Management																																													0	0	0	0,6%
Process Model																																												0	0	0	0	0,6%
e-SCM																																											0	0	0	0	0	0,6%
Capacity Planning																																										0	0	3	0	0	0	0,6%
RFID																																									0	0	0	0	1	0	0	0,7%
Cloud Provider																																								0	0	0	0	0	0	0	0	0,7%
Traffic Networks & Systems																																							0	0	0	0	0	0	0	0	0	0,8%
SC Agility																																						0	0	0	0	0	0	0	2	1	0	0,8%
IT Outsourcing																																					0	0	0	0	0	0	0	0	0	0	0	1,0%
PaaS																																				0	0	0	0	0	0	0	0	0	0	0	0	1,0%
Enterprise IS																																			0	0	0	0	1	0	0	0	1	0	0	0	0	1,0%
Hybrid Systems & Networks																																		2	1	0	0	0	0	0	0	0	0	0	0	0	0	1,1%
Automotive Industry																																	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1,1%
Digital Business Strategy																																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,1%
EDI																															0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1,1%
e-Procurement																														0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1,2%
Virtualisation & Scalability																													0	0	0	0	1	0	1	0	0	3	1	0	0	0	0	0	0	0	0	1,4%
IT Value & Performance																												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1,4%
Information Management																											0	0	1	2	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1,5%
IaaS																										0	0	1	0	0	1	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1,5%
Service Level Agreements																									0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1,5%
System Selection and Evaluation																								1	0	0	0	0	0	0	0	2	1	1	0	0	0	0	1	0	0	0	2	0	0	0	0	1,5%
Selected Industries																							0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1,6%
Services Management																						1	0	1	2	0	0	1	0	0	2	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1,6%
Internet Operations																					0	0	0	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1,7%
SME																				1	0	1	0	0	2	0	0	0	0	0	0	0	0	4	2	1	0	0	0	0	0	0	1	0	0	0	2	1,8%
Security																			0	2	1	0	0	1	1	1	0	3	0	0	0	0	2	0	1	0	0	2	1	0	0	0	0	0	0	0	0	1,8%
Risks & Opportunities																		2	1	0	0	1	2	0	0	1	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1,8%
Data Management																	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2	0	0	0	0	1	1	0	1	0	0	0	0	3	0	0	1,9%
Customer Relationships																0	0	1	0	2	0	1	2	3	0	0	2	1	1	0	1	1	0	0	0	1	0	0	1	0	0	0	2	0	0	0	0	2,1%
IT Service Market															0	0	0	0	0	0	1	1	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	3	0	0	0	2,1%
Diffusion of Innovation														0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	1	1	2	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2,2%
Interorganizational Systems													1	2	0	2	0	0	0	1	0	0	0	0	0	3	0	0	2	2	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2,3%
Value Networks												0	0	1	4	1	1	2	0	4	0	0	2	3	0	0	0	2	1	0	0	0	1	0	0	0	0	0	2	3	0	0	0	0	0	1	0	2,4%
Service Oriented Architecture											0	0	0	3	0	2	0	2	0	0	1	1	4	3	1	2	0	2	0	0	0	0	1	2	1	2	2	1	0	1	0	1	0	0	1	0	0	3,6%
IT Adaption & IT Integration										7	0	0	1	0	2	0	3	0	2	1	0	3	0	3	0	0	2	0	1	0	2	0	0	1	0	3	3	0	0	0	0	2	0	0	0	1	0	3,7%
Business & Economic Value									0	2	1	3	1	4	0	0	0	0	0	1	4	2	0	0	1	0	9	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4,0%
Collaboration & Coordination								4	3	2	4	5	0	0	2	3	1	1	0	3	4	1	0	1	2	1	0	1	2	0	2	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	3,8%
SaaS							2	2	5	1	1	2	1	0	2	2	2	1	4	0	2	0	1	2	4	2	1	1	0	2	2	2	1	2	3	2	0	0	1	0	0	0	0	0	0	0	0	3,9%
Management IS						1	3	7	6	4	0	2	8	2	0	0	2	1	2	2	1	1	0	1	1	0	2	1	2	1	0	0	1	0	1	0	0	1	0	1	0	2	0	0	0	0	0	4,7%
Used Research Theories					9	3	5	6	2	3	0	2	8	3	0	2	3	1	1	1	4	2	0	0	2	1	1	0	2	1	3	0	1	0	1	1	0	1	0	1	0	3	0	0	0	0	0	5,3%
SCM				2	12	3	7	6	8	3	1	5	0	2	9	2	3	2	0	3	0	3	1	2	1	4	3	1	3	2	0	2	2	0	1	5	1	0	0	0	0	1	2	2	0	1	0	6,6%
Used Research Methodologies			12	10	7	7	5	13	7	3	5	7	3	4	2	5	2	0	0	1	1	3	6	1	0	4	2	0	3	5	0	5	0	0	0	0	2	0	0	1	2	2	1	1	0	1	0	7,4%
Cloud Computing		10	12	18	8	8	5	8	3	11	7	1	6	7	1	6	7	6	6	1	4	5	2	0	6	1	1	5	1	0	3	0	4	5	5	2	2	4	0	2	2	1	1	1	1	0	2	9,8%

3.3 Quantitative data analysis and empirical findings

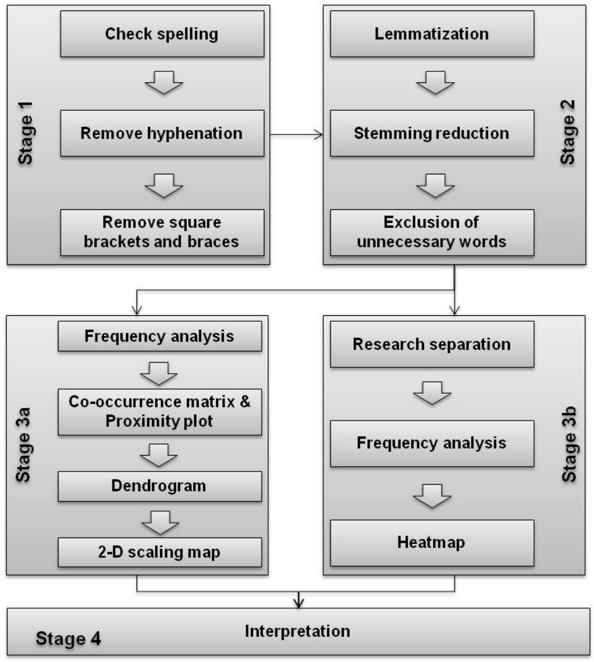
In the prior keyword analysis we investigated the interconnections of the keywords on an overriding level. Now, our objective for the data analysis is to identify the detailed relationships and find hidden features (Sullivan, 2001) of the sample's entire content. The three goals and instruments are stated in table 8. When following the third goal by identifying the main influence factors, we will augment the quantitative results with the existing empirical findings even if there is a limited amount of empirical papers (c.f. table 7).

Table 8 Goals and instruments

Goals	Instruments
1) Identify main co-occurences	• Dendrogram
2) Compare disciplinary views on research topic	• Heat-map
3) Identify main influence factors	• Term Frequency • Proximity Plot • TF IDF

According to Lijphart (1971), content analysis is a suitable methodology for theory development especially in research fields that lack a theoretical background, like the underlying topic. Herein, content analysis of textual messages has to fulfill six requirements (Neuendorf, 2002), which are defined as: objectivity, intersubjectivity, a priori design, reliability, validity, generalizability, replicability, and hypothesis testing. To address the six requirements and foster the transparency in the analysis as well, we applied a process based on a flow model, which is visible in figure 2. During data processing in accordance to the flow model, we used a special document mining software called "WordStat" that is an extension of "QDA Miner" (Provalis, 2010).

Figure 2 Process of software based analysis



To prepare the software based analysis, the sample documents are copied directly into the software QDA Miner, whose add-on WordStat is used for quantitative analysis. Before starting with the analysis in the 3rd stage, two preliminary stages require preparation (1st Stage) and preprocessing (2nd Stage). The 1st stage, preparation, consists of checking the spelling of the individual documents, removal of hyphens and hyphenation and the removal of brackets and braces, which is a special feature within the software for excluding/including certain text segments. Therefore, misspelled words and inconsistencies in hyphenations, and the presence of brackets and braces can cause misleading conclusions.

For preprocessing the documents for the software based analysis, we made use of a generally accepted process in the 2nd stage (Sidorova et al., 2008). We started with lemmatization, a procedure in which all plural forms are transferred into the singular and all the verbs from the past tense are taken into in the present tense. Thereafter, the stem-form reduction is performed, a process in which different nouns, verbs, adjectives, and adverbs that belong to the same root word are transformed into a single word without suffixes and prefixes. This step eliminates one of the biggest issues of the quantitative content analysis, namely, the existence of synonyms and of identical terms with different spellings (Martens et al., 2011; Freundlieb and Teuteberg, 2013). For example, the words *management, managing, manage*, and *manager* have been reduced to *MANAG*. In the last step of the 2nd Stage, the exclusion dictionary, also known as a stop list, is used to remove all words with little or no semantic value like *the* and *any*. Additional information resulting from the two stages is shown in Table 9.

Table 9 Statistics of the quantitative data analysis

Statistics	**Value**
Total number words	686,433
Excluded words (in %)	318,167 (46.4%)
Total number of sentences	30,359
Words per sentence	22.6
Total number of paragraphs	34,385
Words per paragraph	20.0

In the 3rd stage, our aim was twofold. On the one side (Stage 3a), clarification of the content relationships, and on the other side (Stage 3b), discovering the word frequency variations in contents between IS and SCM research within the sample size.

The word frequencies indicate how often a single word appears absolutely or relatively in the analyzed text passages, whereas with the help of co-occurrence, the conjoint appearance of two words (1:1) can be analyzed and transferred into a proximity plot. Using this information, dendrograms can be derived. They provide information about words mentioned in connection with independent variables (1: n). These results can be visualized (Provalis, 2010) by means of a 2D scaling map (cf. appendix figure I for details on 2D scaling map). For analyzing these interrelations, the Jaccard's index (JI) similarity coefficient was used. This simple measure is reasonable especially for word analysis within a sample (Murguia and Villasenor, 2003; Tan et al., 2005) and is defined by:

$$J = \frac{a}{a + b + c}$$

where *a* represents a document's paragraph in which both words occur, and *b* and *c* represent paragraphs in which one word is found but not the other (Tan et al., 2005). In a parallel process, we separated the 21 SCM papers from the 78 IS papers. The word frequencies were analyzed by research field. We reunited the outcomes and put them into a heat-map, where word frequencies are represented by different tone levels (Provalis, 2010).

We tried to figure out the parallelism between IS and SCM research via a "Heat-map" in order to identify the similarities and differences of the two research fields (Stage 3b). We used the 60 most commonly occurring words as a basis and transformed their appearance into a percentage by dividing the word frequency by the total number of words of both independent fields. Then, the word distribution among the both fields is transferred into color scale, where bright red means a high percentage and dark blue a relatively low percentage (cf. appendix figure II for the heat map). Terms like "CLOUD & COMPUT", "INFORM & SYSTEM", "SERVIC & PROVID", and "SUPPLI & CHAIN &

MANAG" are frequently mentioned in both research fields. However, SCM research has a stronger process orientation with regards to cause and effect (PROCESS, CHANG, RELATIONSSHIP, ORDER, TIME) and is often speaking in more general terms (TECHNOLOGI, CLOUD) instead of specific technical aspects (SAAS, SOFTWAR, DATA, APPLIC, INFRASTRUCTUR). Therefore, it is not surprising, that managing these unspecified aspects in order to realize the mentioned opportunities mostly with the help of models (MODEL) is viewed as a complicated operation (COMPLEX) from SCM point of view.

As can be deduced from partly resembling colors, there are some similar understandings with regards to the common research field. Interestingly, both fields elaborate the CC provider role (PROVID) more often than the user role (USER), which is contrary to the fact that only 2% of the papers are written from the provider side. This indicates that users are mainly in a claiming position and have process requirements and needs that providers have to fulfill. More attention should be paid to necessary changes at own IT processes and organizational structures.

As we are strongly interested in the initial reasons for CC adoption, we tried to figure out the most discussed influence factors of the whole sample. (cf. appendix table IV for the absolute frequencies of word stems occurring in the studied sample). Given the object of investigation, it is not surprising that the word stems CLOUD, SERVIC, and SUPPLI, CHAIN, MANAG appear relatively frequently. Further, the vast amount of the sample explores the adoption (ADOP) and integration (INTEGR) of CC at SC business processes (BUS, PROCESS) within firms (FIRM), companies (COMPANI), and organizations (ORGAN). Next, we will investigate three emerged influence factors.

- Cost reduction (frequency: 1,888)

The most discussed factor is related to COST/TIME reduction. This factor refers to the cost leadership concept by Porter (1980) and aims to have the lowest operational IT-costs in the industry at equal IT-service quality. In this context and with regards to economizing opportunistic behaviors of transacting partners (Wiliamson, 1981), also the "transaction cost theory" is valid. Depending on the industry sector (excluding the IT-industry), IT-costs account for up to 10% of the revenues with increasing percentage rates over years and suffer from low cost transparency (PWC, 2009), which leads to the implication of a high cost reduction potential. Especially since the financial crisis in 2008, companies more than ever strive for economic flexibility. And as IT-costs normally belong to period expenses, they are under close investigation by top-management anyway. Research literature has proven the potential total cost of ownership benefits of SaaS compared to traditional on-premise IT (Benlian, 2009; Bibi et al., 2012) and further, cross-sectional surveys and expert interviews indicate a preexisting cost reduction potential for specific SC processes as well (e.g., Garrison, 2012; Venters and Whitley, 2012; Alshamaila and Papagiannidis, 2013). Morgan and Conboy (2013) investigated three case companies and note that the companies have lowered costs for servers, licenses, maintenance, back-ups, and electricity. But they also state that there may be hidden costs such as additional trainings. Therefore, the widely cited implicit assumption of a quasi-automatic reduction of costs by adopting CC (Bensch, 2012;

Schrödl, 2012; Wind at al., 2012) has to be viewed more critically, since only Meer et al. (2012) have proven a beneficial cost effect under real circumstances for SCM by observing transport distribution processes. They improved the scalability of the data layer in online multi-tier applications by routing a request to a database instance that can process it with a minimal amount of work. In general, preventing capital expenditures (depreciations), administrative costs on the user side sounds favorable, but the increased cost dependency on the provider has to be taken into account, as contracts are mostly planned long term (Demirkan et al., 2010) due to high switching costs. Further, the (short term) freedom of choice for the frequency of upgrades and downgrades depending on the economic situation is given away. Future research should investigate these economic dependency effects in more detail in order to provide decision support for practice.

- IT-value increase (frequency: 1,742)

The second most often mentioned influence factor refers to the need of IT-value increase and higher IT-performance with the usage of CC (VALU, PERFORM). In this context, adaptors expect a high level of support (LEVEL, SUPPORT), high speed data access, functional coverage, add-on services, customizability, latest hard and software, as well as service bundles (Li et al., 2012; Wind et al., 2012). Here, one of the few empirical works was written by Wu et al. (2013), who analyzed the CC support in aspects of SC information systems infrastructure. They state that organizations with more complex business processes might find that CC offers a functional advantage over traditional IT solutions and is more compatible with their information processing requirements, which would in turn enhance their propensity to adopt CC services. Ziekow et al. (2010) investigated a radio-frequency identification (RFID) cloud service for high-speed data access in distributed supply chains. With their data-on-network experiments they reduced request concurrency by distributing load and reduced network delay by providing RFID data via short network paths. But their paradigm can result in long response times for data access. Li et al. (2012) focus the CC implementation in small/medium cold chain logistics companies via a formal model. They conclude that CC can help small/medium cold chain logistics companies to achieve a high quality IT service with minimal investment, enabling these enterprises to obtain IT services at a large enterprise level. Generally, the factor IT-value is highly related to the cost benefits factor, since the CC provider compensates the above average IT-value services with cost increases. As is valid for the factor "costs", the factor "IT-value increase" is missing even more evidence from practical research.

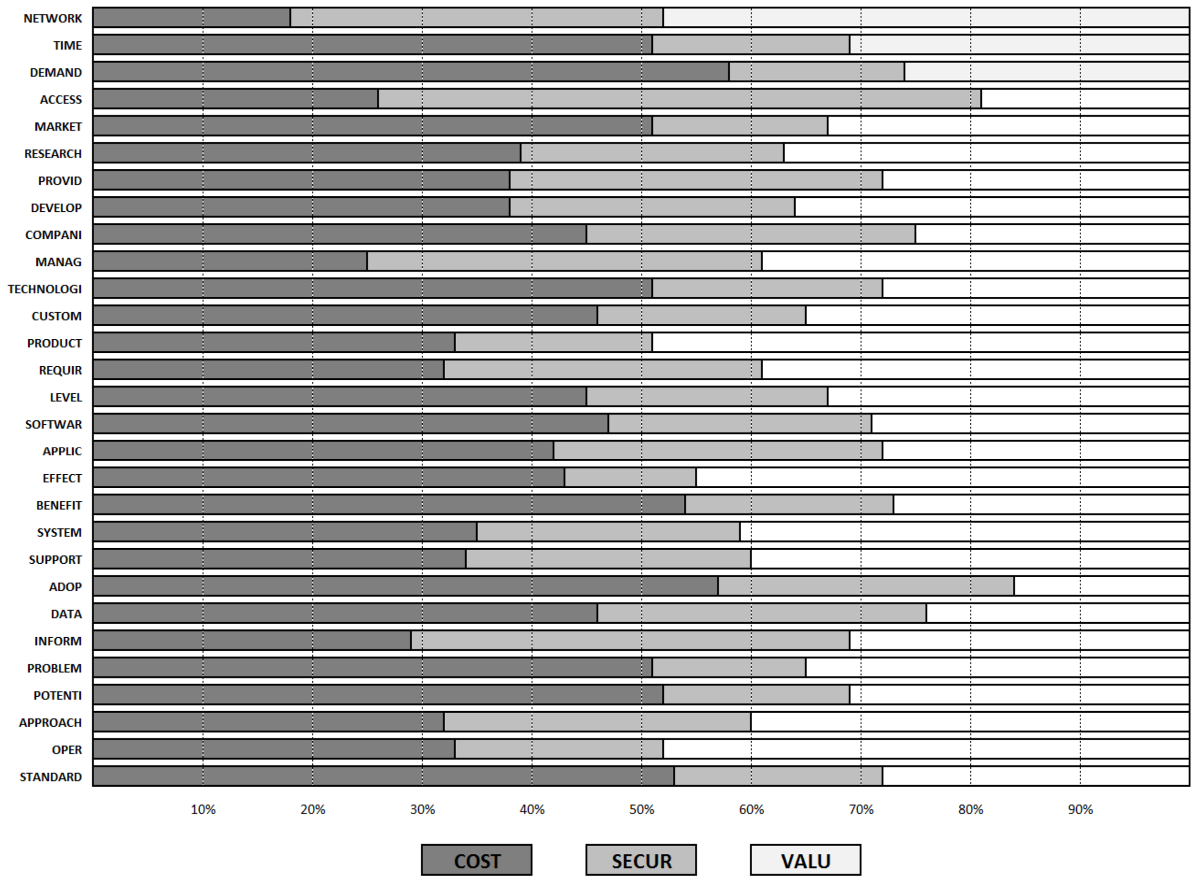
- IT-security increase / decrease (frequency: 1,249)

IT-security (SECUR) is in third place and is discussed controversially in the sample, as it may increase and decrease depending on the initial status. By providing a massive concentration of data through the internet, adopting companies arouse the attention of hackers (ENISA, 2009). Contrary, a high level of data security is depending on financial investments and security know-how (Kaufman, 2009), which can better be managed by CC-providers like Amazon or Microsoft than, e.g. by a small logistics company, as the established CC-providers gain from economies of scale (Brender and Markov, 2013). But in the great majority of the papers, data security is discussed as a risk. And most of the cross sectional survey (c.f. table 7) hypothesize conflicting relations between IT security and CC adoptions (e.g., Gupta et al., 2013; Lee et al., 2013; Benlian and Hess, 2011). Durowoju et al. (2010) focus security and how it can impact the supply chain operations using entropy as an assessment tool. They prove that CC is just advantageous for supply chain partners under the conditions of high security. Demirkan and Goul (2013) addressed transitioning multiple, collaborating organizations to what can be referred to as a “value-network” CC. They propose a cloud service broker model from the view point of the service provider in order to be able to run secure business process executions of an entire value network. In a transportation case study Yan et al. (2013) describe a model where vehicles automatically form a cloud by connecting virtual cells, which can be a group of vehicles. They ensure protection against security attacks in vehicular clouds due to an algorithm that enhances authentication of high-mobility vehicles.

Private CC provides the highest security level, but is detrimental to costs and IT-value as the mentioned benefits cannot appear (e.g., no up-front costs). Therefore, the three implementation factors must always be considered together and the interrelationship between them should be studied in detail with valid measures.

After having identified the influence factors costs, IT-value, and security, we were interested in their main co-occurrence topics in order to investigate the specific risks and opportunities especially for SCM more closely. The below stated figure 3 was calculated with the use of Jaccard’s index by computing the top 30 co-occurrences based on the three identified factors. For example, the highest Jaccard’s index (JI) is given to the co-occurrence (VALU > NETWORK; JI: 0.599). Thereafter, the other two factors with the predefined co-occurrence topic “NETWORK” are computed: (COST > NETWORK; JI: 0.219) and (SECUR > NETWORK; JI: 0.402). This distribution in percentage is shown in the figure 3. The co-occurrence (COST > TIME; JI: 0.552) has the second highest rate and is therefore ranked 2nd and so forth. Most of the co-occurrence topics are predefined by the factor cost, which again indicates the dominant position this factor holds.

Figure 3 Proximity plot of the factors costs, security, and value



- Value – networks (JI: 0.599)

Value networks are often understood as a network of suppliers, distributors, and customers that are connected via electronic media like CC to create ideally values for their end customers and the network members. Thereby, the strategic key component is the digital procurement process (Bensch, 2012; Tapscott, 2000). To ensure smooth processes across this network, the participants should implement adequate technical services, since a chain is only as strong as its weakest member. Further, by integrating other SC members into the CC network, an adequate orchestration of digital processes and a suitable interface configuration is required. Also the question, how to model product-service bundles (VALU > PRODUCT; JI: 0.433) and procurement recommender systems, especially with CC-based components in value networks (Bensch, 2012; Schrödl, 2012), is of increasing scientific interest.

- Security – access (JI: 0.524)

By nature, security is closely related to data access and data networks (NETWORK; JI: 0.402) as well, since the data does not "sleep" within the companies' IT (at public CC). The ubiquitous feature of CC enables a fast access to any type of data, on any platform, using a wide range of interfaces, and data access standards by portioning data in-memory across multiple servers (Yuhanna et al., 2010; Gunawi et al., 2011). Additionally, if a CC service acts as an interface with various customers (CUSTOM; JI: 0.181), e.g., by placing a manufacturing order directly, security breaches may appear within an inter-organizational SC (Durowoju et al., 2011), especially when affected companies have risk policies with different security levels. Further risks may occur at the provider's data centers (PROVID; JI: 0.389) that are accessed by many independent users day by day (Nuseibeh, 2011).

- Cost – demand (JI: 0.542)

In addition to the above mentioned direct cost reduction potential, there is an indirect cost reduction opportunity by forcing inventory to a more demand-driven structure. Jones explained the stock out reduction and inventory turn rate increase at a grocery store, where suppliers were connected to a CC ordering process (Jones, 2011). Thus, demand management in combination with CC implicates improvements at the "Profit and Loss Statement" (lower interests) and higher cash flows. The indirect influence factors that may lead to the trailing effect of inventory reduction are discussed in the following.

Another way to determine the significance of a paper's words in a collection or corpus is the numerical statistic "term frequency – inverse document frequency (TF IDF)" (Salton and Buckley, 1988). Normally, this algorithm is used as a weighting factor to such an extent as it increases proportionally to the number of times a specific word appears in a single document, but decreases with the frequency of the word in the corpus. Although there were many modification models developed based on "TF-IDF", the initial search formula has proven extraordinarily robust (Berger, 2000; Robertson, 2004; Salton and Buckley, 1988). The underlying assumption is: words with the highest TF-IDF are characterizing the papers' content best. The definition is as follows. If we denote the total amount of documents within the sample by $|D|$, a word by w, and an individual document by $d \varepsilon D$, we calculate (Salton and Buckley, 1988):

$$w_d = f_{w,d} * \log \frac{|D|}{f_{w,D}}$$

where $f_{w,d}$ equals the number of times w appears in d and $f_{w,D}$ equals the number of documents in which w appears in D (cf. appendix table V for the ranking by TF IDF).

Coming back to the major influence factors for CC adoption, risks (RISK) and concerns with regards to IT-security (SECUR) still belong to the major topics. It is remarkable that with the use of TF IDF index, the SCM-specific influence factors are emerging. The three upcoming hidden influence factors are related to efficiency as well, since they may improve the material flows and the physical logistics service performance. Furthermore, these improvements within the inventory process may reduce the lagging financial indicator "working capital". These three factors refer to SC network ***flexibility*** and are interrelated to each other, too. However, Fremdt et al. (2013) describe an indirect leverage of CC. Thus, CC introduces an increased flexibility at the management level of information and this in turn positively affects the management level of material flows and physical cooperation. Compared to the factor cost, the flexibility related arguments are multifaceted and multidimensional. Therefore, due to missing a single term, they are not listed in the simple frequency term ranking. But taking all the upcoming arguments into account, increasing flexibility has the same relevance from the perspective of SCM as costs. Detached from our analysis, this result is confirmed by the works of Venters and Whitley (2012), Cegielski et al. (2012) and Fremdt et al. (2013), who, independently from each other, came to the same conclusion through expert interviews.

- Agility (TF IDF: 223.1)

First, as SCs drift from traditional relationships to loosely coupled dynamic ecosystems (Bharadwaj et al., 2013), the digital processes require increasing technical agility (AGIL) in order to respond quickly to changes in the environment (Blome et al., 2014). The important role of agility for SCM has widely been showed as a key component for SC's success (Duclos et al., 2003; Goldsby and Stank, 2000; Swafford et al., 2006). By the means of CC, we pay special attention to interoperability, compatibility, configuration, deployment, portability, scalability, virtualization, automation, and the standardization degree (Cegielski et al., 2012; Wind et al., 2012). Mainly focusing on electronic data interface (EDI), Gosein et al. (2004) showed that the ability of creating inter-organizational linkages (offering flexibility) and the ability to alter existing linkages (partnering flexibility) with different supply chain partners (adjusted by environmental needs) are crucial for overall SC success. This insight served as basis for Steinfield et al. (2011). In their automotive industry case study they analyzed cloud-based EDI systems in aspects of increasing standardization. Furthermore, they focus whether information flows sequentially in a point-to-point fashion among supply chain partners (like traditional EDI) or is provided simultaneously to relevant partners via a system hub. The study provided evidence that the standards and the shared hub approach addresses transparency problems in inter-organizational SCs. Leukel et al. (2011a) stated the question, how to distribute airline orders to grounded handling services at airport SCs best? They created a CC service with a standardized electronic interface that increased the accessibility of handling service providers and accomplished work load bottlenecks effectively.

- Coordination / collaboration (TF IDF: 125.3 / 91.5)

Second, a suitably degree of SC coordination and collaboration (COORDIN, COLLABOR) is primary an organizational challenge on employees' job level (e.g., creating workflows and enable communication within and across the company's boundaries). Here, information asymmetries in supply chains hinder a single participant to create, propagate, and coordinate a production or distribution plan for the entire supply chain (Leukel et al., 2011a). Therefore, collaboration and coordination willingness is a requirement for SC success. And CC can enforce transparency and a higher quality of data (Morgan and Conboy, 2013; Azevedo et al., 2013) across SC partners. By involving SC partners, Pareto-efficient, IT-value networks may be created. Autry et al. (2010) and Liu et al. (2010) pointed out that eSCM's major benefit lies in the coordination and collaboration improvement, leading to a competitive advantage. Further, when using various CC providers, another challenge is to design mechanisms with a stringent IT-coordination strategy for optimal service compositions (Blau et al., 2009; Demirkan et al., 2010; Leukel et al., 2011a).

- Knowledge / sharing (TF IDF: 62.8 / 69.7)

Third, referring to the knowledge-based view (c.f. table 1), CC supposes to indirectly offer a higher level of knowledge sharing with internal and external SC partners (KNOWLEDG, SHAR, PARTNER) by creating and transferring knowledge. This means in other words an integration of SC processes based on partnering relationship. Supply chain literature has proven the advantageous effects of information and knowledge sharing for all participating units within a supply chain network, especially with regards to minimize demand risks (Cachon and Fisher, 2000; Guo et al., 2006) and the bullwhip effect (Lee et al., 1997). In this context, CC acts as a medium for cross organizational analysis of data, process planning, and finally decision support system (Cegielski et al., 2012; Leukel et al., 2011b), which can be aggregated to knowledge sharing. Leukel et al. (2011b) conducted an in-depth case study with a document management system (DMS) in SCM and found evidence that a cloud-based DMS service enables "knowledge extraction" and knowledge distribution across SCs. A CC platform for small manufacturing companies is proposed and tested by Huang et al. (2013). The platform facilitates to exploit and share the manufacturing information and manufacturing resources, improve operations management, and even promote design of products.

3.4 Implications from different regions

Technical, cultural, political, and economic differences between the regions can have a significant impact on the development of CC usage within SCM. Furthermore, we have shown through the quantitative analysis that the implementation reasons are multi-dimensional and not generalizable. Hence, we investigated all papers for country specific preconditions in individual countries in order to find relations between implementation factors and premises for CC adoption. Most of the findings mentioned below stem from empirical surveys.

In ***China***, the financing channels for small and medium sized entities are quite limited, and therefore management is unwilling to invest remarkable amounts in IT hardware and software (Li et al., 2012). The rental model of CC can enhance the use of the latest IT without capital expenditure and provide transparency throughout SC processes as in particular the Chinese logistics infrastructure suffers from a low level (Li et al., 2012). The Chinese authors emphasize potential data security increases from the use of CC since the logistics companies suffer from a low initial security level (Cho and Chan, 2013; Li et al., 2012).

Picking up the traffic issues especially in Chinese metropolitan areas, Wang impressively demonstrated via prototyping that CC can enable a well-functioning smart intersection traffic-control system (Wang, 2010). The Chinese CC market is just emerging, as it lacks the relevant number of vendors and thus too few adopting companies (Cho and Chan, 2013). Additionally, the IT-staff ratio per company is significantly lower than in Europe or in the U.S. (Cho and Chan, 2013), which means that the companies meet the increasing demand for inter-organizational IT-process with limited IT capabilities (Xiao et al., 2011). Considering these factors, the Chinese government, known to play a major role within the economy, established a well-known cloud service platform in order to gain from the mentioned opportunities (Huang et al., 2013).

In ***South Korea***, the SaaS market was also forced by the government with strong policies and SaaS quality certifications in order to develop a well-functioning SaaS market system (NISA, 2008). But neither the certifications nor the introduced SaaS marketplace did foster remarkable progress. Via analytical hierarchy process in combination with a survey, Lee at al. (2013) figured out that South Korea has transformed from a policy-led to a customer-driven market, in which reduced costs and fast deployment possibilities have the strongest impact for companies to implement SaaS. They conclude that the big distrust in security is still a major barrier to catch up with the developed CC markets.

On the contrary, ***Central Europe*** has a well-established CC provider market (Repschläger et al., 2012). However, compared to the US and Chinese entities, European companies have a more risk averse mindset with regards to data security (Benlian, 2009; Gupta et al., 2013). Especially valid for SME, adequate data protection regulations set by the European Union would increase CC reliability (Tarzey, 2012). In a large cross-sectional survey within ***German*** companies, Benlian and Hess (2011) also see security risks as the dominant influence factor for CC implementation, followed by performance and economic risks. On the other hand, they address the strongest SaaS opportunity factor to costs, which was followed by strategic flexibility and quality improvements. Generally, researchers see no difference between European companies' average knowledge and the current state of knowledge of the scientific literature (Alshamaila and Papagiannidis, 2013; Benlian and Hess, 2011; Brender and Markov, 2013).

Compared to under-developed CC markets, which are mainly cost-driven, the CC influence factors in companies in the ***United States*** are more granular, by taking into account factors like business process complexity, functionality, compatibility, and business culture as well (Wu et al., 2012). Further, empirical surveys emphasized the CC importance for inter-organizational SC success within US based companies (Cegielski et al., 2012; Ranganathan et al., 2011). Further, most of the biggest CC providers like Amazon and Salesforce.com come from the US. But the advanced usage of CC services confronts the US-companies with next level issues as they suffer from lower IT-performance (Compuware, 2011). And once again, the national government holds a leading position within a country as the US government is one of the biggest Community- and Hybrid-CC adapters, using various specific services and processing citizens' requests efficiently. Furthermore, federal, state, and local US governments are linked to each other through a cleverly designed hybrid-CC system (Gupta, 2013; Marston et al., 2011).

Although the examples given represent just a small subset of the sample, the overall evidence from literature is consistent with the distribution in table 6: currently, Europe and North America are the leading regions in science and practice in the underlying field. Regardless of the respective development level, all regions mention cost reduction potential to be a major influential factor. This implicates that this factor may represent a fundamental baseline, before continued CC developments enable multi-dimensional benefits like flexibility increase and inter-organizational supply chain linkage. Furthermore, governments obviously play an interesting and important double-role in the CC-ecosystem. On the one side, especially in Central Europe, users expect them to take the regulatory role and to be a standard setting body that ensures high data security. On the other side governments try to act as catalyzer that enforces CC development by deploying, providing, and using own CC services.

Disregarding the country-specific CC-premises, there are two principle ways evolving that governments pursue. Whereas in GBR and in the USA the governments cooperated with existing privately owned CC-providers (Chang and Wills, 2013; Maude, 2011; Marston et al., 2011), the governments in South Korea and China funded organizational structures for providing completely own CC-services (NISA, 2008; Huang et al., 2013). Future research should further investigate this multiplicative dependency, especially the single and double loop learning possibilities as well as the adequate extent of activities for respective governments. In general, similarities, differences, and influence factors for specific regions may be a fruitful area for future research.

3.5 Applied theoretical concepts

As mentioned before the terms "Research Theories" belongs to the top five keywords within the sample (cf. figure 1). In general, scientific theories represent the most reliable, rigorous, and comprehensive form of scientific knowledge (Schafersman, 1994). In order to mature a research field, it is essential to understand a theory's foundation and also to adequately adopt the key content in order to extend the scientific knowledge. In this context, our study provided two outstanding points that suffer from the same reason: the high quantity and the wide variety of the used research theories. As the underlying research field, which is multi-disciplinary, has to be grounded in theory and is still searching for sustainable directions, researchers are exploring a broad range of mathematical, organizational, sociological, and psychological theories. Beside the occurrence of theories in defined keywords, we also entirely checked all papers for generally accepted theories through a qualitative investigation. The outcome is shown in table 10 and is structured by a short theory description and the corresponding usage (stated as question) within the sample. Since no question is completely answered, this table can provide some ideas and may also serve as a starting point for future research.

Table 10 Theories and their usage within the literature sample

Theory	Short description	Usage in literature sample	References
Attention Based View (ABV)	ABV is to explain how firms regulate and spread the attention of their decision-makers (Ocasio, 1997).	How can CC channel CIOs attention on strategic business processes?	Malladi and Krishnan, 2012
Diffusion of Innovation Theory (DIT)	DIT, strongly dependent on human behavior, is defined as the process by which an innovation is communicated through certain channels among the participants of an organization over time (Rogers, 2003).	How does the implementation and use of a SaaS ERP system (with a SCM module) influences the process performance at a small company, where IT-knowledge is strongly limited?	Wu et al., 2013; Seethamraju, 2013
Game Theory (GT)	GT is about mathematical models of conflict and cooperation between decision-makers with imperfect information (Myerson, 1991).	How to model coordination strategies in a SaaS supply chain consisting of application service providers and application infrastructure providers?	Xiao et al., 2011; Demirkan et al., 2010
Information Processing Theory (IPV)	Grounded in psychology, IPV takes into account the increasing internal and external task uncertainty and suggests that rational organizations pursue the systematical progression for decision-making support (Galbraith, 1974).	How to link a company's information processing requirements and capabilities to influence the intention to implement CC as an enabler of SCM?	Cegielski et al., 2012; Wu et al., 2013
Knowledge Based View (KBV)	KBV suggests that gaining competitiveness is depending on the firm's ability to create and transfer	How to positively influence SC flexibility through both internal and external knowledge transfer?	Blome at al., 2013

	knowledge, which is consisting of know-how and information (Kogut and Zander, 1992).		
Prospect Theory (PT)	PT is a behavioral probabilistic model about the overweighting of negative but improbable outcomes, owing to rational decision-makers who rather refer to personal heuristics that are based on the potential value of gains and losses instead of concentrating on final outcomes (Kahneman and Tversky, 1979).	Question just stated as future research: How to explain the risk aversion of the CC adoption decision especially with the aid of PT? How to involve partner companies and share information?	Cegielski et al., 2012
Queuing Theory (QT)	QT is a mathematical model to forecast queue lengths and waiting times at production systems, transportation and stocking systems, communication systems, and information processing systems (Adan and Resing, 2002).	How to evaluate and select the adequate CC provider for SC business functions in order to get the desired level of flexibility by the means of scalability?	Durowoju et al., 2011
Real Option Valuation (ROV)	ROV applies financial options theory to quantify the strategic value of decision flexibility with respect to investment projects under uncertain conditions (Borison, 2003).	How to develop a formal e-SCM framework that will allow for enhanced communication in the supply chain, thereby increasing information flow?	Zandi et al., 2013
Resource Based View (RBV)	RBV of the firm suggests that financial resources may be utilized to gain competitive advantage; but just in case the firm implements a value creating strategy that is not being implemented by current or potential competitors (Barney, 1991). (Closely related to RDT)	How to combine SCM-IT with positive buyer-supplier relationships in a way that forces innovation?	Hazen and Byrd, 2012; Schniederjans and Özpolat, 2013
Resource Dependence Theory (RDT)	RDT suggests that the environments of organizations have a major influence on the behavior of the organization. Multidimensional resources could have internal and external characteristics, e.g., employee, capital, raw material (Pfeffer and Salancik, 1979).	How to explain organizations' willingness to control over and own inter-organizational IS, knowing that this procedure is the main reason for system failure? How to understand the IT-Outsourcing decision through the lens of RDT?	Nuseibeh et al., 2011; Chatterjee and Ravichandran, 2013
Social Capital Theory (SCT)	Based on sociology research, SCT suggests that advantages derived from relationships between companies can be intangible and tangible types, including those that are psychological, social, emotional, and economic in the short- and long-term (Lin, 2001).	How to understand the relationship between collaboration and flexibility at humanitarian logistics with CC adoption, and the effect of inter-organizational trust on this relationship?	Schniederjans and Özpolat, 2013
Socio-Technical Systems Theory (STS)	STS focuses on organizations' workplaces and suggests that technical improvements do not necessarily lead to superior overall outputs due to complex socio-technical interaction (Trist and Bamforth, 1951).	How does a new SCM system implementation affect employees' perceptions of changes in their work process complexity and rigidity? How does this system influence job satisfaction, job concerns, and quality performance?	Bala, 2013
Technology Acceptance Model (TAM)	TAM is an information system based theory and assumes that the user appreciation for a new technology is depending on the factors "perceived usefulness" and "perceived ease-of-use" (Davis, 1989).	What are the relationships between a company's perceived usefulness as well as perceived ease of use and a company's purpose to adopt a new supply chain system in technologically complex environments? Which effect has the company's IT knowledge?	Autry et al., 2010
Theory of Reasoned Action (TRA)	Grounded in social psychology, TRA constitutes a prediction model that investigates the coherence of beliefs, attitudes, intentions, and behaviors (Fishbein and Ajzen, 1975).	How do SaaS adopters and non-adopters compare regarding their risk/ opportunity judgment? What are logistics managers' perceptions of cloud computing?	Benlian and Hess, 2011; Aviles et al., 2012
Transaction Cost Theory (TCT)	TCT explores the two organizational alternatives, do it yourself or buy from an external supplier, and therefore TCT helps to define the efficient organization boundaries. Transaction costs are the costs affiliated with organizational structure, financials, and contractual law (Williamson, 1981).	How to provide companies with decision support in IT-Outsourcing assessment? What impact does application specificity, environmental uncertainty (incl. SC uncertainty), usage frequency, and firm size have on CC adoption?	Nuseibeh et al., 2011; Benlian, 2009
Two Factor Theory (TFT)	TFT is about that job motivators (e.g., responsibility, recognition, and advancement) give positive satisfaction whereas hygiene factors (e.g., salary, status, and security) results in dissatisfaction from their absence (Herzberg, 1968).	How to classify the SaaS market into adoption-driving and adoption-inhibiting factors? What are the relevant factors for a successful SaaS market? Why do employees perceive radical changes when collaborating with partner companies via CC?	Lee et al., 2013

4 Conclusions

4.1 Limitations

Like every scientific paper, our paper has potential limitations, too. Hence, during the paper selection phase (with the use of keywords) possibly not all of the relevant papers have been filtered. The three main reasons for this may be the incompleteness of the initially defined keywords, alternative terms, and names in relevant articles, and the limitation of pre-determined publication journals and conferences. Further, the IS and SCM portions are not balanced due to the majority of the 99 papers is derived from IS literature, whereas only 21 papers came from SCM literature. This is eminent especially for the comparison of the heat-map.

4.2 Implications for theory

We set out to conduct a comprehensive literature review on CC usage in SCM. From our point of view, the defined procedure of ***qualitative and quantitative content analysis*** is adequate for theory building. In particular, the ***keyword analysis*** in section 3.2 represents a powerful tool for exploring a research field. Not surprisingly, there is a strong link between the papers´ keywords and their entire content. Dominating keywords like coordination and collaboration constitute major implementation factors as well. It would be interesting to actualize the matrix along a timeline in order to observe the directions a research field takes. Emerged from the matrix and as stated above, the ***theory table*** 10 may serve as starting point for future research. The diffusion of innovation theory has a leading position at the moment. For the future, combinations of adequate theories may be useful. Here, adaption from more developed research fields that operate with multi-theories and multi-research methods can be suitable.

We have seen that the research base is quite distributed by having 219 various researchers in 99 papers. Hence, the broad basis indicates ***broad application possibilities of CC in SCM***. German and American researchers created almost 60% of all published papers in the sample. Furthermore, IS conferences show an increasing interest with regard to the underlying research field. Unfortunately, we could not found any valuable paper from SCM conferences. Furthermore, the vast amount of papers discusses the SC processes on the overall level. There are just a few papers that investigate specific SCM activities like procurement, inbound logistics, operations, inventory management, outbound logistics, distribution, or customer relationship management. Future research should analyze the implementation factors on ***individual activity level***.

We would like to take the mentioned imbalance for ***motivating SCM research*** to investigate the "CC" paradigm and to no longer undervalue possible opportunities. Especially, we have seen that on the one hand more technical investigation is needed from a process-oriented perspective and on the other hand research should focus more on empirical investigations in order to understand and enlarge knowledge about reality interconnections. As mentioned prior, traditional ERP systems cannot provide SCM progress accordingly (Akkermans et al., 2003) and CC has the potential to address key SCM concerns.

4.3 Implications for practice

Considering the most important influence factors, we have found that ***costs reduction***, ***IT value increase***, and ***security*** represent three general factors that are SCM relevant but not SCM specific. The three additionally identified factors ***agility***, ***coordination/collaboration***, and ***knowledge/ information sharing*** address specific SCM issues and trends such as standardization across SCs, growing transparency between across related companies, and the demand for flexible and stable SCs. But the flexibility gains increase through CC with the increase of complexity of IT-processes (Cegielski et al., 2012; Swafford et al., 2008). However, these complicated IT integration processes require a higher internal planning and implementation effort, which can offset the other advantages such as costs. Up to now, research investigates mostly argumentatively the preconditions, the risks, and the opportunities. The next step for scientific research and especially for practice should remark the definition of qualitative and quantitative ***CC-KPI*** for specific influence factors, service models, deployments, and business fields such SCM.

4.4 Outlook

Based on a systematic literature review, we presented the actual state of CC usage in SC processes. The outcomes indicate that the linkage between CC and SCM will get stronger in future. Further, we believe that practice has not realized the full potential of this connection up to now and theory lacks both a general research basis and empirical SCM-related papers that ground on real application scenarios. By means of prototyping, expert interviews, action research, and further empirical studies the underlying research field should be investigated more in detail. This will support managers and operational users to understand cross-organizational interconnections and facilitate necessary learning processes. At the same time, the compelling needed exchange of knowledge between theory and practice will be promoted.

References

The following reference list contains just sources that were explicitly cited within our paper. The complete literature sample reference list is available at: http://tinyurl.com/kx7xzv2

Adan, I. and Resing, J. (2002), "Queuing Theory", available at: http://www.win.tue.nl/~iadan/queueing.pdf (accessed 1 June 2014).

Alshamaila, Y., Papagiannidis, S. and Li, F. (2013), "Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework", *Journal of Enterprise Information Management*, Vol. 26 No. 3, pp. 250-275.

Akkermans, H.A., Bogerd, P., Yücesan, E. and Van Wassenhove, L.N. (2003), "The impact of ERP on supply chain management: Exploratory findings from a European Delphi study", *European Journal of Operational Research*, Vol. 146 No. 2, pp. 284-301.

Autry, C.W., Grawe, S.J., Daugherty, P.J. and Richey, R.G. (2010), "The effects of technological turbulence and breadth on supply chain technology acceptance and adoption", *Journal of Operations Management*, Vol. 28 No. 6, pp. 522-536.

Aviles, M.E., Rutner, P. and Dick, G. (2012), "Logistics Management: Opportunities in the Cloud", in *Proceedings of the Southern Association of Information Systems Conference* (SAIS), 23th-24th March 2012, Atlanta, Georgia.

Azevedo, S., Prata, P. and Fazendeiro, P. (2013), "Assessment of Supply Chain Agility in a Cloud Computing-based Framework", *Scalable Computing: Practice and Experience*, Vol. 13 No. 4, pp. 295-301.

Bala, H. (2013), "The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation", *Journal of Operations Management*, Vol. 31 No. 6, pp. 450-473.

Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R.J. and Sougstad, R. (2010), "An interdisciplinary perspective on IT services management and service science", *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 13-64.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No.1, pp. 99-120.

Benlian, A. (2009), "A transaction cost theoretical analysis of Software-as-a-Service (SaaS)-based sourcing in SMBs and enterprises", in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Benlian, A. and Hess, T. (2011), "Opportunities and risks of software-as-a-service: Findings from a survey of IT executives", *Decision Support Systems*, Vol. 52 No. 1, pp. 232-246.

Bensch, S. (2012), "Recommender Systems for Strategic Procurement in Value Networks", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Berger, A., Caruana, R., Cohn, D., Freitag, D. and Mittal, V. (2000), "Bridging the lexical chasm: statistical approaches to answer-finding", available at: http://ftp10.us.freebsd.org/users/azhang/disc/disc01/ cd1/out/papers/sigir/ p192-berger.pdf (accessed 2 July 2014).

Bharadwaj, A., El-Sawy, O.A., Pavlou, P.A. and Venkatraman, N. (2013), "Digital Business Strategy: Toward a Next Generation of Insights", *Management Information Systems Quarterly*, Vol. 37 No. 2, pp. 471-482.

Bibi, S., Katsaros, D. and Bozamis, P. (2012), “Business application acquisition: on-premise or SaaS-based solutions?”, *IEEE Software*, Vol. 29 No. 3, pp. 86-93.

Blau, B.S., Conte, T. and Meinl, T. (2009), “Coordinating service composition”, in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Blome, C., Schoenherr, T. and Eckstein, D. (2014), “The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view”, *International Journal of Production Economics*, Vol. 147 No. 1, pp. 307-316.

BME, Bundesverband für Material, Einkauf und Logistik e.V. (2013), “Deutschland bleibt führender Logistikstandort“, available at: http://www.bme.de/Deutschland-bleibt-fuehrender-Logistikstandort. 10058146.0.html (accessed 1 August 2014).

Böhmer, R. (2005), “Spezial Logistik: Leuchtendes Vorbild“, *Wirtschaftswoche*, Vol. 40 No. 29, pp. 54-65.

Böhm, M., Koleva, G., Leimeister, S., Riedl, C. and Krcmar, H. (2010), “Towards a generic value network for cloud computing”, in *Economics of Grids, Clouds, Systems, and Services*, Springer Berlin Heidelberg, pp. 129-140.

Borison, A. (2003), “Real Options Analysis: Where are the Emperor’s Clothes?”, available at: http://ardent.mit.edu/real_options/RO_current_lectures/borison.pdf (accessed 1 June 2014).

Brender, N. and Markov, I. (2013), “Risk perception and risk management in cloud computing: Results from a case study of Swiss companies”, *International Journal of Information Management*, Vol. 33 No. 5, pp. 726-733.

Cachon, G.P. and Fisher, M. (2000), “Supply chain inventory management and the value of shared information”, *Management Science*, Vol. 46 No. 8, pp. 1032-1048.

Cegielski, C.G., Jones-Farmer, L.A., Wu, Y. and Hazen, B.T. (2012), “Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach”, *International Journal of Logistics Management*, Vol. 23 No. 2, pp. 184-211.

Chang, V. and Wills, G. (2013), “A University of Greenwich Case Study of Cloud Computing”, in Graham, D., Manikas, I. and Folinas, D. (Eds.), *E-Logistics and E-Supply Chain Management: Applications for Evolving Business*, IGI Global, Hershey, pp. 232-253.

Chatterjee, D. and Ravichandran, T. (2013), “Governance of Interorganizational Information Systems: A Resource Dependence Perspective”, *Information Systems Research*, Vol. 24 No. 2, pp. 261-278.

Cho, V. and Chan, A. (2013), “An integrative framework of comparing SaaS adoption for core and non-core business operations: An empirical study on Hong Kong industries”, *Information Systems Frontiers*, published online http://link.springer.com/ article/10.1007/s10796-013-9450-9# (accessed 23 June 2014).

Compuware (2011), “North American and European Businesses Lose Millions of Revenue Dollars Yearly Due to Poor Cloud Performance”, available at: http://investor.compuware.com/releasedetail.cfm?Release ID=553490 (accessed 12 April 2014).

Cooper, M.C., Lambert, D.M., and Pagh, J.D. (1997), “Supply chain management: more than a new name for logistics”, *The International Journal of Logistics Management*, Vol. 8 No. 1, pp. 1-13.

Davis, F.D. (1989), “Perceived usefulness, perceived ease of use, and user acceptance of information technology”, *Management Information Systems Quarterly*, Vol. 13 No. 3, pp. 319-340.

Demirkan, H., Cheng, H.K. and Bandyopadhyay, S. (2010), “Coordination strategies in an SaaS supply chain”, *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 119-143.

Demirkan, H. and Goul, M. (2013), “Taking value-networks to the cloud services: security services, semantics and service level agreements”, *Information Systems and e-Business Management*, Vol. 11 No. 1, pp. 51-91.

Dibbern, J., Goles, T., Hirschheim, R. and Jayatilaka, B. (2004), “Information Systems Outsourcing: A Survey and Analysis of the Literature”, *ACM SIGMIS Database*, Vol. 35 No. 4, pp. 6-102.

Duclos, L.K., Vokurka, R.J. and Lummus, R.R. (2003), “A conceptual model of supply chain flexibility”, *Industrial Management and Data Systems*, Vol. 103 No. 6, pp. 446-63.

Durowoju, O., Chan, H.K. and Wang, X. (2011), “The impact of security and scalability of cloud service on supply chain performance”, *Journal of Electronic Commerce Research*, Vol. 12 No. 4, pp. 243-56.

ENISA, European Network and Information Security Agency. (2009), “Cloud computing: Benefits, risks and recommendations for information security”, available at: http://www.enisa.europa.eu/activities/risk-management/files/deliverables/cloud-computing-risk-assessment (accessed 12 August 2014).

Fettke, P. (2006), „State-of-the-Art des State-of-the-Art: Eine Untersuchung der Forschungsmethode “Review” innerhalb der Wirtschaftsinformatik“, *Wirtschaftsinformatik*, Vol. 48 No. 4, pp. 257-266.

Fishbein, M. and Ajzen, I. (1975), “Belief, attitude, intention, and behavior: An introduction to theory and research”, available at: http://people.umass.edu/aizen/fanda1975.html (accessed 1 July 2014).

Fremdt, S., Beck, R. and Weber, S. (2013), “Does Cloud Computing Matter? An Analysis of the Cloud Model Software-as-a-Service and Its Impact on Operational Agility”, in *Proceedings of the 46th Hawaii International Conference on in System Sciences* (HICSS), 7th-10th January 2013, Grand Wailea, Hawaii.

Freundlieb, M. and Teuteberg, F. (2013), “Corporate Social Responsibility Reporting − A Transnational Analysis of Online Corporate Social Responsibility Reports by Market-Listed Companies: Contents and their Evolution”, *International Journal of Innovation and Sustainable Development*, Vol. 7 No. 1, pp. 1-26.

Galbraith, J.R. (1974), “Organization design: an information processing view”, *Interfaces*, Vol. 4 No. 3, pp. 28-36.

Garrison, G., Kim, S. and Wakefield, R.L. (2012), “Success factors for deploying cloud computing” *Communications of the ACM*, Vol. 55 No. 9, pp. 62-68.

Giménez, C. and Lourenço, H.R. (2008), “E-SCM: internet's impact on supply chain processes”, *The International Journal of Logistics Management*, Vol. 19 No. 3, pp. 309-343.

Goldsby, T.J. and Stank, T.P. (2000), “World class logistics performance and environmentally responsible logistics practices”, *Journal of Business Logistics*, Vol. 21 No. 2, pp. 187-208.

Gosain, S., Malhotra, A. and El Sawy, A.O. (2004), “Coordinating for flexibility in e-business supply chains”, *Journal of Management Information Systems*, Vol. 21 No. 3, pp. 7-45.

Guo, Z., Fang, F. and Whinston, A.B. (2006), “Supply chain information sharing in a macro prediction market”, *Decision Support Systems*, Vol. 42 No. 3, pp. 1944-1958.

Gunawi, H.S., Do, T., Hellerstein, J.M., Stoica, I., Borthakur, D., and Robbin, J. (2011), “Failure as a service (FaaS): a cloud service for Large Scale”, available at: http://www. eecs.berkeley.edu/Pubs/TechRpts/2011/ EECS-2011-87.pdf (accessed 12 April 2014).

Gupta, P., Seetharaman, A. and Raj, J.R. (2013), “The usage and adoption of cloud computing by small and medium businesses”, *International Journal of Information Management*, Vol. 33 No. 5, pp. 861-874.

Hazen, B.T. and Byrd, T.A. (2012), “Toward creating competitive advantage with logistics information technology”, *International Journal of Physical Distribution and Logistics Management*, Vol. 42 No. 1, pp. 8-35.

Herzberg, F. (1968), “One More Time: How Do You Motivate Employees?”, *Harvard Business Review*, Vol. 46 No. 1, pp. 53-62.

Hoberg, P., Wollersheim, J. and Krcmar, H. (2012), “The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Hogan, M., Liu, F., Sokol, A. and Tong, J. (2011), “Nist cloud computing standards roadmap”, available at: https://www.miketib.com/coreplus/20110715%20NIST%20%20Cloud%20Computing%20Standards%20Roadmap_SP_500-291.pdf (accessed 20 July 2014).

Huang, B., Li, C., Yin, C. and Zhao, X. (2013), “Cloud manufacturing service platform for small-and medium-sized enterprises”, *The International Journal of Advanced Manufacturing Technology*, Vol. 65 No. 9-12, pp. 1261-1272.

Jones, S.D. (2011), “Cloud computing is changing how businesses work. KPMG finds”, *The Wall Street Journal*, October 3rd 2011.

Kahneman, D. and Tversky, A. (1979), “Prospect Theory: An Analysis of Decision Under Risk“, *Econometrica*, Vol. 47 No. 2, pp. 263-291.

Kaufman, L.M. (2009), “Data security in the world of cloud computing”, *IEEE Security and Privacy*, Vol. 7 No. 4, pp. 61-64.

Kogut, B. and Zander, U. (1992), “Knowledge of the firm, combinative capabilities, and the replication of technology”, *Organization Science*, Vol. 3 No. 3, pp. 383-397.

Lee, H.L., Padmanabhan, V. and Whang, S. (1997), “Information distortion in a supply chain: the bullwhip effect”, *Management Science*, Vol. 43 No. 4, pp. 546–558.

Lee, S.G., Chae, S.H. and Cho, K.M. (2013), “Drivers and inhibitors of SaaS adoption in Korea”, *International Journal of Information Management*, Vol. 33 No. 3, pp. 429-440.

Leimeister, S., Boehm, M., Riedl, C. and Krcmar, H. (2010), “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks”, in *Proceedings of the 18th European Conference on Information Systems* (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Leukel, J., Jacob, A., Karaenke, P., Kirn, S. and Klein, A. (2011a), “Individualization of Goods and Services: Towards a Logistics Knowledge Infrastructure for Agile Supply Chains”, in *AAAI Spring Symposium: AI for Business Agility*, 21th-23th March 2011, Palo Alto, California.

Leukel, J., Kirn, S. and Schlegel, T. (2011b), “Supply chain as a service: A cloud perspective on supply chain systems”, *Systems Journal*, Vol. 5 No. 1, pp. 16-27.

Levy, Y. and Ellis, T.J. (2006), “A systems approach to conduct an effective literature review in support of information systems research”, *International Journal of an Emerging Transdiscipline*, Vol. 9, pp. 181-212.

Li, X., Wang, Y. and Chen, X. (2012), “Cold chain logistics system based on cloud computing”, *Concurrency and Computation: Practice and Experience*, Vol. 24 No. 17, pp. 2138-2150.

Lijphart, A. (1971), “Comparative Politics and the Comparative Method”, *American Political Science Review*, Vol. 65 No. 3, pp. 682-693.

Lin, N. (2001), “Social Capital”, Cambridge University Press, Cambridge, pp. 19-25.

Liu, H., Ke, W., Wei, K.K., Gu, J. and Chen, H. (2010), “The role of institutional pressures and organizational culture in the firm’s intention to adopt internet-enabled supply chain management systems”, *Journal of Operations Management*, Vol. 28 No. 5, pp. 372-84.

Malladi, S. and Krishnan, M.S. (2012), “Cloud Computing Adoption and its Implications for CIO Strategic Focus - An Empirical Analysis”, in *Proceedings of the 33rd International Conference on Information Systems* (ICIS), 16th-19th December 2012, Orlando, Florida.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011), “Cloud computing - The business perspective”, *Decision Support Systems*, Vol. 51 No. 1, pp. 176-189.

Martens, B., Pöppelbuss, J. and Teuteberg, F. (2011), “Understanding the Cloud Computing Ecosystem: Results from a Quantitative Content Analysis”, in Proceedings of Wirtschaftsinformatik (WI), 16th-18th February 2011, Zurich, Swiss.

Martens, B. and Teuteberg, F. (2009), “Why Risk Management Matters in IT Outsourcing - A Systematic Literature Review and Elements of a Research Agenda”, in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2009, Verona, Italy.

Maude, F. (2011), “ICT Strategy Strategic Implementation Plan to Deliver Savings of Over a Billion Pounds”, available at: http://www.cabinetoffice.gov.uk/news/ict-strategy-strategic-implementation-plandeliver-savings-over-billion-pounds (accessed 18 April 2014).

Meer, D.V., Dutta, K. and Datta, A. (2012), “A cost-based database request distribution technique for online E-commerce applications”, *Management Information Systems Quarterly*, Vol. 36 No. 2, pp. 479-507.

Mell, P. and Grance, T. (2011), “The NIST definition of cloud computing”, available at: http://pre-developer.att.com/home/learn/enablingtechnologies/The_NIST_Definition_of_Cloud_Computing.pdf (accessed 10 August 2014).

Morgan, L. and Conboy, K. (2013), “Factors affecting the adoption of cloud computing: an exploratory study”, in *Proceedings of the 21st European Conference on Information Systems* (ECIS), 20th-25th November 2013, Utrecht, Netherlands.

Murguía, M. and Villaseñor, J.L. (2003), “Estimating the effect of the similarity coefficient and the cluster algorithm on biogeographic classifications”, *Annales Botanici Fennici*, Vol. 40 No. 6, pp. 415-421.

Myerson, R.B. (1991), “Game Theory: Analysis of Conflict”, Harvard University Press.

Neuendorf, K.A. (2002), ”The Content Analysis Guidebook”, Sage, Thousand Oaks, CA, pp. 10 ff.

Nuseibeh, H. (2011), ”Adoption of cloud computing in organizations”, in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

NISA, National Information Society Agency (2008), “Summary on 2007 ASP/SaaS”, available at: http://eng.nia.or.kr/english/bbs/board_view.asp?BoardID=201112221611162611andid=9288andnowpage=2andOrder=301andsearch_target=andkeyword=andFlag=andobjpage=0 (accessed on 10 August 2014).

Ocasio, W. (1997), “Towards an Attention-Based View of the Firm”, *Strategic Management Journal*, Vol. 18 No. 1, pp. 187-206.

Pereira, J.V. (2009), “The new supply chain's frontier: Information management”, *International Journal of Information Management*, Vol. 29 No. 5, pp. 372-379.

Pfeffer, J. and Salancik, G.R. (1978), “The External Control of Organizations: A Resource Dependence Perspective”, Harper and Row, New York, NY, pp. 12-14.

Porter, M.E. (1980), “Competitive advantage: Creating and sustaining superior performance”, New York: Free Press, NY.

Porter, M.E. and Millar, V.E. (1985), “How Information gives you Competitive Advantage”, *Harvard Business Review*, Vol. 63 No. 4, pp. 149-160.

PWC, PriceWaterhouseCoopers (2009), “IT-Kosten- und Wertmanagement”, available at: https://www.pwc.de/de/prozessoptimierung/assets/Studie-IT-Kosten-Wertmanagement.pdf (accessed 10 July 2014).

PWC, PriceWaterhouseCoopers (2011), “Zuverlässig, Zukuftsorientiert, International”, available at: http://www.pwc.de/de/transport-und-logistik/assets/transport_und_logistik.pdf (accessed 10 July 2014).

Provalis Research (2010), “WordStat 6: Content Analysis Module for QDA Miner and SimStat”, available at: http://www.provalisresearch.com/Documents/WordStat6.pdf (accessed 13 March 2014).

Ranganathan, C., Teo, T.S. and Dhaliwal, J. (2011), “Web-enabled supply chain management: Key antecedents and performance impacts”, *International Journal of Information Management*, Vol. 31 No. 6, pp. 533-545.

Repschlaeger, J., Wind, S., Zarnekow, R. and Turowski, K. (2012), “Selection criteria for software as a service: an explorative analysis of provider requirements”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Robertson, S. (2004), “Understanding inverse document frequency: on theoretical arguments for IDF”, *Journal of documentation*, Vol. 60 No. 5, pp. 503-520.

Rogers, E.M. (2003), “Diffusion of innovations”, New York: Free Press, NY, pp. 11-12.

Salleh, S., Teoh, S. and Chan, C. (2012), “Cloud enterprise systems: a review of literature and its adoption”, in *Proceedings of the 16th Pacific Asia Conference on Information Systems* (PACIS), 9th-12th July 2012, Ho Chi Minh City, Vietnam.

Salton, G. and Buckley, C. (1988), “Term-weighting approached in automatic text retrieval”, *Information Processing and Management*, Vol. 14 No. 5, pp. 513-523.

Schafersman, S. (1994), “An introduction to science: Scientific thinking and the scientific method”, available at: http://www.geo.sunysb.edu/esp/files/scientific-method.html (accessed 10 July 2014).

Schniederjans, D. and Özpolat, K. (2013), “An Empirical Examination of Cloud Computing in Humanitarian Logistics”, available at: http://www.cba.uri.edu/research/brownbag/spring2013/documents/DaraS2013329 paper.pdf (accessed 29 April 2014).

Schrödl, H. (2012), “Purchasing Cloud-Based Product-Service Bundles in Value Networks – The Role of Manageable Workloads”, in *Proceedings of the 20th European Conference on Information Systems* (ECIS), 10th-13th June 2012, Barcelona, Spain.

Seethamraju, R. (2013), “Determinants of SaaS ERP Systems Adoption”, in *Proceedings of the 17th Pacific Asia Conference on Information Systems* (PACIS), 18th-22nd June 2013, Jeju Island, Korea.

Sidorova, A., Evangelopoulos, N., Valacich, J.S. and Ramakrishnan, T. (2008), “Uncovering the Intellectual Core of the Information Systems Discipline”, *Management Information Systems Quarterly*, Vol. 32 No. 3, pp. 467-482.

Steinfield, C., Markus, M.L. and Wigand, R.T. (2011), “Through a glass clearly: standards, architecture, and process transparency in global supply chains”, *Journal of Management Information Systems*, Vol. 28 No. 2, pp. 75-108.

Sullivan, D. (2001), “Document Warehousing and Text Mining”, Wiley Computer Publishing, New York, NY.

Swafford, P., Ghosh, S., and Murthy, N. (2006), “The antecedents of supply chain agility of a firm: scale development and model testing”, *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-88.

Swafford, P.M., Ghosh, S. and Murthy, N. (2008), “Achieving supply chain agility through IT integration and flexibility”, *International Journal of Production Economics*, Vol. 116 No. 2, pp. 288-297.

Tan, P.N., Steinbach, M. and Kumar, V. (2005), „Introduction to Data Mining”, Addison-Wesley, Boston, MA.

Tapscott, D., Ticoll, D. and Lowy, A. (2000), “Digital capital: harnessing the power of business Webs”, Harvard Business Press, Boston, MA.

Tarzey, B. (2012), “Adapting to new data rules”, *Computer Weekly*, Vol. 12, 2012.

Trist, E. and Bamforth, K. (1951), “Some social and psychological consequences of the longwall method of coal getting”, Human relations, Vol. 4, pp. 3.

Venters, W. and Whitley, E.A. (2012), “A critical review of cloud computing: researching desires and realities”, *Journal of Information Technology*, Vol. 27 No. 3, pp. 179-197.

Wagner, S.M. (2008), “Innovation management in the German transportation industry”, *Journal of Business Logistics*, Vol. 29 No. 2, pp. 215-231.

Wang, F.Y. (2010), “Parallel control and management for intelligent transportation systems: Concepts, architectures, and applications”, *Intelligent Transportation Systems*, Vol. 11 No. 3, pp. 630-638.

Webster, J. and Watson, R.T. (2002), “Analyzing the Past to Prepare for the Future: Writing a Literature Review”, *Management Information Systems Quarterly*, Vol. 26 No. 2, pp. xiii-xxiii.

Wilde, T. and Hess, T. (2007), „Forschungsmethoden der Wirtschaftsinformatik: Eine empirische Untersuchung“, *Wirtschaftsinformatik*, Vol. 49 No. 4, pp. 280-287.

Williamson, O. (1981), “The Economics of Organization: The Transaction Cost Approach”, *American Journal of Sociology*, Vol. 87 No. 3, pp. 548–577.

Wind, S., Repschlaeger, J. and Zarnekow, R. (2012), “Towards a Cloud Computing Selection and Evaluation Environment for Very Large Business Applications”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Wu, Y., Cegielski, C.G., Hazen, B.T. and Hall, D.J. (2013), “Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud”, *Journal of Supply Chain Management*, Vol. 49 No. 3, pp. 25-41.

Xiao, J., Wang, H., Cheng, Z.L., Xie, K. and Hu, Q. (2011), “Why Is Web-based Supply Chain Management Popular in China? A Factor Endowment’s Perspective”, in *Proceedings of the 32nd International Conference on Information Systems* (ICIS), 4th-7th December 2011, Shanghai, China.

Yan, G., Wen, D., Olariu, S. and Weigle, M.C. (2013), “Security challenges in vehicular cloud computing”, *Intelligent Transportation Systems*, Vol. 14 No. 1, pp. 284-294.

Youseff, L., Butrico, M. and Da Silva, D. (2008), “Toward a unified ontology of cloud computing”, *Grid Computing Environments Workshop 2008* (GCE), 16th November 2008, Austin, Texas.

Yuhanna, N., Gilpin, M. and Knoll, A. (2010), “The Forrester Wave: information-as-a-service”, available at: http://www.forrester.com/rb/Research/wave%26trade%3B_information-as-a service%2C_q1_2010/q/id/55204/t/2 (accessed 17 June 2014).

Zandi, F., Tavana, M. and Martin, D. (2013), “A fuzzy group Electre method for electronic supply chain management framework selection”, *International Journal of Logistics: Research and Applications*, Vol. 14 No. 1, pp. 35-60.

Ziekow, H., Fabian, B., Müller, C. and Günther, O. (2010), “RFID in the Cloud: A Service for High-Speed Data Access in Distributed Value Chains”, in *Proceedings of the 16th American Conference on Information Systems* (AMCIS), 12th-15th August 2010, Lima, Peru.

Appendix

All additional figures and tables to this paper are available online and contain additional information:

Figure I: 2D interrelations map of cloud computing and supply chain management

Figure II: Heat map
Table I: Applied 5-stage procedure of the systematic literature review

Table II: Selected journals and conferences
Table III: Used keywords during the paper search phase
Table IV: Ranking by absolute word frequency

Table V: Ranking by TF IDF

The figures and tables may be downloaded from:
http://tinyurl.com/kx7xzv2

Integrating Cloud Computing in Supply Chain Processes: A Comprehensive Literature Review

Appendix

References of the systematic literature review sample

Ali, S.I. (2013), "Adoption Of Cloud Computing In Manufacturing Industry Supply Chains, A Hype or a Myth?", *International Journal of Enhanced Research in Science Technology & Engineering*, Vol. 2 No. 7, pp. 29-33.

Ali, S.I. (2013), "Cloud Computing and its impact on Supply Chain Performance", *International Journal of Enhanced Research in Management and Computer Applications*, Vol. 2 No. 3, pp. 1-5.

Alshamaila, Y., Papagiannidis, S. and Li, F. (2013), "Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework", *Journal of Enterprise Information Management*, Vol. 26 No. 3, pp. 250-275.

Autry, C.W., Grawe, S.J., Daugherty, P.J. and Richey, R.G. (2010), "The effects of technological turbulence and breadth on supply chain technology acceptance and adoption", *Journal of Operations Management*, Vol. 28 No. 6, pp. 522-536.

Aviles, M.E., Rutner, P. and Dick, G. (2012), "Logistics Management: Opportunities in the Cloud", in *Proceedings of the Southern Association of Information Systems Conference* (SAIS), 23th-24th March 2012, Atlanta, Georgia.

Azevedo, S., Prata, P. and Fazendeiro, P. (2013), "Assessment of Supply Chain Agility in a Cloud Computing-based Framework", *Scalable Computing: Practice and Experience*, Vol. 13 No. 4, pp. 295-301.

Baars, H. and Kemper, H.G. (2011), "Ubiquitous Computing - an Application Domain for Business Intelligence in the Cloud?", in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Baars, H. and Zimmer, M. (2013), "A Classification For Business Intelligence Agility Indicators", in *Proceedings of the 21st European Conference on Information Systems* (ECIS), 20th-25th November 2013, Utrecht, Netherlands.

Bala, H. (2013), "The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation", *Journal of Operations Management*, Vol. 31 No. 6, pp. 450-473.

Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R.J. and Sougstad, R. (2010), "An interdisciplinary perspective on IT services management and service science", *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 13-64.

Benlian, A. (2009), "A transaction cost theoretical analysis of Software-as-a-Service (SaaS)-based sourcing in SMBs and enterprises", in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Benlian, A., Koufaris, M. and Hess, T. (2010), "The role of SaaS service quality for continued SaaS use: Empirical insights from SaaS using firms", in *Proceedings of the 31st International Conference on Information Systems* (ICIS), 12th-15th December 2010, Saint Louis, Missouri.

Benlian, A. (2011), "Is traditional, open-source, or on-demand first choice & quest; Developing an AHP-based framework for the comparison of different software models in office suites selection", *European Journal of Information Systems*, Vol. 20 No. 5, pp. 542-559.

Benlian, A. and Hess, T. (2011), "Opportunities and risks of software-as-a-service: Findings from a survey of IT executives", *Decision Support Systems*, Vol. 52 No. 1, pp. 232-246.

Bensch, S. (2011), "Technical and Organizational Potentials of Value Networks for Ubiquitous Information Products and Services: Exploring the Role of Cloud Computing", in *Proceedings of the 4th International Conference on Ubi-Media Computing*, 3rd-4th July 2011, Sao Paulo, Brazil.

Bensch, S. (2012), "Recommender Systems for Strategic Procurement in Value Networks", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Bharadwaj, A., El-Sawy, O.A., Pavlou, P.A. and Venkatraman, N. (2013), "Digital Business Strategy: Toward a Next Generation of Insights", *Management Information Systems Quarterly*, Vol. 37 No. 2, pp. 471-482.

Blau, B.S., Conte, T. and Meinl, T. (2009), "Coordinating service composition", in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Blome, C., Schoenherr, T. and Eckstein, D. (2014), "The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view", *International Journal of Production Economics*, Vol. 147 No. 1, pp. 307-316.

Böhm, M., Koleva, G., Leimeister, S., Riedl, C. and Krcmar, H. (2010), "Towards a generic value network for cloud computing", in *Economics of Grids, Clouds, Systems, and Services*, Springer Berlin Heidelberg, pp. 129-140.

Brender, N. and Markov, I. (2013), "Risk perception and risk management in cloud computing: Results from a case study of Swiss companies", *International Journal of Information Management*, Vol. 33 No. 5, pp. 726-733.

Cegielski, C.G., Jones-Farmer, L.A., Wu, Y. and Hazen, B.T. (2012), "Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach", *International Journal of Logistics Management*, Vol. 23 No. 2, pp. 184-211.

Chang, H.H., Tsai, Y.C. and Hsu, C.H. (2013), "E-procurement and supply chain performance", *Supply Chain Management: An International Journal*, Vol. 18 No. 1, pp. 34-51.

Chang, V. and Wills, G. (2013), "A University of Greenwich Case Study of Cloud Computing", in Graham, D., Manikas, I. and Folinas, D. (Eds.), *E-Logistics and E-Supply Chain Management: Applications for Evolving Business*, IGI Global, Hershey, pp. 232-253.

Chatterjee, D. and Ravichandran, T. (2013), "Governance of Interorganizational Information Systems: A Resource Dependence Perspective", *Information Systems Research*, Vol. 24 No. 2, pp. 261-278.

Chen, P.Y. and Wu, S.Y. (2012), "The Impact and Implications of On-Demand Services on Market Structure", *Information Systems Research*, published online, available at: http://community.mis.temple.edu/pychen/files/2012/09/ondemand _ISR_final.pdf (accessed 20 April 2014).

Cho, V. and Chan, A. (2013), "An integrative framework of comparing SaaS adoption for core and non-core business operations: An empirical study on Hong Kong industries", *Information Systems Frontiers*, published online, available at: http://link.springer.com/ article/10.1007/s10796-013-9450-9# (accessed 23 June 2014).

Cusumano, M.A. (2012), "Can services and platform thinking help the US Postal Service?", *Communications of the ACM*, Vol. 55 No. 4, pp. 21-23.

Demirkan, H., Cheng, H.K. and Bandyopadhyay, S. (2010), "Coordination strategies in an SaaS supply chain", *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 119-143.

Demirkan, H. and Delen, D. (2013), "Leveraging the capabilities of service-oriented decision support systems: Putting analytics and big data in cloud", *Decision Support Systems*, Vol. 55 No. 1, pp. 412-421.

Demirkan, H. and Goul, M. (2013), "Taking value-networks to the cloud services: security services, semantics and service level agreements", *Information Systems and e-Business Management*, Vol. 11 No. 1, pp. 51-91.

Dong, C.S.J. and Srinivasan, A. (2013), "Agent-enabled service-oriented decision support systems", *Decision Support Systems*, Vol. 55 No. 1, pp. 364-373.

Dorsch, C. and Häckel, B. (2013), "Combining models of capacity supply to handle volatile demand: The economic impact of surplus capacity in cloud service environments", *Decision Support Systems*, published online, available at: http://www.wi-if.de/paperliste/paper/wi-382.pdf (accessed 10 April 2014).

Dorsch, C. (2013), "IT-enabled Excess Capacity Markets for Services: Examining the Economic Potential in Cost-driven Service Supply Chains", in *Proceedings of the 19th American Conference on Information Systems* (AMCIS), 15th-17th August 2013, Chicago, Illinois.

Dos Santos, B.L., Zheng, Z.E., Mookerjee, V.S. and Chen, H. (2012), "Are New IT-Enabled Investment Opportunities Diminishing for Firms?", *Information Systems Research*, Vol. 23 No. 2, pp. 287-305.

Downing, C.E. (2010), "Is web-based supply chain integration right for your company?", *Communications of the ACM*, Vol. 53 No. 5, pp. 134-137.

Durowoju, O., Chan, H.K. and Wang, X. (2011), "The impact of security and scalability of cloud service on supply chain performance", *Journal of Electronic Commerce Research*, Vol. 12 No. 4, pp. 243-256.

Egberink, J.G.H. (2013), "Supply Chain Management: Horizontal collaboration and the role of Information Systems– a literature review", available at: http://referaat.cs.utwente.nl/conference/18/paper/7378/supply-chain-management-horizontal-collaboration-and-the-role-of-information-systems-a-literature-review.pdf (accessed 4 April 2014).

Eltoweissy, M., Olariu, S. and Younis, M. (2010), “Towards autonomous vehicular clouds”, *Ad Hoc Networks*, Vol. 49 No. 1, pp. 1-16.

Fabian, B., Kunz, S., Müller, S. and Günther, O. (2013), “Secure federation of semantic information services”, *Decision Support Systems*, Vol. 55 No. 1, pp. 385-398.

Fremdt, S., Beck, R. and Weber, S. (2013), “Does Cloud Computing Matter? An Analysis of the Cloud Model Software-as-a-Service and Its Impact on Operational Agility”, in *Proceedings of the 46th Hawaii International Conference on in System Sciences* (HICSS), 7th-10th January 2013, Grand Wailea, Hawaii.

Friedrich, I., Kosch, L., and Breitner, M.H. (2012), “A practical test of a process model for customer relationship management system selection with an automotive supplier”, in *Proceedings of the 20th European Conference on Information Systems* (ECIS), 10th-13th June, Barcelona, Spain.

Garrison, G., Kim, S. and Wakefield, R.L. (2012), “Success factors for deploying cloud computing” *Communications of the ACM*, Vol. 55 No. 9, pp. 62-68.

Giménez, C. and Lourenço, H.R. (2008), “E-SCM: internet's impact on supply chain processes”, *The International Journal of Logistics Management*, Vol. 19 No. 3, pp. 309-343.

Gupta, P., Seetharaman, A. and Raj, J.R. (2013), “The usage and adoption of cloud computing by small and medium businesses”, *International Journal of Information Management*, Vol. 33 No. 5, pp. 861-874.

Hartmann, E. and Grahl, A. (2012), “Logistics outsourcing interfaces: the role of customer partnering behavior”, *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 6, pp. 526-543.

Hazen, B.T. and Byrd, T.A. (2012), “Toward creating competitive advantage with logistics information technology”, *International Journal of Physical Distribution and Logistics Management*, Vol. 42 No. 1, pp. 8-35.

Hoberg, P., Wollersheim, J. and Krcmar, H. (2012), “The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Hoof Van, A. (2010), “Cloud services and the value chain”, available at: https://www.os3.nl/_media/2009-2010/students/alain_van_hoof/icp/cloud_ and_value_chain.pdf (accessed 29 April 2014).

Huang, B., Li, C., Yin, C. and Zhao, X. (2013), “Cloud manufacturing service platform for small-and medium-sized enterprises”, *The International Journal of Advanced Manufacturing Technology*, Vol. 65 No. 9-12, pp. 1261-1272.

Jiang, W., Zhang, J. and Li, J. (2013), “A Multi-agent Supply Chain Information Coordination Mode Based on Cloud Computing”, *Indonesian Journal of Electrical Engineering*, Vol. 11 No. 11, pp. 6427-6433.

Kawa, A. and Ratajczak-Mrozek, M. (2013), “Cooperation between logistics service providers based on cloud computing”, in *Proceedings of the 5th Asian Conference on Intelligent Information and Database Systems* (ACIIDS), 18th-20th March 2013, Kuala Lumpur, Malaysia.

Khajeh-Hosseini, A., Greenwood, D. and Sommerville, I. (2010), “Cloud migration: A case study of migrating an enterprise it system to IaaS”, in *Proceedings of the 3rd International Conference on Cloud Computing*, 8th-10th May 2010, Aachen, Germany.

Kunkel, M., Doppstadt, C. and Schwind, M. (2010), “Open service-oriented computing for logistics: a case in courier, express and parcel networks”, in Dan, A., Gittler, F., & Toumani, F. (Eds.), *Service Oriented Computing*, Springer, Berlin, Germany.

Lee, S., Park, S.B. and Lim, G.G. (2013), “Using balanced scorecards for the evaluation of Software-as-a-service”, *Information & Management,* Vol. 50 No. 7, pp. 553-561.

Lee, S.G., Chae, S.H. and Cho, K.M. (2013), “Drivers and inhibitors of SaaS adoption in Korea”, *International Journal of Information Management*, Vol. 33 No. 3, pp. 429-440.

Leimeister, S., Boehm, M., Riedl, C. and Krcmar, H. (2010), “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks”, in *Proceedings of the 18th European Conference on Information Systems* (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Leukel, J., Jacob, A., Karaenke, P., Kirn, S. and Klein, A. (2011), “Individualization of Goods and Services: Towards a Logistics Knowledge Infrastructure for Agile Supply Chains”, in *AAAI Spring Symposium: AI for Business Agility*, 21th-23th March 2011, Palo Alto, California.

Leukel, J. and Kirn, S. (2011), “A Service-Oriented Approach to Freight Routing in Intermodal Transport Systems“, in *Tagungsband der 10. Internationalen Tagung Wirtschaftsinformatik*, 16th-18th February 2011, Zurich, Swiss.

Leukel, J., Kirn, S. and Schlegel, T. (2011), “Supply chain as a service: A cloud perspective on supply chain systems”, *Systems Journal*, Vol. 5 No. 1, pp. 16-27.

Li, S., Xu, L., Wang, X. and Wang, J. (2012), “Integration of hybrid wireless networks in cloud services oriented enterprise information systems”, *Enterprise Information Systems*, Vol. 6 No. 2, pp. 165-187.

Li, X., Wang, Y. and Chen, X. (2012), “Cold chain logistics system based on cloud computing”, *Concurrency and Computation: Practice and Experience*, Vol. 24 No. 17, pp. 2138-2150.

Loebbecke, C., Thomas, B. and Ullrich, T. (2011), “Assessing Cloud Readiness at Continental AG”, *Management Information Systems Quarterly Executive*, Vol. 11 No. 1, pp. 11-23.

Malladi, S. and Krishnan, M.S. (2012), “Cloud Computing Adoption and its Implications for CIO Strategic Focus - An Empirical Analysis”, in *Proceedings of the 33rd International Conference on Information Systems* (ICIS), 16th-19th December 2012, Orlando, Florida.

Mantena, R., Tilson, V. and Zheng, X. (2012), “Literature survey: Mathematical models in the analysis of durable goods with emphasis on information systems and operations management issues”, *Decision Support Systems*, Vol. 53 No. 2, pp. 331-344.

Manuel, P., Al-Hamadi, H. and Qureshi, K. (2013), "Challenges, strategies and metrics for supply-driven enterprises", *Annals of Operations Research*, Vol. 203 No. 1, pp. 1-11.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011), "Cloud computing - The business perspective", *Decision Support Systems*, Vol. 51 No. 1, pp. 176-189.

Meer, D.V., Dutta, K. and Datta, A. (2012), "A cost-based database request distribution technique for online E-commerce applications", *Management Information Systems Quarterly*, Vol. 36 No. 2, pp. 479-507.

Morgan, L. and Conboy, K. (2013), "Factors affecting the adoption of cloud computing: an exploratory study", in *Proceedings of the 21st European Conference on Information Systems* (ECIS), 20th-25th November 2013, Utrecht, Netherlands.

Morgan, L. and Conboy, K. (2013), "Value Creation in the Cloud: Understanding Business Model Factors Affecting Value of Cloud Computing", in *Proceedings of the 19th American Conference on Information Systems* (AMCIS), 15th-17th August 2013, Chicago, Illinois.

Nantaburom, K., Chan, H.K., Chung, S.H. and Chan, F.T. (2010), "Impact of Service-Oriented Architecture on service supply chains", in *Proceedings of the 8th International Conference on Supply Chain Management and Information Systems* (SCMIS), 6th-9th October 2010, Hong Kong, China.

Neff, A.A., Hamel, F., Herz, T.P., Uebernickel, F. and Brenner, W. (2013), "Fostering Efficiency in Information Systems Support for Product-Service Systems in the Manufacturing Industry", in *Proceedings of the 19th American Conference on Information Systems* (AMCIS), 15th-17th August 2013, Chicago, Illinois.

Nuseibeh, H. (2011), "Adoption of cloud computing in organizations", in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Olariu, S., Khalil, I. and Abuelela, M. (2011), "Taking VANET to the clouds", *International Journal of Pervasive Computing and Communications*, Vol. 7 No. 1, pp. 7-21.

Pereira, J.V. (2009), "The new supply chain's frontier: Information management", *International Journal of Information Management*, Vol. 29 No. 5, pp. 372-379.

Qu, L., Chen, Y. and Yang, M. (2009), "The coordination and integration of agile supply chain based on service-oriented technology", in *Proceedings of the 3rd International Symposium on Intelligent Information Technology Application* (IITA), 21st-22nd November 2009, Nanchang, China.

Ranganathan, C., Teo, T.S. and Dhaliwal, J. (2011), "Web-enabled supply chain management: Key antecedents and performance impacts", *International Journal of Information Management*, Vol. 31 No. 6, pp. 533-545.

Rehan, M. and Akyuz, G.A. (2010), "Enterprise application integration (EAI), service oriented architectures (SOA) and their relevance to e-supply chain formation", *African Journal of Business Management*, Vol. 4 No. 13, pp. 2604-2614.

Repschlaeger, J., Wind, S., Zarnekow, R. and Turowski, K. (2012), "Selection criteria for software as a service: an explorative analysis of provider requirements", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Salim, S.A. (2013), "Cloud ERP Adoption-A Process View Approach", in *Proceedings of the 17th Pacific Asia Conference on Information Systems* (PACIS), 18th-22nd June 2013, Jeju Island, Korea.

Salleh, S., Teoh, S. and Chan, C. (2012), "Cloud enterprise systems: a review of literature and its adoption", in *Proceedings of the 16th Pacific Asia Conference on Information Systems* (PACIS), 9th-12th July 2012, Ho Chi Minh City, Vietnam.

Schniederjans, D. and Özpolat, K. (2013), "An Empirical Examination of Cloud Computing in Humanitarian Logistics", available at: http://www.cba.uri.edu/research/brownbag/spring2013/documents/DaraS2013329 paper.pdf (accessed 29 April 2014).

Schrödl, H. (2012), "Purchasing Cloud-Based Product-Service Bundles in Value Networks – The Role of Manageable Workloads", in *Proceedings of the 20th European Conference on Information Systems* (ECIS), 10th-13th June 2012, Barcelona, Spain.

Schrödl, H. (2012), "Towards a Research Framework for VLBA Operation Management", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Schrödl, H. and Turowski, K. (2013), "Risk management in hybrid value creation", *Decision Support Systems*, available at: http://www.sciencedirect.com/science/article/pii/S0167923613000250 (accessed 19 May 2014).

Seethamraju, R. (2013), "Determinants of SaaS ERP Systems Adoption", in *Proceedings of the 17th Pacific Asia Conference on Information Systems* (PACIS), 18th-22nd June 2013, Jeju Island, Korea.

Steinfield, C., Markus, M.L. and Wigand, R.T. (2011), "Through a glass clearly: standards, architecture, and process transparency in global supply chains", *Journal of Management Information Systems*, Vol. 28 No. 2, pp. 75-108.

Swafford, P., Ghosh, S., and Murthy, N. (2006), "The antecedents of supply chain agility of a firm: scale development and model testing", Journal of Operations Management, Vol. 24 No. 2, pp. 170-88.

Tao, F., Zhang, L., Venkatesh, V.C., Luo, Y. and Cheng, Y. (2011), "Cloud manufacturing: a computing and service-oriented manufacturing model", *Journal of Engineering Manufacture*, Vol. 225 No. 10, pp. 1969-1976.

Thies, H. and Stanoevska-Slabeva, K. (2011), "Towards Inter-Organizational Environmental Information Systems for Sustainable Business Networks", in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Thompson, W.J.J. and Van der Walt, J.S. (2010), "Business intelligence in the cloud", *South African Journal of Information Management*, Vol. 12 No. 1, pp. 1-5.

Venters, W. and Whitley, E.A. (2012), "A critical review of cloud computing: researching desires and realities", *Journal of Information Technology*, Vol. 27 No. 3, pp. 179-197.

Wang, F.Y. (2010), “Parallel control and management for intelligent transportation systems: Concepts, architectures, and applications”, *Intelligent Transportation Systems*, Vol. 11 No. 3, pp. 630-638.

Wind, S., Repschlaeger, J. and Zarnekow, R. (2012), “Towards a Cloud Computing Selection and Evaluation Environment for Very Large Business Applications”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Wu, Y., Cegielski, C.G., Hazen, B.T. and Hall, D.J. (2013), “Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud”, *Journal of Supply Chain Management*, Vol. 49 No. 3, pp. 25-41.

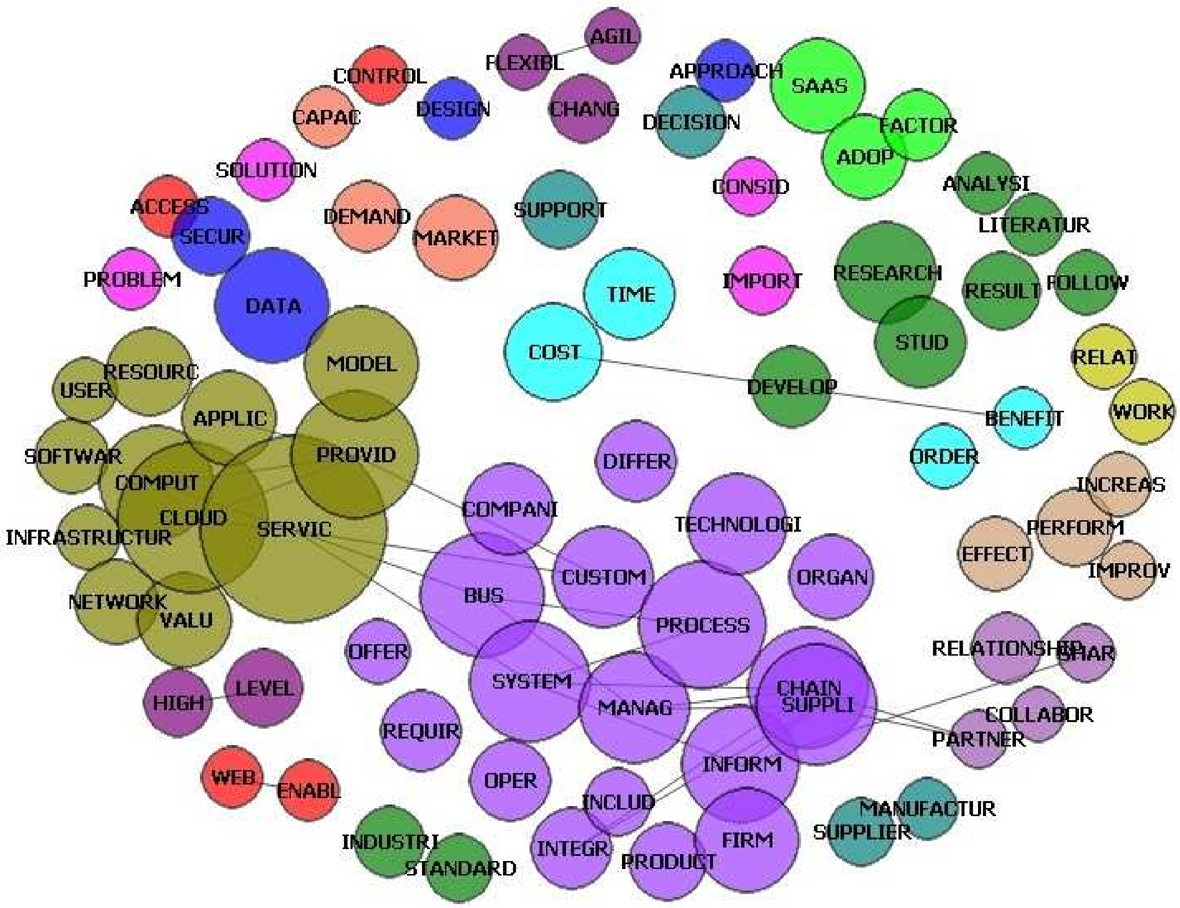
Xiao, J., Wang, H., Cheng, Z.L., Xie, K. and Hu, Q. (2011), “Why Is Web-based Supply Chain Management Popular in China? A Factor Endowment’s Perspective”, in *Proceedings of the 32nd International Conference on Information Systems* (ICIS), 4th-7th December 2011, Shanghai, China.

Yan, G., Wen, D., Olariu, S. and Weigle, M.C. (2013), “Security challenges in vehicular cloud computing”, *Intelligent Transportation Systems*, Vol. 14 No. 1, pp. 284-294.

Zandi, F., Tavana, M. and Martin, D. (2013), “A fuzzy group Electre method for electronic supply chain management framework selection”, *International Journal of Logistics: Research and Applications*, Vol. 14 No. 1, pp. 35-60.

Ziekow, H., Fabian, B., Müller, C. and Günther, O. (2010), “RFID in the Cloud: A Service for High-Speed Data Access in Distributed Value Chains”, in *Proceedings of the 16th American Conference on Information Systems* (AMCIS), 12th-15th August 2010, Lima, Peru.

Figure I 2D interrelations map of cloud computing and supply chain management



Additional information to figure I:

The 2D map in figure I is a graphical concept of word interconnections with the use of JI-proximity computed by multidimensional scaling (MDS). Here, the size of the circles is corresponding with the words' frequency. The distance between the circles indicates how likely those words occur together. Further, colors are used to mark upper-level groups and lines represent strong relationships between circles. Although all papers fulfill the requirement of dealing in the intersection of both research fields, there is a clear separation between SCM and CC. This means that the authors of both research fields understand the possible win-win situation as they obviously study each other, but it seems to be difficult to internalize and involve the specifics of the other field. The triangle consisting of the terms business (BUS), systems (SYSTEM), and processes (PROCESS) represents a kind of bridge between SCM on the one side and CC on the other side in the map. Not surprisingly, the words organization, operation, company, firm, industry, supplier, manufacturer are surrounding the SCM oval, whereas words like service, software, application, user, and provider encircle the CC terms. These technologically driven specifications are often summed up to the general word stem TECHNOLOGI, when speaking in terms of SCM. The term resource (RESOURC) is placed closed to CC, as it frequently represents an abstract synonym for server and storage in CC science.

Figure II Heat map

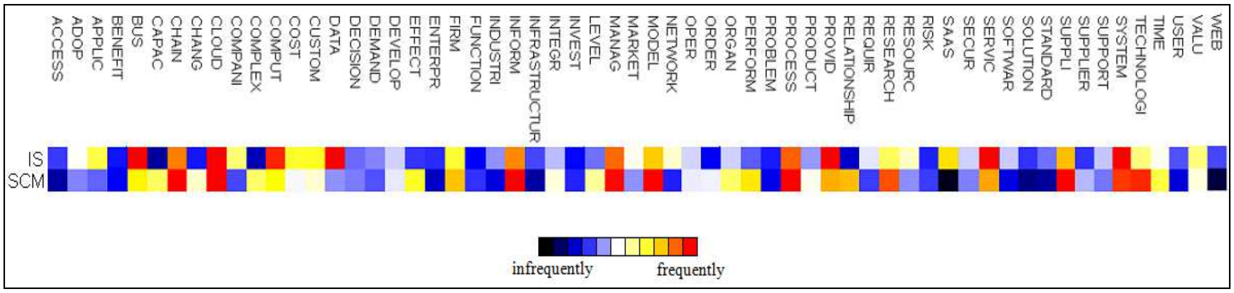


Table I Applied 5-stage procedure of the systematic literature review

Stage	Description
1	**Issue description and definition of the research field:** The topic of this paper is discussed in the introduction. In the second section, key terms are defined and the research origins are presented briefly. Both the literature search and the structure of the work are discussed in this section.
2	**Literature search:** For the keyword based search within scientific journals, we considered three journal rankings. Hence, IS research is covered by the lists “WI” (WIRTSCHAFTSINFORMATIK) and “AIS” (Association for Information Systems). To our knowledge, the ranking “Transport, Logistics and SCM" of the University of Sydney is the most comprehensive one in the field of SCM. Therefore, this list serves as basis for SCM research. In the selection phase, we considered only those journals that had an “A” rating or were rated better than 15 points in the case of AIS rankings in order to ensure a high quality basis. In total, the sample consists of 63 journals. Here, 33 came from IS research and 32 from SCM research (two journals belong to both fields). In addition, the conferences “ECIS”, “ICIS”, and “WI”, rated as the best IS-conferences by the “Wissenschaftliche Kommission für Wirtschaftsinformatik (WKWI)”, expanded the selection. Although only in 6th place in the WKWI list, the conference “AMCIS” put forward with a disproportionate number of relevant contributions and therefore completed the sample. For searching specific papers within the selected journals, we used numerous keywords and keyword combinations from the second section of this paper. Besides the obvious search terms like “Cloud Supply Chain” and “SaaS Logistic*”, we included also terms like “Financ*” and “Strateg*” in this context to emphasize the strategic aspect of CC for SCM. Furthermore, only articles from the years 2007 to 2013 have been analyzed, since the term “Cloud Computing” appeared in scientific literature for the first time in 2007. The described searching parameters resulted in 118 papers.
3	**Literature evaluation:** At this stage, first we read the abstracts of all papers in order to validate the papers’ relevance. If the abstract had no relation to our subject or led to any confusion, the entire paper’s content was examined for relevance. During this process, we sorted out 55 papers. Thereafter, based on the remaining 63 relevant papers, we ran a forward and backward search (Webster and Watson 2002). Again we only considered publications from the years 2007 to 2013. To maximize the gain in actual

	knowledge, we also included publications on the Internet and papers in edited volumes. Analogous to the primary search, we repeated the process with regard to the examination of the papers relevance. As a result, 36 additional papers were identified (8 from the backward search, and 28 from the forward search). In total, the sample contains 99 papers of which 62 papers come from scientific journals, 33 from conferences, and four papers from the remaining sources mentioned above. With 78 papers, the majority is derived from IS literature, whereas only 21 papers come from SCM literature. All selected papers meet an important condition: they address topics in the intersection of both research fields.
4 & 5	**Literature analysis and interpretation:** We evaluated the data based on the classification in the analysis pattern. The last three sections deal with the results of the analysis, open research questions, limitations, and a brief outlook.

Table II Selected journals and conferences

Journal name	Research field	Journal [J] Conference [C]
ACM Transactions Journals	Information Systems	J
ACM Transactions on Database Systems	Information Systems	J
AI Magazine	Information Systems	J
Artificial Intelligence	Information Systems	J
Communications of the AIS	Information Systems	J
Communications of the Association for Computer Machinery	Information Systems	J
Decision Sciences	Information Systems	J
Electronic Markets	Information Systems	J
European Journal of Information Systems	Information Systems	J
Harvard Business Review	Information Systems	J
Human-Computer Interaction	Information Systems	J
I&O (Information and Organization)	Information Systems	J
IEEE Software	Information Systems	J
IEEE Transactions journals	Information Systems	J
IEEE Transactions on Software Engineering	Information Systems	J
IEEE Transactions on Systems, Man, and Cybernetics	Information Systems	J
Information & Management	Information Systems	J
Information Systems	Information Systems	J
Information Systems Journal	Information Systems	J
Information Systems Research	Information Systems	J
Informing Science Journal	Information Systems	J
International Journal of Information Management	Information Systems	J

Journal of Computer and System Sciences	Information Systems	J
Journal of Information Technology	Information Systems	J
Journal of Management Information Systems	Information Systems	J
Journal of Strategic Information Systems	Information Systems	J
Journal of the Association of Information Systems	Information Systems	J
Management Information Systems Quarterly	Information Systems	J
Organization Science	Information Systems	J
Sloan Management Review	Information Systems	J
Wirtschaftsinformatik	Information Systems	J
Accident Analysis and Prevention	Supply Chain Management	J
Computers and Operations Research	Supply Chain Management	J
Environment and Planning A	Supply Chain Management	J
Environmental and Resource Economics	Supply Chain Management	J
European Planning Studies	Supply Chain Management	J
European Urban and Regional Studies	Supply Chain Management	J
International Journal of Operations and Production Management	Supply Chain Management	J
International Journal of Production Economics	Supply Chain Management	J
International Journal of Urban and Regional Research	Supply Chain Management	J
Journal of Advanced Transportation	Supply Chain Management	J
Journal of Economic Geography	Supply Chain Management	J
Journal of Environmental Economics and Management	Supply Chain Management	J
Journal of Operations Management	Supply Chain Management	J
Journal of the Operational Research Society	Supply Chain Management	J
Journal of Transport Economics and Policy	Supply Chain Management	J
Journal of Urban Economics	Supply Chain Management	J
Land Economics	Supply Chain Management	J
Regional Science and Urban Economics	Supply Chain Management	J
Regional Studies	Supply Chain Management	J
Supply Chain Management	Supply Chain Management	J
Town Planning Review	Supply Chain Management	J
Transport Policy	Supply Chain Management	J
Transport Reviews	Supply Chain Management	J
Transportation	Supply Chain Management	J
Transportation Research Part A: Policy and Practice	Supply Chain Management	J
Transportation Research Part B: Methodological	Supply Chain Management	J

Transportation Research Part C: Emerging Technologies	Supply Chain Management	J
Transportation Research Record: Journal of the Transportation Research Board	Supply Chain Management	J
Transportation Science	Supply Chain Management	J
Urban Studies	Supply Chain Management	J
Decision Support Systems	SCM/IS	J
Management Science	SCM/IS	J
ECIS- European Conference on Information Systems	Information Systems	C
WI- Wirtschaftsinformatik	Information Systems	C
AMCIS- Americas Conference on Information Systems	Information Systems	C
ICIS- International Conference on Information Systems	Information Systems	C

Table III Used keywords during paper searching phase

Cloud	&	Logistic*	Software as a Service	&	Logistic*	Infrastructure as a Service	&	Logistic*	Platform as a Service	&	Logistic*
Cloud	&	Warehous*	Software as a Service	&	Warehous*	Infrastructure as a Service	&	Warehous*	Platform as a Service	&	Warehous*
Cloud	&	Transport*	Software as a Service	&	Transport*	Infrastructure as a Service	&	Transport*	Platform as a Service	&	Transport*
Cloud	&	SCM	Software as a Service	&	SCM	Infrastructure as a Service	&	SCM	Platform as a Service	&	SCM
Cloud	&	Supply Chain	Software as a Service	&	Supply Chain	Infrastructure as a Service	&	Supply Chain	Platform as a Service	&	Supply Chain
Cloud	&	Strateg*	Software as a Service	&	Strateg*	Infrastructure as a Service	&	Strateg*	Platform as a Service	&	Strateg*
Cloud	&	Business Process	Software as a Service	&	Business Process	Infrastructure as a Service	&	Business Process	Platform as a Service	&	Business Process
			SaaS	&	Logistic*	IaaS	&	Logistic*	PaaS	&	Logistic*
			SaaS	&	Warehous*	IaaS	&	Warehous*	PaaS	&	Warehous*
			SaaS	&	Transport*	IaaS	&	Transport*	PaaS	&	Transport*
			SaaS	&	SCM	IaaS	&	SCM	PaaS	&	SCM
			SaaS	&	Supply Chain	IaaS	&	Supply Chain	PaaS	&	Supply Chain
			SaaS	&	Strateg*	IaaS	&	Strateg*	PaaS	&	Strateg*
			SaaS	&	Business Process	IaaS	&	Business Process	PaaS	&	Business Process

Table IV: Ranking by absolute word frequency

#	Word	Frequency	Document Appearance
1	SERVIC	6,737	100.0%
2	CLOUD	4,396	82.8%
3	PROCESS	3,190	96.0%
4	PROVID	3,137	100.0%
5	CHAIN	3,075	81.8%
6	SUPPLI	3,067	85.9%
7	BUS	2,949	100.0%
8	SYSTEM	2,880	97.0%
9	INFORM	2,721	98.0%
10	COMPUT	2,627	83.8%
11	MANAG	2,626	98.0%
12	MODEL	2,613	98.0%
13	DATA	2,532	98.0%
14	BAS	2,155	100.0%
15	FIRM	2,074	71.7%

16	RESEARCH	2,060	97.0%
17	TECHNOLOGI	2,017	94.9%
18	CUSTOM	1,945	98.0%
19	COST	1,888	96.0%
20	SAAS	1,752	58.6%
21	VALU	1,742	96.0%
22	APPLIC	1,741	97.0%
23	STUD	1,682	89.9%
24	COMPANI	1,611	91.9%
25	TIME	1,582	99.0%
26	RESOURC	1,494	93.9%
27	ORGAN	1,423	96.0%
28	NETWORK	1,406	88.9%
29	MARKET	1,396	90.9%
30	ADOP	1,371	61.6%
31	OPER	1,328	99.0%
32	DEVELOP	1,319	97.0%
33	INTEGR	1,312	97.0%
34	DIFFER	1,301	97.0%
35	REQUIR	1,261	98.0%
36	PERFORM	1,249	97.0%
37	SECUR	1,249	72.7%
38	SUPPORT	1,226	97.0%
39	PRODUCT	1,220	84.8%
40	LEVEL	1,184	96.0%

Table V Ranking by TF IDF

#	Word	TF IDF	Document Appearance
1	CLOUD	455.2	82.8%
2	SAAS	406.8	58.6%
3	FIRM	299.4	71.7%
4	ADOP	298.0	60.6%
5	CHAIN	268.0	81.8%
6	AGIL	223.1	43.4%
7	SUPPLI	203.1	85.9%
8	COMPUT	201.1	83.8%
9	RISK	173.7	61.6%
10	SECUR	172.7	72.7%
11	CAPAC	137.8	65.7%
12	LOGIST	136.9	61.6%
13	PARTNER	125.4	66.7%
14	COORDIN	125.3	61.6%
15	WEB	114.1	70.7%
16	SUPPLIER	113.5	75.8%
17	FACTOR	112.0	76.8%

18	ADOPT	109.6	74.7%
19	MANUFACTUR	109.3	70.7%
20	ENTERPR	102.0	73.7%
21	COLLABOR	91.5	71.7%
22	PRODUCT	87.1	84.8%
23	DECISION	83.8	82.8%
24	COMPLEX	80.0	79.8%
25	STRATEGI	78.3	76.8%
26	MEASUR	77.8	77.8%
27	STUD	77.8	89.9%
28	FRAMEWORK	74.8	75.8%
29	NETWORK	71.9	88.9%
30	SHAR	69.7	79.8%
31	TABL	64.6	81.8%
32	KNOWLEDG	62.8	79.8%
33	CASE	60.9	83.8%
34	EVALU	60.9	79.8%
35	ENABL	60.7	82.8%
36	COMPANI	59.0	91.9%
37	APPROACH	58.7	82.8%
38	MARKET	57.8	90.9%
39	PROCESS	57.1	96.0%
40	WORK	56.9	84.8%

Beitrag Nr. 2	
Titel	Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	Journal of Systems and Software
DOI	http://dx.doi.org/10.1016/j.jss.2015.09.029

Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application

Abstract

In IS research, reference models have demonstrated to be a beneficial instrument for providing blueprints for a reasonable, good design of information systems and underlying organizational settings. Researchers assume that the application of reference models allows time savings, cost savings, and quality increases. But these effects may only appear when providing a research-based and empirically evaluated reference model that is profoundly documented. However, research criticizes the often missing identification of similarities in related work and preexisting knowledge, which might lead to arbitrariness. Moreover, linking existing knowledge during development and evaluation processes of reference models can bring new and fruitful insights. Therefore, this paper uses a scientific approach consisting of four steps. First, we develop a requirements framework for designing reference models. Second, we use this framework as a basis for the comparison of well-documented reference models. Thereafter, the gained insights from step one and two are consolidated into a conceptual process model that has a strong regard to preexisting knowledge. Finally, a case study will show the applicability of the determined model. With this paper, we enrich research by a valuable guideline for developing methodologically well-designed reference models that support users to take full advantage of the above mentioned benefits.

Keywords: Reference modeling, Conceptual process model, Design science research, Document analysis, Literature analysis, Case study research

1 Introduction and Motivation

Conceptual information models constitute important artifacts within the domain of information systems (IS) research and have been studied by scientific institutions and by practice (e.g., Chen, 1976; Scheer and Hars, 1992; Cash and Wilkerson, 2003; Keller and König, 2014) for many decades. With the development of information models, the intention is to build manageable artifacts that enable decision makers to understand the complexity (Thomas, 2006) and to increase the transparency of the underlying IS processes (Becker et al., 2010). For the adoption of information models, there are various areas of application, ranging from initial software development to advanced business process reengineering. Thereby, conceptual information models reconstruct a piece of reality.

The paper at hand focuses on one specific type of conceptual information models, namely the reference information model or *reference model* (RM) to use the more common term. In general, RMs have their origin in the need for creating an abstract of in-depth company or project-specific IS in order to reuse this abstract in other applications or to transfer it on other environments (Frank, 2007). According to Thomas (2006), a RM always constitutes an initial model as a point of reference for the construction of other and more specific models. Such an initial model promises the model users time savings, cost savings, and quality increases (Fettke and Loos, 2005). In spite of these advantages, research still struggles with providing a common understanding of RM. Furthermore, research literature argues that reference modeling may consist of specific IS methods, IS languages, and IS tools. But these specifications vary from author to author, which leads to a broad fluctuation range within the RM paradigm.

However, it is common sense that the effectiveness and efficiency of the application of a RM is strongly determined by the quality of the initial RM. In order to be able to properly translate the model and to ensure clear model guidance, according to Thomas (2006) and Becker et al. (2010), there are two basic quality conditions: an adequate *degree of universality* and an adequate *degree of recommendation* for the users. But it is unclear how these quality characters can be verified. Vom Brocke (2003), Fettke et al. (2006), as well as Möller et al. (2011) discover a lack of assessability for the content of universality and recommendation in RMs. In this regard, Thomas (2006) as well as Fettke and Loos (2004) motivate scientific research to provide adequate approaches for measuring and evaluating the quality of RMs, as operational and practical users are not in a position to assess the universality and recommendation quality of suchlike models. To be more precise, Fettke and Loos (2003) also refer to the research outcome “reference model” that can be understood as a theory in the IS area. Hence, it is indisputable that the construction of RMs should strongly and systematically be based on already existing knowledge. This strong knowledge regard (e.g., involving research in science and practice, expert knowledge) constitutes the starting point of our paper, as we intend to meet both conditions (universality and recommendation) in a document-driven way. Stating very clearly, the purpose of our work is not to call into question the valuable outcomes of existing RM research. Moreover, we believe that there cannot be a one-way-fits-all approach on the complex domain of RM research. Thus, we strive to contrast with the other already existing and well-known conceptual models for designing RM (e.g., Fettke, 2005; Vom Brocke, 2003). Given a rich knowledge base, we intend to provide a document-driven process model that might bring new insights for RM developers and users by linking the RM to the underlying body of knowledge. Herein, document-driven means that the design process of RM is in addition to the modeler´s subjective intuition or personal experience effectuated by documents´ contents (e.g., scientific and practical literature, transcripts of expert interviews, postings in social media networks).

Moreover, our paper goes in line with the argumentation of the recently developed research on inductive RM development (e.g., Ardalani, et al., 2013, Martens, et. al. 2014, 2015) by stating that the *identification of similarities* between already existing knowledge is compellingly needed for deriving abstracted RMs in order to meet the above mentioned two conditions. Towards this end, statistical analysis and data mining constitute important RM development and evaluation methods for enabling a higher level of objectivity and for reducing arbitrariness. In classic research on RMs, only few authors of such RMs reveal the procedural methodology with which they developed and evaluated the presented models. This leads to models that are only loosely anchored in scientific literature and practice knowledge. Fettke and Loos (2004) consider it essential to perform the evaluation and assessment procedure already during model creation and not only at the final phase, since this is the only way to enable an iterative creation and evaluation process. Therefore, we aim to present a more complex RM design life cycle that involves related knowledge by a metric-based evaluation. The underlying research questions (RQ) of this paper are as follows:

RQ1: What characteristics of a conceptual process model are necessary for the design and evaluation of RMs that are, contrary to many already existing RMs, deeply anchored in related knowledge?

RQ2: How can objectivity be ensured and arbitrariness be avoided during the design and evaluation of RMs?

In terms of the paper's structure, we adopted Becker et al. (2009) who provided a general procedure model for the development of maturity models, while criticizing preexisting arbitrariness in model development as well. In section 2, we explain the relevant theoretical background, which leads us to the general requirements of reference modeling. In section 3, we use the determined requirements as a basis and compare various selected RMs. Thereafter, we extend the existing body of knowledge by presenting the conceptual process model for the development of RMs. In section 5, we experimentally apply the model on the topic of cloud usage in supply chains. The paper ends with a conclusion in section 6.

2 Theoretical backgrounds

2.1 Related work

The synthesis of the reference modeling research field has brought much valuable insights to the existing body of knowledge. Within this section, we focus on research that discusses procedures and approaches for designing RMs (*research methodologies*), whereas the analysis of finished RMs, as an aid for end users (*research outcomes*), is covered in section 3. For identifying relevant work, we used two scientific databases (Science Direct, Springer Link) and the following searching terms: (reference model OR reference modeling) AND (methodology* OR research). Moreover, we took only publications from the year 2000 and ongoing into account as we were interested in the latest research progress, assuming that prior work (< year 2000) was implicitly involved in the latest research. Further, the term reference model has widely been used with different meanings. Therefore, we took only papers that go in line with our understanding of the term (cf. section 2.3) and focus RM methodologies and/or procedures instead of RM applications (research outcomes). In the next step, we excluded papers that show only minimal additional contribution to existing literature (e.g., proceedings´ papers similar to extended journal papers of the same authors or similar papers in different languages). Herewith, we got 16 relevant papers.

Hence, we have identified important studies that could, despite of some significant differences, be compared to ours. These 16 studies are summarized in Table 1 and compared to our approach according to the following attributes:

- Semantic approach: Does the study provide any ontology to analyze RM processes?
- Literature regard: Does the study compare related work?
- Evaluation: Does the study discuss an evaluation approach and, if so, is there a new evaluation approach determined?

- Major issue: What is the problem domain of the study and what is the main difference between this approach and ours?

Looking at Table 1, which contains studies of some of the most influential researchers on RM development, it is obvious that research on RM covers a quite broad range and includes various semantic approaches, evaluation methods, and IS issues. Furthermore, there are various papers that discuss general guidelines in RM development, and hence, seem to be similar to our study. Our paper distinguishes from the existing literature by two main aspects: (i) there is no paper on RM research that discusses the RM development and evaluation from a business process modeling notation (BPMN 2.0) perspective, which would enable an intensive analysis of the RM developer and the RM user role; and (ii) there is no metric-based RM evaluation presented. Highly depending on the amount and the quality of the underlying documents, this evaluation phase might bring novel insights by analyzing RM contents in preexisting knowledge (e.g., testing the discussion intensity in documents of specific connection points in the RM). The recently created metric-based approaches by Ardalani et al., (2013) and Martens et al., (2014, 2015) are helpful especially for *inductive RM development* of individual projects, while (by nature) allowing a high degree of encapsulation from existing adjacent knowledge. In contrast, the metric part of our approach focuses particularly on the *RM evaluation processes* and allows virtually inductive (e.g., involving transcripts of expert interviews around one common process) and deductive (e.g., involving practice research and/or scientific theories) evaluation. But although a large part of the referenced papers have a related work section (literature regard), most of the approaches have been developed independently from each other, which is criticized by Becker at al. (2007) and Vom Brocke et al., (2014). With our approach, we aim at a comprehensive involvement of related work during the whole RM creation process.

Table 1 Summary of related work

Reference	Semantic approach	Literature regard	Evaluation	Major issue
Becker et al., 2000	Yes, event-driven process chain (EPC) and entity-relationship-modeling (ERM)	No	Yes, via simulation; no new evaluation approach is presented	Study determines guidelines for RM development while focusing on the functional, the organizational and the data view
Fettke and Loos, 2003	No, structural/ argumentative study	No	Yes, argumentative proposals of several evaluation types	Study provides an evaluation framework
Vom Brocke, Buddendiek, 2004	Yes, event-driven process chain (EPC) and entity-relationship-modeling (ERM)	Yes	Yes, exemplary software application; new evaluation approach is presented	Study focuses on the adequate usage of languages and tools
Fettke and Loos, 2005	No, structural/ argumentative study	No	Yes, need is discussed; no new approach is presented	Study analyzes the helpful link between RM and business engineering
Fettke, et al., 2006	No, structural/ argumentative study	Yes	Yes, study discusses mainly lack of evaluation; no new approach is presented	Study provides qualitative evaluation criteria for analyzing existing RMs
Thomas, 2006	No, literature review	Yes	No	Study aims to explain the research field RM
Becker et al., 2007	Yes, event-driven process chain (EPC) and entity-relationship-modeling (ERM)	Yes	Yes, exemplary adaption of a new approach is described	Study focuses on the integration of configurative adaption methods
Frank, 2007	No, structural/ argumentative study	Yes	Yes, proposals for various evaluation perspectives such as economic or knowledge sharing	Study provides an extensive evaluation catalogue
Ahlemann, 2009	Yes, unified modeling language (UML)	Yes	Yes, exemplary excerpt of new evaluation type	Study discusses software development for project management
Houy, et al., 2010	No, literature review	Yes	No	Study provides an analysis of empirical research of RM development
Walter et al., 2013	No, structural/ argumentative study	Yes	Yes, within the life cycle, no new approach shown	One of the first studies that presents an inductive strategy for RMs
Ardalani et al., 2013	Yes, event-driven process chain (EPC)	No	Yes, new evaluation type through an user interface example is presented	Study presents inductive RM development that bases on existing individual projects
Malinova et al., 2014	Yes, unified modeling language (UML)	Yes	No	Study provides organizational support for process mapping
Martens et al., 2014	Yes, formal model using minimal graph-edit distance	Yes	Yes, new procedure is tested via software prototyping	Study presents new procedure for inductive RM development
Vom Brocke, et al., 2014	No, structural/ argumentative study	No	No	Study provides framework for business process management
Martens et al., 2015	Yes, formal model using factor analysis	Yes	Yes, in various application scenarios, new evaluation type is shown	Study presents new procedure for inductive RM development

2.2 Characterization of knowledge involvement

The Oxford dictionary defines knowledge as awareness or familiarity of facts, information, or skills, which are gained through experience or education; the theoretical and practical understanding of a subject. Hence, knowledge may be documented in various forms such as scientific and practical literature, social networks or transcribed expert interviews. And consequently, our approach may include virtually any written form or document. In the following, we distinguish between qualitative and quantitative analyses.

While a qualitative analysis may be seen as an ex-ante analysis prior to RM creation, a quantitative content analysis may be used as a metric-based evaluation of preexisting knowledge via data mining. A qualitative analysis constitutes a review of the existing relevant literature or documents and is an elementary feature of any research project as it facilitates theory development and accelerates research knowledge (Webster and Watson, 2002). In IS research literature, there are many papers guiding a systematic document analysis (e.g., Webster and Watson, 2002; Levy and Ellis, 2006; Okoli and Schabram, 2010). As an adequate knowledge building is strictly linked to existing knowledge in related work (e.g., published IS articles, transcript interviews), the execution of the analysis should follow a clear structure. For instance Fettke (2006) proposed a five-stage model that consists of issue description and definition of the research field, document search, document evaluation, document analysis, and interpretation. In order to ensure relevant results and to better understand the nature and characteristics of the model artifacts, developers of RM should search for similar issues in scientific and practical documents (e.g., by keyword-oriented searches in scientific and practical data bases). Moreover, it is important to find similarities and differences in RM literature in order to avoid redundant work and uncover new application possibilities. Unfortunately, the term RM is not clearly defined in literature, which makes it necessary to search for adjoining terms and research fields. Although the leading papers on the issue of literature analysis provide orientation tables and best practices (e.g., Frank, 2007; Vom Brocke et al., 2014), the fact that there are vast amounts of documents as well as unclear terms may lead to a relatively high degree of subjectivity in both document search and document evaluation. Thus, although the execution of qualitative document analyses is time-consuming and requires a considerable analysis effort, it is compellingly needed for the design process of RMs. Further, the inclusion of other information sources such as social/expert networks may lead to valuable insights for qualitative analysis as well.

In contrast, the quantitative content analysis, which we equate to the bibliometric analysis, leads to more objectivity. Due to the computer-assisted processing, also vast amounts of papers, books, transcripts and other documents can be involved. This should, however, not tempt a researcher to increase the amount of documents indiscriminately. The computer-assisted evaluation process runs in a clearly defined way, which ensures at least reliability. Acknowledging Lijphart (1971), the quantitative content analysis constitutes a suitable methodology for knowledge development and theory proof, particularly when having an imprecise underlying theoretical background. Towards this end, we go in line with Becker et al., (2004) who understand theory as consensus theory. They further consider a theory to be proved as valid when all related parties accept it under optimal conditions. Towards this end, quantitative data analysis can help to grasp the general theory acceptance of the related parties by analyzing the relationship of contents more in detail and on a wide basis. Moreover, an adequate quantitative content analysis of textual messages has to fulfill certain requirements (Neuendorf, 2002, pp. 10), which are determined as: objectivity, intersubjectivity, a priori design, reliability, validity, generalizability, replicability, and hypothesis testing. There are various document mining software solutions available (e.g., WordStat by Provalis, 2010), yet comprehensive solutions require a lot of preparation work, such as spell checking of the individual documents, removal of hyphens and hyphenation, removal of brackets and braces, as well as lemmatization or stemming reduction. Once a data basis has been generated, various analyses can be performed (e.g., total word or term frequency or inverse document frequency). In the context of this paper, there is one specific feature that is especially promising, as it provides more objectivity during the metric assessment phase of constructing RMs: This feature enables calculating the conjoint appearance of words (1:1, 1:n, n:n) and is called co-occurrence. Formally, the co-occurrence (*CO*) is a weighted, undirected calculation of the form:

$$CO = (W, C, f)$$

where *W* is the set of all words in the sample or corpus, and *C* is the set of all pair-wise co-occurrences across words deduced from the episodes in the corpus. The underlying co-occurrences calculation in the corpus is indicated by the function f. The co-occurrence count for two words is defined by $w_i, w_j \in W$. For analyzing these interrelations, e.g., the Jaccard's index (*JI*) similarity coefficient can be used. This kind of measure is especially appropriate for word analyses in a sample of documents (Murguia and Villasenor, 2003; Tan et al., 2005) and is defined by:

$$JI = \frac{a}{a + b + c}$$

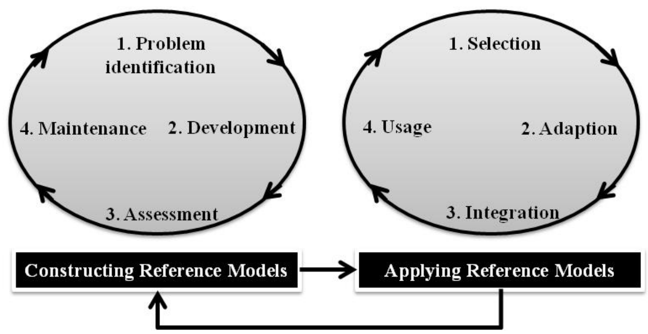
where *a* represents a document's paragraph in which both words w_i *and* w_j occur, and *b* and *c* represent paragraphs in which one word is found but not the other (Tan et al., 2005). Hence, when having created a first piece of the RM, it is possible to calculate the co-occurrence of the related terms in the RM in order to investigate the interrelations of the terms. For instance, when using the entity relationship model as the RM language, the co-occurrences of specific attributes and their entities may be calculated for investigating the data base´s most discussed attributes of entities. As some attributes may have higher co-occurrences, they may hence have a higher discussion relevance than others. Contrary, when having significantly high co-occurrences that are missing in the RM, the completeness and fit of the actual RM can be questioned. This procedure will allow an additional and more objective evaluation step by grounding developed RMs stronger in related scientific and practical work.

2.3 Understanding the reference modeling process

As mentioned in section 1 of this paper, there is no clear definition of the RM terminology. But there is general consensus that RMs constitute aggregated models, generic models, or theoretical models that have to be adapted to the specific conditions of enterprises and projects. For the upcoming determination of requirements, especially the universal process model on RM design proposed by Fettke and Loos (2004) constitutes an adequate basis, which we briefly explain. Looking at the construction process in Figure 1, the *problem has to be identified* by investigating the key issue in the IS by means of the relevant resources, roles, responsibilities, and interrelations. Derived from the identification of the problem, a viable model artifact has to be *developed*, which demands an adequate degree of abstractness with a clear communication. Fettke and Loos (2004) emphasize that the quality of the artifact has to be ensured before completion of the RM. Herewith, reliable and valid *assessment* measures have to be selected and applied. The assessment should be carried out as neutral and objective as possible in order not to mislead potential users. The *mainte-*

nance phase constitutes the last step of the construction process and comprises correction, adjustment, and/or extension of the model artifact. The extent to which amendments have to be made is thereby highly dependent on the outcome of the assessment phase. In order to apply a RM, the user has to *select* an adequate RM, *adapt* it to the specific issue, and *integrate* it. The assessment results do not only support the developer during the construction process, they also help the user to select the correct RM. Finally, the experiences gained from applications should be traced back to the abstracted constructing process, which ensures an evaluation of the RM. In section 2.4, we link this process model to the general requirements on design science by Hevner et al., (2004), and we extend the existing body of knowledge by considering a stronger qualitative and quantitative regard to related work in the overall RM construction process.

Figure 1 Reference modeling process (Adapted from Fettke and Loos, 2005)



2.4 Determining the requirements for viable reference model design

In this section, we intend to investigate and establish a general requirements guideline for RMs. Towards this end, we use the design science guidelines provided by Hevner et al., (2004) as a basis and transfer them to the RM requirements guideline. According to March and Smith (1995) and Pfeffers et al. (2008), design science is about creating innovative problem-solving artifacts, such as model, methods, and constructs. Hence, we argue that reference modeling may constitute a subgroup of design science research. Not surprisingly, we found that papers on RM coincide with papers on design science in one major aspect: In both cases there is a more or less intensive separation in two sub processes (Vom Brocke, 2003; Fettke and Loos, 2004; Becker et al., 2010; March and Smith, 1995; Hevner et al., 2004), namely the *construction process* and the *application process*.

For the improvement process in design science, Hevner et al. (2004) describe seven generally accepted guidelines. We take these guidelines as a basis (cf. Table 2) and transfer them to the context of designing RMs. Furthermore, we augment the guidelines by stronger anchoring RMs in related work. We explicitly stipulate that a qualitative document review is indispensable in reference model requirements (RMR) 2. Further, we follow Fettke and Loos (2003) by calling for a multi-perspective analytical evaluation. This includes not only a qualitative document review prior to the construction phase, but also an evaluation of preexisting IS knowledge (RMR8) after the construction phase, which may include paradigmatic evaluation (such as the guidelines of modeling by Becker et al., 1995; Frank, 2007), meta model-based evaluation, or metric-based evaluations (such as quantitative content analyses, cf. section 2.2). Moreover, literature argues that there are two more or less separated model processes in the design of RMs, namely *construction* and *application*. Therefore, we distinguish between the developer role and the user (or applier) role, which, however, may ultimately be one and the same actor. This abstraction helps us to indicate that a certain process is categorized as construction or as application process.

Table 2 Reference model requirements

Guideline from Hevner et al. (2004)	Reference model requirement (RMR)	Role	Description of reference model requirement
Problem relevance	RMR1: Problem definition	From the developer perspective	The key issue has to be investigated with its related resources, roles, responsibilities, and interrelations.
Research contributions	RMR2: Qualitative document verification	From the developer perspective	The problem of the outstanding RM has to be set in relation to existing literature (and - if any - with existing RMs) via a qualitative document analysis. It has to be clear whether the new RM aims to extend, replace, or improve already existing RMs.
Design as a search process	RMR3: Iterative construction	From the developer perspective	The new RM must be developed iteratively; through searching for solutions in related work, adopting RM, and/or proposing new ways; and, if necessary, through refinement.
	RMR4: Iterative selection	From the user perspective	The RM has to be substantiated iteratively via a search and selection process. Compared with other models, it is necessary to explain how and why the new model is accepted as a reference.
	RMR5: Iterative adaption	From the user perspective	The generic RM needs to be adapted iteratively to a company- or project-specific model. The adjustments, replacements, or extensions as well as the implementation/integration process have to be clarified in width and depth.
Research rigor	RMR6: Selection of methodologies	From the developer perspective	The new RM may have various abstraction levels and may include methods, languages, and tools, which have to be selected and adopted accordingly to the underlying issue.
Design as an artifact	RMR7: Development of sections	From the developer perspective	Due to the multifaceted nature of RMs, the new model can normally not be produced from one single source only. It rather has to be created in sections, whereby every section has to be based on preexisting knowledge gained from documents and tested for validity prior to integration into the overall RM. Only in this way it will be possible to create a viable artifact.
Design evaluation	RMR8: Knowledge-based evaluation	From the developer perspective	As a new RM always constitutes a new theory, it is necessary to evaluate the RM through an IS knowledge-oriented perspective. This may include analytical evaluations (e.g., meta-model-based evaluation (RMR8a)), and metric-based evaluation (e.g., quantitative data analysis of documents and/or transcripts (RMR8b)).
	RMR9: Empirical assessment	From the user perspective	After having applied the RM in empirical environments, the usefulness, the quality, and the effectiveness of the intermediary outcomes need to be measured with scientific methodologies.
Communication of research	RMR10: Literature enrichment	From the developer perspective	The results from RMR1 to RMR9 must adequately and scientifically be documented in a technology-oriented as well as management-oriented way.

3 Comparison of literature foundations and designs of selected reference models

In this section, we use the ten determined reference model requirements (RMR) for the purpose of comparing already existing RMs. In this way we determine to what degree these models fulfill the requirements. On the basis of this comparison, we extract the existing body of knowledge by presenting a generically applicable process model (cf. section 4) for designing RMs that are strongly anchored in related work and meet the determined requirements. Subsequently, we exemplarily apply this conceptual process model on the use of cloud services in cross-company supply chain processes (cf. section 5). In order not to exceed the limits, in our paper, we especially focus on RMs that investigate service-oriented architectures (i) because for these processes, the reusability is of extraordinary importance and (ii) because the service-oriented models differ substantially more from each other than in other application domains (Vom Brocke and Buddendiek, 2004; Becker et al., 2010), which calls for consolidations and a stronger evaluation between the documented service-oriented models. Towards this end, we define service-oriented architectures as a paradigm of structuring and using of distributed IT-functionalities that are assigned to diverse users (Brown et al., 2012). But at the same time, we emphasize that the upcoming conceptual process model for reference modeling may also be applied in various other research-driven environments. As a precondition for an adequate comparison, the existing service-oriented models need to meet RMR10, because only RMs with a clear documentation and communication can be compared with each other. Becker et al. (2009) have classified three ascending documentation degrees: 1) documentation includes comparison with existing models, 2) documentation roughly includes the steps of design and evaluation processes, and 3) documentation includes a comparison as well as the steps of design and evaluation processes in detail. In line with Becker et al. (2009), we considered only RMs that fulfill the third level.

As a source for comparing service-oriented RMs, we used the catalogue provided by Becker et al. (2010). They conducted a systematic literature review by searching for service-oriented RMs in various well-recognized conference proceedings and journals as well as in standard setting organizations. As a result, they found 18 service-oriented RMs (including 3 integrated RMs that discuss the intersection of services and physical goods). In order to identify relevant RM publications, we extended the search process by considering three scientific databases (EBSCO, Science Direct, Springer Link). Moreover, we took publications until 2014 into account. Finally, we conducted a forward and backward search (Webster and Watson, 2002). Due to the fact that the term “reference model” has been used very frequently in the meantime, we considered only papers that are in line with our understanding of reference modeling (cf. section 2.3). By means of this approach, we yielded another 13 service-oriented RMs. Hence, we identified a total of 31 relevant models. In the next step, we excluded all those papers that do not distinguish between construction and application phase. Thereafter, each of the selected models was checked for compliance with the third documentation type in RMR10. On the basis of this appraisal, seven RMs proved to be well documented. These seven works have been checked synoptically in terms of RMR 1 to RMR 9. However, in more than three quarter of all published, service-oriented RMs the design and evaluation processes are not adequately documented. This fact reaffirms us in our intention to more strongly anchor RMs in preexisting research knowledge. As we used RMR 10 as filter for the identification of the 31 papers, this requirement will not be reinvestigated again. In the following, we briefly discuss the seven RMs and present an overview in Table 3.

The first model is the ECO-integral RM (Krcmar et al., 2000). It was designed as an open standard for linking ecological aspects with management information systems. Herein, various institutions, consulting companies, service providers, as well as case companies participated. The second RM constitutes a combination of organizational aspects and software development processes (Duarte et al., 2007), while the third RM represents a mixture of a reference model, a maturity model and a balanced scorecard (Martens and Teuteberg, 2009). The paper investigated fundraising activities at academic institutions with a strong focus on organizational responsibilities. Derived from an extensive literature review, the RM aims to create a management information system. The fourth model deals with a functional RM for increasing the quality at master data management (Otto et al., 2012). It stands out for being constructed over more than three years and having three iteratively developed versions. Furthermore, the results of the case company indicate that the model can easily be transferred with relatively low costs. This is indicated for the fourth RM as well. With this, Winkelmann (2012) proposes a new and effective way for RM maintenance. However, Czarnecki et al., (2013) provide an abstracted process guideline for telecommunication companies in a transformation process towards integrating and bundling new business models and innovative technologies. Finally, Keller and König (2014) created a model that supports risk identification in cloud computing networks.

Table 3 Comparison of selected reference models

Reference model requirement (RMR)	Source						
	Krcmar et al. (2000)	Duarte et al. (2007)	Martens and Teuteberg (2009)	Otto et al. (2012)	Winkelmann (2012)	Czarnecki et al. (2013)	Keller and König (2014)
Problem Identification (RMR1)	How can company-specific ecological data be generated and analyzed, and how can these data be integrated into the enterprise resource planning system? Further: How can top management be involved?	How can an organizational platform for a software provider be created that encourages a clear way to control and define software development processes?	How can academic institutions be supported in intensifying their fundraising activities?	How can the quality of companies´ master data be increased, and how can adequate system support be provided for master data management?	How can a procedure model for updating and maintaining RMs be created with regard to the implicit system knowledge? (Knowledge within enterprise resource planning (ERP) software)	How can telecommunication companies be supported during their transformation process towards creating innovative services bundles?	How can cloud actors identify risks in cloud networks and increase the transparency in network structures?
Qualitative document verification (RMR2)	Use the principles and instruments from the "Eco-management and audit scheme (EMAS)" and "ISO 14001" as a basis.	The paper provides analyses on related work in terms of process-oriented organization and change management. RM is extension of own, previously created work.	Review the literature on fundraising from a psychological, organizational, technical, and economic perspective and evaluate the most important issues.	Review the literature on master data management and data quality management, before deriving business requirements of both fields for a functional RM.	Reviews the literature on the reuse of RM as well as parameterization and customization, before coming to own research objectives.	Analyze enterprise architectures (e.g., ANSI/IEEE Standard 1471-2000), and enterprise architecture frameworks (e.g., Zachman framework), RM is extension of existing RM.	Ground the model on an extensive literature review by including developments, actors and risks in cloud networks. No comparable RM was found in literature.
Iterative construction (RMR3)	Application in four case companies led to gradual modifications of the RM.	Iterative construction process is clearly described by customization of RM contents in order to meet user requirements.	Findings from an application at a University and participating academics led to iterative improvements.	Knowledge sources for the first design iteration are presented. Qualitative interviews and a participative case study led to three iteratively created versions.	Model consolidation is applied, namely by iterative integration of new elements and elimination of obsolete parts.	RM was applied in two case companies in emerging regions. After the application adjustments were needed at operational level.	Modeler applied a multi-method approach with two rounds of interviews and real world examples. The received feedback was incorporated into the model.
Iterative selection (RMR4)	The using companies accept the model as a reference, because it stands out by providing cost transparency and management support.	The RM was initiated by the case company, requiring an instantiation of their processes with the rational unified process (RUP) method. No other suitable RM was found.	The user demands an integrated solution with a “balanced scorecard” and a maturity model, which is provided by the RM.	The model is a suitable basis for identifying unnecessary application system licenses and potentials for consolidations.	A company with specialization on food retailing required a procedure model that allows ongoing maintenance of existing RMs without significant entry barriers.	An acknowledged standard setting body (TM Forum) included RM processes in its framework as they force standardization in service compositions.	Due to the newly emerging and mostly hidden risks from cloud networks, the developers create a RM that is confirmed by interview partners to be the new reference.

Iterative adaption (RMR5)	In-depth company-specific extensions have been made by defining and determining specific data, such as bill of material.	RM contains a reviewer part that continually refines the business processes as well as roles and responsibilities.	Institution-specific processes and roles have been considered, before creating an overall data base.	Based on the case company´s SAP application landscape, the RM was applied for rating functions and creating tables.	Two modelers collected and evaluated processes and data of the ERP system on the requirements derived from the case study.	A vast amount of adjustments and refinements were needed in order to align RM processes to company-specific information systems.	The model is instantiated with real world cloud actors by describing dependencies and extending the initial RM.
Selection of methodologies (RMR6)	Architecture of integrated information systems (ARIS) has been used as a method in combination with event-driven process chains (EPC) and function trees as semi-formal modeling languages. No additional tools have been used for RM design.	The use case models are determined with the help of UML activity diagrams. Formulas have been created for employees' compensation. Their roles and activities are depicted in simple tables. No additional tools have been used for RM design.	UML notation has been used for the overall RM. Sub-processes are explained with event-driven process chains (EPC). Neither overall methods tools nor theoretical tools have been used for RM design.	Architecture of integrated information systems (ARIS) has been used as a method. The modeling languages followed the principle of process maps in tabular form. No additional tools have been used for RM design.	The interaction patterns are formalized as event-driven process chains (EPC) and UML diagrams. Data requirements are formalized with entity relationship models (ERM) and UML diagrams.	Semi-formal process mapping figures have been used. Took the existing tool "enhanced telecom operation map (eTOM)" as a basis and integrated additional reference process activities in various levels.	A simplified version of UML notation with class diagrams has been used as a semi-formal modeling language. For displaying actors and risks, tree based structures were applied. Neither overall methods tools nor theoretical tools have been used for RM design.
Development of sections (RMR7)	Various aspects such as legal requirements or financial conditions have been derived from literature and integrated as sections into the RM.	Researchers start the real life application with the relevant organizational units before coming to business objects and other business artifacts.	The reference model consists of seven sections, such as maturity model, balance scorecard, data base, or roles.	The model comprises six function groups, where every function group bears reference to research and is described in detail.	The developer differentiates between an external view (e.g., system analysis, model consolidation) and an internal view (refinement of sub-processes).	Take service bundle definitions from literature as a base for classifying four sections in RM, namely customer, product, service, and technical network.	Overall RM consists of two partial models: connections between actors; causalities between hazards, risks, and reinforcement.
Knowledge-based evaluation (RMR8)	After the development phase, the overall RM has been evaluated, provided it is consistent with the generally accepted research guidelines.	The practice-driven RM was evaluated by quality assessments as milestones between phase transitions. No research guidelines proof.	The evaluation procedure is not described in detail in the paper, but expert interviews with various IS researchers approved the validity.	In order to evaluate the validity of the artifact design, the developer assessed the model with theoretical guidelines for orderly modeling.	The evaluation procedure is not described in detail in the paper, but expert interviews approved the validity.	Evaluation and approval have been made through the standard setting body (TM Forum).	In order to enhance the quality of the RM, the developer used the theoretical guidelines of modeling.
Empirical assessment (RMR9)	The usage at the four case companies indicates that the benefits from cost savings overcompensate the implementation costs, and reduce waste at the same time.	RM benefits the individual performance in software development processes as well as drives premium wages.	The application of the model decreases the efforts for structuring fundraising activities and created a better understanding through its integrated approach.	From the case company´s economic perspective, the application costs are low and from the deployment perspective the model is easy to understand and well applicable.	The paper indicates that the case company could maintain its ERP reference model more effectively by using the proposed consolidation method.	The two case companies are able to operate more efficiently without having any additional costs.	The real life application displays the dissemination of risks through the cloud network, where the actors are able to identify the impending risks.

It is noteworthy that the publication types of the respective RMs' results are manifold, ranging from a single conference paper (Keller and König, 2014; Mertens and Teuteberg, 2009), to chapters in books (Duarte et al., 2007), to research journals (Czarnecki et al., 2013; Otto et al., 2012; Winkelmann, 2012), and large processing reports covering several hundred pages (Krcmar et al., 2000). Beyond that, it is remarkable that in the design of all seven cases, the qualitative document review was made prior to the model development. This does not only support the RM developer and the RM user during the design process, it also allows the interested reader to understand the issue relevance and the contributions. Moreover, all RMs were constructed via an iterative process, in which expert interviews, standard setting bodies, or case studies led to valuable feedback and redesign. In general, this was well documented and communicated. In terms of knowledge-based evaluation (RMR8a), Otto et al. (2012) provide the most comprehensive theoretical evaluation, after having constructed the final RM. They describe the theoretical IS requirements for orderly modeling and assess their RMs accordingly. Nevertheless, neither the selected papers nor the remaining papers used a bibliometric-oriented assessment during the theoretical evaluation of the RMs (RMR8b). This creates the impression that the developers either do not attach importance to this research method or they deem it difficult to find and adapt adequate measurements to their RMs. Hence, in section 4, we follow Fettke and Loos (2003), who encourage researchers to consider more metric orientation in the RM design evaluation. This entails useful and hidden insights in the RM creation.

4 Conceptual process model for designing bibliometric-oriented reference models

In this section, we propose a conceptual process model for the development of a RM that is strongly anchored in literature. Constructing a new process model or a method from preexisting methods is typically a research contribution in the domain of method engineering (Harmsen and Saeki, 1996; Hendersen-Sellers at al., 2014). In general, method engineering is a well-recognized classic research field that involves a broad range of approaches and concepts. As one of the first researchers in the domain of method engineering, Mayer et al. (1995) have proposed an approach that includes a more process-oriented view. Therefore, we take this approach as basis and align our upcoming model to the chosen method engineering process model (MEPM). By discussing the single connection points between the MEPM and our model, we aim to show the already existing implicit closeness between research on RM and method engineering (cf. Figure I in the appendix for more details on MEPM).

The elements of the model (cf. Figure 2) are mainly derived from the determined RM requirements (cf. Table 2) and from the insights gained from the presented, well-documented RMs (cf. Table 3). Therefore, our conceptual process model generalizes the design process of the reviewed, well-documented RMs and provides a great basis for the development of future RMs. For the depiction of our conceptual process model, we use business process model notation (BPMN) 2.0. In general, BPMN provides an intuitive and process-oriented notation that enables researchers from theory and practice to standardize and structure complex process semantics (Ko et al., 2009). Moreover, we link the single RMR to the specific elements by means of black circles in Figure 2. In the conceptual process model (cf. Figure 1), there is a differentiation between development phases and application phases. In the next paragraphs, we discuss the single phases. Moreover, we want to motivate research and practice to document every single event in the phases in order to be compliant with the third level documentation requirements (cf. section 3).

Starting with the construction phase and the problem identification (RMR1), all seven RMs discuss their issues with the related resources, roles, responsibilities, and interrelations and demonstrated very clearly the actual demand at that specific point in time for the new model. In most cases, this takes place in the introduction section of the works. Nevertheless, it is obvious that in models with a strong initiation by practice (e.g., Krcmar et al., 2000; Duarte et al., 2007) the problem descriptions have a higher relevance than in models that are mostly research driven and indicate a lack of practical experience (e.g., Keller and König, 2014; Winkelmann, 2012). Not surprising, the MEPM begins with document motivation as well [step 1], including almost the same issues such as the identification of shortcomings, opportunities and potential users.

After the problem identification, we propose to proceed with the qualitative document review of preexisting research knowledge (RMR2). In this regard, only the paper by Czarnecki et al. (2013) constitutes an extension of an already existing RM, whereas the other works obviously did not find comparable solutions, which especially Keller and König (2014) emphasize. Although the results of the qualitative document review were well-documented, we missed the documentation of the search process for the identification of relevant documents and comparable models for all seven cases. It thus remains unclear what publication organs were used and which research directions were included or excluded. Therefore, we would like to motivate research to apply a more scientific approach with respect to RMR2. At the MEPM, this phase is called “search for existing methods” [step 2], constituting the base for the important construction phase.

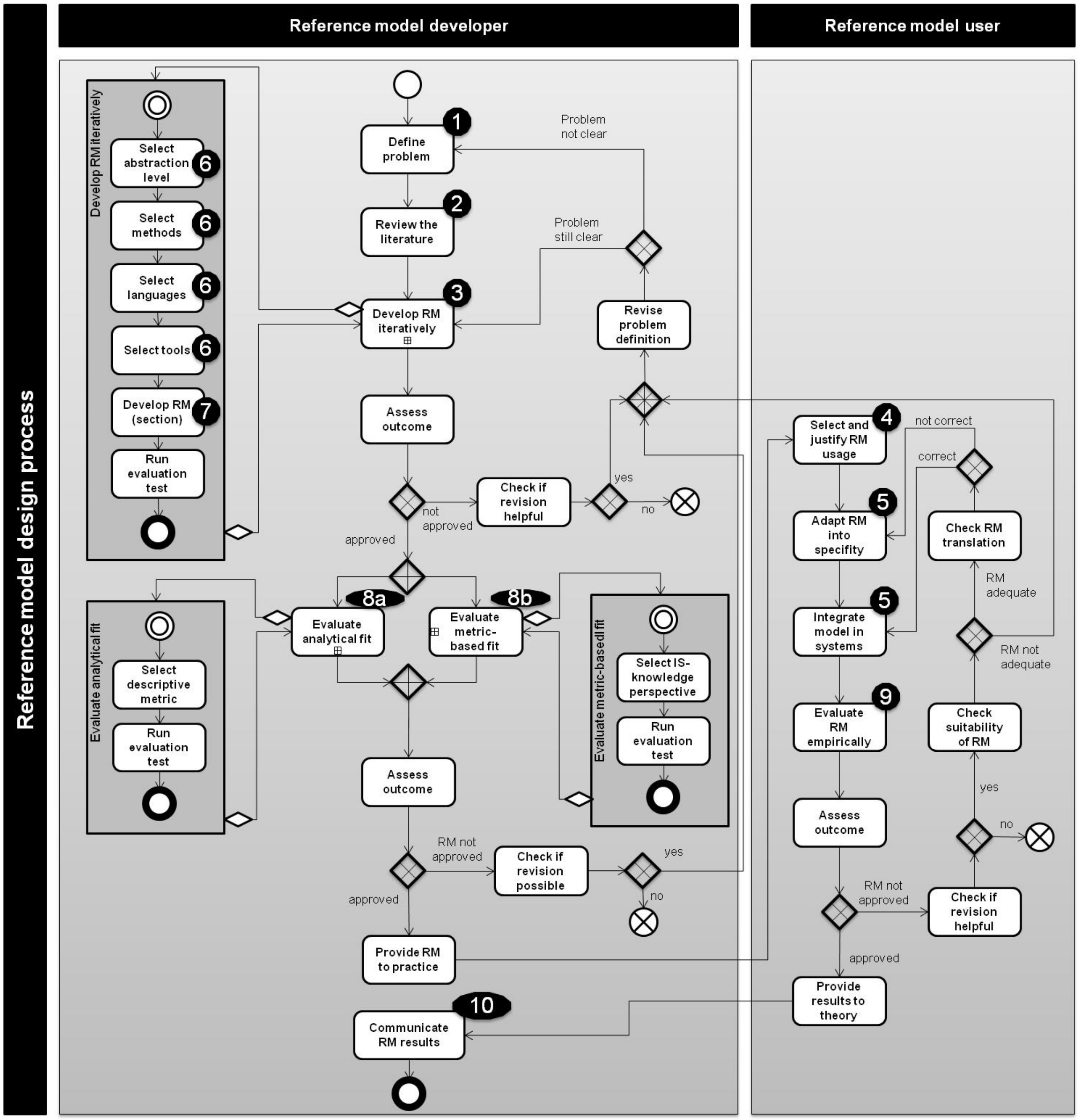
The main phase of our conceptual process model is the iterative RM construction, which is derived from RMR3. All of the synoptically investigated works provide more than one construction loop. Due to the diversity of the underlying issues, the conceptual processes within this phase are varying accordingly. In summary, the following sub-processes have been used: selection of abstraction level, methods, languages, and tools (RMR6). After these sub-processes the development of the RM takes place (RMR7). Concerning the abstraction level, for instance the RMs by Krcmar et al. (2000) or Czarnecki et al. (2013) display a more detailed structure than the RM by Keller and König (2014), which again may be led back to the strong initiation by practice of the former. The highest abstraction degree is needed for the overall RM architecture (Becker al., 2009). Moreover, none of the RMs discusses methods, languages, and tools at the same time, but all RMs are designed with a clear description of the underlying semi-formal languages. However, in most cases the model development cannot be based on one single source only, but has to be created section-wise. Thereby, every section has to be tested for validity, before it is integrated into the RM. The integration of a section may lead to exclusions or needed adjustments in other sections, which is indicated by the iterative process flow in the conceptual process model. Unnecessary sub-phases during the construction process can be left out, which is the case with all seven RMs. Afterwards, the developed construct must be tested for comprehensiveness, consistency, and problem relevance (Becker et al., 2009). During this phase, for instance, Keller and König (2014) conducted a first round of interviews, in which they asked questions with regard to the determined sections. Towards this end, Duarte et al. (2007) conducted quality assessments between every milestone. Comparing our model with MEPM, this phase is the most intensive, too. Basically MEPM proposes three exclusive ways before grouping them [steps 3-6], namely (i) adopt, or (ii) adjust existing methods, or (iii) develop new ones (creation of a new ontology, distillation of best practice, design of languages). It is obvious from both process models that the details of this phase are highly depending on the underlying issues; making it hard to provide more specifications and preserve the scientific manner at same time (we will be more precise on this phase in the application section 5).

In the next phase, an analytical evaluation (RMR8a) takes place. Thus, it has to be assessed whether the overall model is in compliance with the generally accepted guidelines for reference modeling such as semantic correctness. Otto et al. (2012) entirely completed this evaluation. They used well-known frameworks (Becker et al., 1995; Frank, 2007) in order to test the theoretical validity. In parallel with the theoretical evaluation of the model via a qualitative approach, we integrate a metric-based evaluation in the next phase in order to motivate research to conduct objective measurements (RMR8b). Matured metrics have been proposed, e.g., by Moody (1998). Even if these kinds of measures do not allow for absolute conclusions (Fettke and Loos, 2003), they provide a great basis for the operationalization of the single elements and make hidden issues transparent. Hence, this sub-process contains the selection of adequate metrics, the evaluation process and the test of the RM elements. This two-sided evaluation step is one of the major contributions of the paper to research on RM. Whereas, most process models include an evaluation section (models in Table 1 and [step 7 in the MEPM]), the description of the evaluation phase is often vague and encapsulated from existing knowledge. The case study in section 5 will show the exemplarily functioning of RMR8 and RMR8b more in detail.

In the phase following the theoretical design of the RM, the user has to substantiate his decision to use a specific model as reference prior to transferring the model (RMR4). Even if the initial problem identification and definition may be derived from practice, the user may not accept the theoretical model as suitable for his specific issue (which is unlikely in cases where the developer and the user are the same). The seven selected cases do not directly describe this phase, but they indicate that the uniqueness and relevance of their respective models constitute the best available solution for the user. Thereafter, the RM has to be translated and integrated into company-specific or project-specific environments (RMR5). In most cases, the application of the model requires software support, as the used information systems have to be replaced, adjusted, or extended in terms of the RM. This may include uploading of specific files and tables (Otto et al., 2013; Winkelmann, 2012), customizing of management information systems (Krcmar et al., 2000), or implementing new features (Czarnecki et al., 2013).

Furthermore, according to requirement RMR9, the empirical evaluation should establish whether the RM provides the assumed benefits and an improved solution for the defined problem. The defined goals are to be compared with real-life observations. Here again, objective scientific measures and methodologies are required. The advantages may be of a material and a non-material nature, whereby the latter is very difficult to measure. Not surprisingly, all seven cases presented the benefits in an argumentative-deductive manner, while two works highlighted the gained economic advantages (Czarnecki et al., 2013; Krcmar et al., 2000). The empirical results indicate the validity and suitability of the model from the application perspective. If the results turn out to be as expected, the model could serve as a reference and may be applied to related issues. This requires an adequate communication within research and practice. In order to be compliant with RMR3 and enable learning possibilities, we involved exclusive gateways after every "assess outcome" (cf. Figure 2). Hence, the conceptual process model requires decisions for RM rejection, revision, or acceptance. This phase is assigned to "iteratively refine method design" [step 8] in the MEPM as the last phase.

Figure 2 Conceptual process model for designing reference models



Before coming to the application part in section 5, we briefly explain the relation between our conceptual process model and the well-recognized models of design science research by Hevner et al. (2004) and MEPM by Mayer et al. (1995).

We start with seven guidelines of design science, out of which we derived ten RMRs (cf. Table 2). Further, design science research consists of three cycles (relevance, design and rigor cycle) that link the three underlying areas iteratively (Hevner, 2007): (i) *environment*, (ii) *knowledge base*, and (iii) *design science research*. To be more precise as to our conceptual process model, the *RM user elements* of our model (cf. right line of Figure 2) could be interpreted as the *environmental* elements of Hevner´s (2007) design science model. On the other hand, the *RM developer elements* of our model (cf. left line of Figure 2) might involve the remaining two underlying areas (*knowledge base* and *design science research*). Although there typically is a clear separation between the two areas, this separation would not be beneficial in our model. This is because we focus on subsequent RM development process steps and switch between *knowledge base* and *design science research* often (instead of providing a general overview of important areas). Further, we aim to link the defined RMRs to specific process steps in our model, which is done by Hevner et al. (2004) on a more aggregated level as well. To sum up, we take another, more process-oriented perspective on the research of RM design.

Compared with MEPM, we go in line with Mayer et al. (1995) by aiming to advice activities, objectives and roles at every research phase. This alignment is the result of taking a more process-oriented view. However, MEPM is a strongly practice-driven approach and beneficial especially for modeling languages. As such, there is no clear separation between the construction phases and the application phases. As our approach is part of research on RM, we follow this strict requirement (cf. Figure 1) and hence, we are more precise than MEPM in terms of the needed separation. Moreover, MEPM evaluation processes are much more encapsulated from existing knowledge, which is seen critical as well (Tolvanen et al., 1996; Hendersen-Seller, 2014).

5 Exemplary application of the conceptual process model

5.1 Problem identification

As already mentioned, in this section we apply the presented process model for developing a RM to the application specific topic of cloud usage in inter-company supply chains (SC). In order to keep the paper focused, we do not discuss all underlying development and evaluation phases in detail. However, we aim to explain the general functioning and the strong literature regard in the RM development and include scientific knowledge only. This section is a concise version of the original research made by Jede and Teuteberg (2014). Contrary to the original paper, we focus more on the RM development processes and describe the relevant evaluation steps more precisely (cf. Table I in the appendix for more details on every single RMR step during the RM design process).

In general, SCs face consistently big challenges as the complexity and the dynamics of contemporary SCs increase. At the same time stakeholders require SCs to be environmentally friendly, social, and profitable. Therefore, it is essential to select and adopt suitable information systems that support the preexisting challenges of specific SCs. Due to the fact that IT processes are becoming more and more stable and flexible, e.g., through scalability and virtualization (Bharadwaj et al. 2013, Hoberg et al., 2012, Pereira 2009), both research and practice hope to obtain benefits from cloud computing (CC)[23]. We are motivated by the circumstance that the mostly assumed advantages of CC usage at SC processes lack a profound theoretical basis, since the current research is still at an early stage in both theory and practice (Marston et al., 2011). Up to now, the bulk of publications on CC focus especially on the technical aspects (Böhm et al., 2010; Fremdt et al., 2013). Interdisciplinary conclusions and recommendations for specific business areas (Hoberg et al., 2012), such as supply chain management (SCM), are scarce (Blau et al., 2009; Leimeister et al., 2010). Notwithstanding that first noteworthy successes have been reached (Meer et al., 2012), the construction of cloud based SC systems remains significantly more challenging than of traditional systems. We argue that this is partially because researchers and practitioners suffer from the lack of aggregated or general models with a precise structure and vocabulary for explaining and describing the key architectural characteristics of CC usage in SCM. The underlying key issue is (RMR1): Which elements should be considered to design an adequate RM for integrating CC in SC processes? Eventually, derived from literature analysis and applied in a participative case study, we present a RM, that supports SC managers during the conceptual phase of CC implementation and serves as a solid base for further specific information models (Ahlemann and Riempp, 2008; Thomas, 2006; Otto et al., 2012). We discussed the lack of such RMs with industry experts in order to guarantee the relevance of the problem. Further, our intention meets the requirements for investigating CC in a more interdisciplinary context (Bardhan et al., 2010) by including the

[23] Within this paper, we focus especially the public CC type, while emphasizing that other deployments such as community CC might be beneficial as well.

intersection of the science disciplines information systems (IS) and SCM as well as by using a multi-method approach during the development and evaluation of the RM.

5.2 Qualitative literature review

We pursued a systematic knowledge building that is strictly linked to the published work (RMR2). The execution of the analysis is closely related to the described five-stage model (cf. section 2.2) of Fettke (2006) that contains problem description and definition of the research field, document search, document evaluation, document analysis, and interpretation. During the 2nd stage, we used keywords and considered 33 top rated IS journals and 31 top rated SCM journals, that were derived from selected journal rankings. By adopting this approach, we determined 99 papers in total. During the literature search phase, we identified no comparable RMs. The 99 papers have been completely reviewed and clustered via a predefined framework. Hence, the underlying taxonomies are grounded on existing literature in CC and SCM, and then elaborated with our own critical reflection. Within this framework, wherever possible, we included the single papers´ empirical findings as well. Finally, with the predefined framework, we identified connections between actors and the causalities between different external and internal service resources.

However, literature foresees three specific advantages of using CC in SC networks: (i) agility, (ii) collaboration, and (iii) knowledge sharing. In terms of ***agility***, we pay special attention to interoperability, compatibility, configuration, deployment, portability, scalability, virtualization, automation, and the standardization degree (Cegielski et al., 2012; Wind et al., 2012, Bharadwaj et al., 2013, Blome et al., 2014). The second advantage is related to coordination and ***collaboration***. It is in particular the prevailing information asymmetry in cross-company supply chains that hinders an assigned employee to create, propagate, and coordinate a production or distribution plan for the entire supply chain (Leukel et al., 2011). Therefore, what is required for the overall SC success is the willingness of the parties involved to collaborate and coordinate. And CC is predestined to create transparency as well as a higher quality of data (Morgan and Conboy, 2013; Azevedo et al., 2013) along the entire SC. The third advantage is related to information and ***knowledge sharing***. Towards this end, CC acts as a medium for cross-company analyses of data, process planning, and finally for decision support systems (Cegielski et al., 2012). We further interpret the results in section 5.3 with the aid of the eight underlying sub-models.

5.3 Iterative reference model construction and analytical evaluation

The forthcoming RM summarizes the most important research findings and provides a common ontological framework and standard for the characterization of CC usage in SCM. By drawing analogies between the reference components of the section models, various linkages, gaps, and points of overlap can be identified. For future research, it may serve as a basis framework for complementary or build-on models. For SCM practice, it embodies CC adoption suggestions.

Derived from the qualitative literature analysis and based on the sample's empirical and logical findings, in Figure 3, we designed the first RM that represents the interconnections between CC and SCM (RMR3). The major preconditions, structures, and dependencies were aggregated to elements and linkages between the elements. We depicted the most important factors within the underlying research field as sub-models in grey boxes. These sub-models, emerged from qualitative analysis, constitute RM sections that were constructed and tested separately (RMR7).

Following the conceptual process model (cf. Figure 2), for the abstraction level we used the highest possible aggregation level (RMR6), namely the architectural level, as we indent to increase the general understanding of CC usage in SCM processes on the holistic system. We select the Unified Modeling Language (UML) as an object-oriented modeling language and use class diagrams for the presentation of the RM. In general, UML is directly compatible to object-oriented programming languages, which supports the upcoming application in ADOit (cf. section 5.5). Hereby, our RM describes a structured semi-formalized application problem (Rosemann and Van der Aalst, 2007). In Table 4, we briefly describe the eight underlying sub-models that we identified in literature via the qualitative approach. At this point, we would like to stress that the literature sample´s major empirical findings were included wherever possible.

Table 4 Literature-based reference model sections

Section	Description
Strategy model	This model is aligned with the triple bottom line concept. The model assumes that ecological and social responsibility can lead to long-term economic success (Carter and Rogers, 2008). Hence, it is proposed to integrate these three dimensions in the SC strategy (Elkington, 2004). The defined strategy consists of an action plan, measures, and targets for an adequate SC process adoption in order to satisfy related stakeholders.
Stakeholder model	This model involves internal and external stakeholders who may have diverse interests. They influence the company´s strategy directly and indirectly. Major external stakeholders constitute standard setting bodies and governmental authorities (Marston et al., 2011). They encourage companies to initiate activities for a sustainable SCM. At the same time they define rules and preconditions for the usage of CC (Leimeister et al., 2010). Internal stakeholders such as shareholders, investors, and managers define the SC strategy, the goals, and their management support (Wu et al., 2013). Contrary, internal employees contribute to achieving the targets and goals through their efforts and commitment.
Organization model	This model determines the organizational units and roles that have to be established, included, or excluded for executing a business process (Cegielski et al., 2012). Here, not only internal employees have specific roles, resources, and access rights, but also the supply chain partners. When using CC services cross-company, an overall authorization concept has to be defined with the cloud provider.
Process model	This model addresses all business processes within the SC and has a central position in our RM. The quality and the speed of the processes are primarily depending on the efficiency of IT support (Cegielski et al., 2012; Steinfield et al., 2011). Processes are impacted by SC partners, both directly and indirectly (via the external stakeholder that affects the resulting strategy). Normally, a process can be structured into sub-processes and connection points between the sub-processes. Further, a business process consists of elements such as operators, functions, and events.
IT-architecture model	The nature of this model is to support business processes. In aspects of CC, much attention has to be paid to the interfaces and the configuration between the own organization, the SC partner and the CC provider (Benlian et al., 2010). In general, the architecture model determines data streams and systems that have to be used. Furthermore, the access types between hardware and software components should be justified as well as the specific modules of the single IT systems.
SC cooperation model	The overall SC success is strongly dependent on the interaction between the SC partners (Fremdt et al., 2013; Wu et al., 2013). This model contains the SC related chances and risks of CC implementations. The SC partners constitute a subset of the stakeholders. Kumar and Dissel (1996) point out that the success of SC co-operations is mainly determined by the behavior of the interacting employees. Managers can encourage employees to behave in a desired manner by assigning them responsibilities, roles, and IS such as CC. However, literature foresees three main advantages with CC usage: agility, collaboration, and knowledge sharing (cf. section 5.2).

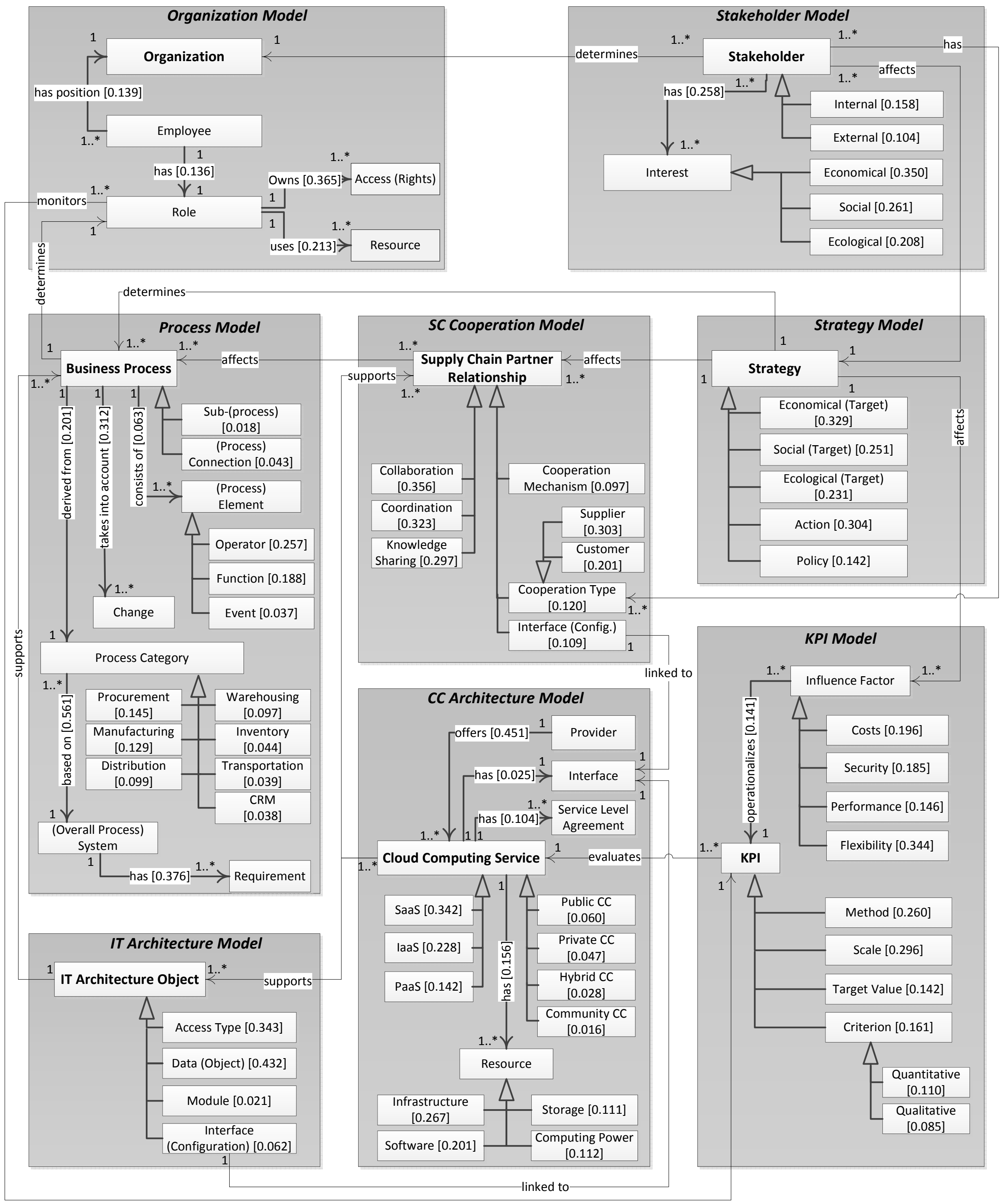
CC architecture model	This model shows the specific resources and features for supporting the IT-architecture. As there is no direct linkage to the process model, we want to underline the indirect influence of CC on SC processes. Moreover, this contains the CC service provider and the underlying service level agreements (Leimeister et al., 2010) that have to be controlled by the internal staff.
KPI model	Finally, this model contains the general (not SCM-specific) influence factors for CC implementation: costs, IT security, IT performance, IT flexibility. The KPI model is incumbent upon organizational roles. One possible method to operationalize these factors (and monitor CC) might be a balanced scorecard (BSC) as discussed by Lee et al. (2013).

After the construction process, we applied well-known principles, conventions and standards in reference modeling (RMR8a) to enhance the quality (e.g., Ahlemann and Riempp, 2009; Frank, 2007; Becker et al., 1995). Especially due to the high degree of aggregation, we easily proved our overall RM to be correct, relevant, clear, compatible, and systematic (Becker et al., 1995).

5.4 Metric-based evaluation

As mentioned before, for years now research literature has been motivating the research community to use metric-based evaluations for RM design (e.g., Fettke and Loos, 2003; Moody, 1998). We tried to meet this requirement by applying a unique linkage between quantitative literature analysis and reference modeling, namely by co-occurrences (RMR8b). We used the 99 papers as a basis and followed the instruction made in section 2.2. Herein, we used the document mining software called WordStat. We calculated the co-occurrences of the single elements in the reference model by using the Jaccard's index (JI) similarity coefficient. The calculation of the co-occurrences increased the transparency within our RM remarkably and enhanced the understanding of the most discussed linkages. After having calculated the first round of co-occurrences, we refined the model, structured the elements by co-occurrence values, and re-calculated the co-occurrences. Exemplary, we discuss some linkages. As one can see in Figure 3, social interests in the stakeholder model have a quite high co-occurrence (0.261), when considering the intersection of CC and SCM research. Hence, CC does not only support economic interests but also social and environmental aspects. However, in terms of the process model, the sample literature obviously propagates a general process change (0.321) in aspects of CC and discusses the needed requirements (0.376). Yet, the interface configuration across SC partners, which is essential in practice, is mostly ignored by literature. In case of a structured and standardized SC, the linkage is not as complicated as is the case in a reciprocal, unstructured, or highly problematic SC with de-central responsibilities (Kumar and Dissel, 1996). Due to the researches´ argumentation that CC is advantageous, especially for complex SC (Cegielski et al., 2012; Swafford et al., 2008), future research should focus much more CC details, such as interfaces, in order to provide practice with support. However, the overall co-occurrence picture indicates that our model has considered the relevant elements and significant linkages between these elements. (In order to hedge this statement, we analyzed all co-occurrences within the entire literature sample that show a value of above 0.050). Conversely, this means that the fitness of the overall model would have to be questioned if the RM led to low co-occurrences only.

Figure 3 Reference model for cloud computing usage at supply chain processes



After having derived the RM from research literature, we exemplarily applied the model and evaluated it by adopting a multi-method approach (Knackstedt et al., 2009) in order to comply with the already mentioned need for such an approach (Marston et al., 2011). In a participative case study (Baskerville, 1997) at an international automotive supplier (TIER1), we applied the model to real life. From the RM user perspective, the authors and the case company´s representatives found no other RM that addresses the company´s underlying key issue (RMR4). Therefore, the selection process in terms of the conceptual process model (cf. Figure 2) was completed without any iteration.

The case company intends to switch its electronic data interface (EDI) procurement process into a cloud based procurement process, where not only the case company and its supplier (TIER2) should participate, but also the supplier TIER3. This offers the advantage of having procurement orders available at a central place and in real time. Hence, compared to EDI, the supplier TIER3 obtains the needed information earlier and can therefore set up his physical production and logistics processes in time, which consequently helps the supplier TIER1 to increase his business performance. In order to improve the understanding of these cross-company linkages and to make them transparent, the case company set out a simulation. Therefore, the generic RM was translated into a project-specific information model (RMR5). Herein, we specified the information relevant to the SC such as bill of material and order frequencies on the one hand, and information relevant to CC such as service costs, responsibilities, and interfaces on the other.

The project-specific model was implemented with the help of the software ADOit by BOC GmbH (RMR5). This software is widely used at companies in various branches. The software platform provides various model types that can be used for projecting organizational and IT-structures as well as processes and measures. By first draft prototyping, we implemented the sub-models of the reference model and considered the specific information of the case company. In ADOit, an interrelation between two elements can be applied as a reference (cf. Figure II in the appendix for more details on ADOit). With the help of experts from science and from the case company, we refined and improved this model gradually. Furthermore, we conducted four expert interviews with professionals from a SC software provider, in order to test the validity of the theoretical RM and the applied information model. The first empirical results indicate that financial benefits will by far compensate for the incurred cloud usage costs (RMR9), while having higher security risks. However, real business applications are compellingly needed in order to increase the suitability of the specific model and generalize the model findings. This will be conducted by the case company in the next step.

6 Conclusion

6.1 Implications

Reference information models constitute a suitable basis for creating company- or project-specific information models. However, in the light of the great amount of RMs that have been developed in the past, there is a danger of arbitrariness during the development and evaluation phases of these RMs. Even RMs published in scientific and practical outlets suffer from a low level of comprehensive documentation, which is indicted by our analysis (cf. section 3). And compared to other research disciplines such as medicine, IS still tends to design models encapsulated from each other by often neglecting already existing research (Vom Brocke et al., 2014). Having considered service-oriented RMs only, in our analysis we indicate that the vast amount of papers, in which newly developed RMs are presented, do not document their respective development procedures accordingly. Furthermore, the authors of such RMs often do not distinguish between construction and application processes, which can prevent the models from being used. This makes it hard to accept such models as real theoretical references. Therefore, with this paper we provide ***10 subsequent requirements*** for reference modeling. These specific requirements are derived from general design science requirements and augmented by the ***findings of seven well-documented RMs***. In contrast to prior works on reference model processing and method engineering, our approach has a higher preexisting knowledge regard, in particular by RMR2 (document review) and RMR8 (knowledge-based evaluation), which may increase the degree of universality and recommendation of future RMs. As mentioned before, both phases will gain even more relevance when founding the RM on a broad and qualitative preexisting body of knowledge. Moreover, we propose a comprehensive ***conceptual process model*** for the overall development and evaluation of RMs. This model includes the determined RM requirements and connects every RM event to the both underlying roles, namely developer and user. Hence, we provide an adequate overall framework for the methodologically and scientifically founded development and evaluation of RMs and postulate to more strongly anchor future RMs in related work. Thus, this framework may be seen as a valuable extension of the present body of knowledge by combining already existing approaches from design science, reference modeling, and particularly document analysis.

As to RMR8b (metric-based evaluation), we propose a completely new approach, namely to ***combine semi-formal languages with co-occurrences***. This approach increases the degree of objectivity and brings new, mostly hidden features to the reference modeling paradigm. For instance, it may be of help in finding gaps in scientific literature: if, for example, co-occurrences are relatively low although there obviously are important interrelations, and beyond this, the approach provides an additional evaluation step. Hence, (i) interrelations may be weighted by co-occurrences, (ii) the model sections may be questioned when showing only low co-occurrences, and (iii) the underlying document sample may be questioned when showing relatively low co-occurrences. Especially the third point may constitute an indicator for the fulfillment of RMR2 (qualitative document verification), when there is the same base for the qualitative and quantitative document analysis. Finally, we ***applied the conceptual process model exemplary*** and developed a RM for CC in inter-company SC processes. We consciously decided not to discuss all underlying development and evaluation phases in detail as this would have gone beyond the scope of this paper. Moreover, apart from the involvement of scientific literature, also the integration of the state-of-the-art in practice may constitute a valuable basis for future research. Nevertheless, we deem it important to show the applicability and usability of our conceptual process model.

6.2 Limitations

Since this paper combines domain knowledge from design science and reference modeling as well as from document analyses, it is obvious that the general limitations of these domains are valid for this paper as well. For instance, design science research suffers from subjectivity and bears the risk of developing well-created theoretical artifacts that are useless in real organizational environments (Hevner et al., 2004). Contrary, qualitative document analysis is about investigating approaches and solutions from the past, which means that their contents may be outdated or ineffective for analyzing present and future challenges. Additionally, quantitative content analyses indeed provide a high degree of objectivity as the computation runs in a predefined way, the interpretation of the results, however, does not allow for absolute conclusions. Furthermore, the significance of the single units of the underlying document base (e.g., scientific and practice papers, transcripts) is hard to determine, often leading to equal weighting of all selected documents. However, we believe that a stronger linkage between the mentioned domains reduces the degree of weakness and improves the quality of future RMs. Moreover, the requirements of RMs may vary dramatically from model to model, which means that the determined RMR as well as the conceptual process model can be seen as a valuable starting point that might need adjustments to specific requirements (e.g., adding/deleting RMRs, extending/reducing process steps). Further, there is no doubt that some preexisting RMs such as ITIL or SCOR contribute valuable guidance, which represent *best practice* for some real-life cases. However, providing best practice is not our main concern, which can be stated as a limitation. Our approach rather aims to serve as a guidance in the development and evaluation of *common practice* RMs, namely by more firmly integrating the RM in preexisting knowledge and by analyzing similarities of related work.

6.3 Future work

We propose a metric-based theoretical evaluation of RMs, which enhances clarification and transparency, while providing more objectivity. To the best of our knowledge, this theoretical phase is new and therefore, it has not yet been sufficiently explored in information modeling, which may motivate future research. Hence, it is possible to include various valuable sources for RMs, such as practical literature, social networks, and transcribed expert interviews, which could provide more actual and relevant data to the information model (in order to mitigate the limitations of classic document analyses). Valuing the effectiveness of these sources may constitute a fruitful research approach. Further, the gathering of data from various sources will meet the often stated requirement of more triangulation in IS research (e.g., Loos et al., 2011; Venkatesh et al., 2013). Moreover, the approach can be extended by considering conceptual wording trees, ontologies, synonym data bases (e.g., WordNet), n-grams etc., which can further increase the data quality.

Switching to the empirical evaluation process, future work may investigate more properly how to involve objective measures and scientific methodologies, which are still scarce in this phase. Besides from economic measures, we found no relevant key performance indicators for the fit of the underlying RM. Towards this end, the conclusion from the specific information model to the reference model is widely unexplored.

In general, it has to be investigated whether our overall proposed conceptual process model stimulates research to develop future RMs in a more scientific and preexisting knowledge-oriented way instead of using intuitive approaches. And furthermore, it has to be found out whether the conceptual process model in itself leads to better outcomes than those RMs that have been developed more arbitrarily.

References

Ahlemann, F. (2009). Towards a conceptual reference model for project management information systems. International Journal of Project Management, 27(1), 19–30.

Ahlemann, F. & Riempp, G. (2008). A Conceptual Reference Model for Project Management Information Systems. Wirtschaftsinformatik, 50(2), 88–97.

Ardalani, P., Houy, C., Fettke, P., & Loos, P. (2013). Towards A Minimal Cost Of Change Approach For Inductive Reference Model Development. In: Proceedings of the 21st European Conference on Information Systems (ECIS), 6th-8th June 2013, Utrecht, Netherlands.

Azevedo, S., Prata, P., & Fazendeiro, P. (2013). Assessment of Supply Chain Agility in a Cloud Computing-based Framework. Scalable Computing: Practice and Experience, 13(4), 295–301.

Bardhan, I. R., Demirkan, H., Kannan, P. K., Kauffman, R. J. & Sougstad, R. (2010). An interdisciplinary perspective on IT services management and service science. Journal of Management Information Systems, 26 (4), 13–64.

Baskerville, R. L. (1997). Distinguishing action research from participative case studies. Journal of Systems and Information Technology, 1(1), 24–43.

Becker, J., Beverungen, D. F., & Knackstedt, R. (2010). The challenge of conceptual modeling for product–service systems: status-quo and perspectives for reference models and modeling languages. Information Systems and e-Business Management, 8(1), 33–66.

Becker, J., Delfmann, P., & Knackstedt, R. (2007). Adaptive reference modeling: integrating configurative and generic adaptation techniques for information models. In: Reference Modeling, 27–58, Physica-Verlag HD.

Becker, J., Knackstedt, R., & Pöppelbuß, D. (2009). Developing maturity models for IT management. Business & Information Systems Engineering, 1(3), 213–222.

Becker, J., Niehaves, B., & Knackstedt, R. (2004). Bezugsrahmen zur epistemologischen Positionierung der Referenzmodellierung. In: Referenzmodellierung, 1–17, Physica-Verlag HD.

Becker, J., Rosemann, M., & Schütte, R., (1995). Grundsätze ordnungsmäßiger Modellierung (Guidelines for orderly modeling). Wirtschaftsinformatik, 37(5), 435–445.

Becker, J., Rosemann, M., & Von Uthmann, C., (2000). Guidelines of business process modeling. In: Business Process Management, 30–49, Springer, Berlin Heidelberg.

Benlian, A., Koufaris, M., & Hess, T. (2010). The role of SaaS service quality for continued SaaS use: Empirical insights from SaaS using firms. In: Proceedings of the 31st International Conference on Information Systems (ICIS), 12th-15th December 2010, Saint Louis, Missouri.

Bharadwaj, A., El-Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. Management Information Systems Quarterly, 37(2), 471–482.

Blau, B. S., Conte, T., & Meinl, T. (2009). Coordinating service composition. In: Proceedings of the 17th European Conference on Information Systems (ECIS), 8th-10th June 2010, Verona, Italy.

Blome, C., Schoenherr, T., & Eckstein, D. (2014). The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view. International Journal of Production Economics, 147(1), 307–316.

Böhm, M., Koleva, G., Leimeister, S., Riedl, C., & Krcmar, H. (2010). Towards a generic value network for cloud computing. In: Economics of Grids, Clouds, Systems, and Services, Springer Berlin Heidelberg, pp. 129–140.

Brown, P., Estefan, J. A., Laskey K., et al., (2012). Reference Architecture Foundation for Service Oriented Architecture Version 1.0. OASIS Committee Specification 01.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. International journal of physical distribution & logistics management, 38(5), 360–387.

Chen, P. P. S. (1976). The entity-relationship model – toward a unified view of data. ACM Transactions on Database Systems, 1(1), 9–36.

Cegielski, C. G., Jones-Farmer, L. A., Wu, Y., & Hazen, B. T. (2012). Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach. International Journal of Logistics Management, 23(2), 184–211.

Czarnecki, C., & Winkelmann, A. (2013). Referenzprozessabläufe für Telekommunikationsunternehmen. Wirtschaftsinformatik, 55(2), 83–97.

Duarte, F. J., Fernandes, J. M., & Machado, R. J. (2006). Business Modeling in Process-Oriented Organizations for RUP-based Software Development. In: Fettke, P., & Loos, P. (eds). Reference Modeling for Business Systems Analysis, 98–117, IGP, London.

Elkington, J. (2004). Enter the Bottom line. In: Henriques, A., & Richardson, J. The Triple Bottom Line, Earthscan, London.

Fettke, P. (2006). State-of-the-Art des State-of-the-Art: Eine Untersuchung der Forschungsmethode "Review" innerhalb der Wirtschaftsinformatik, Wirtschaftsinformatik, 48(4), 257–266.

Fettke, P., & Loos, P. (2003). Multiperspective evaluation of reference models–towards a framework. Conceptual Modeling for Novel Application Domains. Springer Berlin Heidelberg, 80–91.

Fettke, P., & Loos, P. (2004). Reference modeling research. Wirtschaftsinformatik, 46(5), 331–340.

Fettke, P., & Loos, P. (2005). Der Beitrag der Referenzmodellierung zum Business Engineering. HMD-Praxis der Wirtschaftsinformatik, 241, 18–26.

Fettke, P., Loos, P., & Zwicker, J. (2006). Business process reference models: Survey and classification. In: Business Process Management Workshops. Springer Berlin Heidelberg, 469–483.

Fremdt, S., Beck, R., & Weber, S. (2013). Does Cloud Computing Matter? An Analysis of the Cloud Model Software-as-a-Service and Its Impact on Operational Agility. In: Proceedings of the 46th Hawaii International Conference on in System Sciences (HICSS), 7th-10th January 2013, Grand Wailea, Hawaii.

Frank, U. (2007). Evaluation of reference models. In: Fettke, P., Loos, P. (Eds) Reference modeling for business systems analysis. Idea Group, Hershey, 118–139.

Harmsen, F., & Saeki, M. (1996). Comparison of four method engineering languages. In: Brinkkemper, S., Lyytinen K., & Welke, R. (Eds.), Method Engineering, Springer US, 209–231.

Henderson-Sellers, B., Ralyté, J., Ågerfalk, P. J., & Rossi, M. (2014). Method Engineering as a Social Practice. In: Situational Method Engineering, Springer, Berlin Heidelberg, 53–68.

Hevner, A. R. (2007). A three cycle view of design science research. Scandinavian journal of information systems, 19(2), 4.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. MIS quarterly, 28(1), 75–105.

Hoberg, P., Wollersheim, J., & Krcmar, H. (2012). The Business Perspective on Cloud Computing – A Literature Review of Research on Cloud Computing. In: Proceedings of the 18th American Conference on Information Systems (AMCIS), 9th-11th August 2012, Seattle, Washington.

Houy, C., Fettke, P., & Loos, P. (2010). Empirical Research in Business Process Management–Analysis of an emerging field of research. Business Process Management Journal, 16(4), 619–661.

Jede, A., & Teuteberg, F. (2014). Cloud-gestützte Supply-Chain-Architekturen – Entwicklung eines Referenzmodells auf Basis einer systematischen Literaturanalyse. In: Lecture Notes in Informatics (LNI), Stuttgart, Germany.

Keller, R., & König, C. (2014). A Reference Model to Support Risk Identification in Cloud Networks. In: Proceedings of the 35th International Conference on Information Systems, 14th-17th December, Auckland, New Zealand.

Knackstedt, R., Lis, L., Stein, A., Becker, J., & Barth, I. (2009). Towards a reference model for online research maps. In: Proceedings of the 17th European Conference on Information Systems (ECIS), 8th-10th June 2009, Verona, Italy.

Ko, R. K. L., Lee, S. S. G., & Lee, E. W. (2009). Business Process Management (BPM) Standards: A Survey. Business Process Management Journal, 15(5), 744–791.

Krcmar, H., Dold, G., Fischer, H., Strobel, M., Seifert, E. K., Scheide, W., et al. (2000). Informationssysteme für das Umweltmanagement. Das Referenzmodell ECO-Integral, München/Wien.

Kumar, K., & Van Dissel, H. G. (1996). Sustainable collaboration: managing conflict and cooperation in interorganizational systems. Management Information Systems Quarterly, 20(3), 279–300.

Lee, S. G., Chae, S. H., & Cho, K. M. (2013). Drivers and inhibitors of SaaS adoption in Korea. International Journal of Information Management, 33(3), 429–440.

Leimeister, S., Boehm, M., Riedl, C., & Krcmar, H. (2010). The Business Perspective of Cloud Computing: Actors, Roles and Value Networks. In: Proceedings of the 18th European Conference on Information Systems (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Leukel, J., Jacob, A., Karaenke, P., Kirn, S., & Klein, A. (2011). Individualization of Goods and Services: Towards a Logistics Knowledge Infrastructure for Agile Supply Chains. In: AAAI Spring Symposium: AI for Business Agility, 21th-23th March 2011, Palo Alto, California.

Levy, Y., & Ellis, T. J. (2006). A systems approach to conduct an effective literature review in support of information systems research. International Journal of an Emerging Transdiscipline, 9, 181–212.

Lijphart, A. (1971). Comparative Politics and the Comparative Method. American Political Science Review, 65(3), 682–693.

Loos, P., Fettke, P., Weißenberger, B.E., Zelewski, S., Heinzl, A., Frank, U., Iivari, J. (2011). What in Fact Is the Role of Stylized Facts in Fundamental Research of Business and Information Systems Engineering?. Business & Information Systems Engineering, 3(2), 107-125.

Malinova, M., Leopold, H., & Mendling, J. (2014). A meta-model for process map design. In: Proceedings of the CAiSE Forum, 16th – 20th June 2014, Thessaloniki, Greece.

March, S. T., & Smith, G. (1995). Design and Natural Science Research on Information Technology. Decision Support Systems, 15(4), 251-266.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. & Ghalsasi, A. (2011). Cloud computing – The business perspective. Decision Support Systems, 51(1), 176–189.

Martens, A., Fettke, P., & Loos, P. (2014). A Genetic Algorithm for the Inductive Derivation of Reference Models Using Minimal Graph-Edit Distance Applied to Real-World Business Process Data. Tagungsband Multikonferenz Wirtschaftsinformatik, 1613-1626.

Martens, A., Fettke, P., & Loos, P. (2015). Inductive Development of Reference Process Models Based on Factor Analysis. In: Proceedings of the 12th Conference on Wirtschaftsinformatik, 4th-6th March, 2015, Osnabrueck, Germany.

Martens, B., & Teuteberg, F. (2009). Ein Referenz- und Reifegradmodell für integrierte Fundraisingmanagementsystem an Hochschulen. In: Proceedings of the 9th Conference on Wirtschaftsinformatik, 25th- 27th February, Wien, Austria.

Mayer, R. J., Menzel, C. P., Painter, M. K., Dewitte, P. S., Blinn, T., & Perakath, B. (1995). Information integration for concurrent engineering (IICE). http://www.idef.com/pdf/compendium.pdf. Accessed 16. August 2015.

Meer, D. V., Dutta, K., & Datta, A. (2012). A cost-based database request distribution technique for online E-commerce applications. Management Information Systems Quarterly, 36(2), 479–507.

Möller, J., Retelsdorf, J., Köller, O., & Marsh, H. W. (2011). The reciprocal internal/external frame of reference model an integration of models of relations between academic achievement and self-concept. American Educational Research Journal, 48(6), 1315–1346.

Moody, D. L. (1998). Metrics for Evaluating the Quality of Entity Relationship Models. In: 17th International Conference on Conceptual Modeling, 16th-19th November 1998, Singapore.

Morgan, L., & Conboy, K. (2013). Factors affecting the adoption of cloud computing: an exploratory study. In: Proceedings of the 21st European Conference on Information Systems (ECIS), 20th-25th November 2013, Utrecht, Netherlands.

Murguía, M., & Villaseñor, J. L. (2003). Estimating the effect of the similarity coefficient and the cluster algorithm on biogeographic classifications. Annales Botanici Fennici, 40(6), 415–421.

Neuendorf, K. A. (2002). The Content Analysis Guidebook. Sage, Thousand Oaks, CA.

Okoli, C., & Schabram, K. (2010). A Guide to Conducting a Systematic Literature Review of Information Systems Research. ***All Sprouts Content.*** Paper 348.

Otto, B., Hüner, K., & Österle, H. (2012). Toward a functional reference model for master data quality management. Information Systems and e-Business Management, 10(3), 395–425.

Pereira, J. V. (2009). The new supply chain's frontier: Information management. International Journal of Information Management, 29(5), 372–379.

Provalis Research (2010). WordStat 6: Content Analysis Module for QDA Miner and SimStat. http://www.provalisresearch.com/Documents/WordStat6.pdf. Accessed 13 December 2014.

Rosemann, M., & Van Der Aalst, W. M .P. (2007). A configurable reference modelling language. Information Systems Journal, 32(1), 1–23.

Scheer, A. W., & Hars, A. (1992). Extending data modeling to cover the whole enterprise. Communications of the ACM, 35(9), 166-ff.

Steinfield, C., Markus, M. L., & Wigand, R. T., (2011). Through a glass clearly: standards, architecture, and process transparency in global supply chains. Journal of Management Information Systems, 28(2), 75–108.

Swafford, P. M., Ghosh, S., & Murthy, N. (2008). Achieving supply chain agility through IT integration and flexibility. International Journal of Production Economics, 116(2), 288–297.

Tan, P. N., Steinbach, M., & Kumar, V. (2005). Introduction to Data Mining. Addison-Wesley, Boston, MA.

Thomas, O. (2006). Understanding the term reference model in information systems research: history, literature analysis and explanation. In: Business Process Management Workshops. Springer Berlin Heidelberg, pp. 484–496.

Tolvanen, J. P., Rossi, M., & Liu, H. (1996). In: Method engineering: current research directions and implications for future research. In: Brinkkemper, S., Lyytinen K., & Welke, R. (Eds.), Method Engineering, Springer US, 296-317.

Vom Brocke, J. (2003). Referenzmodellierung: Gestaltung und Verteilung von Konstruktionsprozessen, Logos, Berlin.

Vom Brocke, J., & Buddendick, C. (2004). Konstruktionstechniken für die Referenzmodellierung – Systematisierung, Sprachgestaltung und Werkzeugunterstützung. In: Referenzmodellierung, 19–49, Physica-Verlag HD.

Vom Brocke, J., Schmiedel, T., Recker, J. C., Trkman, P., Mertens, W., & Viaene, S. (2014). Ten principles of good business process management. Business Process Management Journal, 20(4), 530-548.

Walter, J., Fettke, P., & Loos, P. (2013). How to identify and design successful business process models: An inductive method. In: Proceedings and Report of the PropelleR 2012 Workshop, Moscow, Russian Federation.

Webster, J., & Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. Management Information Systems Quarterly, 26(2), xiii–xxiii.

Winkelmann, A. (2012). Reference model maintenance based on ERP system implementations. AIS Transactions on Enterprise Systems, 3, 28–35.

Wu, Y., Cegielski, C. G., Hazen, B. T., & Hall, D. J. (2013). Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud. Journal of Supply Chain Management, 49(3), 25–41.

Appendix

All additional tables and figures to this paper are available online and contain additional information:

Figure I Process description of method engineering according to Mayer et al. (1995)

Table I Application of reference model requirements (RMR) to exemplarily case

Figure II Construction of sub-models in ADOit

The download link is: http://tinyurl.com/qxeobpd

Towards a Document-driven Approach for Designing Reference Models: From a Conceptual Process Model to its Application

Appendix

This appendix contains the following information:

Figure I Process description of method engineering according to Mayer et al. (1995)

Table I Application of reference model requirements (RMR) to exemplarily case

Figure II Construction of sub-models in ADOit

Figure I Process description of method engineering according to Mayer et al. (1995)

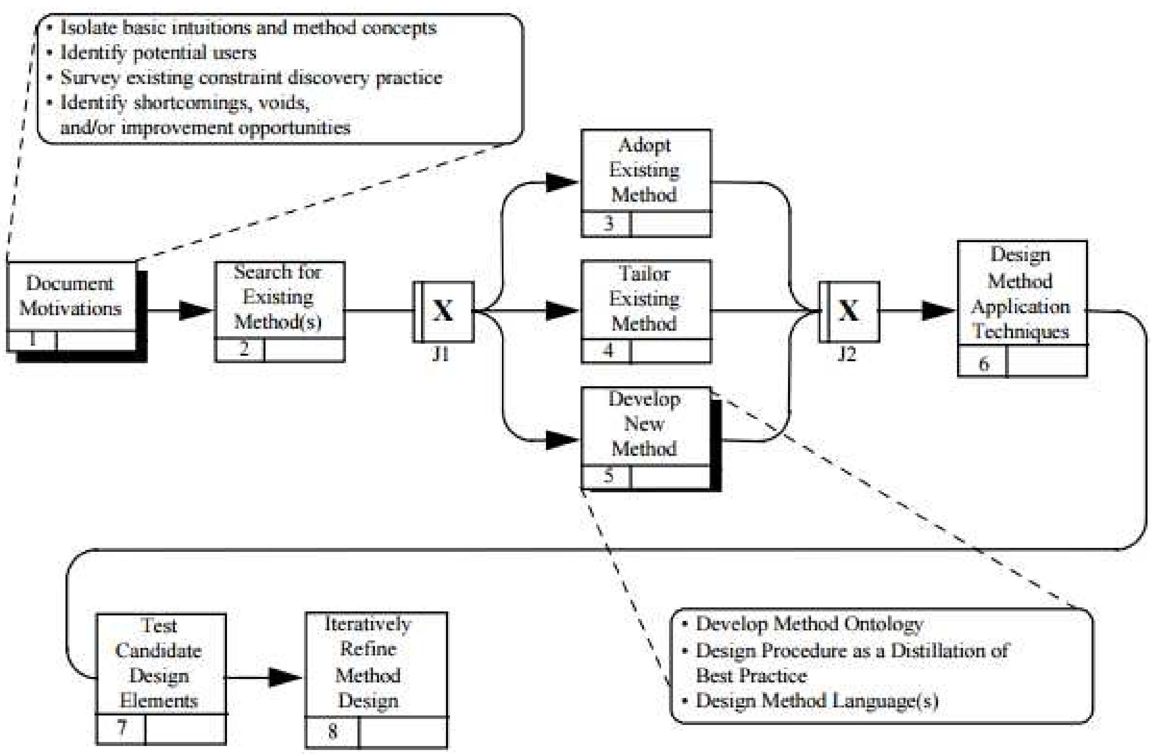


Table I Application of reference model requirements (RMR) to exemplarily case

Reference model requirement (RMR)	Activities	Used procedures/ measures/ techniques	Research outcomes
Problem Identification (RMR1)	Defining key issue: Lack of aggregated models with a precise structure and vocabulary for explaining architectural characteristics (incl. roles, resources etc.) of cloud usage in supply chain processes	Discussion with industry experts	Research question: Which elements should be considered to design an adequate RM for integrating cloud computing in supply chain processes?
Qualitative document verification (RMR2)	Systematic knowledge building that is linked to published work	Systematic literature review: Keyword-based search in predefined publication outlets[24] and paper classification via a determined framework	1) Identification of connections between actors and causalities between external as well as internal (digital and physical) resources 2) Identification of advantages of using cloud services in supply chain processes
Iterative construction (RMR3)	Derived from related work and the created framework, aggregation of structures and dependencies to elements and element´s linkages	Analytical search for elements and dependencies within abstracted framework and RM; (gradually RM improvement with the help of experts)	Path from raw data model to Figure 3
Iterative selection (RMR4)	Substantiation of defined RM artifacts	Systematic literature review: Searching other solutions in related work	No existing model found; therefore, preexisting necessity for presented RM
Iterative adaption (RMR5)	Translation of RM to project-specific information model	First draft prototyping with the help of the software ADOit (cf. Figure II)	1) Promoting users to recognize relationships and linkages between various submodels and management tasks 2) Possibility for simulating underlying cause-effect relations 3) Possibility for analyzing cross-company strategies, policies, and processes, leading to a mutually beneficial learning
Selection of methodologies (RMR6)	Selecting a high abstraction level for RM, (due to the more general nature of the research question)	Usage of the unified modeling language (UML) in combination with class diagrams	Figure 3
Development of sections (RMR7)	Creation of sub-models within RM	Search for logical separation between resources, roles and responsibilities within derived framework	Table 4

[24] IS research is covered by the rankings of the “Association for Information Systems” and “Wirtschaftsinformatik”. To the best of our knowledge, the ranking “Transport, Logistics and SCM” of the University of Sydney constitutes the most comprehensive one in the field of SCM. We considered 33 top rated IS journals and 31 top rated SCM journals. Herewith, we identified 63 relevant and important papers. These papers served as a basis for the forward and backward search.

Knowledge-based evaluation (RMR8)	Conducting analytical (RMR8a) and metric-based (RMR8b) evaluation of RM	RMR8a: applying and testing general principles and standards for good RM development RMR8b: Calculation of co-occurrences	Results indicate validity at both evaluation phases
Empirical assessment (RMR9)	Measuring financial benefits of applied RM	Simulation within ADOit	First indication that financial benefits will by far compensate for the incurred cloud usage costs

Figure II Construction of sub-models in ADOit

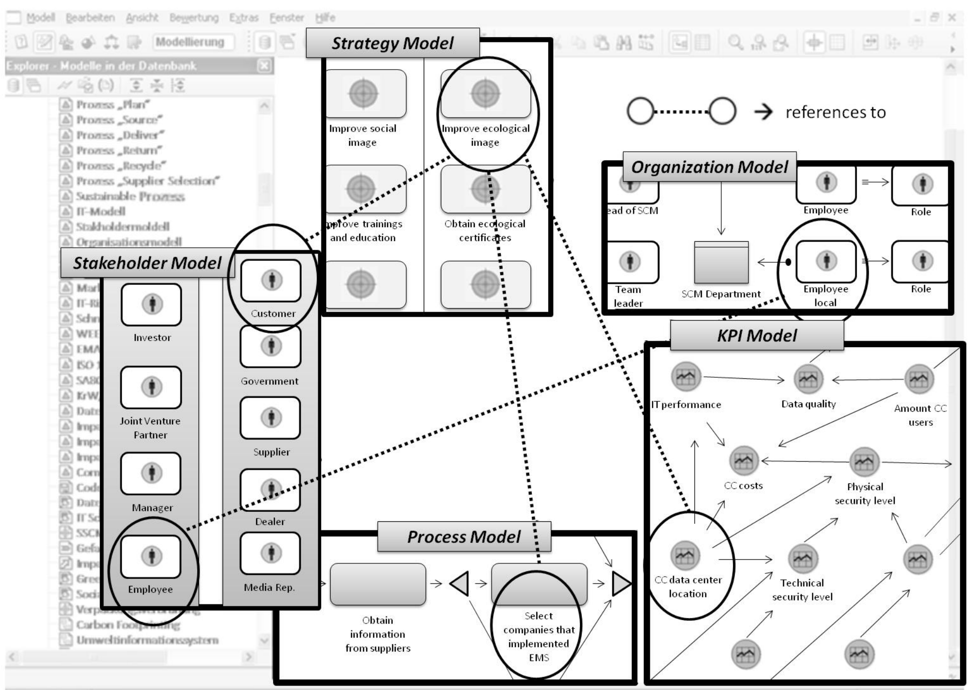


Figure II shows an example of interrelations marked as dashed lines. The referencing style of model elements within ADOit can assist users to recognize relationships and linkages between various sub-models and management tasks. When assigning operational activities to strategic objectives, users of the reference model can be stimulated to reflect the respective underlying cause-effect relations. Furthermore, cross-company strategies, policies, and processes can be investigated, adapted, and gradually improved. The annotated knowledge of individual processes within ADOit can provide transparency to supply chain partners. This enables mutually beneficial learning and stresses the SCM related implementation factors of CC. In addition, ADOit can assign risks, compliance, and policy requirements to elements. Thus, the implemented reference model may help to monitor the user's compliance with applicable laws and standards along the whole cloud based SC.

Beitrag Nr. 3	
Titel	Towards Cloud-based Supply Chain Processes: Designing a Reference Model and Elements of a Research Agenda
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	International Journal of Logistics Management
DOI	http://dx.doi.org/10.1108/IJLM-09-2014-0139

Towards Cloud-based Supply Chain Processes: Designing a Reference Model and Elements of a Research Agenda

Abstract

- **Purpose**

There are cloud computing (CC) services available for various applications within the supply chain management (SCM). These services offer, for example, consistent global networking platforms and enable quick decision-making, which may strengthen competitive advantages. The specification of the single related elements and the coordination mechanisms between actors and information flows is complex. In this paper, we argue that reference models can accelerate understanding these processes. The purpose of this paper is to gain an understanding of the current state of the underlying research field and to present a reference model that supports theory and practice in adopting CC services at SCM.

- **Design/Methodology/Approach**

This paper provides a cross-discipline systematic literature review from the research perspectives of Information Systems and SCM. Based on 102 papers, we designed a reference model showing the interrelations between various elements of CC and SCM.

- **Findings**

We discover the most important chances and risks for CC implementations in supply chain processes and pay special attention to supply chain sustainability aspects of CC. Until now, SCM research in the realm of CC usage is still in its infancy both in theory and practice.

- **Originality/Value**

To the best of our knowledge, there is no systematic literature review that consistently focuses CC usage within supply chain processes while integrating specific aspects of strategic theory. The obtained insights lead to the first SCM related reference model for CC usage.

Keywords: Systematic Literature Review, Reference Modeling, Supply Chain Management, Cloud Computing

1 Introduction and motivation

While complexity and dynamics of contemporary supply chains (SC) increase, stakeholders demand SCs to be environmentally friendly, social, and profitable (Zhang et al., 2014; Steinfield et al., 2011). Herein it is indispensable to select and implement suitable information systems that support the pre-existing challenges of specific SCs. In this context, the term *sustainable supply chain management* often appears, and the questions arises which concepts, methods, and models are needed in order to understand the interrelations between the single aspects.

With the introduction of traditional enterprise resource planning (ERP) systems, it was noted that these systems provide only limited progress for SCM (Akkermans et al., 2003). Rather, they lack to provide effective SCM support especially due to their insufficient functionality in cross-organizational flows, their closed non-modular system architectures, as well as their inflexibility with respect to the ever-changing SC needs (Akkermans et al., 2003). With service-oriented architectures (SOA), which may originate from various vendors, the technical conditions have been created in order to provide complete services from encapsulated functions at any location and any time (Bardhan et al., 2011). Based on SOA, at the end of the last decade, the paradigm of "cloud computing" has emerged (Youseff et al., 2008). Due to the fact that IT processes are becoming more and more stable and flexible, e.g., through scalability and virtualization (Tao et al., 2014; Bharadwaj et al. 2013, Hoberg et al., 2012), CC offers significant advantages particularly for the decentralized and loosely coupled nature of global SCs. By now, first papers indicate positive effects of CC on the environment and on social behaviors of end users (Venters and Whitley, 2012; Morgan and Conboy, 2013).

We are motivated by the fact that the obviously existing advantages of CC usage at SC processes lack a profound theoretical basis, since the current research is at an early stage in both theory and practice (Marston et al., 2011).

So far, the majority of scientific publications on CC focus especially on the technical aspects (Fremdt et al., 2013). Interdisciplinary recommendations for specific strategic business areas (Hoberg et al., 2012), such as SCM (Blau et al., 2009; Leimeister et al., 2010), are scarce. Although first noteworthy successes have been achieved (Meer et al., 2012), the construction of CC-based SC systems remains significantly more challenging than is the case with traditional systems. We argue that this is partially because researchers and practitioners have been struggling with the lack of reference models providing precise vocabulary for describing and reasoning about the key architectural characteristics of CC usage in SCM. Since research propagates that CC offers significant advantages for the information systems of decentralized SCs, we carried out a systematic literature review in order to analyze the detailed links of a cloud-based SC. We are driven by the motivation to unite the existing research on CC and SCM and to detect further research gaps in literature by means of a quantitative and qualitative data analysis. Further, by focusing the intersection of the science disciplines information systems (IS) and SCM, our review fulfills the requirements for investigating CC in a more inter-disciplinary context (Bardhan et al., 2010). Eventually, derived from the literature analysis, we present an application reference model which supports SC managers during the conceptual phase of CC adoption and serves as a solid base to rely on common-practice (Ahlemann and Riempp, 2008). Then, we exemplarily implemented this model. The following research questions (RQ) will be addressed:

- ***RQ1:*** *What is the current state of the art of CC research in the realm of SCM?*
- ***RQ2:*** *Which elements should be considered to design an adequate reference model for integrating CC in SC processes?*

The paper is built up as follows: After the introduction, the basic terms are defined in the second section. In the third section we describe the methodology of the literature analysis. The results from the literature review are presented and discussed in section four. In section five we extract the information for designing and evaluating a reference model. The paper closes with a conclusion in section six.

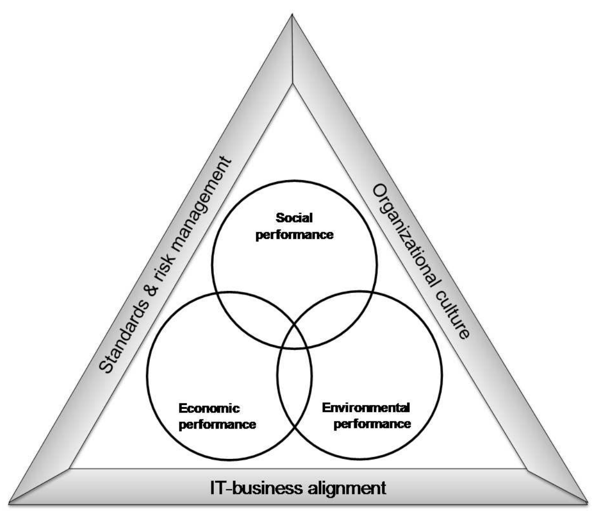
2 Theoretical background

Cooper et al. (1997) define SCM as “the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders”. In the definition, in contrast to prior definitions (Houlihan, 1984; Oliver and Webber, 1992) the borders lie beyond the own organization. Carter and Rogers (2008) expand the preexisting economic definitions by two additional dimensions, namely the social and the environment dimensions. An adequate strategy should determine how to integrate all three dimensions in order to create a sustainable SCM (Wittstruck and Teuteberg, 2012). Derived from the triple bottom line by Elkington (2004), we add the facets *standards and risk management*, *organizational culture*, and *IT-business alignment* shown as a triangle around the three dimensions (cf. figure 1). According to Carter and Rogers (2008), risk management and organizational culture both ensure important support for a sustainable SCM. Regarding IT-business alignment, the challenge lies in selecting and adapting suitable inter-organizational IT solutions that address environmental, social, and economic issues (Chatterjee and Ravichandran, 2013) and have the SCM related limitations of traditional ERP systems (Akkermans et al., 2003).

Referring to the facet *IT-business alignment* (cf. figure 1), research around the concept of SOA began to emerge in the mid-1990s (Joachim, 2011). The goal was to convert functionally defined IT systems into process-oriented architectures, and thus to render IT more flexible (Joachim, 2011). Based on this, the term "cloud computing" was coined. It is classified as an advancement of SOA (Youseff et al., 2008). Legitimately, the scientific literature is currently searching for a commonly accepted definition of the new concept (Marston et al., 2011; Venters and Whitley, 2012). The National Institute of Standards and Technology (NIST) defines CC as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2011). But CC does not represent a new technology. Rather, it stands for a new paradigm for IT processes (Youseff et al., 2008) in which individual, existing technologies are consistently linked (Leimeister et al., 2010). The majority of the research literature distinguishes between three service models (Hoberg et al., 2012; Mell and Grance, 2011): “Infrastructure as a Service (IaaS)“, ”Platform as a Service (PaaS)“, and “Software as a Service (SaaS)“. Furthermore, there are three CC deployments (Hoberg et al., 2012; Marston et al., 2011; Mell and Grance, 2011): The CC origin goes back to the "public CC" in which an external provider offers services through the Internet. On the contrary, "private CC" are in-house services (e.g., between two plants within the company owned SC), which implies the necessity for a self-reliant CC mode. The third version "community CC" could be interesting for a group of interrelated companies that pursue common objectives, similar safety standards, and that want to control the CC services independently from a provider. However, the fourth version "hybrid CC" is a combination of "CC public" and "private CC", where sensitive information are managed internally and non-critical services and data are transferred to the custody of an external provider.

Looking at CC from the perspective of SCM, there are already services available that require cross-company standardization and address the specific requirements of risk management, such as data recovery management (e.g., Steinfield et al., 2011). Moreover, literature argues that with CC resources and energy can be used more efficiently than is the case with traditional information systems (Venters and Whitley, 2012). At the same time, these services require inter-organizational aspects such as collaboration (Cegielski et al., 2012). Linking the single findings that we already gained in research literature, we propose the concept of a cloud-supported sustainable SCM.

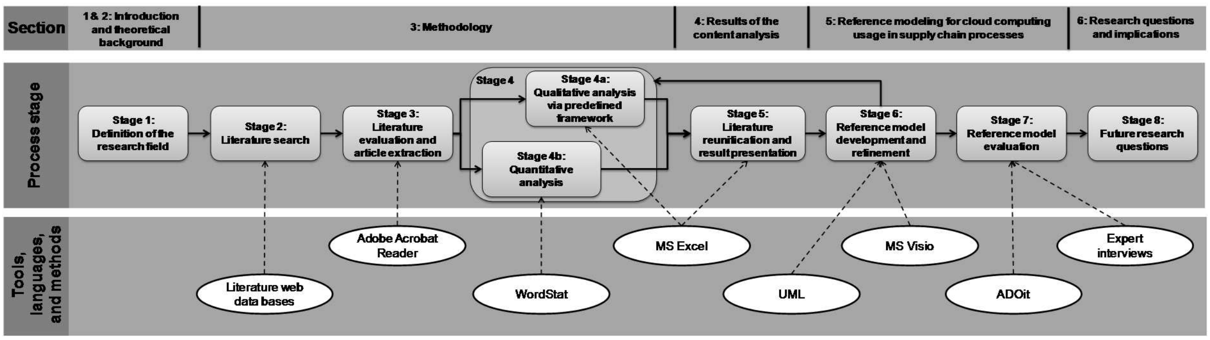
Figure 1 Concept of sustainable SCM (adapted from Elkington, 2004; Carter and Rogers, 2008)



3 Methodology

We based our paper on a systematic literature analysis, as this methodical approach has proven useful for the identification of the respective current status in scientific research (Fettke, 2006; Levy and Ellis, 2006). The execution of the analysis is closely related to Fettke´s (2006) “five stages model” (cf. process stages in figure 2). This model consists of issue description and *definition of the research field*, *literature search*, *literature evaluation*, *literature analysis*, and *interpretation*. Further, we interpret and use the literature knowledge foundation for designing and evaluating a reference model for the CC usage in SC processes. During the research process, we apply various tools and methods. Thus, we follow Bandera et al. (2011), who propose a systematic and tool-supported procedure to review the relevant literature. The rest of this methodology section will explain specific process stages.

Figure 2 Research approach (adapted from Bandera et al., 2011)



3.1 Literature search and evaluation

For the literature search (cf. figure 2, 2nd stage), we used a keyword based search within top rated scientific outlets that were derived from three journal rankings. Hence, IS research is covered by the lists “WI” (WIRTSCHAFTSINFORMATIK) and “AIS” (Association for Information Systems).[25] To our knowledge, the ranking “Transport, Logistics and SCM" of the University of Sydney constitutes the most comprehensive ranking in the field of SCM. In total, the sample consists of 63 journals and five conferences. Thereof, 38 stem from IS and 32 from SCM research; two journals belong to both fields. We used numerous keywords and keyword combinations[26] from section 2 of this paper in order to identify specific papers within the selected journals. Furthermore, we solely considered articles as of 2007, since the term “Cloud Computing” appeared in scientific literature only as of that year (Youseff et al., 2008). The described searching parameters yielded 118 papers. For literature evaluation (cf. figure 2, 3rd stage), we read the abstracts of all papers in order to assess the papers’ relevance. In cases where the abstract showed no relation to our subject or led to confusion, we reviewed the entire paper for relevance. By means of this process, we sorted out 55 papers. Based on the remaining 63 relevant papers, we conducted a forward and backward search (Webster and Watson, 2002). As a result, we extended our sample by 39 additional papers and thus yielded a total of 102

[25] Sources: WI ranking from Frank et al., 2008; AIS ranking from http://aisnet.org/?JournalRankings; Transport, Logistics and SCM ranking from http://sydney.edu.au/business/itls.

[26] The complete list of the used keywords during the paper search phase as well as the selected journals and conferences are available at: https://ssl.tsdprivatserver.de/share/1426617058/Appendix.pdf.

relevant papers. All selected papers meet an important condition: they address topics in the intersection of both research fields.

3.2 Related work

During our literature research, we identified four papers that also apply literature reviews in content related topics. Three of these papers also conduct literature reviews on CC and have a strong focus on information systems but are of lesser significance for SCM research (Hoberg et al., 2012; Salleh et al., 2012; Fremdt et al., 2013). By contrast, the forth paper by Giménez and Laurenco (2008) has a strong orientation towards SCM. However, the paper deals with pre-CC online solutions and hence is based on older publications. Our work distinguishes from the existing scientific literature for the following reasons: To our knowledge, there is up to now no systematic analysis of the literature that consistently focuses the CC usage within SC processes (while integrating strategic aspects). In addition, we do not only evaluate the selected papers qualitatively and quantitatively, we also present the first reference model for cloud usage in SCM.

3.3 Qualitative and quantitative literature analysis

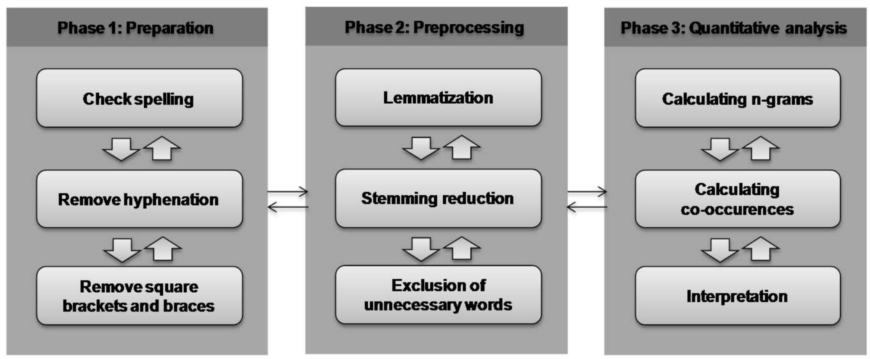
In the literature analysis (cf. figure 2, 4th stage), we followed the framework of Dibbern et al. (2004) to classify the individual papers. Based on the framework (cf. table 1), we pursued a systematic knowledge building that is strictly linked to the published articles. For the qualitative analysis, we analyzed each of the selected articles and structured them according to the mentioned framework. In terms of the perspective "interrelations" (cf. table 1), we searched the articles for the most important aspects which we then grouped into sub-models (e.g., "strategy" sub-model) and related subordinated sub-model elements (e.g., "economical target"). In this way, we aimed at an overall reference model that consists of interrelated sub-models. This analysis served as basis for designing the reference model in the sixth stage.

Table 1 Framework of analysis

Perspective	**Focus**	**Research content**	**Section**
Motivation	Why?	CC within the SC	1
Drivers	What?	Major advantages and risks of CC usage in SCM	4.1
Stakeholders	Who & How?	CC support for sustainable SCM	4.2
Interrelations	How?	Creation of a reference model based on literature analysis	5.1
Implications	Which?	Unanswered research questions	6.3

The goal of the quantitative content analysis was twofold: On the one hand, we used it to investigate the main advantages and risks of CC usage in SC processes (cf. section 4.1). On the other hand, we verified and structured the reference model via co-occurrences (cf. section 5.1). According to Lijphart (1971), content analysis is a suitable methodology for theory development, especially in research fields that lack a theoretical background, as is the case here. Thereby, the content analysis of textual messages has to fulfill six requirements (Neuendorf, 2002), namely: objectivity, intersubjectivity, a priori design, reliability, validity, generalizability, replicability, and hypothesis testing. To address these requirements, we applied a process based on a flow model (cf. figure 3).

Figure 3 Process of software based analysis



During data processing in accordance to the flow model, we used a special document mining software called "WordStat", which constitutes an extension of "QDA Miner" (Provalis, 2010) and is capable to perform quantitative analyses. In order to prepare the software based analysis, we copied the sample documents directly into the software QDA Miner. Prior to the quantitative analysis (cf. figure 3, 3rd phase), the two preliminary phases preparation (1st phase) and preprocessing (2nd phase) need to be passed.[27]

For the quantitative analysis, we investigated n-grams. In general, n-grams are contiguous sequences of words that occur in the texts (Schumie et al., 2009). This paper uses uni-grams (n = 1), bi-grams (n = 2), tri-grams (n = 3), and four-grams (n = 4) in order to identify important word combinations on the issues of advantages and risks when using cloud services in SC processes. Another way to determine the significance of the interrelation of words within a paper in a collection or corpus is the numerical statistic "co-occurrence". We used the co-occurrences in section 4.1 in order to confirm the importance that was indicated by the n-gram combinations. Also, we applied the co-occurrences in section 5 in order to link the sub-models of the reference model. Using both methods, n-grams and co-occurrences, enables a better understanding and preserving of a complex document's context (Weigel et al., 2013). Hence, the combination of both methods is much more effective than using pure word frequency statistics only (n = 1). For

[27] Details of the 1st and the 2nd phase are available at: https://ssl.tsdprivatserver.de/share/1426617058/Appendix.pdf.

calculating the co-occurrences, we used the Jaccard's index (*JI*) similarity coefficient. This simple measure is reasonable especially for word analysis within a sample (Murguia and Villasenor, 2003; Tan et al., 2005) and is defined by:

$$JI = \frac{a}{a + b + c}$$

where *a* represents a document's paragraph in which both words occur, and *b* and *c* represent paragraphs in which one word is found but not the other (Tan et al., 2005). A *JI* of 0.100 indicates that all paragraphs contain at least one of the words, 10% contain both.

3.4 Reference model development

We developed the reference model (cf. figure 2, 6th stage) iteratively (Becker et al., 1995). After having derived the first round of structured sub-models from literature in stage 4a, we reorganized the sub-models slightly (e.g., by deleting the "governmental" sub-model as it is an element of the "stakeholder" sub-model). Further, we added and adjusted some sub-model elements with the aim of achieving an internal consistency and adequate representation of the underlying topic also on an aggregated level (e.g., an "economic interest" in the "stakeholder sub-model" requires an "economic target" in the "strategy" sub-model). Moreover, we considered the identified major advantages and risks of CC usage in SC processes (cf. section 4.1) within our model. By means of the calculated co-occurrences between the underlying words, we linked the sub-models, whereby relatively high co-occurrences indicate a strong link of the sub-models. Moreover, we computed the co-occurrences of all linked elements in the sub-models in order to evaluate the developed reference model in literature. Towards this end, the overall reference model could be questioned when having merely low co-occurrences between the linked elements, because this would imply a low degree of reference model suitability. Thereafter we run a second loop of qualitative literature analysis, as we again analyzed all articles for ensuring consistency between the derived reference model and the literature base. We used the Unified Modeling Language (UML) and class diagrams for the presentation of the model with MS Visio. The UML fulfills the basic principle of systemic construction of reference information models and is directly compatible to object-oriented programming languages (Rosemann and Van der Aalst, 2007). Hereby, our application reference model describes a structured semi-formalized application problem (Rosemann and Van der Aalst, 2007). Finally, we checked the consistency of our reference model with general requirements of reference modeling (Becker et al., 1995) for testing the quality (e.g., semantical and systematical correctness).

4 Literature analysis and synthesis

4.1 Major advantages and risks of cloud computing usage at supply chain processes

In a first step, we used the n-gram filter function (n > 1), where one word was predefined by the term "advantage" or the term "risk" respectively. The frequencies of the computed n-grams indicated their relevance. Thereafter, we used the function "keywords-in-context" in order to analyze the n-gram in its environment from a qualitative perspective.

Through this approach, we identified two advantages and one major risk that stand out due to their high frequencies. This is confirmed by the quite high co-occurrences.[28]

- **Competitive advantage** (overall frequency: 181; appearance in amount of papers: 43; co-occurrence: 0.502): The most frequently mentioned advantage refers to the need of an ***IT-value*** increase and higher ***IT-performance*** with the usage of CC. In this context, adopters expect a high level of support, high speed data access, functional coverage, add-on services, customizability, latest hard and software, as well as service bundles (e.g., Li et al., 2012; Wind et al., 2012; Venters and Whitley, 2012). But obviously, these features entail costs, since the CC providers demand an appropriate payment for these above average IT-value services (Marston et al., 2011). In practical research, however, there is still no evidence for the aspect “competitive advantage” through the use of CC.

- **Cost advantage** (overall frequency: 70; appearance in amount of papers: 19; co-occurrence: 0.271): This factor refers to the cost leadership concept by Porter (1980) and aims at having the lowest operational IT-costs in the industry at equal IT-service quality. Research literature has proven the potential total cost of ownership benefits of CC compared to traditional on-premise IT (Benlian, 2009; Bibi et al., 2012). But the widely cited implicit assumption of an automatic cost reduction that is associated with the adoption of CC (Bensch, 2012; Wind at al., 2012) has to be viewed more critically, since only Meer et al. (2012) have proven a beneficial cost effect under real circumstances for SCM by observing transport distribution processes. Although the possibility to avoid capital expenditures (depreciations) as well as administrative, energy, and maintenance costs on the user side seems attractive, also the increased cost dependency on the provider has to be taken into account: due to high switching costs, most contracts are concluded long-term (Demirkan et al., 2010). Further, the (short term) freedom of choice for the frequency of upgrades and downgrades depending on the economic situation is given away.

- **Security risks** (overall frequency: 43; appearance in amount of papers: 15; co-occurrence: 0.195): IT-security is discussed controversially in the sample, as it may increase and decrease depending on the initial status. By providing a massive concentration of data through the internet, adopting companies arouse the attention of hackers (Venters and Whitley, 2012). Contrary, a high level of data security is depending on financial investments and security know-how (Kaufman, 2009). This can better be managed by CC-providers like Amazon or Microsoft, thus established CC-providers that benefit from economies of scale, than , by a small logistics company, for instance (Brender and Markov, 2013). But in the great majority of the papers, data security is discussed as a risk. Private CC provides the highest security level (Mell and Grance, 2011; Leimeister et al., 2010), but is

[28] Moreover, we used synonym platforms such as www.thesaurus.com and www.synonym.com for searching “advantage” and “risk” synonyms, which we used for the n-gram filter as well. However, we found no relevant synonym appearances.

detrimental to the mentioned advantages as the mentioned benefits cannot appear (e.g., no up-front costs). Therefore, all factors must be considered together, and their interrelations should be studied in detail with adequate measures.

In a second step, we analyzed all n-grams (n > 1) without predefined terms in order to find the key topics and reasons for the use of CC in SC processes. Herein, we excluded obviously general terms such as “supply chain management”, “cloud computing”, or “information system”. With the derived list sorted by n-gram frequencies, we gained three further n-grams with outstanding relevance. We once more used the “keywords-in-context” function for investigating the three most commonly appearing n-grams in a qualitative manner. In contrast to the above stated advantages and risks, which may be seen as general CC advantages and risks, the next three n-grams constitute SCM-specific advantages of CC usage. Wherever possible, we discuss empirical findings in research literature.

- **Value networks** (overall frequency: 352; appearance in amount of papers: 29; co-occurrence: 0.599): The first topic is about creating value networks through CC, which is strongly determined by the factors ***coordination*** and ***collaboration*** (Steinfield et al., 2011; Demirkan et al., 2010). A suitable degree of SC coordination and collaboration is primarily an organizational challenge (Bala, 2013) at employee level (e.g., creating workflows and enabling communication within and across the company’s boundaries). Here, information asymmetries in supply chains can hinder a single participant to create, propagate, and coordinate a production or distribution plan for the entire supply chain (Leukel et al., 2011a). Therefore, the willingness to collaborate and coordinate is indispensable for SC success. And CC can entail transparency and improve data quality across the SC partners inevitably (Morgan and Conboy, 2013; Azevedo et al., 2013). By involving SC partners, Pareto-efficient, IT-based value networks may be enhanced. Autry et al. (2010) and Liu et al. (2010) pointed out that eSCM’s major benefit lies in the improvement of coordination and collaboration, which leads to a competitive advantage by creation of value networks. Alam et al. (2014) analyzed 187 organizations and found the quality of the state of cross-company collaboration to be the most important aspect for SC performance. Further, when using various CC providers, another challenge is to design mechanisms with a stringent IT-coordination strategy for optimal service compositions (Blau et al., 2009; Demirkan et al., 2010; Leukel et al., 2011a).
- **Information sharing** (overall frequency: 275; appearance in amount of papers: 30; co-occurrence: 0.281): The second topic is related to ***information and knowledge sharing***. With an adequate usage of CC, the level of knowledge sharing with internal and external SC partners may increase (Cegielski et al., 2012). In other words, there is an integration of SC processes based on partnering relationships. Supply chain literature has proven the advantageous effects of information and knowledge sharing for all participating units within a supply chain network, especially as regards the minimization of demand risks (Ninikas et al., 2014; Guo et al., 2006) and the bullwhip effect (Lee et al., 1997). In this context, CC acts as a medium for cross organizational analysis of data, process planning, and finally decision support system (Cegielski et al., 2012; Leukel et al., 2011b), which can be

aggregated to knowledge sharing. Leukel et al. (2011b) conducted an in-depth case study with a document management system (DMS) in SCM and found evidence that a cloud-based DMS service enables "knowledge extraction" and knowledge distribution across SCs. A CC platform for small manufacturing companies is proposed and tested by Huang et al. (2013). The platform facilitates to exploit and share the manufacturing information and manufacturing resources, improve operations management, and even promote the design of products.

- **Supply chain flexibility** (overall frequency: 212; appearance in amount of papers: 24; co-occurrence: 0.215): As SCs drift from traditional relationships to loosely coupled dynamic ecosystems (Bharadwaj et al., 2013), the digital processes require increasing technical flexibility and agility in order to respond quickly to changes in the physical environment (Blome et al., 2014). The important role of ***flexibility*** for SCM has widely been showed as a key component for SC's success (Goldsby and Stank, 2000; Swafford et al., 2006). By the means of CC, we pay special attention to interoperability, compatibility, configuration, deployment, portability, scalability, virtualization, automation, and the standardization degree (Cegielski et al., 2012; Wind et al., 2012). Steinfield et al. (2011) analyzed cloud-based systems in aspects of increasing standardization. Furthermore, their focus is on whether information flows sequentially in a point-to-point fashion among supply chain partners or whether it is provided simultaneously to relevant partners via a system hub. The study provided evidence that the standards and the shared hub approach address transparency problems in inter-organizational SCs. Leukel et al. (2011a) stated the question how to distribute airline orders to grounded handling services at airport SCs best. They created a CC service with a standardized electronic interface that increased the accessibility of handling service providers and accomplished work load bottlenecks effectively.

4.2 Cloud computing and sustainable supply chain management

After having presented the most important advantages and risks for CC adoption, we aim to show how CC can enforce sustainable SCM in terms of the figure 1. Anyhow, customers increasingly demand products and services that have been produced and shifted through an environmentally friendly supply chain (Tacken et al., 2014). At the same time, companies expect a higher customer satisfaction and loyalty when providing "green" products and services (Marston et al., 2011; Venters and Whitley, 2012). Looking at the physical aspects of CC, the literature states the following two arguments: 1) by the use of CC, IT-resources can be managed more efficiently through scalability and virtualization (Leimeister et al., 2010; Mell and Grance, 2011; Thies and Stanoevska-Slabeva, 2011), and 2) data centers can be located centrally, in environmentally friendlier locations (Venters and Whitley, 2012) instead of running various decentralized systems with an overall higher level of energy consumption. With these direct effects, a company may verify its sustainable computing by certificates and standards of the "green IT" field (e.g., energy star). The indirect impacts of CC on sustainable SCs are even more important and even harder to measure. As mentioned before, CC enables a closer relationship between various companies within the SCs and hence, contributes to optimize production planning, warehouse management, and transportation routes (cf. section 4.1). Due to the fact that data and information are not transferred sequentially from one SC partner to the other, like is the case with the transfer of the respective goods each SC partner has real time access via the central data location. This increased transparency allows that also partners at the end of the SC obtain vital information on time (e.g., production stops) and are thus in a position to react accordingly (e.g., to eliminate waste in their SCs). On the other side, partners at the beginning of the SC may receive more detailed and prompt information about customer orders and customer claims. In order to take full advantage of these positive effects in terms of *economic performance* as well as *environmental performance*, technical and operational requirements have to be met: on the one hand, there is a need for clearly standardized cloud interfaces (Steinfield et al., 2011; Venter and Whitley, 2012); and on the other hand, there must be the capability and the willingness for information sharing and transparency increase.

The connection between CC and *social performance* is widely unexplored. There are no empirical findings yet that would prove the CC influence on social aspects. However, distinctive aspects of organizational culture should thus significantly influence a company´s decision to adopt CC. Organizational culture reflects many facets of a company, such as basic assumptions, beliefs, values, models of behavior and technology, which describe the dynamics of a particular company (Hofstede et al., 1990). These values have been shown to constitute the characteristics of the company and its social performance (Carter and Rogers, 2008). A few papers in the selected sample indicate that there is a massive influence of CC on organizational culture and individual employees (Marston et al., 2011, Morgan and Conboy, 2013, Pereira, 2009). For instance Marston et al. (2011), who wrote one of the most recognized papers on CC, state: “The effect of cloud computing on corporate culture will play an important role in its eventual success or failure”. The efficient usage of the potential of CC will reduce the stress on the internal employees (e.g., service or process owners) as they have to spend less time on maintaining and managing IT systems and more on their core work processes (Bala, 2013). This is especially valid for the field of SCM, in which there is a complex array of various business processes. Furthermore, CC may help to build a social network around a common IT-process or object.

5 Reference modeling for cloud computing usage in supply chain processes

5.1 Designing a reference model

The upcoming reference model summarizes the most important research outcomes and provides a common ontological framework and standard for the characterization of CC usage in SCM. At this juncture, this model is suitable for describing a class of relevant real-life phenomena on an abstract level (Ahlemann and Riempp, 2008). By drawing analogies between the reference components of the model, various gaps and points of overlap can be identified. For future research, it can provide a basis framework for complementary or build-on models. For SCM practice, it embodies CC implementation suggestions. Derived from the previous quantitative and qualitative literature analysis and based on the sample’s empirical findings, we designed the first reference model (cf. figure 4) that represents the interconnections between CC and SCM. The major preconditions, structures, and dependencies were aggregated to elements and links between the elements. We exhibited the most important factors within the underlying research field in grey boxes as sub-models.

Furthermore, we present a unique link between content analysis and reference modeling, namely by the means of co-occurrences. In our reference model, we stated the co-occurrences in square brackets in order to show the actual relevance of one element for another. Moreover, we paid special attention to the determined chances and risks of CC usage in SCM and their positioning within the model. In the following, we briefly describe the eight underlying sub-models:

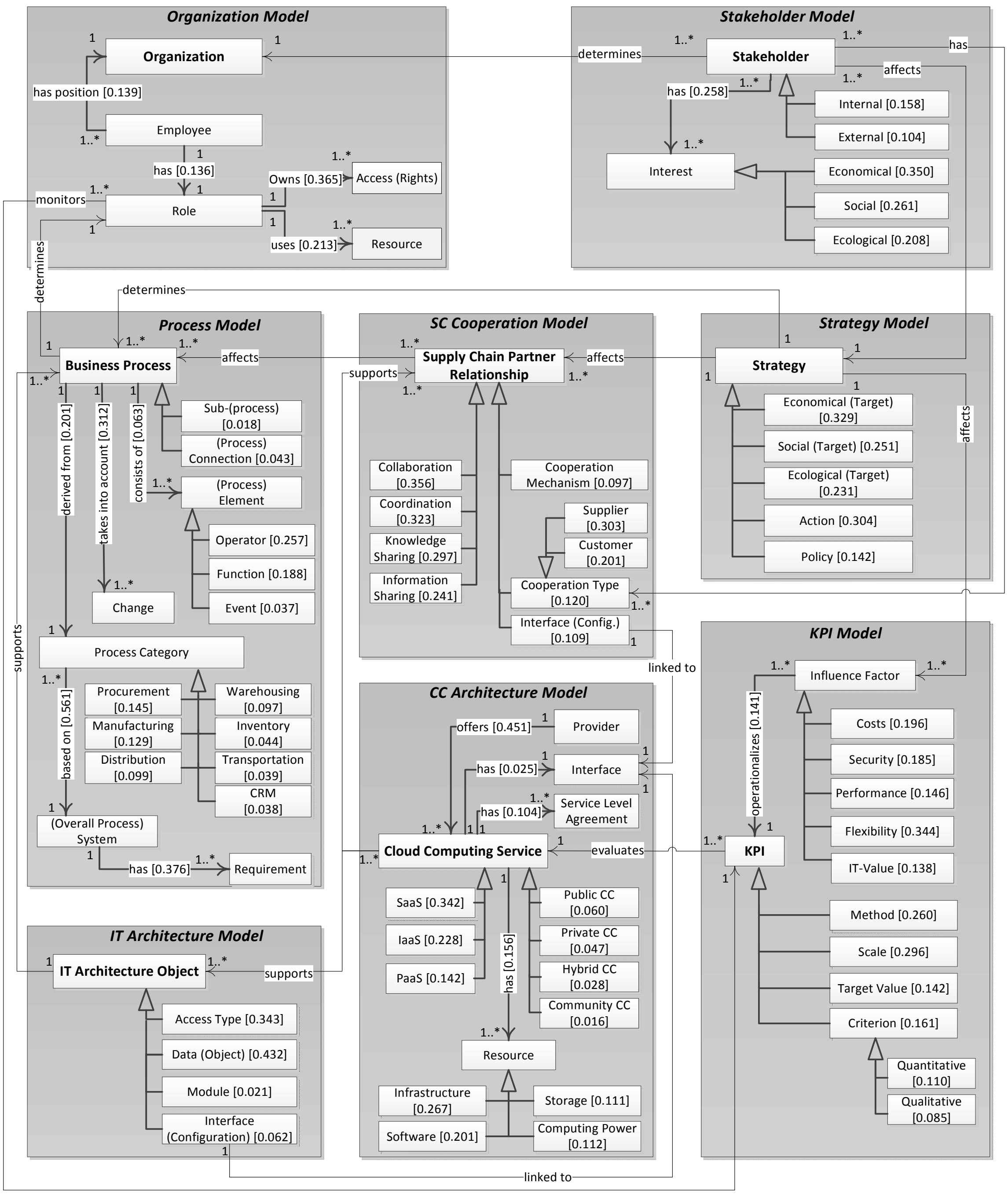
- CC postulates not only financial, but also ecological and social advantages (cf. section 4). Out of a variety of existing ***strategy models***, we tried to substantiate and to test the triple bottom line concept for the underlying research field. The concept assumes that ecological and social responsibility can lead to long-term economic success (Carter and Rogers, 2008). Hence, it is proposed to integrate these three dimensions in the SC strategy (Elkington, 2004). The defined strategy consists of an action plan, measures, and targets for an adequate SC process implementation in order to satisfy related stakeholders.
- The ***stakeholder model*** contains internal and external stakeholders which may have diverse interests. They influence the company´s strategy directly and indirectly. Major external stakeholders constitute governmental authorities and standard setting bodies (e.g., Joachim, 2011; Marston et al., 2011). They obligate companies to initiate activities for a sustainable SCM. At the same time, they define rules and preconditions for the usage of CC (Leimeister et al., 2010). Internal stakeholders such as managers and shareholders define the SC strategy, the goals, and their management support (e.g., Malladi and Krishnan, 2012; Wu et al., 2013). Internal employees, for their part, contribute with their efforts to achieving the goals.
- The ***organization model*** determines the organizational units and roles that have to be established, included, or excluded in order to execute business processes optimally (e.g., Cegielski et al., 2012). Here, not only internal employees have resource, roles and access rights (Morgan and Conboy, 2013), but also the supply chain partners. When CC services are to be used across companies, the definition of an overall authorization concept with the cloud provider is required (Yan et al., 2013; Demirkan and Goul, 2013).
- The ***process model*** addresses all business processes within the supply chain and has a central position in our reference model. Here, the quality and the speed of the processes are primarily depending on the efficiency of the IT support (e.g., Cegielski et al., 2012; Steinfield et al., 2011). Processes are affected by SC partners, both directly and indirectly (via the external stakeholder who affects the resulting strategy). Normally, a process can be divided into sub-processes and connection points between the sub-processes. Further, a business process consists of elements such as operators, functions, and events.
- The nature of the ***IT-architecture model*** is to support business processes (e.g., Hoberg et al., 2012). In aspects of CC, considerable attention has to be paid to the interfaces and the configuration between the own organization, the SC partners and the CC provider (e.g., Leukel et al., 2011b; Benlian et al., 2010). In general, the architecture model defines the data streams and systems that have to be used. Further, the access types between

hardware and software components as well as the specific modules of the single IT systems should be determined (Demirkan and Delen, 2013). In traditional research literature, it is recommended to adjust the IT applications to the design of the overall supply chain (Kumar and Dissel, 1996).

- As mentioned previously, the overall SC success is strongly dependent on the interaction with SC partners (e.g., Fremdt et al., 2013; Wu et al., 2013). We have taken account of this in our ***supply chain cooperation model.*** This sub-model contains the SCM related chances and risks of CC implementations (cf. section 4.1). The SC partners constitute a subset of the stakeholders. Kumar and Dissel (1996) point out that the success of SC cooperations is mainly determined by the behavior of the interacting staff. Managers can encourage employees to behave in a desired manner by assigning them roles, responsibilities, and systems such as CC (Bala, 2013). Depending on the configuration of the SC, appropriate mechanisms have to be used (Hoberg et al., 2012). In case of a sequentially configured and highly structured SC, standardized plans may be preferred. In a reciprocal, less structured supply chain, the delegation of responsibility to decentralized organizational units might be appropriate to make timely decisions in a dynamic environment (Kumar and Dissel, 1996). Hence, the structure and the complexity of the SC affect the selection criteria for an adequate cloud service as well.
- The ***CC architecture model*** shows the specific features and resources for supporting the IT-architecture. Since there is no direct link to the process model, we want to underline the indirect influence of CC on SC processes, which is implicitly assumed by literature as well (e.g., Meer et al., 2012; Steinfield et al., 2011). Furthermore, the model contains the service provider and the underlying service level agreements (Martson et al., 2011; Leimeister et al., 2010) that have to be controlled by the internal staff.

- Finally, a ***KPI model*** is required, which contains the mentioned influence factors for CC implementation (cf. section 4). This model is incumbent upon organizational roles. One possible method to operationalize these factors (and monitor CC) might be a balanced scorecard (BSC) as proposed by Lee et al. (2013). However, the traditional BSC should be supplemented by an environmental and a social perspective. The KPIs contain criterions, scales, and target values.

Figure 4 Reference model for cloud computing at supply chain processes



Looking at the co-occurrences of the "strategy" and the "stakeholder" models, the relatively high co-occurrence values indicate the validity of the triple bottom line concept for the underlying research field. Hence, CC does not only support economic interests, but also social and environmental aspects. However, in terms of the process model, the sample literature obviously propagates a general process change in aspects of CC and discusses the needed requirements. But the sample primarily provides generic suggestions and lacks an evaluation of specific SC sub-processes, connections, or sequences (parallel or alternative), that are particularly adequate for CC usage. Further, the interface configuration across SC partners, which is essential in practice, is mostly ignored by literature as well. In case of a structured and standardized SC, link is not as problematic as it is the case in a reciprocal, unstructured, or highly complicated SC with decentral responsibilities (Kumar and Dissel, 1996). Due to the researchers' argumentation that CC is advantageous, especially for complex SC (Cegielski et al., 2012; Swafford et al., 2008), future research should devote much more attention to technical details that are relevant for an adequate usage in SC processes (e.g., interfaces) in order to provide support for practice.

5.2 Evaluating the reference model

In general, reference models constitute aggregated models or general models that have to be applied to company-specific or project-specific environments in order create suitable information models (Fettke and Loos, 2004). Towards this end, the overall reference model establishes guidelines and strengthens the understanding which is necessary to increase the quality of the subsequent, specific and more detailed information model (Thomas, 2006). However, a specific qualitative model mostly presupposes a qualitative reference model. In this evaluation stage (cf. figure 2), we want to show the applicability as well as the high recommendation character of our reference model. Both are indicators for the quality of a reference model (Thomas, 2006). Hence, after having derived the reference model from research literature, we evaluated the model by adopting a multi-method approach (Martens and Teuteberg, 2011).

In a participative case study (Baskerville, 1997) at an international automotive supplier, we applied the determined reference model. Herein, we first conducted four semi-structured expert interviews with professionals from the SC department of a sub-division of the automotive supplier (TIER1). We interviewed four professionals: the head of the SC department, the key user of the SAP sales and distribution module, the key user of the SAP materials management module, and the purchasing manager. Each of them has more than ten years of experience in the respective working field. We used the sub-models of our reference model as basis for conducting the semi-structured interviews. A common interview protocol was prepared. Before we explain our application procedure, we briefly describe the issue of the case company.

The automotive supplier intends to switch his electronic data interface (EDI) procurement process into a CC based procurement process. In addition to the case company, also two suppliers (TIER2 and TIER3) should participate. This has the advantage that all three partners share the information on procurement orders in real time at a central place. Hence, the TIER3 supplier obtains the needed information earlier compared to the EDI process. Thus, he is in a position to plan his production and logistics processes earlier, which consequently helps the TIER1 supplier to increase his order fulfillment quote. The three companies have been partners for many years and have detailed knowledge on the processes of the others.

In order to understand these cross-company links and to make them transparent, we set out a simulation together with the mentioned experts. Therefore, the generic RM was translated into a project-specific information model. We implemented the specific model by first draft prototyping with the help of the software ADOit by BOC GmbH. This software is widely used at companies in various industries. The referencing style within ADOit can assist users to recognize relationships, links, and impacts between various elements and management tasks. When assigning operational activities to strategic objectives, users of the information model can be stimulated to reflect the respective underlying cause-effect relations. Furthermore, cross-company interdependencies and processes can be investigated, adapted, and gradually improved. The annotated knowledge of individual processes within ADOit can provide transparency to supply chain partners. This enables mutually beneficial learning and stresses the SCM related implementation factors of CC.

Within ADOit, we specified the relevant sub-models of the SC of the three partners (e.g., defining “organization model” characteristics such as employees and access rights; defining “process model” characteristics such as bill of materials and standard order frequencies; defining “IT architecture object” characteristics such as access types and the data structures; defining “CC architecture model” characteristics such as the composition of cloud services and interfaces). With the help of experts from our scientific institution, we refined and improved this model gradually. However, first outcomes indicate the validity of the specific information model, because it enhances the understanding of the complex interrelations and interdependencies. This means that the underlying reference model has, to a certain extent, a valuable recommendation character. Moreover, we found the reference model to be easily applicable during the adoption procedure. However, real life intercompany cloud usage is compellingly needed when the suitability of the specific information model shall be increased and the model findings shall be generalized. This will be done by the case company in the next step.

6 Conclusion and outlook

6.1 Research outcomes and implications

This paper discusses the current state of the art of CC research in the realm of SCM (RQ1). Herein, we conducted quantitative and qualitative literature analyses in order to understand the chances and risks of a CC adoption in SC processes. Based on a systematic literature review, we presented a reference model (RQ2). In order to answer the determined research questions, we developed and applied a ***comprehensive multi-method research approach*** (cf. figure 2), which we described in detail. We demonstrated that our literature grounded approach has a clear structure and can provide valuable results, when conducted with the needed thoroughness. Moreover, we experienced that the combination of various tools and methods delivers interesting, mutually enriching insights and enhances the quality of the paper´s results. Hence, we would like to motivate future research to adopt comprehensive approaches of this kind.

In section 4.1, we pointed out the ***most important advantages, risks and reasons*** for adopting CC in SC processes. Here, literature rather discusses the advantages and opportunities than the risks of CC in SCM. The single points are derived from literature and are thus already known. The important implication of this paper is the far-reaching consideration of various aspects as well as the combination of these aspects, which provides the interested reader with in-depth integrated literature knowledge. Thereafter, we analyzed ***CC from the viewpoint of sustainable SCM*** in section 4.2. Here, we found that CC may accelerate the companies´ implicit intention to run the triple bottom line concept, as many CC features such as flexibility and encapsulation coincide with today´s SC requirements. The latest research papers on SC collaboration propose systems that enable joining and leaving the SC in run-time (Mirzabeiki et al., 2014). Therefore, given that the preconditions are met, we argue that both fields are particularly suitable to be more closely linked. This should be evaluated by means of future research whereby the upcoming research questions (cf. section 6.3) can provide possible research directions for the stronger interconnection of the two fields.

In section 5, we ***developed and evaluated a reference model*** that provides the first artifact for understanding the strategic, technological, and organizational challenges of CC with regards to SCM. This model has a recommendation essence for CC service implementation in practice. Further, this model provides a basis for cross-company learning processes. For future research, it may serve as a framework. Furthermore, we believe that practice has not yet realized the full potential of this connection and that theory lacks both a general research basis and empirical SCM-related papers that are grounded on real application scenarios. However, more research is needed to generalize the findings and to provide relevant support for business practice. First evaluation steps have been made by involving experts and processing a simulation in ADOit. However, real business applications are compellingly needed for increasing the suitability of the model. By means of expert interviews, action research, and further empirical studies on the level of specific dimensions (sub-models), the model should be verified, adjusted and/or extended by more elements, links, and dimensions. This will support managers and operational users to understand cross-organizational interconnections and facilitate necessary learning processes. At the same time, the needed exchange of knowledge between theory and practice will be promoted.

6.2 Limitations

Like every scientific paper, our paper has potential limitations, too. Hence, during the paper selection phase possibly not all of the relevant papers have been filtered. One of the main reasons for this may be the incompleteness of the initially defined list of keywords, alternative terms, and names in relevant articles. Also, the preselection of publication journals and conferences constitutes a limitation. Further, disproportionately many papers stem from the IS discipline: the majority of the papers stems from IS literature, whereas only 21 papers stem from SCM literature. Additionally, we could not find any valuable paper from SCM conferences. Hence, we would like to use this imbalance as a motivation for SCM researchers to investigate the “CC” paradigm in more detail and not to underestimate the possible opportunities any more. In the development of the reference model, we attached importance to a high scientific degree.

We ensured this by a deep foundation in literature, various loops of improvement, as well as the multi-method approach. However, reference model development may be classified as design science, which by nature always includes a certain degree of subjectivity (Pfeffers et al., 2008).

6.3 Future research directions

Finally, we will discuss the open research questions (cf. table 2). According to the framework in table 1, we investigated the selected documents in terms of their open questions via a qualitative analysis. Following the structure of our reference model, we categorized the identified open questions by the previously determined sub-sections. Since none of the research questions have been completely answered, this table can provide some implications and may also serve as a starting point for future research.

Table 2 Research questions

Research question	References
Strategy and KPI	
• How can CC increase the efficiency and performance of global SCs? What are the strategic and operational advantages of using CC in SCM? How can CC support the alignment between sustainability and profitability? Will CC enable new business options for companies?	Bardhan et al., 2010; Durowoju et al., 2011; Gimenez and Lourenco, 2008; Hoberg et al., 2012
• What impact has CC on SC flexibility? How can CC increase the stability of IT processes? How can these effects be measured?	Leukel et al., 2011b; Fremdt et al., 2013
• Is cost reduction the primal intention for CC implementation in SCM? Is "green IT" just a side effect? What policies and standards are needed?	Venters and Whitley, 2012; Steinfield et al., 2011
• Which influences have environmental uncertainties on CC implementation and SC success? Have more specific SCs a higher intention for CC usage? Can CC set free resources?	Nuseibeh, 2011; Benlian, 2009
• How does CC affect SCM employee´s job satisfaction? Do CC implementations lead to undesired radical changes?	Bala, 2013; Morgan and Conboy, 2013
• How can the impact of CC on SC success be measured? Which objective measures and methods should be used? What is the financial impact?	Ranganathan et al., 2011; Pereira, 2009
• How can CC enforce innovations in SCM? How can adequate models for CC usage be created in SCM? How can these be evaluated?	Venters and Whitley, 2012; Marston et al. 2011
• Is there a need for a cloud culture? Is there a positive relationship between organizational entrepreneurship in SCM and CC adoption?	Marston et al., 2011; Wu et al., 2013
IT and CC architecture	
• How can a suitable IT architecture for CC usage in SCM be designed?	Demirkan et al., 2010
• Which IT processes should be covered by the cloud provider? What is the influence of process complexity on CC usage? How can risks be minimized?	Schrödl and Turowski, 2014; Ranganathan et al., 2011
• How can suitable algorithms for CC service compositions in SCM be designed?	Leukel et al., 2011b
• Which CC deployments (public, private, hybrid, community) are adequate for which kind of SC processes?	Venters and Whitley, 2012

• What effect has the internet capability on the CC adaptation at global SCs with increasing presence in developing countries?	Leimeister et al., 2011; Venters and Whitley, 2012
• CC based real time vehicle management: How can decision support systems be designed? How can data security be increased?	Yan et al., 2013; Meer et al., 2012
• How can CC service providers be integrated into the SC?	Repschläger et al., 2012
• How can potential CC users perform individual experiments and tests? How can users be encouraged to participate in these tests?	Xiao et al., 2011; Venters and Whitley, 2012
Stakeholder and Organization	
• How can employees be involved when implementing and operating CC in SCM?	Bala, 2013
• How can the acceptance for CC usage in SCM?	Marston et al., 2011
• What degrees of freedom to act should be given to individual departments and employees? What is the role of internal IT departments?	Huang et al., 2013
• How should suitable work places and processes be designed in order to gain maximum agility and flexibility from the usage of CC?	Fremdt et al., 2013
Processes and SC cooperation	
• How can CC increase the collaboration and coordination between SC partners? How can CC promote trust and knowledge sharing?	Xiao et al., 2011; Leukel et al., 2011a; Steinfield et al., 2011
• Which process requirements need to be met by the CC service?	Wind et al., 2012
• How can a SCM-CC "community" for the purpose of standardization be established? How can industrial organizations be involved?	Thies and Stanoevska-Slabeva, 2011
• How can standard setting bodies force the cooperation between related companies? What kind of typologies should be used?	Steinfield et at., 2011; Hoberg et al., 2012
• How can suitable algorithm for reducing the costs and efforts of logistics service partners in a CC value network be designed?	Li et al., 2012; Leukel et al., 2011b
• What are the advantages of a cloud based ordering process? Do current CC services meet the requirement of an electronic ordering system?	Bensch, 2011; Schrödl and Turowski, 2014

Most of the questions reflect the early status of CC research in the realm of SCM as they still discuss the usefulness of CC for SCM. But the great variety and the multi-dimensional nature of the questions implicate that cloud-supported SCM has a wider and deeper impact on organizations than short term financial aspects. However, aggregated models that provide a "common language" will enhance the understanding of CC impacts in SC processes.

References

The following reference list contains just sources that were explicitly cited within our paper. The complete literature sample reference list is available at: https://ssl.tsdprivatserver.de/share/1426617058/Appendix.pdf

Ahlemann, F. and Riempp, G. (2008), "A Conceptual Reference Model for Project Management Information Systems", *Wirtschaftsinformatik*, Vol. 50 No. 2, pp. 88-97.

Akkermans, H.A., Bogerd, P., Yücesan, E. and Van Wassenhove, L.N. (2003), “The impact of ERP on supply chain management: Exploratory findings from a European Delphi study”, *European Journal of Operational Research*, Vol. 146 No. 2, pp. 284-301.

Alam, A., Bagchi, P.K., Kim, B., Mitra, S. and Seabra, F. (2014), “The mediating effect of logistics integration on supply chain performance: a multi-country study”, *International Journal of Logistics Management*, Vol. 25 No. 3, pp. 553-580.

Autry, C.W., Grawe, S.J., Daugherty, P.J. and Richey, R.G. (2010), “The effects of technological turbulence and breadth on supply chain technology acceptance and adoption”, *Journal of Operations Management*, Vol. 28 No. 6, pp. 522-536.

Azevedo, S., Prata, P. and Fazendeiro, P. (2013), “Assessment of Supply Chain Agility in a Cloud Computing-based Framework”, *Scalable Computing: Practice and Experience*, Vol. 13 No. 4, pp. 295-301.

Bala, H. (2013), “The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation”, *Journal of Operations Management*, Vol. 31 No. 6, pp. 450-473.

Bandara, W., Miskon, S., and Fielt, E. (2011), “A systematic, tool-supported method for conducting literature reviews in information systems”, in *Proceedings of 19th the European conference on information systems* (ECIS), 9th-11th June 2010, Helsinki, Finland.

Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R.J. and Sougstad, R. (2010), “An interdisciplinary perspective on IT services management and service science”, *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 13-64.

Baskerville, R.L. (1997), “Distinguishing action research from participative case studies”, *Journal of Systems and Information Technology*, Vol. 1 No. 1, pp. 24-43.

Becker, J., Rosemann, M., and Schütte, R., (1995), “Grundsätze ordnungsmäßiger Modellierung (Guidelines for or-derly modeling)“, *Wirtschaftsinformatik*, Vol. 37 No. 5, 435–445.

Benlian, A. (2009), “A transaction cost theoretical analysis of Software-as-a-Service (SaaS)-based sourcing in SMBs and enterprises”, in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Benlian, A., Koufaris, M. and Hess, T. (2010), “The role of SaaS service quality for continued SaaS use: Empirical insights from SaaS using firms”, in *Proceedings of the 31st International Conference on Information Systems* (ICIS), 12th-15th December 2010, Saint Louis, Missouri.

Bensch, S. (2012), “Recommender Systems for Strategic Procurement in Value Networks”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Bharadwaj, A., El-Sawy, O.A., Pavlou, P.A. and Venkatraman, N. (2013), “Digital Business Strategy: Toward a Next Generation of Insights”, *Management Information Systems Quarterly*, Vol. 37 No. 2, pp. 471-482.

Bibi, S., Katsaros, D. and Bozamis, P. (2012), "Business application acquisition: on-premise or SaaS-based solutions?", *IEEE Software*, Vol. 29 No. 3, pp. 86-93.

Blau, B.S., Conte, T. and Meinl, T. (2009), "Coordinating service composition", in *Proceedings of the 17th European Conference on Information Systems* (ECIS), 8th-10th June 2010, Verona, Italy.

Blome, C., Schoenherr, T. and Eckstein, D. (2014), "The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view", *International Journal of Production Economics*, Vol. 147 No. 1, pp. 307-316.

Brender, N. and Markov, I. (2013), "Risk perception and risk management in cloud computing: Results from a case study of Swiss companies", *International Journal of Information Management*, Vol. 33 No. 5, pp. 726-733.

Carter, C.R. and Rogers, D.S. (2008), "A framework of sustainable supply chain management: moving toward new theory", *International journal of physical distribution & logistics management*, Vol. 38 No. 5, pp. 360-387.

Cegielski, C.G., Jones-Farmer, L.A., Wu, Y. and Hazen, B.T. (2012), "Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach", *International Journal of Logistics Management*, Vol. 23 No. 2, pp. 184-211.

Chatterjee, D. and Ravichandran, T. (2013), "Governance of Interorganizational Information Systems: A Resource Dependence Perspective", *Information Systems Research*, Vol. 24 No. 2, pp. 261-278.

Cooper, M.C., Lambert, D.M., and Pagh, J.D. (1997), "Supply chain management: more than a new name for logistics", *The International Journal of Logistics Management*, Vol. 8 No. 1, pp. 1-13.

Demirkan, H., Cheng, H.K. and Bandyopadhyay, S. (2010), "Coordination strategies in an SaaS supply chain", *Journal of Management Information Systems*, Vol. 26 No. 4, pp. 119-143.

Demirkan, H. and Delen, D. (2013), "Leveraging the capabilities of service-oriented decision support systems: Putting analytics and big data in cloud", *Decision Support Systems*, Vol. 55 No. 1, pp. 412-421.

Demirkan, H. and Goul, M. (2013), "Taking value-networks to the cloud services: security services, semantics and service level agreements", *Information Systems and e-Business Management*, Vol. 11 No. 1, pp. 51-91.

Dibbern, J., Goles, T., Hirschheim, R. and Jayatilaka, B. (2004), "Information Systems Outsourcing: A Survey and Analysis of the Literature", *ACM SIGMIS Database*, Vol. 35 No. 4, pp. 6-102.

Durowoju, O., Chan, H.K. and Wang, X. (2011), "The impact of security and scalability of cloud service on supply chain performance", *Journal of Electronic Commerce Research*, Vol. 12 No. 4, pp. 243-56.

Elkington, J. (2004), "Enter the Bottom line", in Henriques, A. and Richardson, J., (eds.), The Triple Bottom Line, Earthscan, London, UK.

Fettke, P. (2006), „State-of-the-Art des State-of-the-Art: Eine Untersuchung der Forschungsmethode "Review" innerhalb der Wirtschaftsinformatik", *Wirtschaftsinformatik*, Vol. 48 No. 4, pp. 257-266.

Fettke, P., and Loos, P. (2004), "Reference modeling research", *Wirtschaftsinformatik*, Vol. 46 No. 5, pp. 331-340.

Frank, U., Heinzl, A., and Schoder, D. (2008): "WI-Orientierungslisten: WI-Journalliste 2008 sowie WI-Liste der Konferenzen, Proceedings und Lecture Notes 2008", *Wirtschaftsinformatik* Vol. 50 No. 2, pp. 155-163.

Fremdt, S., Beck, R. and Weber, S. (2013), "Does Cloud Computing Matter? An Analysis of the Cloud Model Software-as-a-Service and Its Impact on Operational Agility", in *Proceedings of the 46th Hawaii International Conference on in System Sciences* (HICSS), 7th-10th January 2013, Grand Wailea, Hawaii.

Giménez, C. and Lourenço, H.R. (2008), "E-SCM: internet's impact on supply chain processes", *The International Journal of Logistics Management*, Vol. 19 No. 3, pp. 309-343.

Goldsby, T.J. and Stank, T.P. (2000), "World class logistics performance and environmentally responsible logistics practices", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 187-208.

Guo, Z., Fang, F. and Whinston, A.B. (2006), "Supply chain information sharing in a macro prediction market", *Decision Support Systems*, Vol. 42 No. 3, pp. 1944-1958.

Hoberg, P., Wollersheim, J. and Krcmar, H. (2012), "The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Hofstede, G., Neuijen, B., Ohayv, D.D. and Sanders, G.(1990), „Measuring organizational cultures: A qualitative and quantitative study across twenty cases", *Administrative Science Quarterly*, Vol. 35 No. 2, pp. 286-316.

Houlihan, J. (1984), "Supply chain management", Proceedings of the 19th International Technical Conference (BPICS), pp. 101-10.

Huang, B., Li, C., Yin, C. and Zhao, X. (2013), "Cloud manufacturing service platform for small-and medium-sized enterprises", *The International Journal of Advanced Manufacturing Technology*, Vol. 65 No. 9-12, pp. 1261-1272.

Joachim, N. (2011), "A Literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Kaufman, L.M. (2009), "Data security in the world of cloud computing", *IEEE Security and Privacy*, Vol. 7 No. 4, pp. 61-64.

Kumar, K. and Van Dissel, H.G. (1996), "Sustainable collaboration: managing conflict and cooperation in interorganizational systems", Management Information Systems Quarterly, Vol. 20 No. 3, pp. 279-300.

Lee, H.L., Padmanabhan, V. and Whang, S. (1997), "Information distortion in a supply chain: the bullwhip effect", *Management Science,* Vol. 43 No. 4, pp. 546–558.

Lee, S.G., Chae, S.H. and Cho, K.M. (2013), "Drivers and inhibitors of SaaS adoption in Korea", *International Journal of Information Management*, Vol. 33 No. 3, pp. 429-440.

Leimeister, S., Boehm, M., Riedl, C. and Krcmar, H. (2010), “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks”, in *Proceedings of the 18th European Conference on Information Systems* (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Leukel, J., Jacob, A., Karaenke, P., Kirn, S. and Klein, A. (2011a), “Individualization of Goods and Services: Towards a Logistics Knowledge Infrastructure for Agile Supply Chains”, in *AAAI Spring Symposium: AI for Business Agility*, 21th-23th March 2011, Palo Alto, California.

Leukel, J., Kirn, S. and Schlegel, T. (2011b), “Supply chain as a service: A cloud perspective on supply chain systems”, *Systems Journal*, Vol. 5 No. 1, pp. 16-27.

Levy, Y. and Ellis, T.J. (2006), “A systems approach to conduct an effective literature review in support of information systems research”, *International Journal of an Emerging Transdiscipline*, Vol. 9, pp. 181-212.

Li, X., Wang, Y. and Chen, X. (2012), “Cold chain logistics system based on cloud computing”, *Concurrency and Computation: Practice and Experience*, Vol. 24 No. 17, pp. 2138-2150.

Lijphart, A. (1971), “Comparative Politics and the Comparative Method”, *American Political Science Review*, Vol. 65 No. 3, pp. 682-693.

Liu, H., Ke, W., Wei, K.K., Gu, J. and Chen, H. (2010), “The role of institutional pressures and organizational culture in the firm’s intention to adopt internet-enabled supply chain management systems”, *Journal of Operations Management*, Vol. 28 No. 5, pp. 372-84.

Malladi, S. and Krishnan, M.S. (2012), “Cloud Computing Adoption and its Implications for CIO Strategic Focus - An Empirical Analysis”, in *Proceedings of the 33rd International Conference on Information Systems* (ICIS), 16th-19th December 2012, Orlando, Florida.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011), “Cloud computing - The business perspective”, *Decision Support Systems*, Vol. 51 No. 1, pp. 176-189.

Martens, B., Pöppelbuss, J. and Teuteberg, F. (2011), “Understanding the Cloud Computing Ecosystem: Results from a Quantitative Content Analysis”, in *Proceedings of Wirtschaftsinformatik* (WI), 16th-18th February 2011, Zurich, Swiss.

Martens, B. and Teuteberg, F. (2011), “Risk and Compliance Management for Cloud Computing Services: Designing a Reference Model”, in *Proceedings of the 17th Americas Conference on Information Systems* (AMCIS), Detroit, USA.

Meer, D.V., Dutta, K. and Datta, A. (2012), “A cost-based database request distribution technique for online E-commerce applications”, *Management Information Systems Quarterly*, Vol. 36 No. 2, pp. 479-507.

Mell, P. and Grance, T. (2011), “The NIST definition of cloud computing”, available at: http://pre-developer.att.com/home/learn/enablingtechnologies/The_NIST_Definition_of_Cloud_Computing.pdf (accessed 10 August 2014).

Mirzabeiki, V., Holmström, J., and Främling, K. (2014), “Collaborative tracking and tracing: the value of a composite design”, *International Journal of Logistics Management*, Vol. 25 No. 3, pp. 522-536.

Morgan, L. and Conboy, K. (2013), “Factors affecting the adoption of cloud computing: an exploratory study”, in *Proceedings of the 21st European Conference on Information Systems* (ECIS), 20th-25th November 2013, Utrecht, Netherlands.

Murguía, M. and Villaseñor, J.L. (2003), “Estimating the effect of the similarity coefficient and the cluster algorithm on biogeographic classifications”, *Annales Botanici Fennici*, Vol. 40 No. 6, pp. 415-421.

Neuendorf, K.A. (2002), “The Content Analysis Guidebook”, Sage, Thousand Oaks, CA, pp. 10 ff.

Ninikas, G., Athanasopoulos, T., Zeimpekis, V. and Minis, I. (2014), „Integrated planning in hybrid courier operations”, *International Journal of Logistics Management,* Vol. 25 No. 3, pp. 611-634.

Nuseibeh, H. (2011), ”Adoption of cloud computing in organizations”, in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Oliver, R.K. and Webber, M.D. (1992), “Supply chain management: logistics catches up with strategy”, in Christopher, M. (ed.), Logistics: The Strategic Issues, Chapman & Hall, London, pp. 63-75.

Peffers, K., Tuunanen, T., Rothenburger, M.A. and Chatterjee, S. (2007), “A design science research methodology for information systems research”, *Journal of Management Information Systems*, Vol. 24 No. 3, pp. 45-77

Pereira, J.V. (2009), “The new supply chain's frontier: Information management”, *International Journal of Information Management*, Vol. 29 No. 5, pp. 372-379.

Porter, M.E. (1980), “Competitive advantage: Creating and sustaining superior performance”, New York: Free Press, NY.

Provalis Research (2010), “WordStat 6: Content Analysis Module for QDA Miner and SimStat”, available at: http://www.provalisresearch.com/Documents/WordStat6.pdf (accessed 13 March 2014).

Ranganathan, C., Teo, T.S. and Dhaliwal, J. (2011), “Web-enabled supply chain management: Key antecedents and performance impacts”, *International Journal of Information Management*, Vol. 31 No. 6, pp. 533-545.

Repschlaeger, J., Wind, S., Zarnekow, R. and Turowski, K. (2012), “Selection criteria for software as a service: an explorative analysis of provider requirements”, in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Rosemann, M. and Van Der Aalst, W.M.P. (2007), “A configurable reference modelling language”, *Information Systems Journal*, Vol. 32 No. 1, pp. 1-23.

Salleh, S., Teoh, S. and Chan, C. (2012), “Cloud enterprise systems: a review of literature and its adoption”, in *Proceedings of the 16th Pacific Asia Conference on Information Systems* (PACIS), 9th-12th July 2012, Ho Chi Minh City, Vietnam.

Schrödl, H. and Turowski, K. (2014), “Risk management in hybrid value creation”, *Decision Support Systems*, Vol. 58 No. 2, pp. 21-30.

Schuemie, M., Talmon, J., Moorman P. and Kors, J. (2009), "Mapping the Domain of Medical Informatics", *Methods of Information in Medicine*, Vol. 48 No. 1, pp. 76-83.

Sidorova, A., Evangelopoulos, N., Valacich, J.S. and Ramakrishnan, T. (2008), "Uncovering the Intellectual Core of the Information Systems Discipline", *Management Information Systems Quarterly*, Vol. 32 No. 3, pp. 467-482.

Steinfield, C., Markus, M.L. and Wigand, R.T. (2011), "Through a glass clearly: standards, architecture, and process transparency in global supply chains", *Journal of Management Information Systems*, Vol. 28 No. 2, pp. 75-108.

Swafford, P., Ghosh, S., and Murthy, N. (2006), "The antecedents of supply chain agility of a firm: scale development and model testing", *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-88.

Swafford, P.M., Ghosh, S. and Murthy, N. (2008), "Achieving supply chain agility through IT integration and flexibility", *International Journal of Production Economics*, Vol. 116 No. 2, pp. 288-297.

Tacken, J., Rodrigues, V. S. and Mason, R. (2014), "Examining CO2e reduction within the German logistics sector", *International Journal of Logistics Management*, Vol. 25 No. 1, 54-84.

Tan, P.N., Steinbach, M. and Kumar, V. (2005), "Introduction to Data Mining", Addison-Wesley, Boston, MA.

Tao, F., Cheng, Y., Xu, L. D., Zhang, L. and Li, B. H. (2014), "CCIoT-CMfg: cloud computing and Internet of Things based cloud manufacturing service system", *IEEE Transactions on industrial informatics*, Vol. 10, pp. 1435-1442.

Thies, H. and Stanoevska-Slabeva, K. (2011), "Towards Inter-Organizational Environmental Information Systems for Sustainable Business Networks", in *Proceedings of the 17th American Conference on Information Systems* (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Thomas, O. (2006), "Understanding the term reference model in information systems research: history, literature analysis and explanation", In *Business Process Management Workshops*, Springer, Berlin Heidelberg, pp. 484–496.

Venters, W. and Whitley, E.A. (2012), "A critical review of cloud computing: researching desires and realities", *Journal of Information Technology*, Vol. 27 No. 3, pp. 179-197.

Webster, J. and Watson, R.T. (2002), "Analyzing the Past to Prepare for the Future: Writing a Literature Review", *Management Information Systems Quarterly*, Vol. 26 No. 2, pp. xiii-xxiii.

Weigel, F.K., Rainer Jr, R.K., Hazen, B.T., Cegielski, C.G. and Ford, F.N. (2013), "Uncovering Research Opportunities in the Medical Informatics Field: A Quantitative Content Analysis", *Communications of the Association for Information Systems*, Vol. 33 No. 1, article 2.

Wind, S., Repschlaeger, J. and Zarnekow, R. (2012), "Towards a Cloud Computing Selection and Evaluation Environment for Very Large Business Applications", in *Proceedings of the 18th American Conference on Information Systems* (AMCIS), 9th-11th August 2012, Seattle, Washington.

Wittstruck, D. and Teuteberg, F. (2012), "Understanding the Success Factors of Sustainable Supply Chain Management: Empirical Evidence from the Electrics and Electronics Industry", *Corporate Social Responsibility and Environmental Management*, Vol. 19 No. 3, pp. 141-158.

Wu, Y., Cegielski, C.G., Hazen, B.T. and Hall, D.J. (2013), "Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud", *Journal of Supply Chain Management*, Vol. 49 No. 3, pp. 25-41.

Xiao, J., Wang, H., Cheng, Z.L., Xie, K. and Hu, Q. (2011), "Why Is Web-based Supply Chain Management Popular in China? A Factor Endowment's Perspective", in *Proceedings of the 32nd International Conference on Information Systems* (ICIS), 4th-7th December 2011, Shanghai, China.

Yan, G., Wen, D., Olariu, S. and Weigle, M.C. (2013), "Security challenges in vehicular cloud computing", *Intelligent Transportation Systems*, Vol. 14 No. 1, pp. 284-294.

Youseff, L., Butrico, M. and Da Silva, D. (2008), "Toward a unified ontology of cloud computing", *Grid Computing Environments Workshop 2008* (GCE), 16th November 2008, Austin, Texas.

Zhang, L., Luo, Y., Tao, F., Li, B. H., Ren, L., Zhang, X., et al. (2014), "Cloud manufacturing: a new manufacturing paradigm", *Enterprise Information Systems*, Vol. *8 No.* 2, pp. 167-187.

Beitrag Nr. 4	
Titel	Investigating Preconditions for a Financially Advantageous Cloud Usage
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	International Journal of Accounting & Information Management
DOI	http://dx.doi.org/10.1108/IJAIM-04-2015-0018

Investigating Preconditions for a Financially Advantageous Cloud Usage

Abstract:

Purpose: IT expenses constitute an important factor when choosing efficient IT systems. Especially with regard to cloud computing, decision makers tend to associate cost benefits. In this context, cloud providers present often undifferentiated sample calculations which aim to verify the financial favorability of their IT solutions. However, the scientific literature tries to encounter this by means of various total costs of ownership (TCO) approaches. But science mostly neglects essential factors as well and does not provide an integrated approach involving factors, such as (i) cost of capital, (ii) taxation effects, (iii) use intensity, or (iv) duration of use.

Design: The paper uses a multi-method approach. First, existing literature is analyzed by a systematic literature review. Afterwards, the initial model is developed by means of a formal notation. Finally, the suitability of the formal model is evaluated by a real-life case study, where simulation software is used for investigating various scenarios.

Findings: The underlying paper discusses a formal model which integrates the four stated factors and enables decision makers to compare cloud based IT services on a comprehensive financial basis. Thus, the rational cost comparisons with traditional IT systems such as on-premise increase the transparency of the cloud computing field significantly.

Originality: This paper shows impressively the importance of the four mentioned factors and their influence on the decision whether to implement cloud services or on-premise services. Herein, to the best of our knowledge and for the first time, a cash-flow based comparison model is created for comparing cloud services and on-premise solutions.

Keywords: Financial Decision Model, Cloud Computing, Cash Flow Comparison, Case Study Research, Simulation Analysis

1 Introduction

A global study of Gartner (2014) has shown that depending on the industry sector the IT costs of a company amount to an average of around 3.3% of total sales. This share may rise up to 6% in IT-intensive branches such as the financial sector (Gartner, 2014; PWC, 2009). Thus, IT costs and IT investments represent a significant cost factor (Lee et al., 2010; Bose and Luo, 2014). The relatively high share of costs and the comparably low IT cost transparency (PWC, 2009) often mislead managers to think of an implicitly given cost-cutting potential. Furthermore, IT costs are basically classified as period expenses (PWC, 2010) that are generally under investigation, especially since the financial crisis at the end of the last decade. The IT industry takes advantage of study results (e.g., Gartner, 2014; Misra and Modal, 2011; Meer et al., 2012) as well as the managerial attitude and increasingly promotes diverse outsourcing models in addition to their traditional services. In particular the business with cloud computing (CC) is currently heavily pushed and advertised as a “win-win” situation for CC providers and users (Ahmed et al., 2015; Bharadwaj et al., 2013; Demirkan and Delen, 2013).

Scientific research has recognized this trend early, and several critical papers dealing with the financial comparisons between traditional services and CC have been published (e.g., Egwutuoha et al., 2014; Martens and Teuteberg, 2012; Benlian, 2011). Although the corresponding results in terms of financial favorability basically involve both directions, the majority of the papers link CC with financial benefits (e.g., Meer et al., 2012; Brender and Markov, 2013; Bibi et al., 2012; Oliveira et al., 2014). Often, the total costs of ownership (TCO) approach is proposed and applied for the cost comparison between alternative IT services (e.g., Misra and Modal, 2011). However, important financial factors, such as capital costs, tax effects, and operational factors, such as duration of usage or use intensity, are usually neglected in the context of CC, which leads to deceptive results. Especially with CC, these financial and operational factors may have a great impact on financial decisions.

This research gap constitutes the starting point of the underlying paper. In a first step, the missing factors will be complemented via a mathematical model. Herein, we pay special attention to the specific characteristics of on-premise systems and cloud services. Thereafter, the costs and the linked cash flows of both IT systems are set in direct relation to each other. This will enable decision makers to make favorability calculations on a more comprehensive cash flow basis. Finally, the model will be evaluated using a case study. The following research question will be addressed:

> *What are the relevant factors for designing a comprehensive cash flow based comparison model involving the specific characteristics of CC and alternative on-premise solutions?*

The paper is structured as follows: After the introduction, the second section discusses the state of research. The third section describes the methodology of this study. Then, the model is derived and subsequently, in the fifth section, tested by means of a practical application via a case study. The work ends with a discussion in section six and a conclusion in section seven.

2 Literature review

The National Institute of Standards and Technology (NIST) defines CC as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance, 2011). However, CC does not represent a new technology; it rather stands for a new paradigm for IT processes (Youseff et al., 2008; Oliveira et al., 2014) where individual, already existing technologies are linked consistently (Ahmed et al., 2015; Leimeister et al., 2010). The majority of the research literature distinguishes between three service models (Hoberg et al., 2012; Mell and Grance, 2011): "Infrastructure as a Service (IaaS)", "Platform as a Service (PaaS)", and "Software as a Service (SaaS)". Furthermore, there are four CC deployments (Hoberg et al., 2012; Marston et al., 2011; Mell and Grance, 2011): The CC origin goes back to the "public CC" in which an external provider offers services through the Internet. On the contrary, "private CC" are in-house services (e.g., between two plants within the company-owned supply chain), which requires a self-reliant CC mode. The third version "community CC" could be interesting, if a group of interrelated companies, pursuing common objectives and similar safety standards, intends to control the CC services independently from a provider. Then there is the fourth version "hybrid CC" which is a combination of "CC public" and "private CC" where sensitive information are managed internally and non-critical services and data are transferred to the custody of an external provider.

The decision between traditional services such as on-premise services and CC is theoretically justified not least by the ground-braking core competence approach made by Prahalad and Hamel (1990), which in turn is anchored in the resource dependence theory (Chatterjee and Ravichandran, 2013). Here, the cost factor is a fundamental component in the decision-making process (Dos Santos et al., 2012; Barney, 2007, pp. 348 ff.) and is therefore extensively studied in scientific literature. Furthermore, cost reduction potential is discussed as one of the most important reasons for adopting cloud services (Marston et al., 2011). It is said that this is a factor incorporated in the ability that cloud solutions provide the 'pay as you go' model, as it reduces the total expenditure on IT resources (including hardware and software investment) and minimizes the capital expenditure, since no up-front investment is required (Jensen and Joha, 2011; Dos Santos et al., 2012; Leimeister et al., 2010). Contrary to the general research trend, we aim at questioning the deeper, mostly hidden cost effects of CC.

Since CC emerged from the IT-outsourcing trend, researchers in this field will find several points of contact with the IT-outsourcing literature (e.g., Inalsbe et al., 2011). But the specific features of CC make it hard to compare traditional IT-outsourcing with actual CC issues. Here, we want to mention just a few of the major differences (cf. detailed discussion e.g., Armbrust et al., 2009; Marston et al., 2011; Weinhardt et al., 2009). First, with CC and the pay-as-you-go utility model there is a high financial "variabilisation" of IT costs, which can only partially be realized by means of traditional IT-outsourcing. In other words, IT consumption and IT costs have a more proportional relationship with CC. Moreover, as there are no upfront commitments to be settled by cloud users, it is easy to join, test, or quit new services short-term, which is more complicated with traditional IT-outsourcing services and their mid or long term contracts (Armbrust et al., 2009; Mell and Grance, 2011). Additionally, the interactive application type and the access via standard web protocols allows various related cloud users to exchange data, information, and knowledge through a common platform more easily than with traditional IT-outsourcing (Weinhardt et al., 2009; Marston et al., 2011). This CC advantage can lead to an indirect cost reduction as well.

To substantiate this paper theoretically and explore the status quo regarding the financial evaluation of cloud services, we conducted a systematic literature analysis (Webster and Watson, 2002). Hence, we searched for papers that strictly focus on IT cost calculations. The keyword-based searching process started with using significant terms in various combinations: (cost* OR account* OR finance*) AND (cloud OR iaas OR paas OR saas OR outsourc* OR information system*). In order to identify relevant publications, we applied the searching process in three scientific databases (EBSCO, Science Direct, Springer Link). Finally, we conducted a forward and backward search (Webster and Watson, 2002). The most relevant papers are described subsequently.

In an earlier study, Lammers (2004) also derived a model from the resource dependence theory. He conceived a formal decision model for IT outsourcing, which can be adopted to CC as well. He concludes that especially the shared, private use of resources should be given more attention due to its potential cost advantages. One of the first papers focusing CC cost comparisons was written by Walker (2009). He compared CPU costs per hour between CC-services and own operations. Kondo et al. (2009) applied a detailed cost-benefit analysis. They compare CC-services to volunteer computing applications like XtremLab. The benefit analysis concentrates on the system performance. Their overall finding is that in the long run volunteer computing is economically more beneficial but requires high start-up investments. Not surprisingly, for short and high performance tasks it is recommended to apply commercial CC-services. Misra and Mondal (2011), whose formal model stands out in particular by the large number of defined cost variables, came to similar results. The mentioned works of this paragraph have in common that they discuss the *usage length* (analysis in the depth), indicating the importance of usage duration effects, when comparing CC and alternative on-premise systems.

By comparing SaaS and IaaS to an equivalent on premise solution, Bibi et al. (2012) analyzed a practical example. According to their findings, IaaS has larger financial benefits than SaaS. Strebel and Stage (2010), however, investigated the IT infrastructure costs exclusively. They developed a formal decision model that compares costs for the internal IT infrastructure (server and storage expenses) and the external provisioning by means of CC-services (fees for CPU hour, time contingent, storage, internet service provider costs as well as inbound and outbound data transfer costs). They present a formal cost model, an optimization model and a regression model that focus on the hybrid usage of internal and external infrastructure sources. Simulation runs are conducted with data from a case study. Their first finding is that CC is more cost-effective the more business applications and processes are ready to source via a cloud service. In contrast, they find that the cost-effectiveness decreases with the number of virtualized applications, since internal servers can be used more effectively. However, they conclude that the application of CC-services is beneficial for high storage requirements. Egwutuoha et al., (2014) investigate high performance computing and found that wall-clock execution time and cost can be reduced by as much as 30% when running cloud services. The paper by Walterbusch et al. (2013) stands out for its clear separation between the three CC service models and the related direct and indirect costs. Their mathematical models were tested by expert interviews and an in-depth case study. All referenced papers of this paragraph have in common that they especially focus on the *usage intensity* (analysis in the width), meaning that a linear relation between usage amounts and costs is in most cases an exception for traditional services, whereas it is more valid for CC.

All above stated papers have in common that they go back to the TCO approach, and thus, direct as well as indirect costs are considered for comparing various IT services. Here, the aim is to take into account the IT artifact with all related costs as completely as possible. In literature, this trend led to a broad range of cost types up to positions like rent increases for server space. Despite the mentioned goal, the literature remains surprisingly above the line "earnings before interest and taxes (EBIT)" in the profit and loss statement. In the context of long-term economic calculations, however, cash flows should mark the relevant financial influence factor. Consequently, ***cost of capital*** (by the means of interest payments) and ***taxation effects*** should not be neglected (Liu et al., 2014; Grob et al., 2008, pp. 445 ff.). In general, the cash flow statement indicates the creditworthiness of a company, and especially long-term investments are driven by cash flow effects more than ever before. Therefore, value-based management with "future-oriented" measures plays a vital role, such as the discounted cash flow (DCF) approach.

In this context, Grob proposed a general concept named "visualization of financial implications (VOFI)" (Grob, 1993, pp. 188 ff.; Grob et al., 2008, pp. 445 ff.). The VOFI represents a table-oriented approach and allows for both the payments of inflows and outflows associated with a series of payments resulting from the alternatives´ diverse investments, credits and fiscal conditions. Further, VOFI is a TCO-based concept whose use allows for calculating the relevant cash flow effects in the individual periods. Finally, the decision is made based on the net present value. Especially the works of Vom Brocke (2009; 2014) transferred the generic VOFI concept into specific issues in information systems science. Vom Brocke´s subjects of financial investigations were in particular *business processes* and *service-oriented architectures*. Critics of the concept mentioned that benefits and quality of an IT system have been ignored (Riepl, 1998). Since the only goal of the VOFI lies in the calculation of the "total costs", this criticism is ultimately unjustified (Grob et al., 2008). However, problematic is the implicit assumption of the accountability of individual IT artifacts, which means that every IT system has its own credit note and specific tax effects (Grob et al., 2008). In practice, a partition of the company into financial spheres is senseless. Thus, in the abstract, the concept is logical, but for practical usage further adjustments are compellingly needed. Nevertheless, the concept serves as a good starting point.

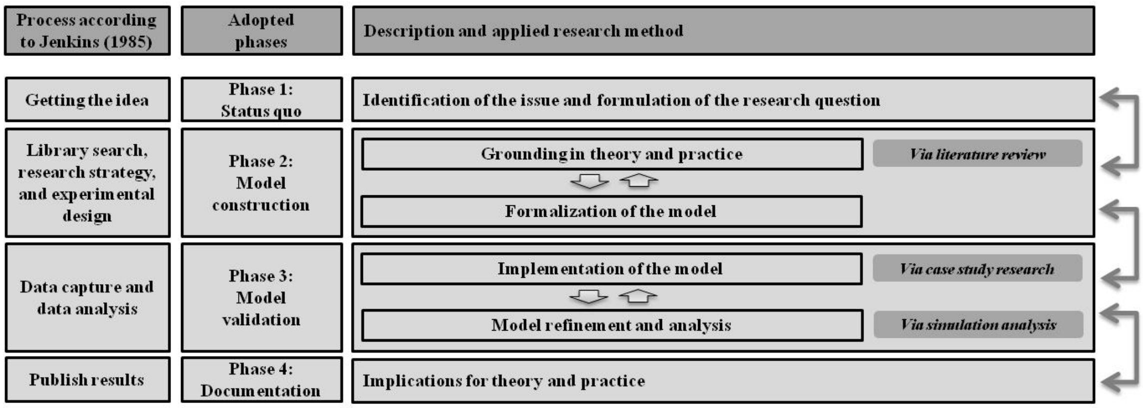
In contrast to the vast majority of previous publications, this paper focuses on cash flows exclusively. This means a more complete view of the financial comparison between IT systems, which leads to a consideration of the effects below EBIT as well. Here, *CC is fundamentally different from traditional services* for several reasons such as stretching costs over time and having quite constant prices per additional usage unit. We will show that these effects may lead to a different decision when considering cash flows instead of simply the costs (often within a TCO approach) like is the case in most of the published papers. Furthermore, the generic VOFI approach will be converted into a mathematical model that will be tailored to the specific cash flow comparison between cloud services and on-premise services. Herein, we will address the mentioned weaknesses of the VOFI in order to gain more practical acceptance. Additionally, we will investigate the two effects ***usage duration*** and ***number of users***[29] and their implication for a cash flow comparison. To the best of our knowledge, this approach ensures the optimum closeness to reality in scientific literature on the subject of CC cost comparisons. Moreover, it will provide unique support for real life decision-making processes.

3 Research process

For this contribution, we applied a multi-method approach as research strategy. The research procedure, derived from Jenkins (1985), is determined by four phases which are linked by feedback loops (cf. Figure 1). As required by Jenkins (1985), the structured formulation of research questions is necessary in phase one. This is what we did in the introduction section. Based on the findings of the literature analysis, we developed a comparison model at the end of the second phase. By using a formal experimental design, we also follow Jenkins (1985). In the third phase, we validated the model by a real-life case study (Radeke, 2010) and refined it further. Towards this end, we use a simulation software for analyzing the data. In general, we follow Grob et al. (2008) as all quality differences between IT systems have no effect on the financial measures.

[29] Within this paper, we define for simplification reasons the number of users to be equal to the number of licenses.

Figure 1 Research process



4 Construction of the cash flow comparison model

4.1 Determining the relevant cash flows for cloud computing and comparable IT systems

Before creating a direct financial comparison of CC and on-premise systems in section 4.2, we first define the relevant factors for calculating the cash flows. Grob et al. (2008) criticize that numerous published TCO approaches add up the cost of the individual periods without any weighting. Against this background, the net present value (*NPV*) forms the basis for calculating the cash flows (*CF*s) of the individual periods. According to the "flow to equity"[30] approach (e.g., Zingales, 2000), *CF*s are discounted at the equity interest rate *r*. The classic formula is shown in (1):

$$(1)\ NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

where, CF_t is defined by the formula (2). As mentioned before (cf. section 2), there is a difference between CC and on-premise solutions in terms of financial investments and point in time of costs, which influences taxation and costs of capital in different ways (equity and debt capital). For the following formula (2) and subsequent formulas, the Table 1 provides an overview over the determined variables. The single effects will be derived successively in the following.

[30] In contrast to the "flow to entity" approach, here shareholders have the right for the company´s equity only after having paid interests for credit capital.

Table 1 Comparison of cost positions

Variable	Full term
HI	Hardware investment
SI	Software investment
C	Costs
IP	Interest payments
ip	Interest rate
CR	Credit note
cr	Ratio of credit
TE	Taxation effect
te	Tax rate
D	Depreciation
d	Depreciation duration

$$(2)\ CF_t = \begin{cases} -HI_0 - SI_0 - C_0 + TE_0 + CR_0, & for\ t = 0 \\ -C_t - IP_t + TE_t, & for\ t = 1, \dots, n-1 \\ -C_t - IP_t + TE_t - CR_0, & for\ t = n \end{cases}$$

The upcoming model will be fitted particularly to the cash flow comparison between CC services and "On-Premise (*OP*)" services. Thereby, OP represents the traditional IT with self-operation rather than remote operation of the software. Although the cash flow based cost comparison model can basically be applied to all four CC deployments (public, private, hybrid, community), it is especially meaningful when comparing public CC with OP-solutions. This is due to the fact that the other deployments (private, hybrid, community) show a lower degree of outsourcing and hence involve smaller financial differences to OP services.

The scientific literature unanimously agrees that the implementation of public CC marks a shift from hardware investments HI_0 and software investments SI_0 to periodic payments (Martens and Teuteberg, 2012). Also, it has been described that the relevant direct and indirect TCO positions have been discussed largely. These findings are taken as given. Therefore, we only distinguish between the costs C_0 at period zero (e.g., for low value assets such as a router or cable) and costs C_t in later periods (e.g., licenses, fees, salaries for own employees). This distinction mainly results from the implementation phase and the operational phase of the respective information system. We define cost as a specific amount of money that is expended to acquire a good or service. Therefore, costs have a direct influence on cash flows as well as an indirect influence via changes in taxable income and the subsequent tax payment.

To keep the model manageable and applicable, it is assumed that during the operational phase ($t = 1,\dots,n$) constant C_t come about, and all interest rates remain unchanged. Furthermore, taking into account the formula (2), a credit CR_0 is borrowed at $t = 0$ and the credit pay back is according to the traditional view in the last period ($t = n$). We define credit as any form of deferred payment (Sullivan, 2003, p. 512). In general, we follow the weighted average cost of capital (WACC) approach by separating between the interest rates of debt capital and equity, which makes our approach more realistic and suitable for investment decisions. For considering the share of the credit *cr*, we recommend to take the debt portion of the total enterprise. Hence, the new IT system is financed to some degree by a credit note and to a residual degree by own equity. Herewith we address the weakness of the concept by Grob et al. (2008) where every IT investment has its own credit condition. Formula (3) denotes the calculation of the credit.

$$(3)\ CR_0 = cr\left(HI_0 + SI_0 + C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}\right)$$

Furthermore, formula (2) integrates a taxation effect TE_t, which is defined by:

$$(4)\ TE_t = \begin{cases} C_0 \cdot te, & for\ t = 0 \\ (C_t + D + IP) \cdot te, & for\ t = 1, \dots, n \end{cases}$$

Herein, *te* represents the relevant tax rate of the underlying company, which is imposed by a state. Since the costs of the IT system lower the overall operating results of a company, the payable income taxes decrease as well. Thus, a positive cash flow effect appears. Furthermore, the depreciation *D* with the depreciation duration *d* and the interest expense *IP* with the interest rate on debt *ip* are crucial for the tax effect, leading to the terms (5) and (6). In general, depreciations determine a method for allocating the acquisition costs of an asset over its useful life.

$$(5)\ D = \frac{1}{d}(HI_0 + SI_0)$$

$$(6)\ IP = CR_0 \cdot ip$$

By inserting the equations (4), (5) and (6) into the formula (2), we get the formula (7). Further insertion of the formula (3) into the formula (7) leads to the final expression (8).

$$(7)\ CF_t = \begin{cases} (cr-1)[HI_0+SI_0]+(cr+te-1)C_0+cr\sum_{t=1}^{n}\frac{C_t}{(1+r)^t}, & for\ t=0 \\ \frac{te}{d}[HI_0+SI_0]+(te-1)C_t+ip\,(te-1)CR_0, & for\ t=1,\dots,n-1 \\ \frac{te}{d}[HI_0+SI_0]+(te-1)C_t+[ip\,(te-1)-1]CR_0, & for\ t=n \end{cases}$$

$$(8)\ CF_t = \begin{cases} (cr-1)[HI_0+SI_0]+(cr+te-1)C_0+cr\sum_{t=1}^{n}\frac{C_t}{(1+r)^t}, & \text{for } t=0 \\ \left[\frac{te}{d}+cr\cdot ip\ (te-1)\right][HI_0+SI_0]+cr\cdot ip\ (te-1)C_0 & \\ +(te-1)C_t+cr\cdot ip\ (te-1)\sum_{t=1}^{n}\frac{C_t}{(1+r)^t}, & \text{for } t=1,\ldots,n-1 \\ \left[\frac{te}{d}+cr\ [ip\ (te-1)-1]\right][HI_0+SI_0]+(te-1)C_t & \\ +cr\ [ip\ (te-1)-1]C_0+cr\ [ip\ (te-1)-1]\sum_{t=1}^{n}\frac{C_t}{(1+r)^t}, & \text{for } t=n \end{cases}$$

In contrast to the previous predominantly generic concepts in literature, *we constructed a comparison model that is strictly oriented to the different financial characteristics of CC and OP services*. The model enables decision makers to analyze individual IT costs and their impact on cash flows. We derived the model from basic axioms in the intersection of investment theory and CC-research. In order to make the model applicable and understandable, we intentionally used a limited number of variables for the formulas. However, the individual effects are not trivial and cannot be interpreted directly. Highly depending on the variables, it is possible that a specific service (CC or OP) has a beneficial net present value before interest and taxes, taking into account these effects, however, may reverse the favorability.

4.2 Delta view of cash flows between cloud computing and on-premise systems

Since the aim of this work is to provide a cash flow comparison between a CC service and an adequate OP service, we first set the above stated variables in relation to each other by means of functions:

$$(9)\ \Delta NPV \coloneqq NPV_{OP} - NPV_{CC}$$

$$(10)\ \Delta NPV \coloneqq \sum_{t=0}^{n}\frac{\Delta CF_t}{(1+r)^t}$$

$$(11)\ \Delta HI_0 \coloneqq HI_{0,OP} - HI_{0,CC}$$

$$(12)\ \Delta SI_0 \coloneqq SI_{0,OP} - SI_{0,CC}$$

$$(13)\ \Delta C_0 \coloneqq C_{0,OP} - C_{0,CC}$$

$$(14)\ \Delta C_t \coloneqq C_{t,OP} - C_{t,CC}$$

Next, we insert the delta formulas (9) - (14) into the formula (8) which leads to the following formula (15). This formula is further simplified in (16).

$$(15)\ \Delta NPV = (cr-1)[\Delta HI_0+\Delta SI_0]+(cr+te-1)\Delta C_0+cr\sum_{t=1}^{n}\frac{\Delta C_t}{(1+r)^t}+$$

$$\sum_{t=1}^{n-1}\left\{\frac{\left[\frac{te}{d}+cr\cdot ip\,(te-1)\right]}{(1+r)^t}[\Delta HI_0+\Delta SI_0]+\frac{cr\cdot ip\,(te-1)}{(1+r)^t}\Delta C_0+\frac{(te-1)}{(1+r)^t}\Delta C_t+\frac{cr\cdot ip\,(te-1)}{(1+r)^t}\sum_{t=1}^{n}\frac{\Delta C_t}{(1+r)^t}\right\}+$$

$$\frac{\left[\frac{te}{d}+cr\,[ip\,(te-1)-1]\right]}{(1+r)^n}[\Delta HI_0+\Delta SI_0]+\frac{cr\,[ip\,(te-1)-1]}{(1+r)^n}\Delta C_0+\frac{(te-1)}{(1+r)^n}\Delta C_n+\frac{cr\,[ip\,(te-1)-1]}{(1+r)^n}\sum_{t=1}^{n}\frac{\Delta C_t}{(1+r)^t}$$

$$(16)\ \Delta NPV = \left\{(cr-1)+\left[\frac{te}{d}+cr\cdot ip\,(te-1)\right]\left(\sum_{t=1}^{n}\frac{1}{(1+r)^t}\right)-\frac{cr}{(1+r)^n}\right\}[\Delta HI_0+\Delta SI_0]+$$

$$\left\{(cr+te-1)+[cr\cdot ip\,(te-1)]\left(\sum_{t=1}^{n}\frac{1}{(1+r)^t}\right)-\frac{cr}{(1+r)^n}\right\}\Delta C_0+(te-1)\sum_{t=1}^{n}\frac{1}{(1+r)^t}\Delta C_t+$$

$$cr\left\{\left(1-\frac{1}{(1+r)^n}\right)+ip\,(te-1)\left[\sum_{t=1}^{n}\frac{1}{(1+r)^t}\right]\right\}\left[\sum_{t=1}^{n}\frac{\Delta C_t}{(1+r)^t}\right]$$

Hence, the created delta analysis enables the decision maker to perform a direct and comprehensive cash flow comparison of two IT alternatives. When using the indifference of choice ($\Delta NPV = 0$), for example, the conditions in which the CC is advantageous may be analyzed. To the best of our knowledge, the above shown procedure is unique so far. However, due to the limited scientific knowledge about the underlying research topic, we analyze the mentioned effects in the context of a case study in the next section. The study is based on real data that we investigated on an aggregated basis while thinking inside the box and without disregarding important information. Basically, case study research is associated with the problem that replicating findings is rather difficult (Eisenhardt, 1989). Nevertheless, the conditions of a unique and exhaustive case study legitimize the use of this research method as this is the only way to reveal practical problems (Yin, 2002, pp. 40-42). Furthermore, case study research is classified as a suitable method for solving real life issues (Radeke, 2010), and at the same time, it at least partly allows for inductive reasoning.

5 Case study

5.1 Case study description

Within the realm of the case study, we investigate a newly acquired entity of an international automotive supplier. The previously stand alone sub-entity focuses particularly on sales activities in the Eastern European aftermarket. Around eight years ago, it implemented an integrated ERP / CRM system (by an unknown provider) that is incompatible to the standards of the automotive corporation today. Therefore, the IT managers of the sub-entity are facing the launch of a new system. Against the background of a suspected cost reduction potential (compared with the costs for traditional OP-systems) the IT management proposed to consider alternative solutions for the new business. Since the automotive supplier had already implemented CC-services in a number of sales areas, and the experiences with this was largely positive, the new business should especially consider CC. The underlying sub-entity employs approximately 260 employees and consists essentially of the departments: sales, sales support, customer service, technical workshop trainings and commercial administration. The logistics management has completely been outsourced. Within the commercial administration department, the job of the 3.75 employees (including a part time employee) consists of IT administration and IT support as well as customizing and IT trainings. At present, the sub-entity has about 150 licenses for the existing ERP / CRM system. Further, it is planned to leave the sub-entity independent from the corporate operational pre-system. Just for reasons related to the central reporting, the sub-entity will get access to the worldwide consolidation system of the automotive supplier. Furthermore, the sub-entity will get access to new high-quality automotive products and well-known brands. It is expected in the business plan that this will lead to enormous short term growth rates. Consequently, a significant increase in number of employees is scheduled.

In order to increase the transparency and to illustrate the relationships of the model, we transferred the above stated model (cf. section 4.2) to a software-supported simulation. For this purpose, the software Matlab (matrix laboratory) by the provider MathWorks was used (www.mathworks.de). Matlab is a multi-paradigm programming language for numerical simulations and is used both in industrial enterprises and in scientific institutions. We designed the programming in such a way that basically all relationships of the model can be analyzed. In the underlying paper, we made especially use of the tool's graphic options through a 3D matrix.

5.2 Cash flow oriented cost comparison

Table 2 lists the cost positions of the potential ERP / CRM systems. These positions are transformed into variables of the developed model in Table 3. The OP-solution is the standard provider of the corporation. The cloud provider, however, has been identified by a multi-stage selection process. In order to take account of an increasing number of users, a cost simulation for a range of 150 to 400 licenses was needed. In the tables below we show exemplary N = 150 and N = 250 licenses. For reasons of simplification, we assume the number of users to be a weighted average for all relevant periods. In the following, the major cost items are briefly described before the paper passes through to the cash flow analysis.

For the OP-solution, two servers with sufficient performance capacity to also cope with a significantly higher number of users are to be procured. Thereby, the operating OP-software constitutes an extension of the corporate solution already in use. As a result, the launching costs can be reduced significantly compared to the purchase of a new solution. The implementation costs arise from customizing for country-specific settings, training for users, key users, IT service management integration and interface integration. The configuration of the cloud service interface would be significantly more complex. Furthermore, a contract and service management for the cloud provider is to be installed, and a security audit has to be performed. While the license costs for the OP-solution are at € 2,400 per user and year, the costs for the cloud provider are at € 3,940. The 3.75 employees of the IT department earn on average € 31,200 per year (including social costs). In case of using cloud services, the current number of internal IT-employees would be reduced by 0.55 for the actual amount of 150 users.

Table 2 Comparison of cost positions

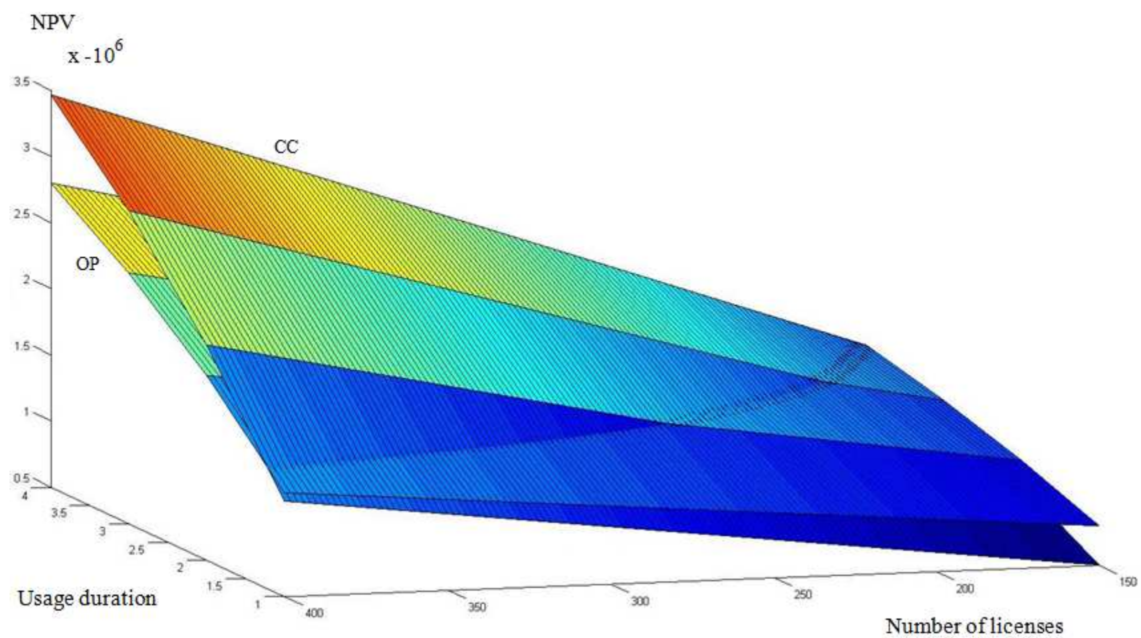
Cost positions	**On-premise service**		**Cloud service**	
	N=150	*N*=250	*N*=150	*N*=250
Implementation phase				
Hardware investment	22,000	22,000	0	0
Software investment	650,000	650,000	18,000	18,000
IT infrastructure	6,000	8,000	18,000	30,000
Implementation costs	62,000	64,000	90,000	92,000
Operational phase				
Licences / fees	360,000	600,000	591,000	985,000
Avg. salary IT depart.	117,000	195,000	99,840	166,400
Other operational costs	4,500	5,500	3,600	6,000

The following parameters apply to the company in the case study: $r = 10\%$, $ip = 5\%$, $te = 0.3$, and $cr = 0.6$. Furthermore, a useful life of up to $n = 4$ years should be simulated. The result of the comparison on cash flow basis can be seen in Figure 2. In the intersection between both surfaces, the NPVs are identical. This intersection is curved, whereas the curvature is stronger at lower number of users. It emerges that the benefit for the company from the OP solution increases with the number of users and the duration of usage. For $n = 4$ and $N = 400$ the CC disadvantage is € 670,870. For $n = 2$ and $N = 150$, there is a CC benefit of € 179,538. However, a pure accumulation of costs excluding interest and tax effects would push the indifference curve further down, which would put CC at a disadvantage. If the OP-software would have been procured as a completely new introduction at a € 150,000 higher price, the slope of the OP NPV-surface would increase and the indifference curve would be pushed in favor of CC clearly upwards. The CC advantage for $n = 2$ and $N = 150$ would then be € 280,336.

Table 3 Transforming cost items to model variables

Variable	On-premise service		Cloud service		Delta	
	N=150	N=250	N=150	N=250	N=150	N=250
I_0	678,000	680,000	36,000	48,000	642,000	632,000
C_0	62,000	64,000	90,000	92,000	-28,000	-28,000
C_t	481,500	800,500	694,440	1,157,400	-212,940	-356,900

Figure 2 Comprehensive cost comparison on cash flow basis



5.3 Results of the case study

The case study shows that the complex relations of the individual parameters must be considered coherently for meeting the requirements of a comprehensive cash flow comparison. The results confirm the scientific knowledge (Gupta et al., 2013; Benlian, 2011; Misra and Modal, 2011) to the effect that from a financial perspective CC is particularly adequate for smaller companies with low number of users. The new and valuable finding of this paper is related to the developed method for determining the financial favorability in a delta view especially in the context of comparing CC and traditional information systems. The case study illustrates the previously made statement that interest and taxation effects can have a significant impact on the profitability of investments of information systems. These effects especially gain in importance when the costs and related cash flows occur at different points in time like the comparison between CC and OP. *It is this important temporal component between CC and OP that directly leads to the basic principles of the investment theory*. The shown temporal cash effects have so far been treated more argumentative and superficially in literature in aspects of CC. However, the example shows that for IT investments profound and far-reaching cash flow based comparisons are compelling needed. Moreover, the advantage of CC, stretching the costs along the useful life and outsourcing of IT investments, simultaneously involves two essential disadvantages. These apply for the number of users or for usage amounts (cf. section 2). With cloud services, the main cost components usually increase proportionally to the increasing number of users and usage amounts. In contrast, for traditional IT, proportional cost developments are rather uncommon. Contrary to prior research, this paper integrates both impacts at the same time and converts these effects to impacts on cash flows statements.

6 Discussion

6.1 Implications for theory and practice

Applied scientific research aims to develop more practical applications. On this basis, we developed and tested a new concept that provides decision-makers with a suitable and sustainable tool for the evaluation of CC services and comparable on-premise services. Based on the work of Grob et al. (2008), we carried out application-oriented adjustments. These needed adjustments are related to the indivisibility of a company in investment and financing issues on the one hand, and they allow for a direct delta analysis of IT alternatives on the other hand. Investment domain research states for many years that cost of debt, cost of equity, and taxes may have great impacts on investment decisions. Contrary, research on CC focuses especially the usage related costs such duration and user amount. This paper stands out from the vast majority of scientific publications on the underlying topic as largely unnoticed elements of the investment theory have been considered in CC research. *To the best of our knowledge, the determined combination of relevant investment theory elements and IT-specific aspects is new*. And this combination is particularly relevant for the CC paradigm as providers advertise CC solutions with benefits such as stretching the costs along the useful life and outsourcing of IT investments.

However, in contrast to previous approaches that usually show a high level of abstraction, the research approach of the paper is more closely aligned to the practical usefulness. Thus, the financial value added and the losses accruing from the implementation of cloud services can be calculated on a cash flow basis. However, the higher the gained realism is, the higher is the effort necessary to determine the optimal solution. This can quickly attain a high degree of complexity. Therefore, the use of powerful and appropriate software is helpful, as this work has demonstrated in detail.

The user benefits primarily from the transparent application of the model, which was achieved by means of the designed simulation. Most of the variables in the model are either defined by corporate instructions (interest rates, tax rates, debt capital ratio) or negotiated with IT providers (investments and operational costs). Ultimately, the parameters expected useful life and the number of users determine the decision making. All in all it can be stated that this paper provides a valid instrument for IT managers with which the subjective favorability calculations of CC and OP providers can be verified. Additionally, we have uploaded an Excel-based tool for enabling self-made real-life calculations.[31] As described before, cash flow-oriented investment comparisons get increasingly important in daily IT practice. In order to understand these interrelations, a comprehensive financial knowledge and the right tools are required. This cash flow-driven development should not be underestimated by managers in IT departments, and this work may serve as an opportunity to question the suitability of the currently used approaches. The cloud providers´ undifferentiated sample calculations should be verified anyhow.

6.2 Future research

Despite the variety and level of detail of this work, there is an ***uncertainty problem*** with respect to in investment decisions in more than one period (Bierman and Smidt, 2012, pp. 31). Future work could incorporate probability distributions instead of secure estimates in order to allow for the assignment of respective probabilities to the net present values of the alternatives. Especially the high dynamics of the newly-developing CC-market could be adequately represented by considering probabilities. In addition, with the discounted cash flow method, there are certain assumptions needed that simultaneously reflect limitations of the method (e.g., Kruschwitz and Löffler, 2006, pp. 9 ff.). Nevertheless, this is the most accepted method in the dynamic investment calculations (Bierman and Smidt, 2012, pp. 15).

Furthermore, in the context of this paper, we found in a separate analysis no significant differences in the periods of notice and the fixed contract terms of the considered IT alternatives, which is why the ***real option approach*** was not investigated in-depth beforehand. However, a more profound exploratory analysis as well as the consideration of other IT alternatives can lead to different conclusions. Hence, a financial assessment of American and particularly European options may be a fruitful area for future research. Due to their possibilities to scale and adapt services, it is most likely that CC providers will continue to strengthen their service flexibility. Hence, real option theory would be predestined to rate this advantage for the CC users accordingly. Previous published papers that themed real options as an IT subject could serve as a valuable basis (Stickel, 1999).

In addition, theoretical models for ***multi-criteria decisions*** (e.g., with choice under uncertainty) could be used. In our model, we only considered investments in the initial point in time ($t = 0$). However, it can happen that the favorability

[31] The Excel tool is available at: http://tinyurl.com/ndm3rx6.

of an OP solution reverses when additional investment costs, e.g., for expansion and/or replacement, arise which would not have occurred or would be significantly lower for a comparable CC-service.

6.3 Limitations

The listed implications for future research can be simultaneously understood as the limitations of this paper. Furthermore, every mathematical approach has some limitations that need to be considered for its practical application. First and foremost, final decisions on alternatives of CC services have to be made in view of multi-dimensional factors (organizational, social, psychological, political and technological) as well as market dynamics. However, these qualitative aspects are relatively difficult to quantify, which makes it hard to involve them into a comparison model. The intention of our approach is to focus solely on the financial comparison of IT investments. Consequently, our model does not include the extensive ***non-monetary*** factors that may influence IT sourcing decisions (e.g., Rao et al., 2015). Nevertheless, the model's financial results constitute an essential aspect of the long-term strategic relevance that some CC services might have for an organization.

Furthermore, we limit the amount of variables and hide ***company specific cost types*** that hinder the applicability of the model (e.g., regarding internal IT infrastructure and IT organization). For instance, if a company has to reduce the IT staffing level, this may entail legal costs and severance payments. In case of bankruptcy of the cloud provider, additional transition costs will accrue. Also, with the usage of the three remaining cloud deployments (private, hybrid, community), coordination costs are highly probable. These specific adjustments have to be considered case by case.

And also the mostly discussed limitations of case study research are valid for this paper. The limitations focus particularly on the ***generalization of the results*** (Eisenhardt, 1989), thus inductive reasoning. Despite the rigorous research process, more ***empirical assessments*** of the model are needed for an in-depth validation. In particular, the robustness of the model's results must be tested in additional settings involving different industries, customer segments and types of CC services (Zhu et al., 2004).

7 Conclusion

Scientific research increasingly concentrates on the incremental search for additional cost items in order to capture a complete picture of IT costs. However, significant cash flow effects have been neglected so far, which can have even bigger influences on financial decisions in the context of implementing CC. Apart from the integration of important financial factors, this contribution also offers a methodological process suitable for the analysis of the general conditions under which CC is advantageous. Contrary to previous works, a continuous case study has been set forth, demonstrating the functionality of the comparison model. Herein, we transferred real-world issues in a simulation model. However, it is likely that the already shown complexity within the simulation may be even higher in other real case applications. Nevertheless, the required effort to solve these issues is justified by the relevance of the subject. Both the conducted expert interviews as well as further user tests indicated that it is strictly misleading to simply believe in the *cloud hype* without creating a reasonable business case. Highly depending on the parameters, the majority of the offered cloud services can hence lead to lower net present values than OP services. Therefore, in order to avoid nasty surprises later on, companies should set up valid business cases prior to any investment decision. Furthermore, the financial perspective is just a slice of a cake in the overall cloud selection process and like for all sub-processes, there is a compelling need for standardizing the financial sub-processes in order to increase the efficiency of the IT system.

Acknowledgement

The author would like to thank the anonymous reviewers as well as Ms. Marita Imhorst, who provided valuable help and substantive feedback. This work is part of the project "Sustainable Consumption of Information and Communication Technologies in the Digital Society − Dialogue and Transformation through open innovation". The project is funded by the Ministry for Science and Culture of the Land of Lower Saxony and the Volkswagen Foundation (VolkswagenStiftung) within the grant programme
"Niedersächsisches Vorab" (grant number VWZN3037).

References

Ahmed, E., Akhunzada, A., Whaiduzzaman, M., Gani, A., Ab Hamid, S.H. and Buyya, R. (2015), "Network-centric performance analysis of runtime application migration in mobile cloud computing", Simulation Modelling Practice and Theory, Vol. 50, pp. 42-56.

Armbrust, M., Fox, A., Griffith, R., Joseph, A.D., et al., (2010), "A view of cloud computing", Communications of the ACM, Vol. 53 No. 4, pp. 50-58.

Barney, J.B. (2007), *Gaining and Sustaining Competitive Advantage*, Pearson International Edition, New Jersey, Upper Saddle River.

Benlian, A. (2011), "Is traditional, open-source, or on-demand first choice & quest; Developing an AHP-based framework for the comparison of different software models in office suites selection", European Journal of Information Systems, Vol. 20 No. 5, pp. 542-559.

Bharadwaj, A., El-Sawy, O.A., Pavlou, P.A. and Venkatraman, N. (2013), "Digital Business Strategy: Toward a Next Generation of Insights", Management Information Systems Quarterly, Vol. 37 No. 2, pp. 471-482.

Bibi, S., Katsaros, D. and Bozamis, P. (2012), "Business application acquisition: on-premise or SaaS-based solutions?", IEEE Software, Vol. 29 No. 3, pp. 86-93.

Bierman, H. and Smidt, S. (2012), *The capital budgeting decision: economic analysis of investment projects*, Routledge, 2012.

Bose, R. and Luo, X. (2014), “Investigating security investment impact on firm performance”, International Journal of Accounting & Information Management, Vol. 22 No. 3, pp. 194-208.

Brender, N. and Markov, I. (2013), “Risk perception and risk management in cloud computing: Results from a case study of Swiss companies”, International Journal of Information Management, Vol. 33 No. 5, pp. 726-733.

Chatterjee, D. and Ravichandran, T. (2013), “Governance of Interorganizational Information Systems: A Resource Dependence Perspective”, Information Systems Research, Vol. 24 No. 2, pp. 261-278.

Demirkan, H. and Delen, D. (2013), “Leveraging the capabilities of service-oriented decision support systems: Putting analytics and big data in cloud”, Decision Support Systems, Vol. 55 No. 1, pp. 412-421.

Dos Santos, B.L., Zheng, Z.E., Mookerjee, V.S., and Chen, H. (2012), “Are New IT-Enabled Investment Opportunities Diminishing for Firms?”, Information Systems Research, Vol. 23 No. 2, pp. 287-305.

Egwutuoha, I.P., Chen, S., Levy, D., Selic, B. and Calvo, R. (2014), “Cost-oriented proactive fault tolerance approach to high performance computing (HPC) in the cloud”, International Journal of Parallel, Emergent and Distributed Systems, Vol. 29 No. 4, pp. 363-378.

Eisenhardt K.M. (1989), “Building theories form case study research”, Academy of Management Review, Vol. 14 No. 4, pp. 532-550.

Gartner (2014), “IT Metrics Data 2014”, available at: http://www.gartner.com/technology/metrics/. (accessed 14 March 2015).

Grob, H.L. (1993), *Capital Budgeting with Financial Plans*, Wiesbaden, Gabler.

Grob, H.L., Strauch, G. and Buddendick, C. (2008), *Conceptual design of a method to support IS security investment decisions*, Springer, Berlin Heidelberg.

Gupta, P., Seetharaman, A. and Raj, J.R. (2013), “The usage and adoption of cloud computing by small and medium businesses”, International Journal of Information Management, Vol. 33 No. 5, pp. 861-874.

Hoberg, P., Wollersheim, J. and Krcmar, H. (2012), “The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing”, In: Proceedings of the 18th American Conference on Information Systems (AMCIS), 9th-11th August 2012, Seattle, Washington.

Ingalsbe, J., Shoemaker, D., and Mead, N. (2011), “Threat modeling the cloud computing, mobile device toting, consumerized enterprise – An overview of considerations”, In: Proceedings of the 17th Americas Conference on Information Systems (AMCIS), 4th-8th August 2011, Detroit, Michigan.

Janssen, M. and Joha, A. (2011), “Challenges for Adopting Cloud-based Software as a Service (SaaS) in the Public Sector”, In: Proceedings of 19th European Conference on Information Systems (ECIS), 9th-11th June 2011, Helsinki, Finland.

Jenkins, A.M. (1985), *Research methodologies and MIS research*, In: Mumford, E. (Ed.), Research Methods in Information Systems, pp. 103-117, North-Holland.

Kondo, D., Javadi, B., Malecot, P., Cappello, F. and Anderson, D.P. (2009), “Cost-Benefit Analysis of Cloud Computing versus Desktop Grids”, In: Proceedings of the 2009 IEEE International Symposium on Parallel & Distributed Processing.

Kruschwitz, L. and Löffler, A. (2006), *Discounted cash flow: a theory of the valuation of firms*. John Wiley & Sons.

Lammers, M. (2004), “Make, buy or share: combining resource based view, transaction cost economics and production economies to a sourcing framework”, Wirtschaftsinformatik, Vol. 46 No. 3, pp. 204-212.

Leimeister, S., Boehm, M., Riedl, C. and Krcmar, H. (2010), “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks”, In: Proceedings of the 18th European Conference on Information Systems (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Liu, C., Luo, X., Sia, C.L., O´Farrell, G., Teo, H.H. (2014), “The Impact of XBRL Adoption in P. R. China”, Decision Support Systems, Vol. 59, pp. 242-249.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011), „Cloud computing - The business perspective”, Decision Support Systems, Vol. 51 No. 1, pp. 176-189.

Martens, B. and Teuteberg, F. (2012), “Decision-making in cloud computing environments: A cost and risk based approach”, Information Systems Frontiers, Vol. 14 No. 4, pp. 871-893.

Meer, D.V., Dutta, K. and Datta, A. (2012), “A cost-based database request distribution technique for online E-commerce applications”, Management Information Systems Quarterly, Vol. 36 No. 2, pp. 479-507.

Mell, P., Grance, T. (2011), “The NIST definition of cloud computing”, available at: http://faculty.winthrop.edu/domanm/csci411/Handouts/NIST.pdf (accessed 23 February 2015).

Misra, S.C. and Mondal, A. (2011), “Identification of a company’s suitability for the adoption of cloud computing and modelling its corresponding Return on Investment”, Mathematical and Computer Modelling, Vol. 53 No. 3, pp. 504-521.

Oliveira, T., Thomas, M. and Espadanal, M. (2014), “Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors”, Information & Management, Vol. 51 No. 5, pp. 497-510.

Prahalad, C.K. and Hamel, G. (1990), “The core competence of the corporation”, Harvard Business Review, Vol. 68 No. 3, pp. 79-91.

PWC (2010), “Financial Service Technology Journal: The cost management issue”, available at: http://www.pwc.com/us/en/financial-services/assets/fs-tech-journal-cost-management.pdf (accessed 14 December 2014).

PWC (2009), “IT-Kosten und Wertmanagement” (Translation: IT costs and managing values), available at: https://www.pwc.de/de/prozessoptimierung/assets/Studie-IT-Kosten-Wertmanagement.pdf (accessed 14 December 2014).

Radeke, F. (1998), “How To Rigorously Develop Process Theory Using Case Research”, In: Proceedings of the 18th European Conference on Information Systems (ECIS), 6th-9th June 2010, Pretoria, South Africa.

Rao, Y., Guo, K.H., Chen, Y. (2015), "Information systems maturity, knowledge sharing, and firm performance", International Journal of Accounting & Information Management, Vol. 23 No. 2, pp. 106-127.

Riepl, L. (1998), "TCO versus ROI", Information Management, Vol. 13 No. 2, pp. 7-12.

Saaty, T.L. (1980), *The analytical hierarchy process*, McGraw-Hill, New York.

Stickel, E. (1999), "Die Bewertung von IV-Entwicklungsprojekten mit Methoden der Optionspreistheorie" (Translation: The valuation of IT development projects with methods of options price theory), In: Proceedings of Wirtschaftsinformatik (1999).

Strebel, J. and Stage, A. (2010), "An economic decision model for business software application deployment on hybrid Cloud environments", In: Proceedings of Multikonferenz Wirtschaftsinformatik, 2010.

Sullivan, A., Sheffrin, S.M. (2003), "Economics: Principles in action", Upper Saddle River, New Jersey.

Vom Brocke, J., Sonnenberg, C. and Simons, A. (2009), "Value-oriented information systems design: the concept of potentials modeling and its application to service-oriented architectures", Business & Information Systems Engineering, Vol. 1 No. 3, pp. 223-233.

Vom Brocke, J., Sonnenberg, C. and Buddendick, C. (2014), *Justifying ECM Investments with the Return on Process Transformation: The Case of an ECM-Driven Transformation of Sales Processes at Hilti Corporation*, In: Enterprise Content Management in Information Systems Research (pp. 255-277). Springer Berlin, Heidelberg.

Walker, E. (2009), "The Real Cost of CPU Power", Computer, Vol. 42 No. 4, pp. 223-233.

Walterbusch, M., Martens, B. and Teuteberg, F. (2013), "Evaluating cloud computing services from a total cost of ownership perspective", Management Research Review, Vol. 36 No. 6, pp. 613-638.

Webster, J. and Watson, R.T. (2002), "Analyzing the past to prepare for the future: Writing a literature review", Management Information Systems Quarterly, Vol. 26 No. 2, pp. xiii-xxiii.

Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., and Stößer, J. (2009), "Cloud computing–a classification, business models, and research directions", Business & Information Systems Engineering, Vol. 1 No. 5, pp. 391-399.

Yao, L.J., Liu, C., Chan, S.H. (2010) "The Influence of Firm Specific Context on Realizing Information Technology Business Value in Manufacturing Industry", International Journal of Accounting Information Systems, Vol. 11 No. 4, pp.353-362.

Yin, R. K. (2002), *Case study research: design and methods*, Sage Publications, Thousand Oaks.

Youseff, L., Butrico, M. and Da Silva, D. (2008), "Toward a unified ontology of cloud computing", In: Grid Computing Environments Workshop 2008 (GCE), 16th November 2008, Austin, Texas.

Zhu, Z., Sivakumar, K. and Parasuraman, A. (2004), "A mathematical model of service failure and recovery strategies", Decision Sciences, Vol. 35 No. 3, pp. 493-525.

Zingales, L. (2000), "In search of new foundations", The Journal of Finance, Vol. 55 No. 4, pp. 1623-1653.

Beitrag Nr. 5	
Titel	Evidente Ausfallrisiken im Cloud-Markt – Eine quantitative Analyse der Finanzberichte von Anbietern
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	Lecture Notes in Informatics (Proceedings of LNI, 2015)
URL	http://cs.emis.de/LNI/Proceedings/Proceedings246/499.pdf

Evidente Ausfallrisiken im Cloud-Markt – Eine quantitative Analyse der Finanzberichte von Anbietern

Andreas Jede[32], Frank Teuteberg

Abstract: Der Cloud-Markt verzeichnet nach wie vor dynamische Wachstumsraten und verspricht den Nutzern günstige Unterstützung bei diversen Geschäftsprozessen. Dabei wird das Cloud-Angebot durch die steigende Zahl der Anbieter sowie durch die steigenden Service-Verflechtungen zunehmend intransparenter. Weitergehend ist die Anbieterseite von einer hohen Vielfalt gekennzeichnet, da sich sowohl etablierte als auch junge oder weitestgehend unbekannte IT-Unternehmen, die i.d.R. eine geringere Finanzkraft mitbringen, um den Cloud-Markt bemühen. Die Forschung hat zwar wertvolle und differenzierte Rahmenwerke hervorgebracht, die die IT-Abteilungen der nutzenden Unternehmen im Cloud-Selektionsprozess begleiten. Die Dimension „Anbieterausfallrisiko“ wurde jedoch bislang eher nebensächlich diskutiert, was eine Forschungslücke darstellt. Gerade vor dem Hintergrund des vielschichtigen Begriffs „Vertrauenswürdigkeit“ gilt es finanziell gesunde Anbieter von Risikoanbietern zu separieren. Diese Arbeit analysiert systematisch die Finanzberichte von 38 Cloud-Anbietern. Die Ergebnisse indizieren die dringende Notwendigkeit zur Schaffung von aktiven Steuerungsinstrumenten für Anbieterausfallrisiken. Die Theorie profitiert von diesem Beitrag durch die Ergänzung bestehender Rahmenwerke um die wichtige Zusatzdimension „Anbieterausfallrisiko“ samt eines Berechnungsschemas.

Keywords: Cloud Computing, Compliance, Ausfallrisiken, Finanzanalyse, Inhaltsanalyse

1 Einleitung

Ressourcenschonung, höhere Wettbewerbsfähigkeit und finanzielle Vorteile sind gewichtige Aspekte, die dem Paradigma „Cloud Computing“ (CC) in den vergangenen Jahren enorme Wachstumsraten bescherten und ein Ende des „Cloud-Booms“ ist nicht absehbar [Ma11, Ri14]. Dabei übermitteln CC-Nutzer (sensible) Daten an die CC-Anbieter in der Annahme, dass Datensicherheit und Datenschutz gewährleistet sind. Aufgrund der unilateralen Abhängigkeit seitens der CC-Nutzer von den CC-Anbietern spielt der Faktor „Vertrauen“ eine wesentliche Rolle [Wa13]. In der Literatur hat sich keine allgemeine Definition für den Vertrauensbegriff durchgesetzt [Ro98]. Während sich beispielsweise Psychologen und Soziologen Bereichen wie Erwartungen, Beziehungen und Charakteristiken widmen, fokussieren sich Ökonomen eher auf quantitative oder institutionelle Untersuchungen, was auf die Komplexität und Vielschichtigkeit des Begriffs schließen lässt. Neuere Arbeiten der Wirtschaftsinformatik subsummieren unter den Vertrauensbegriff so-

[32] Universität Osnabrück, Fachbereich Unternehmensrechnung und Wirtschaftsinformatik, Katharinenstraße 1, 49069 Osnabrück, andreas-jede@gmx.de

wohl harte Faktoren wie z.B. Funktionalität und Stabilität als auch weichere Faktoren wie Glaubwürdigkeit und Verlässlichkeit [Wa13]. Für die Bewertung der Vertrauenswürdigkeit von CC-Anbietern hat die wissenschaftliche Forschung zahlreiche Arbeiten und Rahmenwerke hervorgebracht, die sowohl die Chancen als auch die mit der Cloud-Nutzung einhergehenden Risiken (z.B. Datensicherheit, Lock-In-Effekte, rechtliche Rahmenbedingungen, proprietäre Software, häufige Service-Updates, Schnittstellenprobleme) thematisieren [z. B. MC13, Du13, KK14]. Im Rahmen der bisherigen wissenschaftlichen Literatur wird ein gravierendes Risiko jedoch weitestgehend außer Acht gelassen, welches einen interdisziplinären Ansatz zwingend erfordert: die schwache Finanzlage und Validität zahlreicher, vor allem kleiner CC-Anbieter. Gerade die extrem hohe Dynamik des CC-Marktes bringt viele neue Anbieter mit einer breiten CC-Produktpalette auf den Plan, die einem höheren Ausfallrisiko unterliegen als traditionelle IT-Anbieter mit einem diversifizierten Produktportfolio. Ferner sind zahlreiche Anbieter komplett fremd- oder unterfinanziert, was im Allgemeinen einen risikofreudigeren Geschäftssinn indiziert und somit höhere Insolvenzrisiken birgt [At12]. So stellten in jüngster Vergangenheit mehrere CC-Anbieter (z.B. Nirvanix, Nimbula) ihre Dienstleistung konkursbedingt ohne zeitgerechte Vorwarnungen an ihre Kunden ein. Je nach Bedeutung und Art der Services können die Nutzer erhebliche Auswirkungen erleiden, bis hin zur gezwungenen Unterbrechung ihrer Geschäftsfähigkeit. Erschwerend kommt hinzu, dass sich hinter einem CC-Service in den seltensten Fällen ein einziger Anbieter verbirgt [Le10]. Auch wenn der Nutzer den Vertrag mit einem Anbieter abschließt, besteht der Service in der Regel aus einem komplexen CC-Netzwerk mit diversen vorgelagerten Anbietern, die auf einen Teilbereich des CC-Services spezialisiert sind (z. B. Software, Plattform). Bei einem dauerhaften Ausfall eines relevanten Teilbereichs kann der gesamte Service zum Erliegen kommen. Daher sind bei einem Anbieterausfall nicht nur Nutzer sondern auch andere abhängige Anbieter im CC-Netzwerk von den Auswirkungen direkt betroffen. Um als Nutzer die Risiken einer Abhängigkeit von insolvenzgefährdeten CC-Anbietern zu minimieren, sollte die unternehmerische Vertrauenswürdigkeit der CC-Anbieter vorab bewertet werden. Aus diesem Grund untersucht diese Arbeit die finanzielle Lage ausgewählter CC-Anbieter. Hierdurch sollen die Ausfallrisiken eingeordnet und die bisherigen Arbeiten und Rahmenwerke um eine wichtige Risikodimension ergänzt werden. Der zugrundeliegende wissenschaftliche Ansatz basiert auf der Methode der systematischen Dokumentenanalyse [Fe06]. Die Forschungsfrage lautet dabei: *Lassen sich evidente Ausfallrisiken aus den Finanzberichten der CC-Anbieter ableiten und wie können diese Risiken im CC-Selektionsprozess geeignet Beachtung finden?* Die Arbeit ist wie folgt aufgebaut: Nach der Einleitung folgt im zweiten Abschnitt eine Erläuterung der begrifflichen Grundlagen. Anschließend beschreibt der dritte Abschnitt das methodische Vorgehen der Arbeit. Im vierten Abschnitt werden die Ergebnisse der Analysen vorgestellt, die im fünften Abschnitt zu Implikationen für Wissenschaft und Praxis führen. Die Arbeit schließt mit einem Fazit im letzten Abschnitt.

2 Begriffliche Grundlagen

CC wird vom „National Institute of Standards and Technology" wie folgt definiert [MG11]: „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". Dabei stellt CC keine neuartige Technologie dar, sondern ein neues Paradigma für IT-Prozesse, indem es bekannte Einzeltechnologien konsequent verknüpft [Le10]. Ferner wird in der Literatur zwischen drei „as a Service"-Modellen unterschieden [MG11, Le10]: Infrastructure, Platform und Software (IaaS, PaaS, SaaS). Desweiteren existieren vier CC-Ausprägungen [Ma11]: Der Ursprung geht auf das „Public CC" zurück, bei dem ein externer Anbieter seine Services über das Internet zur Verfügung stellt. Beim „Private CC" hingegen werden Services unternehmensintern angeboten, was implizit einen notwendigen, eigenen CC-Betrieb bedeutet. Die dritte Version „Community CC" ist in Betracht zu ziehen, falls eine Gruppe von Unternehmen, die gemeinsame Interessen verfolgt und vergleichbare Sicherheitsstandards pflegt, den CC-Betrieb eigenständig kontrollieren will. Die vierte Version „Hybrid CC" stellt eine Kombination aus „Public CC" und „Private CC" dar. In der Regel werden dabei sensible Informationen intern abgegrenzt und unkritische Services und Daten in die Obhut eines externen Anbieters übertragen. Im Rahmen dieser Arbeit sind insbesondere Anbieter des „Public CC" relevant, da die Abhängigkeit bei externen Anbietern am höchsten ist. Weiterhin steht hinter einem Cloud-Service in der Regel ein Netzwerk, welches mehrere Anbieter enthalten kann [Le10]. Neben den drei oben beschriebenen „as a Service“ Anbietern kann das Netzwerk auch Integratoren, Aggregatoren oder Mediatoren enthalten, die alle eine gewisse Wertschöpfung innerhalb des Netzwerks erbringen und somit voneinander abhängig sind [Wa14].

3 Methodisches Vorgehen

3.1 Dokumentenbasis

Der vorliegende Beitrag adaptiert die Methode der systematischen Literaturanalyse, die sich in der wissenschaftlichen Forschung zweckdienlich zur Identifikation eines aktuellen Problems erwiesen hat [Fe06]. Die Dokumentenbasis stellen hierbei die Finanzberichte von CC-Unternehmen dar. Die Durchführung der Analyse erfolgt in enger Anlehnung an das Fünf-Stufen-Modell von Fettke [Fe06]: 1) Problemformulierung, 2) Dokumentensuche, 3) -auswertung, 4) -analyse sowie 5) Interpretation. Hierbei ist hervorzuheben, dass ausgehend von der Forschungsfrage in der Einleitung (Stufe 1) die Suche (Stufe 2) nach relevanten CC-Anbietern basierend auf drei Ranglisten (www.**talkincloud**.com/tc100; www.**cloudtimes**.org/top100/; http://www.**forbes**.com/ sites/louiscolumbus/2015/01/29/the-best-cloud-computing-companies-and-ceos-to-work-for-in-2015/) erfolgte. Diese drei Listen führten zu 157 verschiedenen Unternehmen, wobei folgende drei Anbieterkategorien exkludiert wurden: (i) Das Unternehmen erzielt *nicht den überwiegenden Anteil seines Umsatzes mit CC* (> 75%), sondern durch andere Einnahmequellen wie z.B. traditionelle Dienstleitungen oder Werbung (z.B. SAP, Oracle). (ii) Das Unternehmen bietet *vor allem CC-Security-Services* an (z.B. FireEye, Cyren, Wix.com). Denn der Ausfall dieser Dienstleister geht in der Regel nicht mit einem größeren Datenverlust einher und diese Anbieter sind meist leichter zu wechseln. (iii) Das Unternehmen ist *nicht-börsennotiert*. Da nur börsennotierte Unternehmen verpflichtet sind, ihre Abschlüsse zu veröffentlichen, konnte in der Gegenprobe kein nicht-börsennotierter Anbieter gefunden werden, der die Abschlüsse freiwillig veröffentlicht. Diese drei Selektionsmerkmale führten schließlich zu 31 relevanten CC-Anbietern. Ergänzend dazu wurden im zweiten Schritt alle Technologiewerte geprüft, die an den Börsen in New York, London und Frankfurt gelistet sind und die obigen Kriterien erfüllen, was die Anzahl der relevanten CC-Unternehmen auf 38 erhöhte[33].

3.2 Dokumentenauswertung

Für die Auswertung und Finanzanalyse (Stufen 3 und 4 [Fe06]) wurden die aktuellen Jahresabschlüsse der 38 Unternehmen berücksichtigt. Bei der Berechnung des Ausfallrisikos lehnt sich diese Arbeit an das klassische Z-Faktoren-Modell von Altman [Al68] an. Auch wenn zahlreiche Arbeiten das Modell infrage stellen [z. B. Be05, S.75], genießt es nach wie vor hohes Ansehen in der wissenschaftlichen Forschung und bildet in der Praxis oftmals die Grundlage namhafter Ratingagenturen [Ol12, WC10]. In seinem Modell parametrisiert Altman mithilfe der multivariaten, linearen Diskriminanzanalyse einen Z-Faktor und vergleicht die zu beurteilenden Unternehmen mit einer „voraussichtlich solventen" Alternativgruppe (Bestimmung des Signifikanzniveaus). Er erzielt mit seinem Modell eine Prognosegenauigkeit für Insolvenzen von 95% bei einem Horizont von einem Jahr und 72% bei zwei Jahren. Zahlreiche Autoren nutzten Altmans Modelle als Basis und führten spezifische Anpassungen durch (z. B. für bestimmte Länder oder Branchen), um die Prognosequalität weiter zu erhöhen. Da im vorliegendem Fall 97% der selektierten CC-Anbieter amerikanischer Herkunft sind und der Fokus dieser Arbeit eher auf dem Schaffen eines grundsätzlichen Bewusstseins und weniger auf präzisen Prognosen bezüglich spezifischer Anbieter liegt, bedient sich diese Arbeit der originären Z-Faktoren. Dem Verfahren von Altman folgend wurde eine Alternativgruppe selektiert, die ebenfalls aus 38 börsennotierten Unternehmen besteht. Für die Suche nach alternativen IT-Anbietern wurden IT-Unternehmen aus dem Index „S&P 500" herangezogen und nach Herkunftsland „USA" gefiltert. Hierbei wurden Unternehmen mit größerem CC-Angebot selbstverständlich exkludiert. Danach wurden manuell diejenigen IT-Unternehmen selektiert, die gemäß ihrem Anlagevermögen den einzelnen CC-Unternehmen der Fokusgruppe am ähnlichsten sind. Um das Konstrukt auf seine Validität zu testen, wurden die beiden Gruppen

[33] Eine Liste der 38 CC-Unternehmen ist verfügbar unter: https://ssl.tsdprivatserver.de/share/1427016413/38 CC-Anbieter.pdf

mit je 38 Unternehmen schließlich nach dem Zufallsprinzip in zwei Sub-gruppen geteilt: Die „Schätzproben“ bestehen dabei aus 28 CC-Unternehmen und 28 Alternativunternehmen und die „Prognoseproben“ aus 10 CC-Unternehmen und 10 Alternativunternehmen. Das beschriebene Vorgehen folgt den Ansätzen von Altman [Al68, Al00], der die Wirksamkeit seiner Z-Faktoren mit lediglich 33 Unternehmen in der Fokusgruppe bewiesen hat.

3.3 Quantitative Inhaltsanalyse

Ferner wurde eine quantitative Inhaltsanalyse durchgeführt, die auf die Identifikation detaillierter Zusammenhänge zwischen den Termini sowie auf die Identifikation verborgener Merkmale abzielt [Su01]. Dazu wurden die Berichte der 38 CC-Anbieter herangezogen. Für die Inhaltsanalyse wurde die Software „WordStat“ von Provalis genutzt. Die Berichte werden dabei in die Software kopiert und in vier Schritten bearbeitet. Während der erste Schritt die manuelle Normierung der Schreibweise und der Silbentrennung sowie die Entfernung aller Klammern erforderte, beinhaltete der zweite Schritt die systemgestützte Lemmatisierung, die Stammformreduktion, sowie das Exkludieren unnötiger Füllwörter. Die gewonnene Datenbasis diente anschließend der Analyse und der Interpretation. Zum Vergleich wurden auch die 38 Berichte der Alternativgruppe analysiert. Alle Berichte sind in englischer Sprache verfasst.

3.4 Themenverwandte Veröffentlichungen

In einer weiteren systematischen Literatursuche wurden fünf Arbeiten identifiziert, die ein Rahmenwerk für Risikobetrachtungen im CC-Paradigma abhandeln. Diese Arbeiten sind in der Tabelle 1 jeweils mit „Forschungsfrage“ und „Ergebnissen“ aufgeführt.

Ref.	Forschungsfrage	Ergebnisse
[Ar10]	Wie ist CC definiert und was sind Chancen und Hindernisse?	Risikorahmenwerk besteht aus 10 Hindernissen: Service-Verfügbarkeit, Lock-In-Effekte, Datensicherheit, Datentransfer, Performanceunsicherheit, Datenspeicherung, Bugs, Skalierung, Reputation anderer Nutzer, Lizenzsystem.
[Gr11]	Was sind die Schwachstellen bei der CC-Nutzung?	Basierend auf einer anerkannten Risikotaxonomie werden folgende Schwachstellen analysiert: Kerntechnologie (z.B. http-Protokolle, kryptographische Eigenschaften); CC-Charakteristiken (z.B. Daten-Recovery, Bezahlsystem); Sicherheitskontrollen; Gefahren bei speziellen CC-Angeboten (z.B. anfälliges „Cross-site scripting" oder „SQL-injection").
[MT12]	Wie kann ein Entscheidungssystem in CC-Umgebungen ausgestaltet sein?	Mathematisches Modell, welches die CC-Risiken in drei Kategorien gruppiert: Integrität, Service-Verfügbarkeit und Vertraulichkeit.
[Du13]	Welche CC-Risiken entstehen für die nutzende, gesamte Organisation?	Aus der Literatur hergeleitetes Rahmenwerk mit fünf übergeordneten Kategorien (IT-Organisation; CC-Betrieb; Technologie; Rechtliche Risiken), die jeweils aus drei bis fünf Unterkategorien bestehen.
[KK14]	Wie können Risiken in Netzwerken von CC-Anbietern identifiziert werden?	Zunächst Erstellung eines Referenzmodells mit Akteuren in CC Netzwerken. Anschließend Verknüpfung der Akteure mit den jeweiligen Risiken (Datenrisiken, Preisrisiken sowie Verfügbarkeitsrisiken).

Tabelle 1: Themenverwandte Veröffentlichungen

Dieser Beitrag grenzt sich von den bisherigen Arbeiten wie folgt deutlich ab: die zu hinterfragende Finanzstärke sowie die Gefahr einer Insolvenz von CC-Anbietern sind bis dato eher rudimentär und in allgemeinen, kurzen Aussagen ohne fundierte Analysen angeführt worden [z. B. Ma11, Ar10]. Zwar diskutiert die Literatur die Service-Verfügbarkeit als eine Risikogröße. Damit sind aber technische Faktoren wie z.B. „Response time" oder „99,X% Leistungserbringung" gemeint. Diese Arbeit eruiert die Notwenigkeit einer Erweiterung der Literatur durch die Schaffung der zusätzlichen Dimension „Anbieterinsolvenz" bei der Selektion geeigneter CC-Anbieter. Damit soll die Vertrauenswürdigkeit der Anbieter aus finanzieller Perspektive indiziert werden.

4 Auswertung und Analyse

4.1 Ergebnisse der Finanzanalyse

Die Diskriminanzfunktion für börsennotierte, amerikanische Unternehmen, die nicht im Finanzsektor (z. B. Banken) tätig sind, lautet gemäß Altman [Al68]: $Z' = 1,2X_1+1,4X_2+3,3X_3+0,6X_4+0,999X_5$. Die Variablenausprägungen sind der Tabelle 2 zu entnehmen. Unternehmen, die einen Z-Faktor von weniger als 1,81 besitzen, werden dem Modell nach als stark insolvenzgefährdet angesehen. Bei einem Wert von größer als 2,67 ist das Unternehmen hingegen ungefährdet. In einer von vielen späteren Arbeiten entwickelte Altman [Al00] einen Z-

Faktor speziell für Unternehmen in aufstrebenden und neuen Märkten, was gewisser Maßen auch für CC-Unternehmen gilt. Diese Funktion lautet: $Z'' = 6{,}56X_1+3{,}26X_2+6{,}72X_3+1{,}05X_4$. Die kritische untere Grenze liegt hier bei 1,10. Mittels beider Funktionen wurden die Finanzberichte manuell ausgewertet.

Variable	**Berechnung**
X_1	(Umlaufvermögen – kurzfristige Verbindlichkeiten) / Bilanzsumme
X_2	Einbehaltene Gewinne / Bilanzsumme
X_3	Ergebnis vor Zinsen und Steuern / Bilanzsumme
X_4	Marktwert des Eigenkapitals / Summe der Verbindlichkeiten
X_5	Umsatz / Bilanzsumme

Tabelle 2: Variablen des Z-Faktor-Modells

Wie zuvor beschrieben wurden die 38 selektierten CC-Unternehmen (Fokusgruppe) per Zufallsprinzip in eine Prognoseprobe und eine Schätzprobe aufgeteilt und mit den jeweiligen Proben der Alternativgruppe verglichen. Die Ergebnisse sind in der Tabelle 3 aufgeführt. So zeigen die Durchschnittswerte der CC-Unternehmen in beiden Proben erhebliche Insolvenzrisiken, da die unteren Grenzwerte beider Z-Faktoren deutlich unterschritten sind. Zwar gibt es auch bei den CC-Anbietern „gesunde“ Unternehmen in beiden Proben (siehe Maximum), diese sind jedoch in der Minderheit. Vor allem die Variablen X_2 und X_3 haben einen starken negativen Einfluss auf die Z-Faktoren. Diese Variablen messen die vergangenen und aktuellen Gewinne der CC-Unternehmen, die bei den CC-Unternehmen überwiegend negativ ausfallen. Damit können sich diese Unternehmen nicht eigenständig refinanzieren und sind stark vom „Wohlwollen“ ihrer Investoren abhängig. Dabei enthält die Fokusgruppe nicht nur Start-Ups sondern auch gesetzte CC-Unternehmen. Im Durchschnitt sind die 38 CC-Unternehmen seit 15 Jahren aktiv, womit das Argument der „Anschubinvestitionen“ entkräftet werden kann. Die Werte der Alternativgruppe weisen auf ein entgegengesetztes Bild hin. In beiden Proben sind zwar ebenfalls insolvenzrisikobehaftete Unternehmen enthalten, diese sind jedoch in der Minderheit. Die Durchschnittswerte beider Proben der Alternativgruppe sind nicht kritisch.

Art der Probe	Statistische Größe	X_1	X_2	X_3	X_4	X_5	Z´	Z´´
Schätzprobe der Fokusgruppe (n=28)	Durchschnitt	0,09	-0,43	-0,04	1,67	0,54	**0,89**	**0,61**
	Minimum	0,01	-4,03	-0,32	-0,37	0,22	**-6,69**	**-15,60**
	Maximum	0,24	0,28	0,11	5,53	1,39	**5,73**	**8,99**
	Standardabweichung	0,06	0,79	0,12	1,50	0,24	**2,70**	**5,31**
Schätzprobe der Alternativgruppe (n=28)	Durchschnitt	0,10	0,20	0,08	1,10	0,60	**1,92**	**2,98**
	Minimum	-0,03	-1,49	-0,28	-0,19	0,26	**-2,90**	**-7,13**
	Maximum	0,25	1,80	0,39	4,11	1,53	**8,09**	**14,42**
	Standardabweichung	0,07	0,62	0,12	0,80	0,27	**2,10**	**4,13**
Prognoseprobe der Fokusgruppe (n=10)	Durchschnitt	0,05	-0,67	-0,07	1,11	0,51	**0,06**	**-1,17**
	Minimum	-0,06	-2,80	-0,32	0,12	0,19	**-4,80**	**-11,58**
	Maximum	0,13	0,31	0,12	2,79	0,93	**3,60**	**5,64**
	Standardabweichung	0,06	0,82	0,13	0,79	0,17	**2,28**	**4,73**
Prognoseprobe der Alternativgruppe (n=10)	Durchschnitt	0,13	0,37	0,08	3,97	1,00	**4,31**	**6,74**
	Minimum	0,04	-0,37	-0,07	0,53	0,27	**-0,09**	**-0,83**
	Maximum	0,51	1,28	0,46	6,95	3,02	**11,09**	**17,87**
	Standardabweichung	0,13	0,45	0,13	2,21	0,79	**3,36**	**5,57**

Tabelle 3: Statistische Größen zur Berechnung der Insolvenzrisiken

4.2 Ergebnisse der statistischen Signifikanz

Zur Bestimmung der Wahrscheinlichkeitsverteilung wurden die Tests von Kolmogorov-Smirnov und Shapiro-Wilk angewandt. Beide Tests indizierten eine Normalverteilung der Variablen in den jeweiligen Gruppen, womit die Voraussetzungen für einen Zweistichproben-t-Test erfüllt sind. Dieser Test prüft anhand der Durchschnittswerte zweier unabhängiger Stichproben, in welcher Relation die Durchschnittswerte zweier Grundgesamtheiten zueinander stehen. Da die Grundgesamtheiten sowohl in den beiden Schätzproben als auch in den Prognoseproben nicht der gleichen Varianz entstammen, wurde eine spezielle Variante von Zweistichproben-Tests namens „Welch" herangezogen, die die Gleichheit der Varianzen nicht voraussetzt. Anhand des Welch-Tests wurden schließlich die p-Werte ermittelt, um das Signifikanzniveau zu prüfen. Die Nullhypothese lautet, dass die Durchschnittswerte der Proben jeweils derselben Grundgesamtheit entspringen. In der Tabelle 4 sind die p-Werte dargestellt, wobei folgende Symbolik gilt: ** für $p<0{,}01$,* für $p< 0{,}05$ und *n.s.* für nicht signifikant. Als äußerst signifikant erweisen sich die Variablen X_2, X_3 und X_4.

Bei den Variablen X_1 und X_5 kann die Nullhypothese nicht verworfen werden. Insgesamt bestätigen auch die statistischen Ergebnisse die Hypothese, dass zwischen CC-Anbietern und Anbietern der Alternativgruppe teils signifikante Unterschiede bezüglich der Insolvenzrisiken existieren.

Art der Probe	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**
Schätzprobe	0,095 *n.s.*	0,001**	0,000**	0,045*	0,137 *n.s.*
Prognoseprobe	0,044*	0,002**	0,013*	0,002**	0,048*

Tabelle 4: Signifikanz der Variablen

4.3 Ergebnisse der quantitativen Inhaltsanalyse

Die quantitative Inhaltsanalyse ermöglicht die Bestimmung von Worthäufigkeiten und Kookkurrenzen der Datenbasis. Die Worthäufigkeiten lassen sich aus der absoluten Summe ermitteln, wobei im Rahmen dieser Analyse die 100 meistgenannten Wörter berücksichtigt wurden. Darauf basierend wurden die Kookkurrenzen errechnet, welche in der Linguistik als ein Maß zum gemeinsamen Auftreten zweier Wörter (1:1) genutzt werden [Ta05, S.65-72]. In dieser Arbeit wurden die Kookkurrenzen auf Paragraphenbasis ermittelt. Zur Berechnung dieser Interrelationen wurde der Jaccard-Index verwendet [Ta05, S.65-72]. Aus diesen Daten können Dendrogramme abgeleitet werden, die die vorgegebenen Wörter in Verbindung mit Variablen abbilden (1:n). Die Ergebnisse können durch das Verfahren der multidimensionalen Skalierung (MDS) zu einer 2-D Karte visualisiert werden [Pr10]. Die Größe der Kreise korrespondiert mit der Worthäufigkeit. Die Distanz zwischen den Kreisen entspricht der Häufigkeit des gemeinsamen Auftretens von Wörtern. Die Farben markieren übergeordnete Gruppen, die besonders starke Abhängigkeiten repräsentieren. Die Ergebnisse sind in der Abbildung 1 zu sehen.

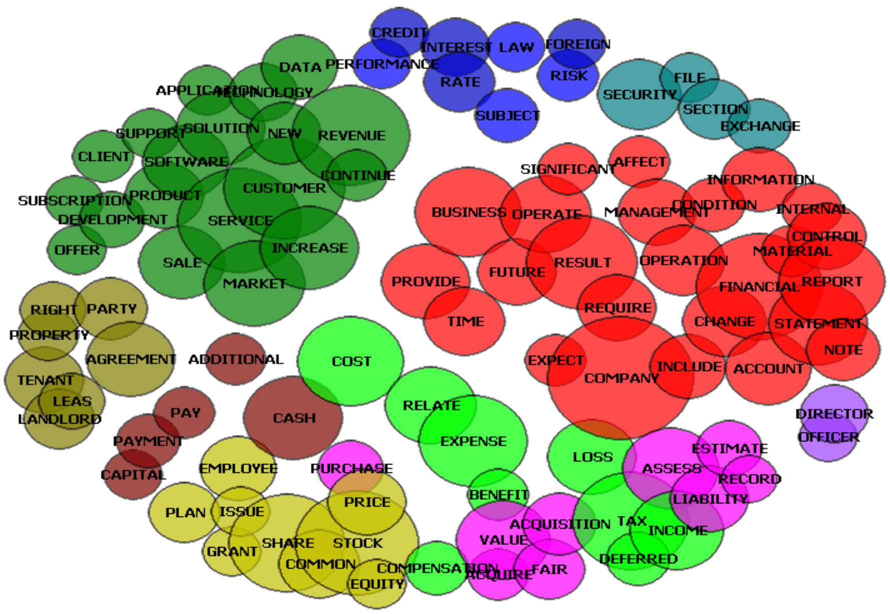


Abbildung 1: 2-D Karte der quantitativen Inhaltsanalyse von Berichten der CC-Unternehmen

Die Abbildung 1 zeigt im oberen Bereich, dass das Thema Risiko derzeit vor allem im Zusammenhang mit *Kreditrisiken* und *Zinsrisiken* verbinden, was die zuvor präsentierten Ergebnisse bestätigt. Im Falle einer Insolvenz ist völlig unklar, wie sich die Daten vor unberechtigtem Zugriff schützen lassen. In diesem Fall könnte auch der Zugang zu den Daten erschwert oder verhindert werden, was zu ungeklärten gesetzlichen Fragestellungen führt. Weiterhin werden sowohl *Performancerisiken* als auch *rechtliche Risiken* und *Sicherheitsrisiken* diskutiert. Diese drei Risiken werden in der Literatur ausführlich diskutiert (siehe Tabelle 1). Um diesen Befund abzusichern, wurden auch die 38 Anbieter der Alternativgruppe nach demselben Verfahren analysiert. Diese Ergebnisse implizieren zumindest keinen unmittelbaren Zusammenhang zu offenkundigen, finanziellen Risiken. Das fortgeschrittene Stadium der Alternativgruppe wird weiterhin dadurch deutlich, dass beim Thema Risiko vor allem der aktive Umgang mit selbigem diskutiert wird, da Termini wie *Risikoreporting, Risikokontrolle* sowie *Risikomanagement* vermehrt auftreten.

5 Implikationen für Theorie und Praxis

Diese Arbeit bietet zahlreiche Implikationen für die weitere wissenschaftliche Forschung. Zunächst wird deutlich, dass der ***interdisziplinäre Austausch*** zwischen Ökonomie und Informatik zwingend erforderlich ist, um Themengebiete wie Vertrauenswürdigkeit und Risikobewertung von CC-Anbietern adäquat sowohl aus technischer als auch aus ökonomischer Perspektive zu untersuchen. Die Signifikanz der Ergebnisse in Tabelle 3 können von der (Wirtschafts-)Informatikforschung nicht ignoriert werden, da ein Anbieterausfall direkte Auswirkungen auf Datensicherheit und Servicebereitstellung hat. Daher müssten die bestehenden, theoretischen Rahmenwerke (siehe Tabelle 1) zwingend um die ***Dimension „Anbieterausfall“*** ergänzt werden. Diese Arbeit stützt sich auf das Berechnungsschema nach Altman, welches speziell für den amerikanischen Markt entwickelt wurde. Die Forschung der kommenden Jahre könnte bei einer entstehenden breiteren Datenbasis die Finanzberichte von Anbieteren aus zurückliegenden Jahren bewerten und mit echten Anbieterausfällen korrelieren, was sich derzeit aufgrund der stark begrenzten Anzahl an insolventen Anbietern, die börsennotierten sind, eher schwierig gestaltet. Ferner müssten neue Modelle konstruiert werden, die zum einen auf den CC-Markt zugeschnitten sind und zum anderen regionale Unterschiede berücksichtigen. Hierdurch entstünde der Praxis die erforderliche Unterstützung, die bei der Bewertung der CC-Anbieter notwendig ist. Für die Bewertung des deutschen Marktes könnte beispielsweise der Bundesanzeiger dienen, der Berichte unabhängig von der rechtlichen Form der Unternehmen veröffentlicht. Bei einer intensiven CC-Nutzung (z.B. für Kerngeschäftsprozesse) könnten spezielle Modelle zur ***Bewertung von Stresstests*** entwickelt werden, die den Nutzern ein geeignetes Risikomanagement bereitstellen. Darin sollten Szenarien und zeitliche Entwicklungen beachtet werden. Ferner sind weitere Forschungstätigkeiten im Bereich Vertrauenswürdigkeit von CC-Anbietern nötig, die neben den Ausfallrisiken ***auch andere Faktoren*** wie fehlende Zertifikate, fehlender Zugang zu Technologien, schwaches Management etc. beinhalten könnten. Auch die Einflüsse und Auswirkungen der jeweiligen Faktoren untereinander stellen ein interessantes Forschungsfeld dar. Auf der Seite der CC-Anbieter gilt es um Vertrauen zu werben und die Nachhaltigkeit des Unternehmens unter Beweis zu stellen. Die Analyse von ***Signaleffekten in der IT*** stellt ein recht neues Forschungsfeld dar [BH11], welches auch um die Aspekte dieser Arbeit ergänzt werden kann. Nach Benlian und Hess [BH11] besitzen insbesondere diejenigen

Indikatoren eine hohe Signalwirkung, die messbar und transparent sind. Beide Anforderungen können für die hier dargestellte Berechnung der Anbieterausfallrisiken als „erfüllt" bezeichnet werden. Für die IT-Praxis wird ein wichtiges Problem transparent, welches proaktiv gesteuert werden muss. Die Bewertung der Kreditwürdigkeit von diversen Zulieferern ist primär Aufgabe des Finanz- und Einkaufswesens. Durch die Nutzung von CC und der einhergehenden organisatorischen Veränderungen - „Making users to choosers" - müssten IT-Abteilungen künftig vermehrt gewisse ***Grundprinzipien aus dem Finanzwesen*** beherrschen. Zwar ist das IT-Outsourcing kein neues Phänomen. Aber die zunehmende CC-Nutzung sowie die Kleinteiligkeit und Intransparenz des CC-Markts erfordert ein stärkeres Bewusstsein für Ausfallrisiken. An dieser Stelle sei erwähnt, dass die Auditoren der Finanzberichte lediglich die Richtigkeit der Berichte prüfen und auf Risiken meist nur unzureichend hinweisen [Mc03]. Somit obliegt die qualitative Bewertung allein dem IT-Nutzer. Ferner gilt es CC-Anbieter nicht nur einmalig im Rahmen eines Selektionsprozesses zu bewerten, sondern periodisch auf ihre Ausfallrisiken zu kontrollieren. Bei offensichtlich kritischen CC-Anbietern müssten im Sinne eines ***aktiven Risikomanagements*** umso dringender Exit-Strategien und Alternativszenarien überlegt werden. Bereits die Verträge mit CC-Anbietern sollten „Disaster Recovery"-Szenarien angemessen adressieren, damit die Nutzer den CC-gestützten Geschäftsprozess zeitnah wieder aufnehmen können. Die Bandbreite dieser Sicherungsszenarien kann von einfachen back-up Lösungen bis hin zur Duplikation des gesamten CC-Services bei einem weiteren Provider reichen [FK15]. Ferner ist die Nutzung proprietärer CC-Software i.d.R. mit einer spezifischen Datenstruktur verbunden (Lock-in-Effekte) [Du13], was sich im Falle einer Anbieterinsolvenz umso problematischer gestaltet. Die Auswirkungen von Insolvenzrisiken beziehen sich nicht nur auf Endnutzer eines CC-Services sondern auch auf andere Teilnehmer im CC-Netzwerk. Wie eingangs erwähnt stehen hinter einem Service oftmals mehrere CC-Unternehmen, die stark voneinander abhängig sein können. Daher sollten Teilnehmer eines CC-Netzwerks ***neue Teilnehmer auf Ausfallrisiken*** testen und die Auswirkungen simulieren. Bezüglich der Ergebnisse in Tabelle 3 muss konstatiert werden, dass nur „reine" CC-Unternehmen berücksichtigt wurden, indem Anbieter mit diversifiziertem IT-Angebot bestehend aus CC und anderen Services im Rahmen der Z-Faktorenanalyse exkludiert wurden. Weitere Stichprobentests indizierten, dass vor allem die ***großen, namhaften Anbieter aufgrund der Diversifikation geringere Ausfallrisiken*** (z.B. SAP) aufweisen als kleinere, reine CC-Anbieter, was die Vertrauenswürdigkeit traditioneller Anbieter stärkt.

6 Limitationen und Fazit

Wie jede wissenschaftliche Arbeit, weist auch diese potentielle Limitationen auf. Demnach besteht die Möglichkeit, dass nicht alle relevanten CC-Unternehmen in der Selektionsphase gefiltert wurden. Die Ursachen hierfür können in der Unvollständigkeit der gewählten Quellen oder in alternativen Bezeichnungen vermeintlicher CC-Anbieter liegen. Ferner wurden nur börsennotierte, überwiegend amerikanische CC-Unternehmen berücksichtigt, womit die Ergebnisse schwer auf deutsche Unternehmen mit anderen Rechnungslegungsstandards übertragbar sind. Jedoch muss festgehalten werden, dass alle selektierten CC-Anbieter auf dem deutschen Markt aktiv sind. Weiterhin ist die Grundgesamtheit mit 38 CC-Anbietern zwar größer als von Altman gefordert. Aber ein Rückschluss von der Empirie auf die Allgemeinheit ist zumindest nicht kritiklos möglich. Dennoch bietet diese Arbeit wichtige, neue Einblicke im Themengebiet „Vertrauen im CC-Markt“ und deckt die aktuellen Risiken von CC-Anbietern auf. Ferner geht diese Arbeit mit der Meinung von IT-Experten von Gartner einher [Ga15], die annehmen, dass jeder vierte CC-Anbieter das Jahr 2015 nicht überstehen wird. Dementsprechend groß sind auch die Auswirkungen auf die Daten- und Geschäftsprozesssicherheit der Nutzer. Der recht junge CC-Markt befindet sich wie jeder neue Markt in einer Findungsphase, bei der adäquate Selektionstechniken bei der Anbieterauswahl unabdingbar sind. Die künftige Forschung sollte sich daher insbesondere der Frage widmen, *wie* diese signifikanten Ausfallrisiken im CC-Selektionsprozess geeignet Beachtung finden können.

Literaturverzeichnis

[Al00] Altman, E.I.: Predicting financial distress of companies: revisiting the Z-score and ZETA models. Stern School of Business, New York University, 2000, S. 9-12.

[Al68] Altman, E.I.: Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. The journal of finance, 1968, 23(4), S. 589-609.

[Ar10] Armbrust, M. et al.: A view of cloud computing. Communications of the ACM, 2010, 53(4), S. 50-58.

[At12] Atherton, A.: Cases of start-up financing: An analysis of new venture capitalisation structures and patterns. Int. J. of Entrepr. Behavior & Research, 2012, 18(1), S. 28-47.

[Be05] Bemmann, M.: Verbesserung der Vergleichbarkeit von Schätzgüteergebnissen von Insolvenzprognosestudien. No. 08/05. Dresden Discussion Paper in Economics, 2005.

[BH11] Benlian, A.; Hess, T.: The Signaling Role of IT Features in Influencing Trust and Participation in Online Communities. Int. J. of Elect. Commerce, 2011, 15 (4), S. 7-56.

[Du13] Dutta, A. et al.: Risks in enterprise cloud computing: the perspective of IT experts. Journal of Computer Information Systems, 2013, 53(4), S. 39-48.

[FK15] Favre, K.; Känzig, D.: IT and Internet Newsletter Switzerland: Legal Aspects of Cloud Computing, available at: http://thouvenin.com/wp-content/uploads/2015/01/20150126-IT-and-Internet-Thouvenin-Newsletter-Switzerland.pdf (Abruf am 18.03.2015).

[Fe06] Fettke, P.: State-of-the-Art des State-of-the-Art: Eine Untersuchung der Forschungsmethode "Review" innerhalb der Wirtschaftsinformatik. Wirtschaftsinformatik, 2006, 48(4), S. 257-266.

[Ga15] Gartner, One of four cloud provider will be gone by 2015, available at: http://www.computerworld.com/article/2486691/cloud-computing/one-in-four-cloud-providers-will-be-gone-by-2015.html (Abruf am 18.03.2015).

[Gr11] Grobauer, B., et al.: Understanding cloud computing vulnerabilities. Security & privacy, IEEE, 2011, 9(2), S. 50-57.

[KK14] Keller, R.; König, C.: A Reference Model to Support Risk Identification in Cloud Networks. Proc. of the 35th Int. Conf. on IS (ICIS), 2014, Auckland.

[Le10] Leimeister, S. et. al.: The Business Perspective of Cloud Computing: Actors, Roles and Value Networks. Proc. of the 18th Europ. Conf. on IS (ECIS), 2010, Pretoria.

[Ma11] Marston, S. et al.: Cloud computing - The business perspective. Decision Support Systems, 2011, 51(1), S. 176-189.

[MT12] Martens, B.; Teuteberg, F.: Decision-making in cloud computing environments: A cost and risk based approach. Information Systems Frontiers, 2012, 14(4), S. 871-893.

[Mc03] McKee, T.E.: Rough sets bankruptcy prediction models versus auditor signalling rates. Journal of Forecasting, 2003, 22(8), S. 569-586.

[Me12] Meer, D.V. et al.: A cost-based database request distribution technique for online E-commerce applications. MIS Quarterly, 2012, 36(2), S. 479-507.

[MG11] Mell, P.; Grance, T.: The NIST definition of cloud computing", available at: http://pre-developer.att.com/home/learn/enablingtechnologies/The_NIST_Definition_of_Cloud_Computing.pdf (Abruf am 18. März 2015).

[MC13] Morgan, L.; Conboy, K.: Factors affecting the adoption of cloud computing: an exploratory study. Proc. of the 21st Europ. Conf. on IS (ECIS), 2013, Utrecht.

[Ol12] Olson, D.L. et al.: Comparative analysis of data mining methods for bankruptcy prediction. Decision Support Systems, 2012, 52(2), S. 464-473.

[Pr10] Provalis Research (2010). WordStat 6: Content Analysis Module for QDA Miner & SimStat. http://www.provalisresearch.com (Abruf am 13 Februar 2015).

[Ri14] Ridder, F.: Gartner Survey Shows One in Four German CIO Respondents Have Adopted Cloud and More Plan to Increase Cloud Investments, available at: http://www.gartner.com/newsroom/id/2731417 (Abruf am 07.02.2015).

[Ro98] Rousseau, D.M. et al.: Not So Different After All: A Cross-Discipline View of Trust. Academy of Management Review, 1998, 23(3), S. 393–404.

[Su01] Sullivan, D.: Document Warehousing and Text Mining", Wiley, New York, NY, 2001.

[Ta05] Tan, P.N. et al.: Introduction to Data Mining. Addison-Wesley, Boston, MA, 2005.

[Wa14] Walterbusch, M. et al.,: Hybride Wertschöpfung durch Cloud Computing. Dienstleistungsmodellierung. Springer Fachmedien Wiesbaden, 2014, S. 155-174.

[Wa13] Walterbusch, M. et al.: Exploring Trust In Cloud Computing: A Multi-Method Approach. Proc. of the 21th Europ. Conf. on IS (ECIS), 2013, Utrecht.

[WC10] Wang, Y.; Campbell, M.: Business failure prediction for publicly listed companies in China. Journal of Business and Management, 2010, 16(1), S. 75-88.

Beitrag Nr. 6	
Titel	Valuing the Advantage of Early Termination: Adopting Real Options Theory for SaaS
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	46th Hawaii International Conference on System Sciences (Proceedings on HICSS, 2016)
DOI	http://dx.doi.org/10.1109/HICSS.2016.605

Valuing the Advantage of Early Termination: Adopting Real Options Theory for SaaS

Andreas Jede
University Osnabrueck
andreas-jede@gmx.de

Frank Teuteberg
University Osnabrueck
frank.teuteberg@uos.de

Abstract

Traditional financial methods such as "net present value" or "discounted cash flow" are strongly limited when evaluating IT with a high usage flexibility degree. Especially with SaaS, the option to adopt and quit these services short term cannot be valued adequately with traditional methods. Towards this end, theory provides the real option approach that allows for evaluating not only the costs and benefits, but also the flexibility of IS. However, in terms of IS research this theory is often applied in order to evaluate the option to "grow" or to "defer". The advantage of early termination, such as with SaaS, has not yet been adequately studied. Therefore, this paper adopts the real option theory and transfers it to the purposes of early termination. Moreover, the impact of real options on overall service evaluation is impressively demonstrated by a case study. The paper aims to expand IS research on the use of real options in the context of SaaS decision-making.

1. Introduction

The importance of acquiring, implementing and using adequate information systems (IS) is rather significant for supporting business processes of organizations and can lead to competitive advantage [3, 8, 46]. Indicators such as costs, benefits, risks, or technical suitability constitute important factors for evaluating the economics of IS [22, 38, 55]. Hence, during the last decade, the IT industry has increasingly promoted various cloud service models such as software-as-a-sevice (SaaS) next to other outsourcing variations and traditional on-premise IS. SaaS is marketed as being cost efficient, highly scalable, and flexible [2, 34]. In contrast, security concerns remain the biggest obstacle for potential organizations [20, 32]. However, scientific research has recognized the SaaS trend early [58], and several critical papers dealing with related topics, such as risk assessment, provider selection, and the financial comparisons between traditional services and SaaS, have been published [e.g., 7, 35]. Although the corresponding results in terms of financial favorability basically involve both directions, the majority of the papers link SaaS with financial benefits [e.g., 9, 38, 44]. Independent from their specific outcomes, previous academic papers lack the consideration of one specific advantage of SaaS, namely the right, but not the obligation to cancel contracts with the SaaS provider short term without having upfront asset investments [2, 23, 39] as is usual with traditional IS, which leads us directly to the real option approach [42]. Almost every formal paper on financial SaaS evaluation and comparisons stresses the asset free provisioning model in the introduction section [e.g., 9, 31, 41], but assumes predefined usage periods for the underlying SaaS and its alternatives in the formal model. This research gap constitutes the starting point of the underlying paper.

In a first step, we involve the option to abandon via a mathematical model. Thereafter, we construct an illustrative case study to demonstrate the impacts of our approach on IS investment decisions. Herewith, we focus especially on the comparison between SaaS and traditional on-premise systems. We strongly believe that this approach will contribute to the existing body of knowledge of both theory and practice: On the one side, scientific research on cloud computing and SaaS will gain from important theory transfer on real options theory (ROT), which has been made only to very limited degree so far. Even though there are many papers on ROT in IS research, these mostly discuss investment decisions for traditional asset models, which can hardly be transferred to SaaS specifics. Moreover, the option to abandon is to the best of our knowledge missing in IS research so far, which again indicates the focus on traditional asset models. In practice, decision makers will gain from running favorability predictions on a more comprehensive and sustainable basis. Therefore, we state the following research question: *Acknowledging SaaS, how can the option to abandon services be evaluated in a formal decision model?*

The paper is structured as follows: After the introduction, the second section discusses the research approach. Next, we will outline the theoretical background and prior research. In section four, the prediction model is derived and subsequently tested by means of a simulation via an illustrative case study. The work ends with the conclusion section.

2. Research approach

Our research approach (cf. Figure 1) is presented in business process modeling (BPM) notation and grounds on a recommended procedure by Jenkins [25]. The first step constitutes the formulation of the research question and literature search. Second, we analyze the literature via a theoretical and empirical lens. Thereafter, we enrich the existing body of knowledge by designing the initial model and by evaluating the model via an exemplary case study [47]. The model design and application phases include an iterative development. Finally, the results have to be documented in research literature.

For the first and the second step, we applied a systematic literature review [56]. Towards this end, we searched the databases of the top 30 IS journals according to the AIS journal ranking list, the Digital Libraries of ACM and IEEE, as well as the major IS conferences ECIS and ICIS. For the search in the papers´ titles, abstracts, and keywords, we used the searching strings (“real option*”) AND (“Information system*” OR “information technolog*” OR “cloud computing” OR “SaaS”). Having reviewed the identified articles, we considered only those that not only argumentatively but also financially evaluate real options in IS. The reason for this is that only these papers discuss and consider the relevant assumptions of ROT. In this way, we identified

42 papers. Our major findings are discussed in the subsequent section.

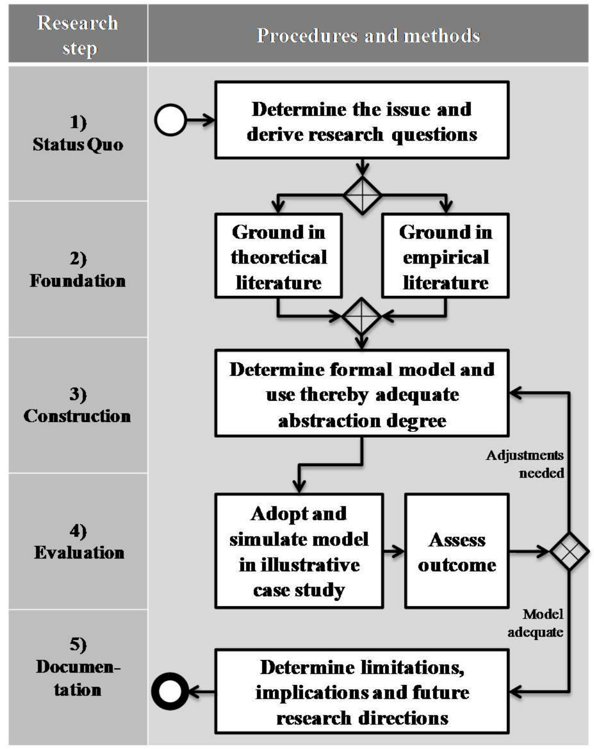
3. Theoretical background and related empirical research

First, we briefly explain the cloud computing (CC) paradigm and SaaS as a specific CC model in particular. Thereafter, we discuss the ROT and outline its necessity for the evaluation of SaaS. Then, we integrate and classify our paper in related work.

3.1. Cloud computing

The National Institute of Standards and Technology generally defines CC as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [39].

Figure 1: Research approach



The majority of the scientific literature outlines three service models [33, 39]: "Infrastructure-as-a-Service (IaaS)", "Platform-as-a-Service (PaaS)", and finally SaaS. The focus of our investigation is on SaaS, which ranges from simple supporting services such as travel management up to complex enterprise resource planning or supply chain systems. With SaaS, there is a switch to asset free IT provisioning models where highly scalable hardware, software, and data resources are available by means of a network [8, 34]. The SaaS end user is able to obtain complete software services from encapsulated functions directly from the provider via the web, at any location and at any time [3]. Furthermore, there are various CC deployments such as public, private, hybrid or community CC [23, 34, 39]. This paper addresses especially public CC where an external provider offers services through the Internet. This is because the other deployment types show a lower degree of outsourcing and hence, this weakens the "asset free" argumentation, which in turn lowers the suitability of ROT in the context of this paper.

Moreover, CC emerged from the general IT-outsourcing trend, and researchers in this topic will find several points of contact with the IT-outsourcing literature [e.g., 24]. But specific features of CC make it hard to compare traditional IT-outsourcing with actual CC issues. Here, we want to mention just a few relevant differences [cf. detailed discussion e.g., 2, 34] in order to delimit our paper from the overall IT-outsourcing research. First, with CC and the pay-as-you-go utility model there is a high "variability" of IT costs, which is not the case with traditional IT-outsourcing. In concrete terms, IT consumption and IT costs have a higher proportional relationship with CC. Moreover, the absence of upfront commitment by cloud users makes it easy to adopt, test, or quit new services short term. Such modifications are far more complicated with traditional IT-outsourcing services and their mid or long term contracts [2, 39].

3.2. Real options theory

Scientific literature often applies ROT for the valuation of IS investments [54, 57]. This is because these investments especially involve a great uncertainty arising from their complex, unpredictable, and changing circumstances [19]. Furthermore, ROT supports the evaluation of managerial flexibility that is accompanied by IS investments [6]. Moreover, early works on ROT in IS argue that classic prediction concepts, such as the simple *net present value*, undervalue investments that include higher flexibility degrees [e.g., 51, 53 pp. 152], which may lead to wrong decisions. ROT is derived from financial theory and transfers the basic flexibility logic – *do not have to react but can* – on all kinds of real life investment projects, often in terms of a financial valuation of these investments [42]. Basically all types of options enable the decision maker to conduct a certain action for an upfront agreed price in certain period of time. Whereas the European option includes the possibility to react at one point in time, namely at maturity, the American option includes reaction possibilities prior to maturity as well.

In the context of IS investments, Trigeorgis [53 pp. 2] presented several types of managerial flexibilities and the related call and put options: (i) option to switch, when the input resources can be replaced; (ii) option to growth, when a successful adoption may lead to follow-up investments; (iii) option to defer, when investments may be postponed or carried out in stages; (iv) option to expand, when systems can be scaled up; (v) option to contract, when systems can be scaled down; and finally (vi) option to abandon, when running a non-adequate system can be stopped. In general, all these option types may be fruitful for investigating the differences between CC and on-premise systems. However, this paper focuses especially on the last aspect (vi) as we found that this was not adequately addressed by scientific research so far. Moreover, this option type is highly relevant for SaaS.

In general, at a specific point in time real options have a specific value that cannot be negative. Herein, option pricing models are often used for assessing this value. Two major pricing models are dominating the scientific literature, namely the Black-Scholes-Model [10] and the Binomial-Model [15]. The Black-Scholes-Model is the most popular continuous-time model assuming that the underlying asset develops in accordance with a continuous geometric Brownian motion [e.g., 54]. Based on this, a solvable equation is constructed that enables the calculation of a European option. In a discrete-time perspective, the binomial-model is the most often applied particularly for multi-option analysis [1]. The multi-option analysis results in a binomial tree. The option values of the single points in time are discounted to the time of IS acquisition and weighted with risk-neutral probabilities in order to calculate the value of the option [15]. Since it is the purpose of this paper to evaluate the advantage of SaaS discontinuation possibilities, that may embed a number of options in various points in time after implementation (put options), we adopt the binomial-model. Furthermore, with the binomial-model the number of assumptions to be made is lower, which promotes transparency at simulation and sensitivity analysis [50].

From the above mentioned statements it is obvious that ROT constitutes a fruitful basis for valuing or comparing various types of SaaS with different periods of notice, or comparing SaaS with other IS such as on-premise systems that require upfront hardware and software investments which may lead to sunk costs in case of system unsuitability. In contrast, SaaS offers a higher degree of flexibility as there are "theoretically" no up-front-costs. The ever changing external business environment as well as internal events may lead to changes in the system adequateness. With SaaS usage, the potential to limit downside losses is bigger than with traditional systems. Hence, the price of a public SaaS includes a specific and hidden real option value that is not existent in traditional IS.

3.3. Related empirical work

As mentioned before, our literature search led to 42 high-quality papers that used ROT for valuing IS investments as well. In this sub-section, we outline the most important empirical findings. Thereafter, we explain how our work distinguishes from the existing papers.

Most of the papers (19) discuss ***growth options*** in IS investment decisions. Logically, earlier works discuss older IS. For instance, Dos Santos [17] investigated organization-wide ISDN implementation and the possible advantage of favorable ad-on services. Towards this end, Panayi and Trigeorgis [45] used a comparable approach for valuing the extension of a company´s telecommunications network. Stickel [50] and Campbell [13] discuss the growth option at a higher abstraction degree, while running extensive simulation analysis. Miller [40] focuses especially on the factors "infrastructure expenditures irreversibility", "managerial flexibility", and "uncertainty". His sensitivity analysis impressively shows the value of a growth option by means of a multi stage procedure. At the end of the last decade, the works by Kim et al. [30] as well as Harmantzis and Tanguturi [21] focused on the IT investment-intensive business of telecommunication companies and the adequate procedure of decision making for profitable growth. All these papers have in common that they analyze investments in new IT projects and new business opportunities. Moreover, they criticize that investments are normally based upon "gut feel" [17]. When switching the view from "making new business" with IS to "adequate usage" of IS [54], there are a few papers that link enterprise resource planning (ERP) investments and growth options [e.g., 51, 52]. The paper by Chen [14] stands out for involving various kinds of risks such as team risks and competition risks, while presenting and applying a model for ERP investments.

There are significantly less publications addressing the other real option variants. Considering the ***option to defer*** (11 papers), especially the papers by Benaroch and Kauffmann provide valuable insights to IS research [e.g., 4, 5, 6, 28, 29]. Herein, the "timing of deployment" plays the major role (e.g., at a point-of-sale debit service by a shared electronic banking network). Regarding the ***switch option***, Singh et al. [49] discuss the software rental agreements of application service providers. This work is important for our study as it includes the factor of spreading out payments along a contractual period; even the contract duration is predefined. Considering the ***option to abandon*** in IS research, we found only one paper [12]. Written from the providers´ perspective, the paper focuses especially on the cost structures of e-commerce products in order to evaluate new business options, while providing a framework that involves some of the other options types as well.

Moreover, there are some valuable works that analyze ***traditional IT-outsourcing*** in combination with ROT, which might be seen as a related field to SaaS (cf. 3.2 for major differences between IT-outsourcing and CC). And also the majority of these papers strive for growth options in particular. Nembhard et al. [43] investigate the optimal outsourcing conditions by means of a monte carlo simulation considering the unit production cost, unit outsourcing price, and unit delivery cost. Datta [16] links ROT and transaction cost theory for the purpose of providing decision support regarding the question under which conditions backsourcing of activities (switch option) should be considered. The contribution of Jiang et al. [26] is of unique nature as the authors evaluate outsourcing contracts from the service providers´ perspective and also take account of the loss of waiting. In contrast, Meinl [36] as well as Meinl and Neumann [37] focus on the need for an advance reservation scheme in grid computing environments, when internal computational resources are limited (growth option). Additionally, there is one paper [48] linking CC and ROT by investigating the most important option types for cloud adoption. However, this paper uses the structural equation model (SEM) approach and indicates that the option to terminate services has a significant influence on CC adoption.

Our work distinguishes from the existing scientific literature for the following reasons. To our knowledge, there is up to date no paper that transfers ***ROT to SaaS (or CC) research via a formal model*** while providing a helpful decision making approach (i.e. outsourcing or backsourcing IS). Further, it gets obvious from the above stated references that ***termination options are underrepresented*** in IS research. And this kind of options is particularly critical in the context of SaaS. Within IS research, the traditional IT-outsourcing field is close to SaaS research. However, the pay-as-you-go model (cf. section 3.1) usually enables the user to enter into contracts with shorter terms in comparison with traditional IT-outsourcing, which leads to more flexibility and makes the option to abandon even more important in terms of SaaS usage. Furthermore, our paper provides a unique comparison model between a SaaS and traditional on-premise services via a case study simulation.

4. Binomial model application

With real option analysis one can answer the question which adoption strategy is the most appropriate considering the termination flexibility. As mentioned before, we use the binomial model by Cox et al. [15], which is acknowledged as a suitable method to value real options in discrete time using binomial lattice. The initial model assumes that the value of a risky underlying asset, in this case the SaaS, will move up or down (u or d) by a specific factor at every step in the tree, where $0 < d < 1$ and $u > 1$. Following the upward and downward movement, the value of an implemented SaaS may increase in value to uV or decrease in value to dV. The probability that the value V will rise is assumed to be q, and the probability that the value V will fall is $1-q$. At each node of the tree the option value is simply its exercise value. The value of a put option in the up state is $Pu = max[(K – uV), 0]$. The value of the down state is $Pd = max[(K – dV), 0]$. Beyond that the value of a call option is $Cu = max[(uV - K), 0]$ and $Cd = max[(dV - K), 0]$ respectively. In these formulas, K is the strike price to exercise the option and rf is the risk free rate. The value of the put option P at $t=0$ can be calculated by:

(1) $P = (pPu + (1 – p) Pd) / (1+ rf)$, where
(2) $p = ((1+ rf) - d) / (u - d)$

The up and down factors are calculated with the equations:

(3) $u = exp (\sigma * dt^{0.5})$
(4) $d = 1 / u$,

where σ is the volatility and dt is the length of each time step in the binomial tree (equal to the option´s maturity divided by the number of time steps). Once the binomial lattice of all possible asset prices up to maturity has been calculated, the option value is found at each node by working backward from the final nodes to present [11, 15]. In equation (1), the P is interchangeable with the value of the call option C.

In a simple 3-year case, we would like to show the effect of using ROT for SaaS implementation decisions. Imagine initial service costs (SC) of $27.7k in $t = 0$ in order to enable the company to access the provider-hosted applications. The company has a constant potential service user amount of 10 and the SaaS takes in total costs of $10k per user. Provided that the service is suitable, the benefit would be 20% higher than the costs ($u = 1.2$). Otherwise, the benefit is 50% of the costs ($d = 0.5$). Hence, we define the periodic service costs of $100k to be equal to the benefit base BB. Due to constantly changing user requirements and service updates, the suitability varies within the three years by the defined upward and downward values. The underlying risk free rate rf is 5%. Furthermore, we assume that there is an asset that has the same in term of arbitrage free markets.

The contract is worded in such a way that termination is possible after every full year usage (European option). Hence, in our example the decision is to be made after year 1 and after year 2. The service has to be paid at the end of every year. The underlying amounts are presented in Figure 2. From the given variables, it is possible to calculate the probability p with the equation (2), which ends up in $p = 0.786$ and $(1-p) = 0.214$. Furthermore, we assume that there is an asset available that has the same upward and downward movements with the same probabilities [15] in term of arbitrage free markets ("pricing by duplication").

The decisions are typically derived by starting backwards at the end of the binomial tree. Acknowledging the needed decision in $t = 2$ in the upward > upward stage, the calculation would be max [(0.786*$72.8k + 0.214*$-28.0k) / 1.05, 0]. This equals the grey marked $48.8k, and hence, the service should not be terminated at this stage. In all other situations in which $t = 2$ it is not beneficial to continue the service. Using this approach in $t = 1$ and $t = 0$ as well, the company has an option-based net present value (NPV) of $22.9k in $t = 0$. However, the ROT concept prevents down side losses, which is stated with a zero in the grey fields.

For calculating this example with the NPV approach neglecting ROT, we would first need to define the "risk-adjusted" interest rate r, which can be determined by (adopted from Stickel [50]):

$$(5)\ DB = BB \sum_{t=0}^{T} \sum_{k=0}^{t} (t!/k!(t-k)!) p^k (1-p)^{t-k} u^k d^{t-k} (1+r)^{-t},$$

where the DB represents the discounted benefits for the whole binomial tree and BB is the benefit base. From this equation, we get $r = 0.05$. (In this example equal to the *rf* due to the linear relationship to *p*). Hence, we can use equation (6) for deriving the "NPV-only" value, involving the service costs *SC*:

$$(6) NPV = DB + \sum_{t=1}^{T} SC_t (1+r)^{-t}$$

In this case, the NPV is \$0.0 and hence, this approach might lead to wrong recommendations. The value of the termination option can easily be determined by calculating the difference between option-based NPV and the NPV-only amount: \$22.9k - \$0 = \$22.9k (see appendix for a more detailed calculation of the example).

Figure 2: Example for early termination of SaaS

t=0		t=1			t=2			t=3	
Costs	Decision calc.	Costs	Benefit	Decision calc.	Costs	Benefit	Decision calc.	Costs	Benefit
								-100,0	172,8
					-100,0	144,0	48,8		
								-100,0	72,0
		-100,0	120,0	61,3					
								-100,0	72,0
					-100,0	60,0	0,0		
								-100,0	30,0
-27,7	50,6								
								-100,0	72,0
					-100,0	60,0	0,0		
								-100,0	30,0
		-100,0	50,0	0,0					
								-100,0	30,0
					-100,0	25,0	0,0		
in \$k								-100,0	12,5

Before we proceed with the simulation in section 5, we want to make two preliminary conclusions. First, in classic ROT, the early termination right is normally stated as a put option, enabling the decision maker to exit a project in case of undesired project developments. However, in these classic put option assumptions, the decision maker normally receives a predefined payment (e.g., from the counter position), when the underlying has a lower actual value than the strike price. The above stated simple example impressively shows that the right to terminate may not necessarily be connected to any predefined equalization payments, which is unrealistic in the provider-user relationship anyhow.

Hence, from the ROT perspective the right to early termination can be seen as ***subsequent call options***, when the SaaS is beneficial for the company. Compared to traditional IT-outsourcing and on-premise services in particular, literature argues that cloud computing provides a higher degree of flexibility (joining and exiting services short term); and therefore, the additional value through termination chances should be considered in comprehensive decision making processes. From the financial perspective, this might be seen as something unique in the cloud paradigm, namely the ongoing chance to "call" a specific service.

Second, by stating that pure NPV calculations, which are often used for IS investment [49], are ***undervaluing more flexible information systems***, this paper is in conformity with prior work [e.g., 6, 19]. Nowadays, this argumentation is even more valid when comparing more or less non-flexible on-premise systems with highly flexible information systems such as SaaS. For instance, the upfront investments of on-premise systems can be classified as "sunk costs" in case the system proves to be unsuitable. With SaaS, however, the costs are evenly spread along the usage duration, which enables the user to quit the service in case of unsuitability.

5. Illustrative case study simulation

In general, it is quite hard to predict critical variables such as benefits, the upward trend *u*, or the downward trend *d* of specific IT services. And it is even more complex to compare various services adequately. One possibility to analyze the influence of the mentioned critical variables is to assume them to behave randomly according to an underlying probability distribution and to perform numerical simulations in order to obtain the corresponding histograms of the affected quantities. Towards this end, we transferred the above stated model (cf. section 4) to a software-supported simulation. For this purpose, the software Matlab by the provider MathWorks was used. Matlab is a multi-paradigm programming language for numerical simulations and it is used both in industrial enterprises and in scientific institutions. We designed the programming in such a way that basically all relationships of the model can be analyzed. In the underlying paper, we made especially use of the tool's graphic options. In order to illustrate the relationships of the model, we created the following case study.

The upcoming data is derived from three semi-structured expert interviews at a SaaS-experienced international automotive supplier with headquarter in Germany. We aggregated and structured the data in order to increase the transparency and to illustrate the relations of the variables. For the SaaS solution, we take the costs and the benefits from Figure 2 as a basis. (The benefit base of \$100k remains unchanged compared to the prior example).

Moreover, the case company estimates the probability for upwards trend for every of the three years to be $p = 0.8$ and the movements to be $u = 1.2$ and $d = 0.5$. Herewith, we determine an interest rate r of 0.06 (cf. equation *(5)*). Alternatively, the company receives an offer from an on-premise provider for a comparable solution. The investment in $t = 0$ would be \$-268.3k (incl. hardware, software, and integration costs), while the annual service costs for operating expenses, proportional salaries, maintenance, and licenses equal \$-10k. For simplification reasons, we assume the on-premise solution to involve the same u, d, and benefit base structure as the SaaS (cf. Figure 2). (These assumptions are not compellingly needed for carrying out the simulation, but they facilitate the understanding of the underlying relationships significantly). In this initial state, both solutions have the same NPV-only of \$5.0k, when not considering real options (see appendix for a more detailed calculation of the case study).

As the programming allows us to analyze the influence of virtually any variable (including T), we decided for this case exemplarily to vary the upward trend u randomly according to a specific probability distribution. The case company assumes to have an upward mean of 1.2. For every randomly generated u we computed in a first step the corresponding real option value and real option-adjusted NPV of the SaaS solution. In a second step, we computed the needed benefit base of the on-premise service in order to get the same NPV as the real option-adjusted NPV of the SaaS. These computations were carried out for 5,000 randomly generated upward trends u and finally resulted in histograms of the computed quantities.

In research literature, the normal distribution is often used for generating random numbers [e.g., 50]. But this distribution type may include negative values for u, d or the benefits, which does not make sense in our case. Moreover, the normal distribution has a symmetric shaping, which prevents more optimistic or pessimistic formation. Therefore, the distribution for the upward trend u was chosen to be a modified beta-distribution [18 pp. 34-42], which contains only positive values and may take basically any shape. The probability density function of the beta distribution, for $0 \leq x \leq 1$, and shape parameters $\alpha, \beta > 0$, is defined by:

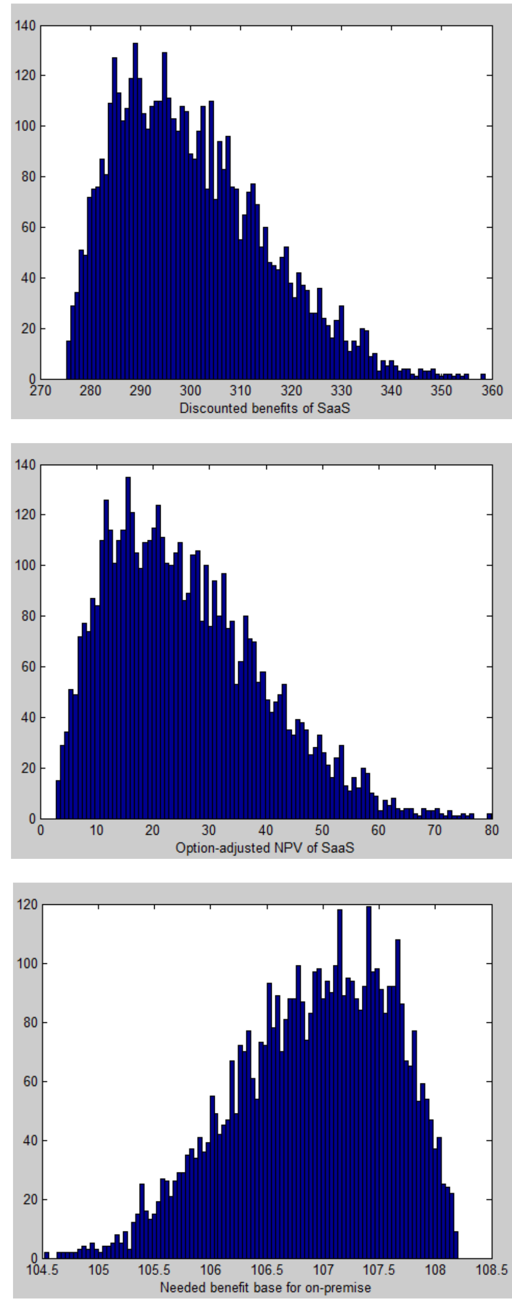
$$(7) \quad f(x; \alpha, \beta) = x^{\alpha-1} (1-x)^{\beta-1} * 1/(\beta(\alpha, \beta)).$$

For the numerical simulations we set the parameters to $\alpha=2, \beta=5$ to model the pessimistic case and to $\alpha=5, \beta=2$ for the optimistic case. For both cases we modified the probability density function by applying a linear transformation on the corresponding random variable *u*, comprising a compression of the possible value range from the interval [0,1] to [0,0.3] and an additional shift of the mean to 1.2. This case study implicitly assumes that the usage durations of the compared alternatives might differ. In general, this assumption has already been extensively discussed and is often used in ROT literature [e.g., 49].

Figures 3 and 4 illustrate histograms of the discounted benefits, the real option-adjusted NPVs of the SaaS solution as well as the equivalently needed benefit bases of the on-premise service for the pessimistic and optimistic case, respectively. It can be seen that the benefit base of $100k of the on-premise solution has to increase up to 10% in order to have the same option-adjusted NPV as the SaaS solution. Moreover, the function of the option values shows that there is a non-linear relationship between the upward trend and the needed benefit of the on-premise solution. In the pessimistic case, the probability of smaller SaaS benefits is higher, which in average leads to a higher value of the option. In order to compensate this higher option value, the needed benefits of the on-premise solution have a skewness to the left. In the optimistic case, the average option value is lower and consequently the needed benefits of the on-premise service are skewed to the right.

This case study simulation leads to a counterintuitive and noticeable outcome, namely the higher the average benefit of the SaaS, the lower the NPV advantage of the SaaS compared to the on-premise service. This is due to downside losses get more unlikely, leading to a lower value of the termination option. These results impressively show the usefulness of simulation analysis for decision-making processes in IT procurement comparisons.

Figure 3: Simulation results of pessimistic case

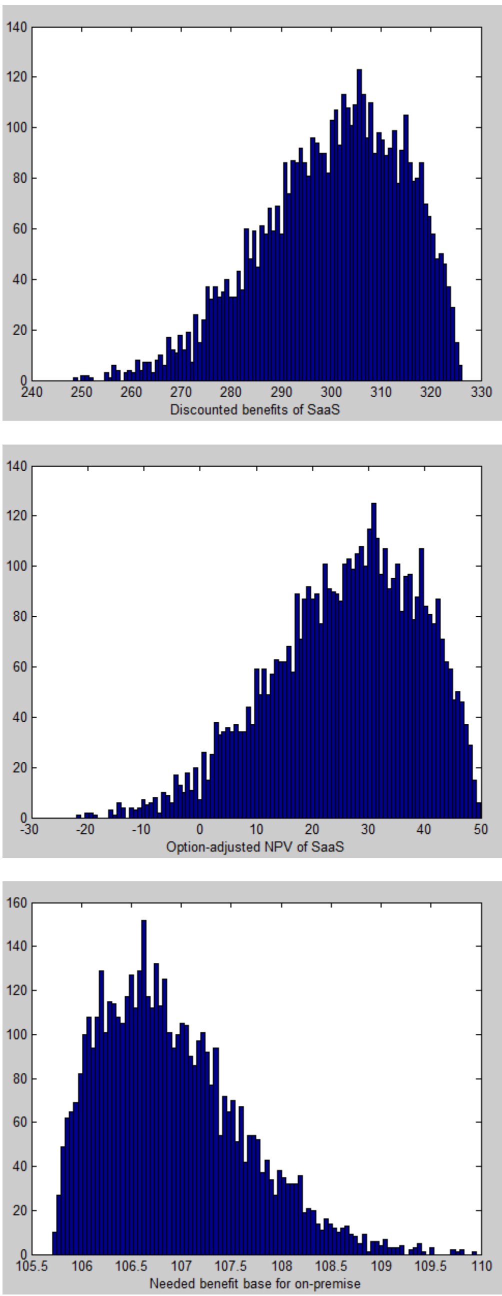


6. Conclusion

6.1. Implications for theory and practice

To the best of our knowledge, as the earliest paper demonstrating the valuation of termination in highly flexible systems such as SaaS, the underlying study extends the burgeoning theoretical literature on real options. It is also consistent with what Kahneman [27] characterizes as systematic errors that arise due to ***managers' bounded rationality***. We explicitly want to mention four major implications. First, we show that the traditional capital budgeting technique cannot

Figure 4: Simulation results of optimistic case



appropriately price the flexibility of pay-as-you-go services such as SaaS, while the option pricing analysis is able to quantify such flexibility. This assessment of flexibility offers the decision maker the ability to evaluate SaaS contracts that offer ***sequential termination opportunities***. Second, the explained stochastic programming model captures the flexibility of decision-making in IS procurement processes and provides support in finding the most appropriate strategy. Thus, it supplies decision makers involved in IS investments with a scientific and useful decision-making ***simulation analysis*** that allows them to seize investment opportunities more effectively. Third, we created a ***unique comparison procedure*** in order to set various IT services in direct relation to each other, which enables the decision-maker to select the right IS and thus ensures higher returns. Fourth, a case study has been conducted with a predefined number of users for the SaaS, and the time span was predefined. This might contradict the pay-as-you-go model at first glance. Here we want to encourage the practitioners to test the ***upload file***, where cases with varying user amounts (function of benefits/costs) as well as subscription periods (function of benefits/costs and interest rates [e.g., monthly rate = r/12]) can be simulated easily.

6.2. Limitations

With ROT there are certain general assumptions needed that simultaneously reflect limitations of the method [e.g., 15]. Nevertheless, this is an accepted method in the dynamic investment calculations [5, 19]. Focusing on our specific assumptions, the model involves the termination option only as we were about to explain particularly this advantage. However, the model involves the possibility of comparing different usage durations. Here we go in line with the argumentation of existing literature [e.g., 49] by stating that (i) a replacement SaaS is not compellingly needed in all cases (e.g., business unit stop) and that (ii) even if a replacement would be needed, the replacement service might have virtually any favorability. However, a combination with other option types (e.g., switch options) might lead to additional valuable findings. Further, the linear development of the benefits and constant yearly costs might be more complex in other cases, when firms face strongly changing requirements. Moreover, we adopt risk neutrality when comparing the services while neglecting factors such as security risks. Future research might include this aspect within interest rates or yearly costs.

6.3. Outlook

The paper at hand bridges ROT and research on SaaS. Starting with theoretical and empirical work, we clearly explain the valuable contribution, namely the advantage of early termination of flexible IT services. We adopt the binomial model and run an extensive case study simulation in order to present the impacts and relationships in more detail. Future research might expand our work in two ways. On the one side, it could broaden the scope of our approach (cf. limitations) in order to derive more realistic models. On the other side, more empirical assessments of the model are needed for an in-depth validation. To conclude, we would like to encourage practice to utilize the presented model for the following reason: with the paradigm shift towards asset free IT, various IT concepts have to be compared and it is mandatory for decision makers to acquire deep technical as well as financial knowledge in order to select the adequate service in the long run.

7. References

[1] Angelou, G.N., Economides, A.A., “A decision analysis framework for prioritizing a portfolio of ICT infrastructure projects”, IEEE Transactions on Engineering Management, 55(3), 2008, pp. 479-495.

[2] Armbrust, M., Fox, A., Griffith, R., Joseph, A.D., et al., “A View of Cloud Computing”, Communications of the ACM, 53(4), 2010, pp. 50-58.

[3] Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R.J., and Sougstad, R., “An interdisciplinary perspective on IT services management and service science”, Journal of MIS, 26(4), 2010, pp. 13–64.

[4] Benaroch, M., and Kauffman, R.J., “A case for using real options pricing analysis to evaluate information technology project investments”, Information Systems Research, 10(1), 1999, pp. 70-86.

[5] Benaroch, M., and Kauffman, R.J., “Justifying electronic banking network expansion using real options analysis”, MIS quarterly, 24(2), 2000, pp. 197-225.

[6] Benaroch, M., “Managing information technology investment risk: a real options perspective”, Journal of MIS, 19(2), 2002, pp. 43-84.

[7] Benlian, A., “Is traditional, open-source, or on-demand first choice & quest; Developing an AHP-based framework for the comparison of different software models in office suites selection”, European Journal of IS, 20(5), 2011, pp. 542-559.

[8] Bharadwaj, A., El Sawy, O.A., Pavlou, P.A., and Venkatraman, N., “Digital business strategy: toward a next generation of insights”, MIS Quarterly, 37(2), 2013, pp. 471-482.

[9] Bibi, S., Katsaros, D., and Bozamis, P., “Business application acquisition: on-premise or SaaS-based solutions?”, IEEE Software, 29(3), 2012, pp. 86-93.

[10] Black, F., and Scholes, M., “The pricing of options and corporate liabilities”, Journal of Political Economy, 81(3), 1973, pp. 637–654.

[11] Boyle, P., “Option Valuation Using a Three Jump Process”, Int. Options Jour., 3(7-12), 1986, pp. 7-12.

[12] Bräutigam J., Esche C., and Mehler-Bicher A., “Uncertainty as a Key Value Driver of Real Options,” In: Proc. of the 7th Conference on Real Options: Theory Meets Practice, Washington, DC, 2003.

[13] Campbell, J.A., “Real options analysis of the timing of IS investment decisions”, Information & Management, 39(5), 2002, pp. 337-344.

[14] Chen, T., Zhang, J., and Lai, K.K., “An integrated real options evaluating model for information technology projects under multiple risks”, Int. Jour. of Project Management, 27(8), 2009, pp. 776-786.

[15] Cox, J.C., Ross, S.A., Rubinstein, M., “Option pricing: a simplified approach”, Journal of Financial Economics, 7(3), 1979, pp. 229-263.

[16] Datta, S., “Strategic outsourcing: a real option approach”, In: Doctoral Symposium of Bristol Business School, 2005.

[17] Dos Santos, B.L., “Justifying Investments in New Information Technologies”, Journal of Management Information Systems, 7(4), 1991, pp. 71-89.

[18] Evans, M, Hastings, N., and Peacock, B., “Statistical distributions”, Third Edition, John Wiley & Sons, New York, 2000.

[19] Fichman, R.G., “Real options and IT platform adoption: implications for theory and practice”, Inf. System Research, 15(2), 2004, pp. 132-154.

[20] Gupta, P., Seetharaman, A., and Raj, J.R., “The usage and adoption of cloud computing by small and medium businesses”, International Journal of Information Management, 33(5), 2013, pp. 861-874.

[21] Harmantzis, F.C., and Tanguturi, V.P., “Investment decisions in the wireless industry applying real options”, Telecom. Policy, 31(2), 2007, pp. 107-123.

[22] Hilhorst, C., van Heck, E., Ribbers, P., “Combining real options and multiattribute decision analysis to define the favourable IT infrastructure implementation strategy: a case study”, In: Proc. of the 14th European conference on IS, Göteborg, 2006.

[23] Hoberg, P., Wollersheim, J., and Krcmar, H. “The business perspective on cloud computing-a literature review of research on cloud computing”, In: Proc. of the 18th American Conference on IS, Seattle, 2012.

[24] Ingalsbe, J., Shoemaker, D., and Mead, N., “Threat modeling the cloud computing, mobile device toting, consumerized enterprise”, In: Proc. of the 17th Americas Conference on IS, Detroit, 2011.

[25] Jenkins, A.M., “Research methodologies and MIS research”, In: Mumford, E., (ed.), Research Methods in Inf. Systems, North-Holland, 1985, pp. 103-117.

[26] Jiang, B., Yao, T., and Feng, B., “Valuate outsourcing contracts from vendors' perspective: A real options approach”, Decision Sciences, 39(3), 2008, pp. 383-405.

[27] Kahneman, D., “Maps of bounded rationality: Psychology for behavioral economics”, American Economic Review, 93(5), 2003, pp. 1449-1475.

[28] Kauffman, R.J., and Li, X., “Technology competition and optimal investment timing: a real options perspective”, Engineering Management, IEEE Transactions on, 52(1), 2005, pp. 15-29.

[29] Kauffman, R.J., and Kumar, A., “Network effects and embedded options: decision-making under uncertainty for network technology investments”, Inf. Tech. and Management, 9(3), 2008, pp. 149-168.

[30] Kim, H.J., Weiss, M.B., and Morel, B., “Real options and technology management: Assessing technology migration options in wireless industry”, Telematics and Informatics, 26(2), 2009, pp. 180-192.

[31] Kondo, D., Javadi, B., Malecot, P., Cappello, F., and Anderson, D.P., “Cost-Benefit Analysis of Cloud Computing versus Desktop Grids”, In: Proc. of the 2009 IEEE Inter. Symposium on Parallel & Distributed Processing.

[32] Lee, S.G., Chae, S.H., and Cho, K.M., “Drivers and inhibitors of SaaS adoption in Korea”, Int. Journal of Information Management, 33(3), 2013, pp. 429-440.

[33] Leimeister, S., Böhm, M., Riedl, C., and Krcmar, H. “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks”, In: Proc. of the 18th European Conference on IS, Pretoria, 2010.

[34] Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., and Ghalsasi, A., “Cloud computing - The business perspective.” DSSs, 51(1), 2011, pp. 176-189.

[35] Martens, B., and Teuteberg, F., “Decision-making in cloud computing environments: A cost and risk based approach”, Inf. Sys. Front., 14(4), 2012, pp. 871-893.

[36] Meinl, T., “Advance reservation of grid resources via real options”, In: Proc. of the 5th Conf. on Enterprise Computing and E-Services, IEEE, 2008, pp. 3-10.

[37] Meinl, T., and Neumann, D., “A real options model for risk hedging in Grid computing scenarios”, In: Proc. of the 42nd Hawaii International Conference on System Science, 2009.

[38] Meer, D., Dutta, K., and Datta, A., “A cost-based database request distribution technique for online E-commerce applications.” MIS Quarterly, 36(2), 2012, pp. 479-507.

[39] Mell, P., and Grance, T., “The NIST definition of cloud computing”, http://faculty.winthrop.edu/domanm/csci411/Handouts/NIST.pdf, Access 1 May 2015.

[40] Miller, L., Choi, S. H., and Park, C.S., “Using an options approach to evaluate Korean information technology infrastructure”, The Engineering Economist, 49(3), 2004, pp. 199-219.

[41] Misra, S.C., and Mondal, A., “Identification of a company’s suitability for the adoption of cloud computing and modelling its corresponding Return on Investment”, Mathematical and Computer Modelling, 53(3), 2011, pp. 504-521.

[42] Myers, S.C., “Interactions of corporate finance and investment decisions – implications for capital budgeting”, Journal of Finance 29(1), 1974, pp. 1-25.

[43] Nembhard, H.B., Shi, L., and Aktan, M. “A real options design for product outsourcing”, The Engineering Economist, 48(3), 2003, pp. 199-217.

[44] Oliveira, T., Thomas, M., and Espadanal, M., “Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors”, Information & Management, 51(5), 2014, pp. 497-510.

[45] Panayi, S., and Trigeorgis, L. “Multi-stage real options: The cases of information technology infrastructure and international bank expansion”, Quarterly Review of Economics and Finance, 38(3), 1998, pp. 675-692.

[46] Prahalad, C.K., and Hamel, G., “The core competence of the corporation”, Harvard Business Review, 68(3), 1990, pp. 79-91.

[47] Radeke, F., “How To Rigorously Develop Process Theory Using Case Research”, In: Proc. of the 18th European Conference on IS, Pretoria, 2010.

[48] Saya, S., Pee, L. G., and Kankanhalli, A., "The Impact of Institutional Influences on Perceived Technological Characteristics and Real Options in Cloud Computing Adoption". In: Proc. of the 31st International Conference on IS, St. Louis, 2010.

[49] Singh, C., Shelor, R., Jiang, J., and Klein, G., "Rental software valuation in IT investment decisions", DSS, 38(1), 2004, pp. 115-130.

[50] Stickel, E., "Die Bewertung von IV-Entwicklungsprojekten mit Methoden der Optionspreistheorie", Electronic Business Engineering, Physica-Verlag HD, 1999, pp. 685-707.

[51] Taudes, A., "Software growth options", Journal of MIS, 15(1), 1998, pp. 165-185.

[52] Taudes, A., Feurstein, M., and Mild, A., "Options analysis of software platform decisions: a case study", MIS Quarterly, 24(2), 2000, pp. 227-243.

[53] Trigeorgis, L., "Real options: management flexibility and strategy in resource allocation", MIT Press, Cambridge, 1996.

[54] Ullrich, C., "Valuation of IT investments using real options theory", Business & Information Systems Engineering, 5(5), 2013, pp. 331-341.

[55] Vom Brocke, J., Sonnenberg, C., and Simons, A., "Value-oriented information systems design: the concept of potentials modeling and its application to service-oriented architectures", Business & Information Systems Eng., 1(3), 2009, pp. 223-233.

[56] Webster, J., and Watson, R.T., "Analyzing the past to prepare for the future: Writing a literature review", MIS Quarterly, 26(2), pp. xiii-xxiii.

[57] Wu, F., Li, H.Z., Chu, L.K., Sculli, D., and Gao, K., "An approach to the valuation and decision of ERP investment projects based on real options", Annals of Operations Research, 168(1), 2009, pp. 181-203.

[58] Youseff, L., Butrico, M., and Da Silva, D., "Toward a unified ontology of cloud computing", In: Grid Computing Environments Workshop, Austin, 2009.

Acknowledgement

The authors would like to thank the anonymous reviewers as well as Ms. Marita Imhorst and Mr. Alexander Krüger, who provided valuable insights, help and substantive feedback during the research process. This work is part of the project "Sustainable Consumption of Information and Communication Technologies in the Digital Society − Dialogue and Transformation through Open Innovation". The project is funded by the Ministry for Science and Culture of the Land of Lower Saxony and the Volkswagen Foundation (VolkswagenStiftung) within the grant programme "Niedersächsisches Vorab" (grant number VWZN3037).

Appendix

Further calculations to this paper are available online and may be downloaded from the following link: http://tinyurl.com/nmgr5yx

Beitrag Nr. 7	
Titel	Looking Behind the Stage: Influence and Effect of Software-as-a-Service on Socio-technical Elements in Companies
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	23rd European Conference on Information Systems (Proceedings on ECIS, 2015)
URL	http://aisel.aisnet.org/ecis2015_cr/87

LOOKING BEHIND THE STAGE: INFLUENCE AND EFFECT OF SOFTWARE-AS-A-SERVICE ON SOCIO-TECHNICAL ELEMENTS IN COMPANIES

Complete Research

Jede, Andreas, University of Osnabrueck, Accounting and Information Systems, Katharinenstraße 1, 49069 Osnabrueck, Germany, andreas-jede@gmx.de

Teuteberg, Frank, University of Osnabrueck, Accounting and Information Systems, Katharinenstraße 1, 49069 Osnabrueck, Germany, frank.teuteberg@uni-osnabrueck.de

Abstract

With Software-as-a-Services (SaaS), benefits such as cost efficiency and flexibility gains are associated, which drive decision-makers to increasingly take this technology into account not only for supporting business processes, but also for core business processes. However, the trailing IT organizational impacts of SaaS integrations after the implementation phase often remain hidden. This paper examines the effects of SaaS on the perceived technical change radicalness and the perceived IT organizational changes from the perspective of the socio-technical systems theory. We derive a research model that is suited to IT employees at SaaS using companies to investigate the changes in their daily tasks. The model is tested with data collected from 66 IT employees from various sectors in German-speaking countries. The empirical results indicate that an increasing SaaS usage level leads to instability in the socio-technical balance of using companies. Especially the perceived individual job outcome, a measure for soft facts such as job satisfaction, indicates that SaaS affects internal IT employees in a negative sense. Our valuable findings help management to understand the need for balancing both their willingness for SaaS adoption and the social impacts. The understanding of this interrelation helps the enforcement of more sustainable SaaS implementations.

Keywords: Software-as-a-Service, Socio-technical systems theory, IT restructuring, IT organization

1 Introduction

The ease of use of Software-as-a-Service (SaaS) and the related advantages such as cost efficiency and scalability (Youseff et al., 2008; Marston et al., 2011) should not obscure the fact that SaaS may have extensive impacts on a company´s organizational IT structure. Literature argues that SaaS may adversely affect the complexity of managing the whole infrastructure of disparate information architectures and distributed data as well as software along internal and external data streams (Leimeister et al., 2010; Hoberg et al., 2012). Generally, the National Institute of Standards and Technology defines the term cloud computing (CC) as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance, 2011). But CC does not represent a new technology. Rather, it stands for a new paradigm for IT processes by consistently linking individual, existing technologies (Youseff et al., 2008; Leimeister et al., 2010). The majority of the research literature outlines three service models (Leimeister et al., 2010; Mell and Grance, 2011): "Infrastructure-as-a-Service (IaaS)", "Platform-as-a-Service (PaaS)", and finally SaaS. The focus of our investigation is SaaS, which ranges from simple supporting services such as travel management up to complex enterprise resource planning systems. With SaaS, there is a shift to asset free IT provisioning models where highly scalable hardware, software, and data resources are available by means of a network (Bharadwaj et al., 2013). The SaaS end user is able to obtain complete software services from encapsulated functions directly from the provider via the web, at any location and at any time (Bardhan et al., 2011), essentially, many key processes bypass the internal IT departments. By the construction of SaaS, specific tasks such as software customizing and engineering, which were mostly proceeded internally, switch to the CC provider (Marston et al., 2011). Contrary, other internal tasks change or gain even more attention, e.g., IT security and IT architecture management (Loske et al., 2014; Gupta et al., 2013). Having this constellation in mind, it is likely that, depending on the degree of SaaS usage, the company´s existing IT competences and organizational IT structures are unsuitable. In particular internal IT employees, who are responsible for managing SaaS processes, may experience major changes and disruptions in their daily work processes after the implementation of such systems. This is especially valid when SaaS is used for core business processes as these processes are often more complex and require special skills for the related job tasks. Consequently, internal IT employees may develop negative reactions toward these new systems (Venkatesh et al., 2010; Boudreau and Robey, 2005; Volkoff et al., 2007). Therefore, it is important to study how IT employees perceive changes in their work processes following a SaaS implementation in order to understand reactions and associated outcomes to these systems. Indeed, prior research has investigated many aspects of SaaS such as provider selection (e.g., Wind et al., 2012; Hoberg et al., 2012), or implementation processes (e.g., Low et al., 2011). However, organizational impacts of SaaS are assumed so far mostly argumentative-deductive and existing papers tackle the topic rather superficially on macro-level (Morgan and Conboy, 2013; Marston et al., 2011). For example, there has only been very limited research focusing on how IT employees react to new SaaS systems that change their work processes. Furthermore and to the best of our knowledge, there is no empirical research up to now that explores the SaaS implementation impact on IT-employees´ job outcomes and process performance. Such research will contribute to both CC research and organization management literatures and will be considered a valuable work at the intersections of these two fields. We seek to address these topics by conducting an individual-level research. Herein, we draw on socio-technical systems (STS) theory, an influential theory from organizational behavior, that has been widely used to study IT implementations and IT enabled changes in organizations (e.g., Lyytinen and Newman, 2008; Bala and Venkatesh, 2013). We focus the following two research questions:

- *Do IT employees´ tasks change significantly when using public SaaS for core business processes?*
- *Do IT employees´ perceptions of their individual job outcome and their individual work process performance change significantly when using public SaaS for core business processes?*

This paper is structured as follows. In the next section, we review previous research and discuss the theoretical foundation of this study. In section three, we derive our research model and the related hypotheses. In section four, we delineate our research methodology followed by the results of the data investigation. The subsequent discussion section highlights the important findings before we summarize the implications and limitations of this study. Finally, we conclude the paper in section six.

2 Theoretical Foundation

2.1 Previous research

At the outset of this study, we conducted a systematic literature review (Webster and Watson, 2002) by searching the databases of the top 30 IS journals according to the AIS journal ranking list, the proceedings of major IS conferences (ICIS and ECIS) as well as the Digital Libraries of ACM and IEEE for relevant extant research. We used the following search terms for the article title and article abstract: (cloud OR saas OR outsourc*) AND (organization* OR social OR employ*). As a result of, we found that even though the papers describe the three CC service types, they tend to analyze and discuss CC on the overriding level and miss conclusions for the specific CC types. Nevertheless, we identified two broad fields of research that are relevant to the present study. The ***first field*** focuses the overall business impact of CC on company´s internal organizational processes, whereby the social perspective represents just a slice of the cake. Within this field, we found 28 papers, whose publication years range from 2008 until 2014. The ***second field*** targets the interrelation between various more matured information systems and IT organizational fits, especially by the means of IT capabilities and IT knowledge. Thus, the latter field starts at an even earlier stage and covers a broader spectrum.

While analyzing research in the first field, we found that the majority of papers put special emphasis on the CC advantages when discussing the impacts on employees of cloud-using organizations. For instance, Marston et al. (2011) and Leimeister et al. (2010) underline the potential interoperability between employees of diverse functions. Furthermore, end users are able to make full use of the company´s information systems when also using less powerful devices like smartphones or tablets. This is confirmed by Polyviou et al. (2014), who write that portability is the most important implementation factor directly after cost advantages. Further, researchers argue that the end users´ job performance increases by being less dependent on in-house IT staff and having a higher ease of use (Gupta et al., 2013; Meer et al., 2012). When particularly focusing on internal IT employees, the statements become noticeably more differentiated. Here, the authors see strategic issues not only because CC usage is linked to large changes in the corporate IT structure and resulting in a host of intra-organizational challenges. Morgan and Conboy (2013) used the technological-organizational-environmental framework as a theoretical base for analyzing three case companies. Within the organizational sphere, they found that IT managers´ “fear of losing control” over their IT environment represents a major factor in the decision whether or not to use CC. Further, there is an implicit anxiety that IT employees´ jobs are getting obsolete. They conclude that adjusting skills and capabilities to suit the cloud landscape is essential. The arising challenges towards the IT employees’ qualifications are also largely discussed by Janssen and Joha (2011). Interestingly, though, Lee et al. (2013) found that social factors like IT qualification and culture were most likely to hinder CC adoption in South Korea, even more than risk concerns. However, the studies by Malladi and Krishnan (2012), Alshamaila and Papagiannidis (2013), and Low et al., (2011) indicate that there is no significant influence of CC adoption on IT employees´ perceptions. Hence, as can be derived from the stated papers, it is important to differentiate between the CC effects of diverse stakeholders as the preconditions are fundamentally different.

The second field focuses impacts of more matured IT systems on organizational transformation and business performance. Hong and Kim (2002) noticed a remarkably high failure when implementing enterprise resource planning (ERP) systems during the 1990s. Their study explores the root of the high failure rate from an “organizational fit of ERP” view. The origin of the issue goes back to the fact that companies shifted from in-house developed software to purchased applications often without the necessary adjustments in internal IT departments. The importance of social and technical alignment was emphasized by the studies of Sykes et al. (2014), Bala (2013), Wang (2010), Wang et al. (2006), and Lee et al. (2004) as well. In contrast, Brynjolfsson et al. (2000) focus on correlations between use of information technology and the needed extent of organizational change. They state that the correlations of both these factors and measures of the economic performance are not sufficient to prove that these factors are complements. Sabherwal et al. (2006) empirically tested the influence of the individual determinants on the success of information systems by means of a meta-analysis from 121 studies between 1980 and 2004. Their results underline the importance of user-related and contextual attributes for IT success. Surprisingly, in this study, user attitude has an extreme high influence on system quality. Ho et al. (2003) investigate “spin-offs” (due to IT changes), a procedure for outsourcing complete internal IT departments (including employees, systems, and operations) to separate external entities. Hence, internal IT employees change their role to external contractors. Findings of the survey show that the presence of strong ties between IT manager and contractor and the lack of prior outsourcing experience increase the persistence of managerial expectations. Even if “spin-offs” constitute an extreme form of transformation, the second research field indicates that the need for social and technical alignment was underestimated in the near past, when implementing new IT systems.

2.2 Socio-technical systems theory

This study is grounded on the STS theory (Rousseau, 1977), which is recognized as one of the most influential theories in explaining and analyzing a wide range of organizational behaviors across a variety of IT enabled changes (Venkatesh et al., 2010). A STS is any construct in an organization consisting of two interrelated subsystems that have independent origins but one conjointly goal to manage – the social subsystems (people and social structures) on the one hand and the technical subsystem (techniques and task) on the other (Venkatesh et al., 2010; Rousseau, 1977). The basic idea of STS theory posits that the social and technical subsystems recursively interact with each other to complete a joint optimization or a bilateral alignment – a state of system equilibrium that involves stable interrelationships within and across the components of these two subsystems (Lyytinen and Newman, 2008; Rousseau, 1977). Such a joint optimization is required for increasing business performance, reducing unintended deviation, and accomplishing general socio-technical system goals (Bostrom and Heinen, 1977; Rousseau, 1977). In aspects of this paper, a specific thesis of STS theory is especially important. The theory propagates that if there is an internal or external change in the arrangement of one of the subsystems, there will be instability in the overall system. This may lead to a high level of individual negativity towards the system. Therefore, individual perceptions and anxieties should be considered whenever changes are made in subsystems (Holman et al., 2005). Out of the vast amount of research using STS theory, the studies by Venkatesh et al. (2010) and Bala (2013) are especially relevant to our paper. These studies investigate organizational behavior on individual level or micro level by analyzing perceived changes during IT implementations. And both studies find STS theory particularly suitable for understanding the IT influences on work life balance and job outcomes.

Following Marston et al. (2011), we assume organizational misalignments and/or instabilities to occur in the STS equilibrium immediately after public SaaS and associated IT processes have been adopted for a company's core business processes. Even though the company expects overall long-term benefits related to the SaaS adoption (e.g., financials, firm performance), a considerable amount of time and effort is required for the social subsystem to react accordingly to the technical changes and vice versa. Given that the focus of this study is to understand how especially IT employees react on the trend on SaaS usage, we adopt STS theory for our study. While STS theory may be applied to virtually any behavior, it is plausible to expect that STS also provides an appropriate framework to explain an IT employee's behavior on SaaS. And although the hypotheses have their roots in that historical theory, we involve the latest theoretical and empirical research on SaaS that is relevant to our context. We believe STS to specifically provide our study with an adequate theoretical lens for the following reasons.

First, STS captures information about technical influences and social behavioral factors. These factors are deemed important in this study as we set out to explain IT employees´ individual perceptions in the organizational context, in which perception and behavior are likely to be influenced by already adopted SaaS as well as by the company's general intention to make increased use of SaaS. This calls for the need to consider IT employees´ perceptions and thus for the application of the STS theory as a general framework. Second, while still adhering to the STS theory, we follow Rousseau (1977) whose findings allows us to analyze the STS belief constructs individually to provide a deeper understanding about specific underlying factors that influence an IT employee's perception of changes due to SaaS. Therefore, we incorporate additional constructs into the model. The third reason why the application of STS is a suitable approach is that it aids us to predict and understand an employee's perceptions on SaaS adoption. According to Venkatesh et al., (2010), each belief construct reveals a different aspect of the behavior which can serve as a point of effect in an effort to change it. Researchers argue that before enacting interventions to organizational changes, it is crucial to understand which organizational elements are influenced by SaaS usage (Polyviou et. al., 2014; Leimeister et al., 2010). Thus, adopting STS eventually supports us in our intention to formulate managerial recommendations that address salient beliefs and thus facilitate IT departments to act in accordance with corporate objectives.

2.3 Research model and hypothesis

In this section, we derive the research model that aims to explain IT employees' perceptions on changes resulting from SaaS adoptions. Herein, we explicitly consider public SaaS. We separate the four major STS constructs organizational structure, people, tasks, and technology (Venkatesh et al., 2010) and deduce important antecedents based on extant research. Subsequently, we further elaborate our model by including a conceptualization of all relevant constructs. Starting with the technical sub-system, companies hope to gain a lot from public SaaS. The expected benefits include in particular cost advantages, efficient cross-company coordination, process performance increases, and higher process flexibility (Bharadwaj et al. 2013; Wind et al., 2012). Some researchers argue that public SaaS will bring new, and as yet unknown, innovation to adopting companies (McAfee, 2011; Marston et al., 2011). And even security might be a reason to move towards the cloud, especially when companies suffer from low security levels and hope to increase their IT security standards in this way (e.g., Cho and Chan 2013; Li et al. 2012). Therefore, the reasons for SaaS implementations are manifold and cannot be generalized. However, this study does not focus on macro-level cognitions and intentions but on individual-level. Previous studies have yielded important theoretical foundations regarding the influences on employees´ intentions to use various technologies (especially in the context of technology acceptance, e.g., Rogers, 2003). At the organizational-level of the analysis, the independent variable reflecting the increased usage (from the view point of the IT employee) is operationalized as the ***company´s increasing SaaS usage (CISU) for core business processes***. Public SaaS solutions are available for various applications, ranging from simple supporting services to comprehensive services that support a company´s core processes. As we assume that internal IT departments that adopt public SaaS for core processes face even bigger changes and challenges, also the forthcoming constructs and relations are all the more valid than in the cases in which SaaS is used for supporting processes only. Regarding the perceived technical change, we would like to aggregate this to three main topics that we derived from literature: IT security, IT architecture, and interfaces.

Almost all papers that discuss CC threats and technical challenges argue that security tasks change dramatically (e.g., Martson et al., 2011; Cegielski et al., 2012; Benlian et al., 2010). Working with CC providers who operate globally distributed networks of datacenters, the cloud service may face specific security risks (i.e. terrorism or cyber-attack) and may also present unique legal issues regarding liability for security infringement (Marston et al., 2011; Brender and Markov, 2013). Internal IT security knowledge is needed to evaluate these risks and advise internal process owners accordingly. The security changes associated with any offsite hosting of data and services (i.e. outsourcing or cloud) include the determination of who has access to customer data, denial of service attack prevention, perimeter security policy, resource starvation, data backup, and compliance. This leads us to the variable ***perceived IT security changes (PISC)*** caused by SaaS adoption. Furthermore, transparent and clear interface configurations between internal systems and the provider are highly relevant and needed for an ease of data exchange. Unfortunately, this topic is not discussed largely in literature up to now. The SaaS provider makes his service available through a standard interface. Customer-specific configurations can only be made at the meta-data layer on top of the common code using interfaces provided by the vendor (Benlian et al., 2010). This operational topic may get even more complicated when customized cross-company SaaS is used. It is through the interfaces with the external environment that organizations expose themselves to the associated technical uncertainty (Cegielski et al., 2012), which leads us to the variable ***perceived interface configuration changes (PICC)***. And finally, it is important to access services and systems across platforms and infrastructures that interact smoothly with each other (beyond operational interface configuration). Hence, in order to be in a position to exchange data, have seamless access across physical locations, provide multiple entry points for users, and support a wide variety of data types, a suitable IT landscape is needed (Malladi and Krishnan, 2012; Venters and Whitley, 2012). This aspect is operationalized as ***perceived IT architecture changes (PIAC)***. However, with an increasing rate of SaaS changes and SaaS usage, all three factors will even more intensify the dependent variable ***perceived technical change radicalness (PTCR)***, a representative for an individual´s ability to understand and predict the relevant steps in specific core work processes. Herein, radicalness constitutes the degree of novelty, lack of experience, or departure from existing knowledge and practices (Aiman-Smith and Green, 2002). Thus, we hypothesize:

- H1: *The higher the perceived task changes in (a) IT security, (b) interface configurations, and (c) IT architecture due to SaaS usage, the higher will be the perceived technical change radicalness.*
- H2: *The higher the company´s increasing public SaaS usage, the higher will be (a) the perceived technical change radicalness and (b) the perceived IT organizational change.*

Building on the social aspects of STS theory, we suggest that when companies adopt SaaS and IT employees experience changes in the material aspects of their work processes (Pentland and Feldmann, 2008; Marston et al., 2011), employees will make needed adjustments to their work processes in order to achieve stability and/or a joint optimization that is necessary to cope with such changes (Lyytinen and Newman, 2008). Some internal IT employees may experience an increase in complexity of their work processes while others may feel a decrease compared to the pre-implementation assessment of work process complexity (Bala, 2013). Traditional STS-theory postulates that with the adoption of new IT, the skill variety will be enlarged. In particular, the scope of a job increases through extending the range of job duties, the responsibilities, and the employee-task relationship (Steers and Porter, 1991; Venkatesh et al., 2010). Considering SaaS, these traditional cognitions are only partly valid since some tasks will be enlarged (e.g., provider management, IT security management) while other tasks will be transferred to the CC provider (e.g., server administration). Being more specific, we follow Bala (2013) by stating that complexity will change in terms of "component complexity". That is, an IT employee involved in SaaS implementation and operation may experience an increasing number of distinct elements or components (e.g., activities, information and resource requirements) related to his or her work processes that he or she needs to handle. As the amount of components increases in an IT employee's daily work processes, the knowledge and skill requirements for carrying out these work processes also increase, which potentially leads to information overload and task conflicts (Wang, 2010; Campbell, 1988; Wood, 1986). Further, changes in different components of work processes can thus create a shift in the knowledge or skills required for execution (Wood, 1986). This misalignment in the socio-technical state has to be addressed accordingly within the IT organization. Finding the correct level of adjustment is particularly problematic during the early stages of SaaS implementation when community know-how is limited (Wang and Ramiller, 2009). We consider the component complexity aspects with the variable ***perceived IT organizational change (PIOC)*** and thus hypothesize:

- H3: *The higher the perceived technical change radicalness caused by the public SaaS implementation, the higher will be the influences on the perceived IT organizational change of the company.*

Finally, from our point of view, the alignment between the social and the technical subsystem can be measured by two dependent variables: ***perceived individual job outcomes (PIJO)*** and ***perceived individual process performance (PIPP)***. In aspects of *perceived job outcomes***,** we suggest that perceived technical and organizational changes will influence individual´s outcomes following the adoption of SaaS. In the organizational domain change literature, there is common sense that employees are primarily concerned with the impact of an organizational change on themselves and their work (e.g., Lau and Woodman, 1995; Rafferty and Griffin, 2006; Bala, 2013). An increasingly complex work process is difficult to execute because of increased components, conflicting interdependencies among the components, uncertainties associated with the components, and the lack of understanding (e.g., knowledge and skills) of the components (Blecker and Kersten, 2006). Within our research model (cf. Fig. 1), we investigate individuals´ *perceived job outcomes* by considering the following soft facts as items (e.g., Sykes, 2014; Venkatesh et al., 2010): job satisfaction, job acceptance, and job significance. If IT employees perceive a radical change in their work processes, it is likely to affect their job outcomes. As noted earlier, a radically different work process entails a new and/or different set of task and/or different information and resources. Some IT employees may find it difficult to include and act upon this radically different configuration of material aspects of their work processes. Existing literature and STS theory have found out that employees like to preserve the status quo in their work and create robust, deep process and structures (e.g., habits; Gersick, 1991). When there are changes inflicted on their habits, it is more probably that their individual job performance will be impacted as they attempt to cope with these changes (Beaudry and Pinsonneault, 2005). Moreover, radically changed tasks and structures are likely to evoke negative affective reactions among IT employees because they have to deviate from their prior routines, habits, and relationships that were substantiated over time and are a source of their success (Bala, 2013). In addition to influencing IT employees' job outcomes, we suggest that changes (increases or decreases) in perceived process complexity will influence employees' *perceptions of individual job process performance*. Drawing on the conceptualization of business process performance at the macro level (e.g., Nyaga et al., 2010), we follow Bala (2013) by defining process performance as the extent to which an employee believes that he or she is able to execute his or her work processes effectively and efficiently. Although it is a subjective evaluation, we assume that it is critical to understand if specific changes in work process will impact IT employees' self-assessment of the effectiveness and efficiency of process performance. When internal IT employees perceive that they are not able to execute their tasks effectively and efficiently, it is more likely that the SaaS adoption will not be advantageous to an organization. Thus, we hypothesize:

- H4: *The higher the perceived technical change radicalness caused by SaaS adoptions, the higher will be the negative influence on (a) perceived job outcomes and (b) perceived process performance.*
- H5: *The higher the perceived IT organizational change caused by SaaS adoptions, the higher will be the negative influence on (a) perceived job outcomes and (b) perceived process performance.*

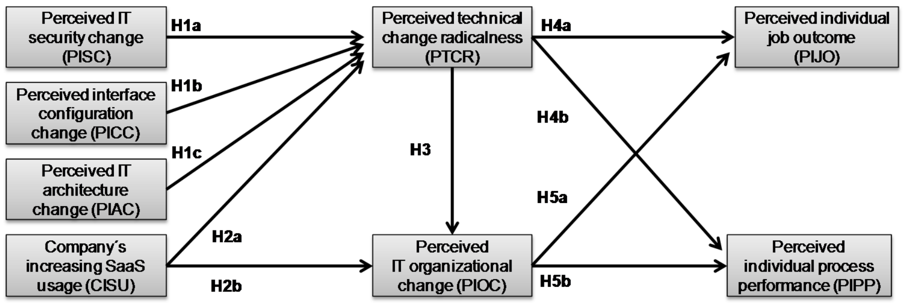


Figure 2. Research model

3 Research Methodology

3.1 Item development and pretesting

In an effort to test our research model in a quantitative manner that allows to statistically generalize the outcomes, we carried out a cross-sectional survey (Pinsonneault and Kraemer, 1993). The paper´s underlying measurement and analysis methods are described subsequently. In order to create suitable measurement items for this research, we first reviewed extant theoretical and empirical literature. Where feasible, we adopted measurement items of the constructs based on existing research and modified these to make them appropriate for our context. All constructs in the determined model are operationalized as reflective constructs following the proposed decision criteria presented by Jarvis et al. (2003) and Petter et al. (2007). The constructs were measured with multiple items on five-point Likert scales. We asked not only for dependent and independent variables, but also for control variables. We created an online questionnaire which was tested in two rounds of personal interviews with four different research colleagues at our institution. During the first round of interviews, we presented and discussed all initial measurement items with the interviewees. Based on the feedback that we received, several items were revised and simplified (MacKenzie et al., 2011). After the first round revisions, we again asked our colleagues for a second feedback. As a consequence, we revised some wordings to clarify ambiguous items and further enhanced the sequence of the questions which were purposefully randomized (Straub et al., 2004). (cf. appendix for details on single constructs).

3.2 Data collection

To test the proposed research model, we administered an online questionnaire and used two professional network platforms (xing.com and linkedin.com) to contact our target respondents directly. The data collection took place between April and August 2014. We especially searched for IT professionals who have at least two years of experience with SaaS implementations at using companies in German speaking countries (Germany, Austria, Swiss). Hence, we excluded IT professionals from SaaS providers, since the research model does not suit their individual job situation. Further, in the survey, we asked for SaaS usage in core business processes only, as we assume them to be more complex and more important not only for the company but also for the IT departments. Knowing that the differentiation between a core business process and a non-core process is difficult, we left it up to the subjective determination of the IT experts. Furthermore, we kindly asked to consider only the deployment type "public" SaaS, as the other services (private, hybrid, community) show a lower degree of outsourcing and hence involve smaller organizational changes. Due to these strong searching restrictions, we only received 102 completed questionnaires from IT professionals. Initially, 21 of the respondents had to be excluded from our sample as they were not well experienced in SaaS usage in their workplace (less than two year SaaS experience) although their profile indicated this. Additionally, we excluded another 15 from the remaining 81 respondents during data screening (Marcoulides and Saunders, 2006), because of unreliable responses (i.e., answering all questions with 5). Eventually, a sample of 66 usable and completed questionnaires was used in the data analysis, which corresponds to an actual response rate of 22.0 percent. Thus, with 66 usable questionnaires, we met the often applied rule of thumb which determines a minimum necessary sample size for PLS analysis, i.e., ten times the largest number of independent latent variables impacting a particular dependent variable in the inner path model (Chin 1998). A Monte Carlo simulation performed by Chin and Newsted (1999) indicated that PLS can adequately be performed with a sample size as low as 50. Moreover, a possible nonresponse bias was addressed by adopting the approach recommended by Armstrong and Overton (1977). We conducted the non-parametric Mann-Whitney U-Test (Mann and Whitney, 1947) to test for differences between the first third and the last third of the respondents' data. The test revealed no significant differences, so we concluded that non-response bias is not an issue in our study. As shown in Table 1, 63.6 percent of the 66 respondents in the final sample were male; and 34.9 percent were in the 40 to 49 age range. Further, 22.7 percent of the sampled employees hold an IT consultant role. The IT infrastructure range also contains IT network engineering. Within the "other" range, there are roles included such as IT portfolio management, IT deployment, or IT project management. Looking at the branches, the automotive industry has the highest portion. Within the “IT” range, there are several industries included, for example, the printing industry (but not cloud providers).

Gender	Male: 63.6%	Female: 36.4%						
Age	20-29: 13.6%	30-39: 27.4%	40-49: 34.9%	50-59: 21.1%	> 60: 3.0%			
Position	Professional staff: 42.4%	First line supervisor:16.7%	Chief manager: 27.3%	Others: 13.6%				
IT job	IT consulting: 22.7%	IT infrastructure: 18.1%	IT architecture: 13.6%	Software engineering: 9.1%	IT service management: 9.1%	IT security: 9.1%	IT controlling: 7.6%	Others: 10.7%
Industry sector	Automotive: 22.7%	IT: 21.2%	Mechanical engineering: 16.7%	Banking: 12.1%	Chemical: 7.6%	Consumable goods: 7.6%	Others: 12.1%	

Table 1. Profile of respondents (n=66)

4 Data Analysis

4.1 Data analysis software

The structural equation modeling (SEM) was used to test the measurement and structural models. The component-based partial least squares (PLS) procedure was chosen and used for both the assessment of the measurement scales and the test of the research hypotheses. We decided to apply the PLS approach, instead of other SEM procedures, such as LISREL, because our response data do not follow a normal distribution which is not necessarily needed when applying PLS (Chin, 1998). For assessing the distribution of our construct indicators, we carried out the Kolmogorov-Smirnov test as well as the Shapiro-Wilk test. Further, compared with covariance-based SEM, PLS addresses the prediction of data and is basically more suitable for the explanation of complex relationships and considered robust to relatively small sample sizes (Chin et al., 2003; Fornell and Bookstein, 1982). To assess our model, we used the software application SmartPLS version 2.0.M3 (www.smartpls.com) for data analysis and closely followed the approaches given by MacKenzie et al. (2011) and Burda and Teuteberg (2013).

4.2 Measurement model assessment

First, we evaluated the individual item reliability and convergent validity of the defined constructs. Toward this end, we investigated the factor loadings of the individual items on their hypothesized constructs and the average variance extracted (AVE). All of the measurement items exhibit loadings that are significant at the 0.01 level on the hypothesized constructs and exceed the recommended minimum value of 0.707. Further, all AVE values are above the accepted minimum of 0.50, which indicates that the latent construct accounts for a minimum of 50 percent of the variance in the items. Thus, both conducted tests indicate an adequate degree of validity (Chin, 1998). In a second step, we assessed the discriminant validity of the defined constructs by comparing the square root of the AVE of each construct with all other inter-construct correlations. The results indicate that the measurement model shows sufficient discriminant validity. Here, the square root of the AVE for each of the constructs is greater than all other inter-construct correlations (Fornell and Larcker, 1981). Following the procedures by Gefen and Straub (2005), we also analyzed the cross loadings of the individual items. The test yielded that each item loading accounts for a minimum of 0.731 on the assigned target construct and is always smaller on other constructs which indicates adequate convergent and discriminant validity. Thirdly, we investigated the internal consistency and scale reliability by calculating the composite reliability (CR) and Cronbach's alpha (CA) values (cf. Table 2). The CR values for all of the constructs in our model are larger than 0.85 while the CA values are ranging from 0.73 to 0.85. This indicates a satisfactory reliability for both criteria since all values are above the generally accepted minimum thresholds of 0.6 or 0.7 respectively (Bagozzi and Yi, 1988; Gefen et al., 2000). Table 2 presents the outcomes of our assessment (cf. appendix for more details on the measurement model assessment).

	AVE	CR	CA	PIJO	PIPP	PTCR	PIOC	PISC	PICC	PIAC	CISU
PIJO	0.75	0.90	0.83	0.86							
PIPP	0.77	0.91	0.85	0.53	0.88						
PTCR	0.72	0.89	0.81	0.65	0.34	0.85					
PIOC	0.59	0.85	0.77	0.62	0.40	0.64	0.77				
PISC	0.66	0.85	0.74	0.69	0.43	0.76	0.68	0.81			
PICC	0.64	0.85	0.75	0.48	0.32	0.40	0.33	0.45	0.80		
PIAC	0.65	0.85	0.73	0.49	0.42	0.51	0.48	0.56	0.68	0.81	
CISU	0.65	0.88	0.82	0.53	0.36	0.62	0.58	0.64	0.29	0.35	0.80
AVE: Average variance extracted, CR: Composite reliability, CA: Cronbach's alpha, Shaded cells: Square root of AVE											

Table 2. AVE, reliabilities and latent variable correlations

4.3 Structural model assessment

As already mentioned, the structural model was estimated with the PLS approach. To test the significance of our loadings and coefficients, we conducted the bootstrapping re-sampling technique with 66 cases and 5,000 samples (Hair et al., 2013). In Figure 2, the estimates obtained by means of the PLS analysis are depicted, including standardized path coefficients, significance of the paths, and the amount of variance explained (R^2). Considering the R^2

values, Figure 2 shows that the determined model accounts for 49.2 percent of the variance in job outcome, 17.1 percent of the variance in process performance, 62.2 percent of the variance in perceived technical change, and 46.4 percent of the variance in perceived organizational change. The profiles of the respondents served as control variables: summed up, they account for an additional 2.9 percent in perceived job outcome and 0.9 percent in perceived process performance. Nevertheless, none of the path coefficients of our control variables on job outcome and process performance are significant. This is why we performed an additional analysis to examine the significance of the increase in R^2. Therefore, we first computed the effect size (f^2) of the control variables in accordance with Chin et al. (2003). Secondly, we conducted a pseudo F-test by multiplying the effect size by (n – k – 1). Herewith, n is the sample size and k is the number of independent variables of the full model, i.e., including the five control variables (Mathieson et al., 2001). For job outcome and process performance, we calculated effect sizes of 0.07 and 0.06, which again implies only weak effects with an insignificant change in R^2 ($F = 0.95$, $p > 0.05$).

Acknowledging the significant path coefficients in Figure 2, Chin (1998) concedes a range of above 0.2 to be significant. This condition is not fulfilled by three paths (PICC>>PTCR, PIAC>>PTCR, PTCR>>PIPP). While the sizes of two of these paths coefficients show small but significant effects, we again conducted pseudo F-tests to examine whether the increase in the variance explained in PTCR and PIPP is significantly influenced by PIAC and PTCR, respectively. The test shows a little but significant effect size of 0.04 ($F = 4.19$, $p < 0.05$) for the path PIAC>>PTCR and no significant effect size for PTCR>>PIPP. Furthermore, we conducted a mediation test to determine whether PIOC mediates the PTCR. In line with Baron and Kenny (1986), mediation is given when the paths PTCR>>PIOC and PIOC>>PIPP are controlled, a previously significant relation between the independent (PTCR) and dependent variable (PIPP) is no longer significant. A full mediation would occur when the direct path PTCR>>PIPP is zero. With regards to Baron and Kenny (1986), our analysis indicates that the influence of *perceived technical change radicalness* on *perceived individual process performance* is partly mediated by *perceived IT organizational change*. However, hypothesis H4b and H1b (marked with "n.s." in Fig. 2) are not supported, whereas the remaining hypotheses are supported.

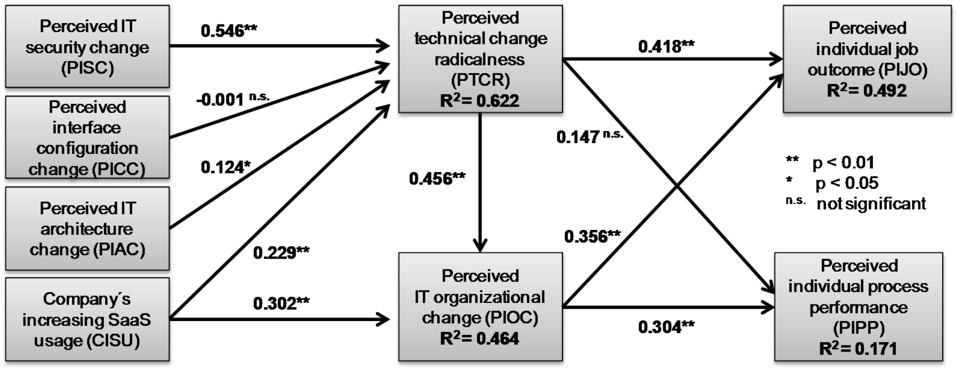


Figure 2. Results of the research model

5 Discussion

5.1 Summarization and interpretation of the results

This work makes several valuable contributions by empirically accomplishing two major objectives that have been derived from the research questions: 1) we examined the influence of the perceived technical task changes *(security, interfaces, architecture)* and *the company´s increasing SaaS usage* on *perceived technical change radicalness* and *perceived IT organizational changes*;
and 2) we examined the overall impact of these changes on individual IT employees´ *perceptions of job outcomes* and *work process performance*. We developed a model consisting of eight constructs, that postulates that the higher the degree in *perceived security changes*, *IT architecture changes*, and the *company´s increasing SaaS usage*, the higher will be the *perceived technical change radicalness* in aspects of SaaS. Not surprisingly though, the *perceived IT organizational change* seems to be a lagging effect on *perceived technical change radicalness* with the second highest significance path coefficient in the model. These changes constitute an overall appraisal for the degree of perceived socio-technical change, as a mechanism through which especially the *perceived individual job outcomes* are affected negatively. Further, with an increasing level of perceived organizational changes through SaaS, IT employees experienced their *perceived individual process performance*, a subjective construct as well, to be decreasing. But this construct has the lowest R^2, which indicates that other factors, such as “perceived usefulness”, might have an even more significant influence on the job performance. However, consistent with the STS theory and our research model, we find that public SaaS usage in core processes influences the social subsystem significantly in a negative sense. Overall, we receive good support for our theoretical model that is based on data collected from 66 IT experts.

5.2 Implications

This study makes three major contributions. First, it contributes to IT business process change literature. We found that while companies establish changes to the technical subsystems by introducing SaaS solutions and related business processes (cf. constructs CISU, PISC, and PIAC in Figure 2), internal ***IT employees may not always internalize these changes*** immediately (cf. constructs PTCR and PIOC in Figure 2). This may involve lower motivation, learning difficulties, as well as overall perceived decreases in efficiency and effectiveness. These attitudes and perceptions of the employees may lead to unfavorable actions and behaviors, which in turn may hinder success performance of SaaS business processes. Further, our findings indicate that in cases where the work processes resultant from a SaaS implementation differ greatly from those prior to the SaaS solution, ***IT employees will take a longer time*** to achieve the state of joint optimization. It is likely that perceived radical changes due to SaaS (without an adequate involvement degree) can lead to an irreconcilable frustration. Hence, decision makers should involve all stakeholders in time. Although our measure of perceived organizational change is not an objective valuation of the degree in change, we found that it is a significant predictor of job outcomes and work process performance. It is probable that the initiator (e.g., end users, process owners, managers in construct CISU) of a SaaS implementation perceives the degree of radicalness as lower or ***has a less negative attitude towards SaaS*** than the related internal IT employees. Furthermore, looking through the lens of this paper, strongly fashion-driven SaaS implementations (Polyviou et al., 2014) ***are predestinated for forcing a partition*** between the IT employees and the rest of the company because of the likely missing social alignment. Thus, our recommendation for the "business process change" goes in line with Silver (1991) and Bala (2013). So, we propose to issue a joint-optimization-usage-guideline for related IT employees prior to the SaaS implementation in order to lower the perceived change radicalness. This could be enforced by the SaaS provider as well.

Second, this research contributes to the organizational change management literature. Prior research has already offered insights in factors that are relevant for successful organizational changes by discussing roles, responsibilities, management support, communications etc. (Cegielski et al., 2012; Leimeister et al., 2010; Malladi and Krishnan, 2012). Nevertheless, companies normally fail to manage organizational IT changes effectively (cf. section 2.1). Our results indicate that organizational ***changes are compellingly needed*** in cases where SaaS is used for core business processes intensively, as the new SaaS tasks differ greatly from the prior tasks (cf. PIOC in Figure 2). By the implementation of SaaS solutions, internal IT departments lose authority to some extent, and a hidden and ***reactive organizational restructuring process*** begins. This is indicated by the personal perceptions within our model and is also consistent with the founded job characteristics of Probst (2003). We found that perceived job outcomes (cf. PIJO in Figure 2), such as dissatisfaction or lower job significance, are strongly affected. Therefore, and due to the myriad of intended and hidden changes, we state SaaS implementations ***to be more challenging for companies*** than it may seem at first glance. Furthermore, our paper supports prior results in aspects of preexistent job uncertainties of internal IT employees (Morgan and Conboy, 2013). On those grounds, we recommend companies to proactively face organizational topics in order to avoid undesirable, hidden organizational reactions in the social sub-system.

Third, literature on CC argues that SaaS will bring new, and as yet unknown, innovation to adopting companies (McAfee, 2011; Marston et al., 2011). And due to the relatively low investments and the ease of testing services, the barriers inhibiting the innovation through SaaS are rather surmountable. However, in the context of our paper, thus, from the perspective of concerned, anxious IT employees, the predicted ***positive developments in the field of innovation would be unlikely*** to occur.

5.3 Limitations and future research

There are some limitations to be mentioned when interpreting the results of this paper. A key limitation of the paper is the sample, which is based on respondents' data from various regions of German speaking countries. Although the sample has a quite diverse set of data as to the respondents' characteristics, caution should be taken when these findings are to be. This is because culture has not only been found to substantially affect negative and positive perceptions, but also other important IS phenomena such as technology acceptance or decision making (Leidner and Kayworth, 2006). Hence, to be able to generalize the findings, it is necessary to conduct additional studies with different sample demographics regarding the country and geographic region. Therefore, new datasets from distinct organizations ought to be collected. This would allow detailed analyses within one organization and an elicitation of context or organizational specifics. In a next step, these findings could be compared across countries and organizations. Another limitation lies in the ***cross-sectional design*** of this study which precludes a more dynamic view for understanding an IT employee's perceptions over time. Although we based our research model on the established STS theory and a comprehensive literature review, a longitudinal design may provide a better understanding and confidence for the causes and consequences in IT employees' perceptions. As such, future research could proceed by surveying a group of individuals across time. Further, we did not differentiate between the ***various points in time*** after the implementation. Although SaaS is a specific deployment of CC, it is a quite new paradigm with strongly increasing usage rates (Van der Meulen and Rivera, 2014). Hence, up to now, almost all companies are unfamiliar with SaaS "cultures and strategies" (Marston et al., 2011). Prior research has suggested that there is a time lag before companies can benefit from new information systems (Sykes et al., 2014). Consequently, it is possible that the perceived degree in changes through SaaS and the perceived individual IT employee´s situation will go back to pre-implementation levels after a more extended period of time. Nevertheless, it is highly important to understand the occurring changes in job characteristics right after a SaaS adoption: because if companies are not able to manage the magnitude of the diversely perceived technical and social changes directly after the implementation, IT employees may take negative reactions, consistent with their perceptions (Herold et al., 2007), and may impede the increased SaaS usage in the long run. Hence, future research should investigate SaaS success in combination with IT employees´ perceptions at varying times after implementation. Further on, we distinguished between SaaS for core and non-core process only, while ***neglecting any further variations***. Towards this end, supply chain services could drive other findings than SaaS for financials. Moreover, we focused ***IT employees exclusively*** as we suggested that this organizational group is affected significantly by SaaS implementation (as indicated by our model). It would be a fruitful area for future research to investigate the expectations and perceptions of different company groups (e.g., end users, managers, IT employees) or even to include external providers. This would make insidious organizational restructuring processes more transparent and, at the end, facilitates the transfer from theory into practice. The fact that our research model exclusively investigates the ***perceived and subjective performance outcomes*** on an individual level constitutes another limitation of this paper, because the outcomes cannot necessarily be equated with the "real" and objective performance outcomes, neither of the individual IT employees, nor of the IT department.

6 Conclusion

We set out to examine the impacts of implementing SaaS on IT employees´ perceived job outcomes and work process performances. Thereby, we especially follow existing literature that states, mostly in an argumentative-deductive approach, that employees will experience significant changes in their workplace when SaaS is implemented (e.g., Marston et al., 2011). Our empirical results indicate that individual IT employees who deal with such implementations, of course experience significant changes in terms of technology and organizational processes. SaaS involves advantages such as interoperability, performance increase, or updates on-demand for both internal IT employees and the remaining stakeholders. But this paper hints at the fact that currently IT employees pay significant attention to the risks SaaS involves. Hence, management needs to understand both STS sub-systems in order to provide a profound implementation basis for sustainable SaaS usage. By means of a survey, this study empirically examines the cognitive and social factors that influence an IT employee's job perceptions from the date of the SaaS implementation. Up to now, there has been only little research regarding impacts of this kind. Moreover, the majority of papers discuss the business process changes in general terms instead of analyzing the perceptions of specific CC deployments or stakeholders. This research supports and extends recent works that examined the influence of CC on organizations (e.g., Morgan and Conboy, 2013; Lee et al., 2013; Malladi and Krishnan, 2012) as well as papers that investigate IT adoptions with the use of STS theory on an individual level (e.g., Sykes et al., 2014; Venkatesh et al., 2010). We have no doubt that a combination of both technological and socio-organizational measures is necessary for an effective SaaS integration management. Therefore, this research provides a deep understanding of IT employees' perceptions by highlighting the important factors that influence these perceptions. However, additional research is needed to generalize the findings of this study.

Acknowledgement

This work is part of the project "Sustainable Consumption of Information and Communication Technologies in the Digital Society − Dialogue and Transformation through open innovation". The project is funded by the Ministry for Science and Culture of Lower

Saxony and the Volkswagen Foundation (VolkswagenStiftung) through the "Niedersächsisches Vorab" grant programme (grant number VWZN3037).

References

Aiman-Smith, L. and Green, S. (2002). "Implementing new manufacturing technology:the related effects of technology characteristics and user learning activities." *Academy of Management Journal* 45(2), 421–430.

Alshamaila, Y., Papagiannidis, S. and Li, F. (2013). "Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework." *Journal of Enterprise Information Management* 26(3), 250–275.

Armstrong, J. and Overton, T. (1977). "Estimating Nonresponse Bias in Mail Surveys." *Journal of Marketing Research* 14, 396–402.

Bagozzi, R.P. and Yi, Y. (1988). "On the Evaluation of Structural Equation Models." *Journal of the Academy of Marketing Science* 16(1), 74–94.

Bala, H. (2013). "The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation." *Journal of Operations Management* 31(6), 450–473.

Bala, H. and Venkatesh, V. (2013). "Changes in employees' job characteristics during anenterprise system implementation: a latent growth modeling perspective." *Management Information Systems Quarterly* 37(4), 1113–1140.

Bardhan, I. R., Demirkan, H., Kannan, P. K., Kauffman, R. J. and Sougstad, R. (2010). "An interdisciplinary perspective on IT services management and service science." *Journal of Management Information Systems* 26(4), 13–64.

Baron, R. and Kenny, D. (1986). "The Moderator–Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations." *Journal of Personality and Social Psychology* 51(6), 1173–1182.

Beaudry, A. And Pinsonneault, A. (2005). "Understanding user responses to information technology: a coping model of user adaptation." *Management Information Systems Quarterly* 29(3), 493–525.

Benlian, A., Koufaris, M. and Hess, T. (2010). “The role of SaaS service quality for continued SaaS use: Empirical insights from SaaS using firms.” In: *Proceedings of the 31st International Conference on Information Systems*, Saint Louis, Missouri, USA.

Blecker, T., Kersten, W., (2006). *Complexity Management in Supply Chains: Concepts, Tools and Methods*. Erich Schmidt Verlag, Berlin.

Bharadwaj, A., El-Sawy, O.A., Pavlou, P.A. and Venkatraman, N. (2013). “Digital Business Strategy: Toward a Next Generation of Insights.” *Management Information Systems Quarterly* 37(2), 471–482.

Bostrom, R. and Heinen, J. S. (1977). “MIS problems and failures: a sociotechnical perspective.” *Management information Systems Quarterly* 1(3), 17–32.

Boudreau, M. and Robey, D. (2005). “Enacting integrated information technology:A human agency perspective.” *Organisation Science* 16(1), 3–18.

Brender, N. and Markov, I. (2013). “Risk perception and risk management in cloud computing: Results from a case study of Swiss companies.” *International Journal of Information Management* 33(5), 726–733.

Brynjolfsson, E. and Hitt, L. (2000). “Beyond computation: Information technology, organizational transformation and business performance.” *The Journal of Economic Perspectives* 14(4), 23–48.

Burda, D. and Teuteberg, F. (2013). “Towards understanding employee´s retention behavior: antecedents and implications for e-mail governance.” In: *Proceedings of the 34th International Conference on Information Systems*, Milan, Italy.

Campbell, D. J. (1988). “Task complexity: a review and analysis.” *Academy of Management Review* 13(1), 40–52.

Cegielski, C., Jones-Farmer, L., Wu, Y. and Hazen, B. (2012). “Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach.” *The International Journal of Logistics Management* 23(2), 184–211.

Chin, W. (1998). “The Partial Least Squares Approach to Structural Equation Modeling.” In: Marcoulides, G. (ed). *Modern Methods for Business Research*. Mahwah, NJ, US: Lawrence Erlbaum Associates, 295–336.

Chin, W., Marcolin, B. and Newsted, P. (2003). “A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from a Monte Carlo Simulation Study and an Electronic-Mail Emotion/Adoption Study.” *Information Systems Research* 14(2), 189–217.

Chin, W. and Newsted, P. R. (1999). “Structural Equation Modeling Analysis with Small Samples Using Partial Least Squares,” In: Rick Hoyle (ed.). *Statistical Strategies for Small Sample Research.* Thousand Oaks, CA, USA, 307–341.

Cho, V. and Chan, A. (2013). “An integrative framework of comparing SaaS adoption for core and non-core business operations: An empirical study on Hong Kong industries”. *Information Systems Frontiers,* published online.

Fornell, C. and Bookstein, F. L. (1982). “Two Structural Equation Models: LISREL and PLS Applied to Consumer Exit-Voice Theory.” *Journal of Marketing Research* (XIX), 440–452.

Fornell, C. and Larcker, D. (1981). “Evaluating Structural Equation Models with Unobservable Variables and Measurement Error.” *Journal of Marketing Research* (XVII), 39–50.

Gefen, D. and Straub, D. (2005). “A Practical Guide To Factorial Validity Using PLS-Graph: Tutorial And Annotated Example.” *Communications of the Association for Information Systems* 16(1), Article 5.

Gefen, D., Straub, D. and Boudreau, M. (2000). “Structural Equation Modeling and Regression: Guidelines for Research Practice.” *Communications of the Association for Information Systems* 4(1), Article 7.

Gersick, C. J. G. (1991). “Revolutionary change theories: a multilevel exploration of the punctuated equilibrium paradigm.” *Academy of Management Review* 16(1), 10–36.

Gupta, P., Seetharaman, A. and Raj, J. (2013). “The usage and adoption of cloud computing by small and medium businesses.” *Int. Journal of Information Management* 33(5), 861–874.

Hair, J. F., Hult, G. T. M., Ringle, C. M. and Sarstedt, M. (2013). *A Primer on Partial Least Squares Structural Equation Modeling (Pls-Sem).* Sage Publications.

Herold, D. M., Fedor, D. B. and Caldwell, S. D. (2007). "Beyond change management: amultilevel investigation of contextual and personal influences on employees'commitment to change." *Journal of Applied Psychology* 92 (4), 942–951.

Ho, V., Ang, S. and Straub, D. (2003). "When subordinates become IT contractors: Persistent managerial expectations in IT outsourcing." *Information Systems Research* 14(1), 66–86.

Hoberg, P., Wollersheim, J. and Krcmar, H. (2012). "The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing." In: *Proceedings of the 18th American Conference on Information Systems*, Seattle, Washington (2012).

Holman, D., Wood, S., Wall, T. and Howard, A. (2005). "Introduction to the essentials ofthe new workplace." In: Holman, D., Wall, T. D., Clegg, C. W., Sparrow, P. and Howard, A. (eds.). *The Essentials of the New Workplace: A Guide to the Human Impact of Modern Working Practices*. ii–xi. John Wiley and Sons, New York, USA.

Hong, K. and Kim, Y. (2002). "The critical success factors for ERP implementation: an organizational fit perspective." *Information and Management* 40(1), 25–40.

Janssen, M. and Joha, A. (2011). "Challenges for adopting cloud-based software as a service (saas) in the public sector". In: *Proceedings of the 19th European Conference on Information Systems*, Helsinki, Finland.

Jarvis, C. B., MacKenzie, S. B., and Podsakoff, P. M. (2003). "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research." *Journal of Consumer Research* 30(2), 199–218.

Lau, C. and Woodman, R. W. (1995). "Understanding organizational change: a schematic perspective." *Academy of Management Journal* 38(2), 537–554.

Lee, J., Miranda, S. and Kim, Y. (2004). "IT outsourcing strategies: Universalistic, contingency, and configurational explanations of success". *Information Systems Research* 15(2), 110–131.

Lee, S., Chae, S. and Cho, K. (2013). "Drivers and inhibitors of SaaS adoption in Korea." *International Journal of Information Management* 33(3), 429–440.

Leidner, D. E. and Kayworth, T. (2006). “Review: a review of culture in information systems research: toward a theory of information technology culture conflict.” *Management Information Systems Quarterly* 30(2), 357–399.

Leimeister, S., Boehm, M., Riedl, C. and Krcmar, H. (2010). “The Business Perspective of Cloud Computing: Actors, Roles and Value Networks.” In: *Proceedings of the 18th European Conference on Information Systems*, Pretoria, South Africa (2010).

Li, S., Xu, L., Wang, X. and Wang, J. (2012). “Integration of hybrid wireless networks in cloud services oriented enterprise information systems.” *Enterprise Information Systems* 6(2), 165–187.

Loske, A., Widjaja, T., Benlian, A. and Buxmann, P. (2014). “Perceived IT security risks in cloud adoption: the role of perceptual incongruence between users and providers.” In: *Proceedings of the 22nd European Conference on Information Systems*, Tel Aviv, Israel.

Low, C., Chen, Y. and Wu, M. (2011). “Understanding the determinants of cloud computing adoption.” *Industrial management & data systems* 111(7), 1006–1023.

Lyytinen, K. and Newman, M. (2008). “Explaining information systems change: a punctuated sociotechnical change model.” *European Journal of Information Systems* 17(6), 589–613.

MacKenzie, S., Podsakoff, P. and Podsakoff, N. (2011). “Construct Measurement and Validation Procedures in MIS and Behavioral Research: Integrating New and Existing Techniques.” *Management Information Systems Quarterly* 35(2), 293–334.

Malladi, S. and Krishnan, M. S. (2012). “Cloud Computing Adoption and its Implications for CIO Strategic Focus–An Empirical Analysis.” In: *Proceedings of the 33rd international conference on information systems*, Orlando, USA.

Mann, H. and Whitney, D. (1947). “On a Test of Whether One of Two Random Variables is Stochastically Larger Than the Other.” *The Annals of Mathematical Statistics* 18(1), 50–60.

Marcoulides, G. A. and Saunders, C. (2006). “PLS: A Silver Bullet?.” *Management Information Systems Quarterly* 30(2), iii-ix.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011). “Cloud computing - The business perspective.” *Decision Support Systems* 51(1), 176–189.

Mathieson, K., Peacock, E., and Chin, W. (2001). “Extending the Technology Acceptance Model: The Influence of Perceived User Resources.” *ACM SIGMIS Database* 32(3), 86–112.

McAfee, A. (2011). “What every CEO needs to know about the cloud.” *Harvard Business Review* 89(11), 124–132.

Mell, P. and Grance, T. (2011). *The NIST definition of cloud computing*. URL: http://pre-developer.att.com/home/learn/enablingtechnologies/The_NIST_Definition_of_Cloud_Computing.pdf (visited 15.10.2014).

Meer, D., Dutta, K. and Datta, A. (2012). “A cost-based database request distribution technique for online E-commerce applications.” *Management Information Systems Quarterly* 36(2), 479–507.

Morgan, L. and Conboy, K. (2013). “Factors affecting the adoption of cloud computing: an exploratory study.” In: *Proceedings of the 21st European Conference on Information Systems*, Utrecht, Netherlands.

Nyaga, G. N., Whipple, J. and Lynch, D., (2010). “Examining supply chain relationships: do buyer and supplier perspectives on collaborative relationships differ?.” *Journal of Operations Management* 28 (2), 101–114.

Pentland, B. T. and Feldman, M. S. (2008). “Designing routines: on the folly of designing artifacts, while hoping for patterns of action.” *Information and Organization* 18(4), 235–250.

Petter, S., Straub, D. and Rai, A. (2007). “Specifying Formative Constructs in Information Systems Research.” *Management Information Systems Quarterly* 31(4), 623–656.

Pinsonneault, A., and Kraemer, K. L. (1993). “Survey Research Methodology in Management Information Systems: An Assessment.” *Journal of Management Information Systems* 10(2), 75–105.

Polyviou, A., Pouloudi, N. and Pramatari, K. (2014). “Cloud Adaption: Relative Advantage or IT Fashion.” In: *Proceedings of the 22nd European Conference on Information Systems*, Tel Aviv, Israel (2014).

Probst, T. M. (2003). “Exploring Employee Outcomes of Organizational Restructuring A Solomon Four-Group Study.” *Group & Organization Management* 28(3), 416–439.

Rafferty, A. and Griffin, M. (2006). “Perceptions of organizational change: a stress and coping perspective.” *Journal of Applied Psychology* 91(5), 1154–1162.

Rogers, E. M. (2003). *Diffusion of innovations.* Free Press, New York, USA, 11–12.

Rousseau, D. (1977). “Technological differences in job characteristics, employee satisfaction, and motivation: a synthesis of job design research and socio technical systems theory.” *Organizational Behavior and Human Performance* 19(1), 18–42.

Sabherwal, R., Jeyaraj, A. and Chowa, C. (2006). “Information system success: individual and organizational determinants.” *Management science* 52(12), 1849–1864.

Silver, M. S. (1991). “Decision guidance for computer-based decision support.” *Management Information Systems Quarterly* 15(1), 105–122.

Steers, R. M. and Porter, L. W. (1991). *Motivation and Work Behavior*. Sage Publications, New York, USA.

Straub, D., Boudreau, M. C., and Gefen, D. (2004). “Validation Guidelines for IS Positivist Research.” *Communications of the Association for Information Systems* 13(24), 380–427.

Sykes, T., Venkatesh, V. and Johnson, J. (2014). “Enterprise system implementation and employee job performance: Understanding the role of advice networks.” *Management Information Systems Quarterly* 38(1), 51–72.

Van der Meulen, R. and Rivera, J. (2014). *Gartner Says Worldwide Public Cloud Services Market to Total $ 131 Billion*. URL: http://www.gartner.com/newsroom/id/2352816 (visited: 15.10.2014).

Venkatesh, V., Bala, H. and Sykes, T. (2010). “Impacts of information and communication technology implementations on employees’ jobs in service organizations in India: a multi-method longitudinal field study.” *Production and Operations Management* 19(5), 591–613.

Venters, W. and Whitley, E. (2012). “A critical review of cloud computing: researching desires and realities.” *Journal of Information Technology* 27(3), 179–197.

Volkoff, O., Strong, D. and Elmes, M. (2007). “Technological embeddedness and organizational change.” *Organization Science* 18(5), 832–848.

Wang, E. T. G., Klein, G. and Jiang, J. J. (2006). “ERP misfit: country of origin and organizational factors.” *Journal of Management Information Systems* 23(1), 263–292.

Wang, P. and Ramiller, N. C. (2009). “Community Learning in Information Technology Innovation,” *Management Information Systems Quarterly* 33(4), 709–734.

Wang, P. (2010). “Chasing the hottest IT: effects of information technology fashion on organizations.” *Management Information Systems Quarterly* 34(1), 63–85.

Webster, J. and Watson, R. T. (2002). “Analyzing the Past to Prepare for the Future: Writing a Literature Review.” *Management Information Systems Quarterly* 26(2), xiii–xxiii.

Wind, S., Repschlaeger, J. and Zarnekow, R. (2012). “Towards a Cloud Computing Selection and Evaluation Environment for Very Large Business Applications”, In: *Proceedings of the 18th American Conference on Information Systems*, Seattle, Washington.

Wood, R. (1986). “Task complexity: definition of the construct.” *Organizational Behavior and Human Decision Processes* 37(1), 60–82.

Youseff, L., Butrico, M. and Da Silva, D. (2008). “Toward a unified ontology of cloud computing”, *Grid Computing Environments Workshop 2008* (GCE), Austin, Texas.

Appendix

All additional tables to this paper are available online and contain additional information that had to be excluded from the present paper due to page limitations:

Table I: Variables and items of research model

Table II: Cross loadings

Table III: Mean, standard deviation, loading, T-statistics

The tables may be downloaded from:
https://www-assist.uwi.uni-osnabrueck.de/jede/looking_behind_the_stage_appendix.pdf

LOOKING BEHIND THE STAGE: INFLUENCE AND EFFECT OF SOFTWARE-AS-A-SERVICE ON SOCIO-TECHNICAL ELEMENTS IN COMPANIES

Complete Research

Jede, Andreas, University of Osnabrueck, Accounting and Information Systems, Katharinenstraße 1, 49069 Osnabrueck, Germany, andreas-jede@gmx.de

Teuteberg, Frank, University of Osnabrueck, Accounting and Information Systems, Katharinenstraße 1, 49069 Osnabrueck, Germany, frank.teuteberg@uni-osnabrueck.de

Appendix

This appendix contains the following tables which had to be excluded from the paper due to page limitations:

Table I: Variables and items of research model

Table II: Cross loadings

Table III: Mean, standard deviation, loading, T-statistics

Variable	Item*	ID	Source of Items
Company´s increasing SaaS usage (CISU)	My company increases SaaS usage to solve problems if these services are effective.	CISU 1	(Autry et al., 2010)
	If there is a superior SaaS available, my company intends to use this service to address key concerns.	CISU 2	
	For the end user, working with a superior SaaS does not require much mental effort.	CISU 3	
	For the end user, a superior SaaS creates clear processes.	CISU 4	
Perceived IT security change (PISC)	Taking all factors into account that affect the overall IT security of the systems and data, security risk changes when using SaaS.	PISC 1	(Featherman and Pavlou, 2003; Loske et al., 2014; Ackerman et al., 2012)
	Taking all factors into account that affect the overall IT security of the systems and data, uncertainty changes when using SaaS.	PISC 2	
	Taking all factors into account that affect the overall IT security of the systems and data, confidentiality changes when using SaaS.	PISC 3	
Perceived interface configuration change (PICC)	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other resources will be needed than before using SaaS.	PICC 1	(Cegielski et al., 2012; Benlian et al., 2010)
	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other information will be needed than before using SaaS.	PICC 2	
	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other work processes will be needed than before using SaaS.	PICC 3	
Perceived IT architecture change (PIAC)	Taking all factors into account that affect the overall IT-architecture of the systems and data, other resources will be needed than before using SaaS.	PIAC 1	(Malladi and Krishnan, 2012; Venters and Whitley, 2012)
	Taking all factors into account that affect the overall IT-architecture of the systems and data, other information will be needed than before using SaaS.	PIAC 2	
	Taking all factors into account that affect the overall IT- architecture of the systems and data, other work processes will be needed than before using SaaS.	PIAC 3	
Perceived technical change radicalness (PTCR)	Using SaaS, it is sometimes hard to understand the sequence of the relevant steps in specific core work processes.	PTCR 1	(Gupta et al., 2013; Loske et al., 2014; Cegielski et al., 2012)
	Using SaaS, it is sometimes hard to predict the relevant steps in specific core work processes.	PTCR 2	
	Using SaaS, the rate of technical changes increases.	PTCR 3	
Perceived IT organizational change (PIOC)	Using SaaS, specific core work processes are greatly different from what I used to perform before using SaaS.	PIOC 1	(Bala et al., 2013; Marston et al., 2011)
	Using SaaS, I need to use information for my tasks that I rarely used before using SaaS.	PIOC 2	
	Using SaaS, I need resources for my tasks that I rarely used before using SaaS.	PIOC 3	
	Using SaaS, my overall work processes are now different compared to my work processes prior to the SaaS implementation.	PIOC 4	
Perceived individual job outcomes (PIJO)	Using SaaS, my job satisfaction is lower than in the phase prior to SaaS usage.	PIJO 1	(Venkatesh et al, 2010)
	Using SaaS, my job acceptance is lower than in the phase prior to SaaS usage.	PIJO 2	
	Using SaaS, my job significance is lower than in the phase prior to SaaS usage.	PIJO 3	

Perceived individual process performance (PIPP)	Using SaaS, I believe that the ability to perform my tasks efficiently is lower than in the phase prior to SaaS usage.	PIPP 1	(Bala et al., 2013; Low et al., 2011)
	Using SaaS, I believe that the ability to perform my tasks effectively is lower than in the phase prior to SaaS usage.	PIPP 2	
	Using SaaS, I believe that the ability to meet the requirements of the tasks that are assigned to me is lower than in the phase prior to SaaS usage.	PIPP 3	

Table I. Variables and items of research model

* When answering, the IT experts were asked to consider public SaaS at core business processes only.

	CISU	PISC	PICC	PIAC	PTCR	PIOC	PIJO	PIPP
CISU 1	0.768	0.480	0.252	0.246	0.398	0.335	0.376	0.178
CISU 2	0.851	0.574	0.234	0.310	0.514	0.508	0.495	0.285
CISU 3	0.832	0.537	0.277	0.387	0.497	0.524	0.419	0.370
CISU 4	0.759	0.470	0.180	0.172	0.567	0.473	0.414	0.292
PISC 1	0.436	0.802	0.342	0.427	0.533	0.534	0.510	0.305
PISC 2	0.496	0.752	0.335	0.334	0.584	0.458	0.485	0.259
PISC 3	0.611	0.872	0.415	0.569	0.715	0.650	0.672	0.449
PICC 1	0.212	0.364	0.784	0.533	0.294	0.262	0.360	0.244
PICC 2	0.348	0.400	0.808	0.544	0.344	0.352	0.432	0.314
PICC 3	0.139	0.335	0.837	0.583	0.326	0.179	0.359	0.208
PIAC 1	0.218	0.508	0.560	0.749	0.362	0.386	0.462	0.312
PIAC 2	0.425	0.458	0.483	0.810	0.452	0.412	0.281	0.352
PIAC 3	0.180	0.392	0.624	0.863	0.409	0.356	0.466	0.348
PTCR 1	0.652	0.694	0.463	0.495	0.850	0.616	0.566	0.297
PTCR 2	0.439	0.611	0.280	0.385	0.876	0.467	0.513	0.251
PTCR 3	0.472	0.625	0.250	0.400	0.820	0.528	0.559	0.317
PIOC 1	0.396	0.528	0.255	0.322	0.493	0.780	0.428	0.242
PIOC 2	0.472	0.546	0.323	0.447	0.527	0.778	0.446	0.275
PIOC 3	0.411	0.415	0.211	0.370	0.449	0.734	0.522	0.417
PIOC 4	0.510	0.616	0.228	0.326	0.501	0.790	0.514	0.280
PIJO 1	0.499	0.565	0.302	0.368	0.584	0.497	0.858	0.326
PIJO 2	0.429	0.675	0.530	0.457	0.583	0.597	0.884	0.443
PIJO 3	0.459	0.554	0.390	0.445	0.502	0.516	0.849	0.606
PIPP 1	0.271	0.293	0.241	0.238	0.225	0.332	0.440	0.864
PIPP 2	0.348	0.347	0.379	0.418	0.278	0.279	0.445	0.881
PIPP 3	0.323	0.453	0.234	0.426	0.370	0.410	0.488	0.883

Table II. Cross loadings

Construct	Item	Mean	Standard deviation	Loading	T-Statistics
CISU	CISU 1	3.500	1.218	0.768	12.460
	CISU 2	3.712	1.064	0.851	18.904
	CISU 3	3.182	0.927	0.832	22.959
	CISU 4	3.561	0.879	0.759	12.058
PISC	PISC 1	3.652	0.953	0.802	15.220
	PISC 2	3.485	0.899	0.752	14.470
	PISC 3	3.742	0.917	0.872	23.640
PICC	PICC 1	3.288	0.780	0.784	7.728
	PICC 2	3.333	0.730	0.808	9.155
	PICC 3	3.424	0.703	0.837	12.813
PIAC	PIAC 1	3.485	0.932	0.749	10.788
	PIAC 2	3.288	0.799	0.810	13.402
	PIAC 3	3.258	0.810	0.863	14.784
PTCR	PTCR 1	3.788	1.045	0.850	23.872
	PTCR 2	3.712	0.941	0.876	17.303
	PTCR 3	3.727	0.921	0.820	12.180
PIOC	PIOC 1	3.833	0.887	0.780	12.153
	PIOC 2	3.894	0.897	0.778	10.542
	PIOC 3	3.591	0.784	0.734	7.655
	PIOC 4	3.742	0.933	0.790	12.869
PIJO	PIJO 1	3.652	0.903	0.858	21.443
	PIJO 2	3.530	1.084	0.884	32.460
	PIJO 3	3.758	0.929	0.849	17.860
PIPP	PIPP 1	3.621	1.106	0.864	8.249
	PIPP 2	3.561	1.010	0.881	8.577
	PIPP 3	3.652	0.850	0.883	11.600

Table III. Mean, standard deviation, loading, T-statistics

References

Ackermann, T., Widjaja, T., Benlian, A. and Buxmann, P. (2012). “Perceived IT Security Risks of Cloud Computing: Conceptualization and Scale Development.” In: *Proceedings of the 33rd International Conference on Information Systems*, Orlando, USA.

Autry, C. W., Grawe, S. J., Daugherty, P. J. and Richey, R. G. (2010). “The effects of technological turbulence and breadth on supply chain technology acceptance and adoption.” *Journal of Operations Management* 28(6), 522–536.

Bala, H. (2013). “The effects of IT-enabled supply chain process change on job and process outcomes: A longitudinal investigation.” *Journal of Operations Management* 31(6), 450–473.

Benlian, A., Koufaris, M. and Hess, T. (2010). “The role of SaaS service quality for continued SaaS use: Empirical insights from SaaS using firms.” In: *Proceedings of the 31st International Conference on Information Systems*, Saint Louis, Missouri, USA.

Cegielski, C., Jones-Farmer, L., Wu, Y. and Hazen, B. (2012). “Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach.” *The International Journal of Logistics Management* 23(2), 184–211.

Featherman, M. S. and Pavlou, P.A. (2003). “Predicting e-services adoption: a perceived risk facets perspective.” *International journal of human-computer studies* 59(4), 451–474.

Gupta, P., Seetharaman, A. and Raj, J. (2013). “The usage and adoption of cloud computing by small and medium businesses.” *Int. Journal of Information Management* 33(5), 861–874.

Loske, A., Widjaja, T., Benlian, A. and Buxmann, P. (2014). “Perceived IT security risks in cloud adoption: the role of perceptual incongruence between users and providers.” In: *Proceedings of the 22nd European Conference on Information Systems*, Tel Aviv, Israel.

Low, C., Chen, Y. and Wu, M. (2011). “Understanding the determinants of cloud computing adoption.” *Industrial management & data systems* 111(7), 1006–1023.

Malladi, S. and Krishnan, M. S. (2012). “Cloud Computing Adoption and its Implications for CIO Strategic Focus–An Empirical Analysis.” In: *Proceedings of the 33rd international conference on information systems*, Orlando, USA.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J. and Ghalsasi, A. (2011): “Cloud computing – The business perspective.” *Decision Support Systems* 51(1), 176–189.

Venkatesh, V., Bala, H. and Sykes, T. (2010). “Impacts of information and communication technology implementations on employees’ jobs in service organizations in India: a multi-method longitudinal field study.” *Production and Operations Management* 19(5), 591–613.

Venters, W. and Whitley, E. (2012). “A critical review of cloud computing: researching desires and realities.” *Journal of Information Technology* 27(3), 179–197.

Beitrag Nr. 8	
Titel	Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data
Autoren	Andreas Jede, Frank Teuteberg
Veröffentlicht in	Business & Information Systems Engineering
DOI	http://dx.doi.org/10.1007/s12599-016-0429-1

Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data

Abstract:

Given the advantages of Software-as-a-Service (SaaS), such as cost efficiency and flexibility gains, decision-makers increasingly deploy this technology for supporting business processes as well as core business processes. But the impact of SaaS integration on a company´s IT organization often does not become apparent until the implementation is completed. Therefore, this paper examines the perceptions of IT professionals in internal IT departments regarding the effects of SaaS. In order to analyze the changes in the daily work processes of internal IT professionals in companies using SaaS, we start with the design and test of a suitable quantitative research model. In a second step, we conduct triangulation by investigating four SaaS cases from the perspectives of internal IT professionals and end users. This step constitutes the qualitative part of the study. From the empirical results we can deduce that with an increasing SaaS usage level a socio-technical instability emerges in the perceived individual job outcome (e.g., job satisfaction, job acceptance, job significance). This is especially true for IT professionals. Our valuable findings help management to understand the need for balancing both their willingness for SaaS adoption and the socio-technical consequences.

Keywords: Software-as-a-Service, IT professionals, Socio-technical systems theory, Survey, Expert interviews

1 Introduction

Despite the user-friendliness of Software-as-a-Service (SaaS)[34] and the benefits associated therewith (e.g., cost efficiency and scalability) (Youseff et al. 2008; Marston et al. 2011), the fact that SaaS may have far-reaching socio-technical consequences for a company´s employees should not be neglected. Whereas end users might enjoy working with innovative

[34] The National Institute of Standards and Technology communicates the following definition for cloud computing: "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance, 2011). This paper focuses on a specific service model of cloud computing, namely SaaS, where the services range from simple supporting services, e.g., travel management up to complex supply chain management systems.

and helpful SaaS solutions, internal IT professionals see themselves confronted with an abundance of tasks: it is in their responsibility to manage the entire infrastructure of diverse information architectures and distributed data as well as to manage software within the internal and external data streams (Leimeister et al. 2010; Hoberg et al. 2012).

When switching to SaaS, particular tasks such as software customizing and engineering, which have previously been completed internally, fall into the responsibility of the cloud computing (CC) provider (Marston et al. 2011). Yet, there are also several internal tasks that become more important or have to be modified, for example, the management of IT security and IT architecture (Loske et al. 2014; Gupta et al. 2013).

It is therefore not unlikely that, according to the degree of SaaS usage, the company´s existing IT competences and organizational IT structures will prove to be insufficient. And as internal IT professionals are in charge when SaaS processes have to be managed, it is especially their work that is subject to major changes and disruptions after the implementation of systems of this sort. This is particularly true when SaaS is applied to the more complex core business processes, for which mostly special knowledge is required. Hence, IT professionals may develop a negative attitude towards such a new system (Venkatesh et al. 2010; Boudreau and Robey 2005; Volkoff et al. 2007).

Thus, it is of crucial importance to gain a profound understanding of the IT professionals' perceptions with respect to changes in their scope of work due to SaaS implementation. With such knowledge, it is possible to comprehend the reactions as well as the associated consequences. Although already studies exist which focus on topics such as provider selection (e.g., Benlian and Hess 2011; Wind et al. 2012; Hoberg et al. 2012), or implementation processes (e.g., Low et al. 2011; Schneider and Sunyaev, 2016), up to now authors often merely assume the organizational consequences of SaaS in an argumentative-deductive manner, and the issue is usually not given more than a cursory glance on macro-level (Morgan and Conboy 2013; Marston et al. 2011).

But apart from that, also the drivers of SaaS implementation and their specific socio-technical perspective cannot be ignored. Hence, the end users of SaaS (e.g., from sales or logistics departments) need to be equally included in order to comprehensively assess the impacts on IT professionals with help of a broader empirical base and to be able to compare the various perspectives.[35]

We have conducted an individual-level research (Bala, 2013) and made use of the socio-technical systems (STS) theory. This is a powerful theory deriving from organizational behavior that is frequently applied to investigate IT implementations and IT enabled changes within organizations (e.g., Lyytinen and Newman 2008; Bala and Venkatesh 2013). We concentrate on the following ~~two~~ research question: *Does SaaS, when used for core business processes, influence IT professionals´ job perceptions; and if so, do these perceptions markedly differ from the perceptions of end users?*

Our paper is structured as follows: In the subsequent section, we evaluate existing research, debate the study's theoretical foundation, and deduce our research model as well as related hypotheses. In section three, we outline our quantitative research involving methodology, data analysis, and limitations. After that, we address the qualitative research. In section five, we merge the conducted research studies and highlight the important findings as part of a discussion. Finally, we conclude the paper in section six.

2 Background

2.1 Related Research

First of all, we conducted a systematic literature review (Webster and Watson 2002). For this purpose, we searched the databases of the leading 30 IS journals as mentioned in the AIS journal ranking list, the proceedings of major IS conferences (ICIS and ECIS) as well as the Digital Libraries of ACM and IEEE for relevant articles. The terms employed for our

[35] Despite knowing that IT professionals might as well be end users, we strictly distinguish between the two roles because the respective preconditions differ fundamentally (e.g., fear of losing your job vs. external support).

search in the articles' titles and abstracts were: *(cloud OR saas OR outsourc*) AND (organization* OR social OR employ* OR professional)*.

In this way, we discovered that although the papers characterize the different CC service types, the respective analyses and discussions remain on a macro-level. Hence, the papers also lack appropriate conclusions for the respective CC service models and deployments (Mell and Grance 2011). Nevertheless, we identified three fields of research that are relevant for the present study and are not independent from each other.

The first field concentrates on the overall effect that CC can have on a company´s internal, organizational processes. Here, the social perspective constitutes only a small part of the whole. These overall business impact studies on CC tend to focus mainly on the end users' side. Thus, we name this field "*micro-level impact on end users*". In contrast, the second field – "*micro-level impacts on IT professionals"* – has received far less attention, and hence a larger backlog demand exists. The third field targets the interrelation between the various more mature information systems and IT organizational fits, accepting that organizations are *imperfect at IT implementing, maintaining, and using*. This field is assigned as "*lessons learnt from predecessor systems*".

Our analysis within the *micro-level impact on end users* (e.g., employees in cloud using companies) revealed that most of the papers rather emphasize the advantages of CC. Marston et al. (2011) and Leimeister et al. (2010), for example, stress the possible interoperability between employees of diverse functions. In addition, by involving mobile devices such as smartphones or tablets, end users are in a position to use the corporate information systems even more efficiently. Polyviou et al. (2014), who state portability to be the key implementation factor immediately after cost advantages, corroborate this view. Other researchers claim that the end users´ job performance and ease of use increase when end users are less dependent on the in-house IT staff (Gupta et al. 2013; Meer et al. 2012).

With respect to the *micro-level impact on IT professionals*, a more differentiated picture emerges. Here, the authors see a strategic importance mainly because CC usage is accompanied by major modifications of the corporate IT structure, which results in a myriad of intra-organizational challenges. Morgan and Conboy (2013) applied the technological-organizational-environmental framework as theoretical foundation for their analysis of three case companies. On the organizational level, they detected that the fear of IT managers to lose control of their IT environment constitutes an important aspect in the decision making process for or against the usage of CC.

Moreover, IT professionals are afraid that they could be made redundant. Morgan and Conboy (2013) come to the conclusion that it is indispensable to correspondingly adjust skills and capabilities in order to match the cloud landscape. Some authors, e.g., Janssen and Joha (2011) and Venters and Whitley (2012), open a comprehensive debate on the newly arising requirements profile for IT professionals. Further, Winkler and Brown (2013) found IT governance drifts towards *shadow IT* that encapsulate IT departments from other stakeholders. Interestingly, though, Lee et al. (2013) revealed that social factors such as IT qualification and culture, even more so than risk concerns, were the main reasons put forward against CC adoption in South Korea. As a preliminary work to the present paper, Jede and Teuteberg (2015) analyzed the influence and effect of SaaS on internal IT professionals and found significant changes in perceptions following a SaaS implementation.

Thus, as a conclusion of the mentioned articles, it is essential to differentiate between the CC effects on different stakeholders as there is a considerable disparity in the respective preconditions. Compared to the paper by Jede and Teuteberg (2015), this work aims at a more holistic approach by integrating end users via a method triangulation and by deriving more differentiated implications from the empirical results.

The third field, *lessons learnt*, is quite broad and covers the impacts that more advanced IT systems have on organizational transformation and business performance. Hong and Kim (2002) determined that in the 1990s an exceptionally high number of efforts to implement enterprise resource planning (ERP) systems failed. With their study, the authors investigated the causes which were responsible for this high failure rate from an “organizational fit of ERP” perspective. The causes lie in the fact that, instead of using internally developed software, the companies began to apply purchased software applications, which are often insufficiently adjusted to the internal IT requirements. Similar reasons led to a high failure rate

(75%) of IT-based business process re-engineering initiatives (Bashein et al., 1994). The importance of a social and technical alignment was also emphasized in the studies of Sykes et al. (2014), Benlian (2013), Bala (2013), Wang (2010), Wang et al. (2006), and Lee et al. (2004). This indicates that the need for social and technical alignment in the course of implementing new IT systems has so far been underestimated.

2.2 Socio-Technical Systems Theory

STS theory assumes that an organizational unit is a combination of two interrelated subsystems – the social subsystems (people and social/ psychological structures) on the one hand and the technical subsystem (techniques and task) on the other – that have independent origins but one common goal (Venkatesh et al. 2010; Rousseau 1977; Bostrom and Heinen 1977).

Because the social and technical subsystems must recursively interact to accomplish tasks, work systems involve both physical products and social outcomes. The key issue is to derive a system equilibrium that involves stable interrelationships within and across the components of the two subsystems for a so called "joint optimization" (Rousseau 1977; Lyytinen and Newman 2008).

One specific thesis of STS theory is of particular interest. According to the theory, any internal or external modification in the shaping of one of the subsystems inevitably leads to an instability in the whole system. This may result in a high degree of individual negativity towards the system and in "productivity losses". Thus, whenever modifications are made in one of the subsystems, it is important to take the individual perceptions and anxieties into consideration (Holman et al. 2005).

In line with Marston et al. (2011), we presume that there will be organizational misalignments and/or instabilities in the STS equilibrium as direct consequence of implementing public SaaS and associated IT processes for core business processes. We argue that there are different levels of task changes between IT-professionals and end users when implementing

SaaS. In addition, undesired instabilities are more probable for a company´s IT professionals than for end users.

Hence, in order to understand how especially IT professionals react to the SaaS trend and in order to compare the perceptions of IT professionals with the perceptions of end users, we adopt STS theory for our study. The STS theory aims at performing analyses at the individual level, which corresponds well with our intention to capture the perceptions and behavior that result from already implemented SaaS as well as from the general trend to increase SaaS usage.

Although some time has elapsed since the establishment of the STS theory's hypotheses, we are convinced that especially STS builds an adequate theoretical foundation for our paper. Therefore, we consider most of the topical theoretical and empirical research on STS theory and link it to SaaS research that is relevant to our context.

2.3 Research Model and Hypothesis for Internal IT Professionals

In this section, we derive the research model that aims to answer the first part of our research question, namely IT professionals' perceptions on changes resulting from SaaS adoptions. Here, we expressly consider public SaaS. We separate the four major STS constructs organizational structure, people, tasks, and technology (Bostrom and Heinen 1977, Venkatesh et al. 2010), and based on existing studies we derive essential predecessors. By integrating a conceptualization of all relevant constructs, we further refine our model and the underlying hypotheses (cf. Fig. 1).

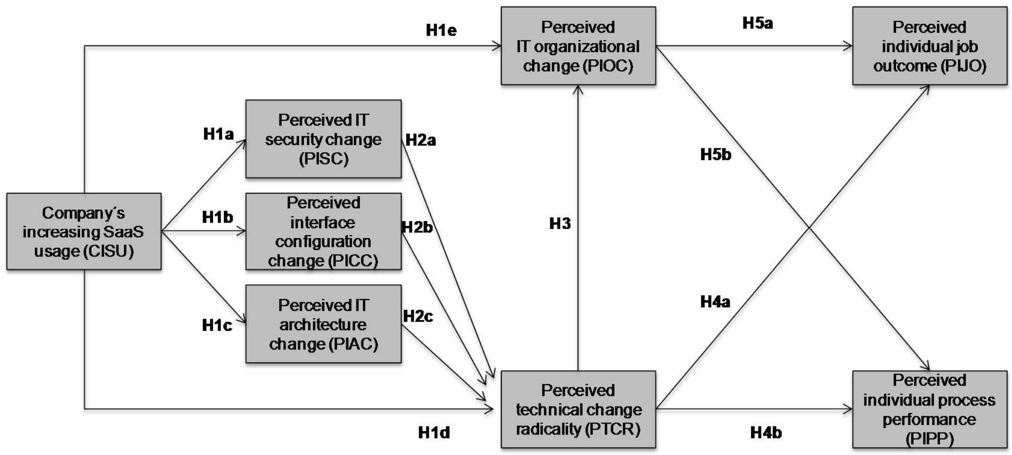


Fig. 1 Research model

From our perspective, the alignment between the social and the technical sub-system can be assessed by two dependent variables: ***perceived individual process performance (PIPP)*** and ***perceived individual job outcomes (PIJO)***. For this reason, we start with the two focal constructs of our study. Then, we revert to the antecedents. (For all of our constructs, except CISU, we employ the term *perceived*, which is supposed to express that the analyses take place on an individual level.)

Starting with *PIPP*, we propose that modifications (increases or decreases) in the perceived process complexity will have an effect on the individuals' *PIPP*. We follow Bala (2013) and define process performance as the degree to which an individual thinks that he or she is in a position to perform *effectively* and *efficiently*, which at the same time constitutes two items of construct *PIPP*. Despite the fact that this is a subjective assessment, we attach great importance to the understanding which changes in work processes have regarding impacts on the IT professionals' self-assessment (with respect to their effectiveness, efficiency and performance). This provides an opportunity to detect imminent productivity losses.

As to *PIJO*, we assume that perceived technical and organizational changes will have an effect on the individuals' job outcomes directly after the implementation of SaaS. It is very challenging to cope with increasingly complex work tasks while the number of components is rising and the interdependencies among the components are conflicting. This situation is even aggravated by the prevailing uncertainty and lack of understanding (e.g., knowledge and skills) as to the components (Blecker and Kersten 2006).

Within our research model (cf. Fig. 1), we analyze the individuals´ perceived job outcomes by taking into account the following soft facts as items (e.g., Sykes 2014; Venkatesh et al. 2010): *job satisfaction*, *job acceptance*, and *job significance*. If IT professionals perceive a drastic change in their work duties, it is highly probable that this will affect their work results. As already mentioned, a completely different work field requires a new and/or different set of tasks and/or different information and resources. Some IT professionals may find it troublesome to cope with their radically changed work processes.

Matured literature and STS theory have detected that individual employees prefer to preserve the status quo of their daily routine in order not to lose the adopted profound understanding of the working processes and structures (e.g., habits; Gersick 1991). Any modification to their working habits inevitably influences their individual job performances, because they are trying to cope with the new situations (Beaudry and Pinsonneault 2005). In addition to this, drastically modified working tasks and structures most likely entail negatively affected reactions of IT professionals. This is because the professionals are forced to deviate from their previous routines, habits, and relationships which have been developed over time and build the basis for their success (Bala 2013). Thus, we hypothesize:

- H1: *The higher the perceived IT organizational change caused by SaaS adoptions, the higher the negative influence on (a) perceived job outcomes and (b) perceived process performance will be.*

- H2: *The more radical the nature of the perceived technical change caused by SaaS adoptions is, the higher the negative influence on (a) perceived job outcomes and (b) perceived process performance will be.*

Based upon the social perspective of STS theory, we expect some internal IT professionals to undergo larger changes with respect to the complexity of their working procedures, whereas others may experience only minor modifications compared to their focus of work prior to the implementation (Marston et al. 2011; Bala 2013). Traditional STS-theory presupposes that through the implementation of new IT, the diversity of capabilities will increase. The nature of a job changes especially through the broadening of tasks, the adoption of responsibilities, and changes in individual task relationships (Steers and Porter 1991; Venkatesh et al. 2010).

However, in view of SaaS, these traditional thoughts are not directly transferable as some tasks will be extended (e.g., provider management, IT security management), whereas other duties will be transferred to the CC provider (e.g., server administration). To refine this, we follow Bala (2013) and determine that the complexity is modified in terms of "component complexity". An IT professional, who is integrated in the implementation process and the operation of SaaS, may experience a growing amount of distinctive elements or components in his or her area of responsibility. This leads us to the items of *changing activities, information* and *resource requirements* related to SaaS usage, which we aggregate to the construct ***perceived IT organizational change (PIOC)***. At the same time as the number of components of an employee's field of duty increases, the job requirements needed for the new field of work change. This could result in an information overload or task conflicts (Wang 2010; Campbell 1988; Wood 1986).

Beyond that, modifications that affect various components of work duties can even involve a shift of the overall requirements profile for the respective position (Wood, 1986). Thus, it is mandatory that the organization suitably responds to such a misalignment in the socio-technical state. Particularly at the outset of SaaS implementation, as long as the existing knowledge is still limited, it is quite difficult to identify the correct level of adjustment (Wang and Ramiller 2009). We take the mentioned component complexity aspects into account with the variable ***PIOC*** and thus hypothesize:

- H3: *The more radical the nature of the perceived technical change caused by the public SaaS implementation is, the greater the influences on the perceived IT organizational change of the company will be.*

As to the perceived technical change, we distinguish three major topics derived from literature: *IT security*, *IT architecture*, and *interfaces*. However, with growing numbers of SaaS changes and SaaS implementations, these three factors will further reinforce the dependent variable ***perceived technical change radicality (PTCR)***, which refers to the ability of an individual to comprehend and assess the respective measures in specific core work processes. Thereby, radicality represents the level of novelty, limited experience, or deviation from consisting knowledge and practices (Aiman-Smith and Green 2002). Therefore, we conceptualize this construct by means of the items *understanding the sequence of the relevant steps*, *predicting relevant steps*, and increasing *rate of technical change* (Gupta, 2013, Cegielski, 2012).

In virtually all papers broaching the issue of CC risks and technical challenges, it is confirmed that security tasks are subject to substantial changes (e.g., Martson et al. 2011; Cegielski et al. 2012; Benlian et al. 2010). We go in line with the understanding of Ackermann et al. (2012), who define perceived security risks in the context of CC as a "perceived risk related to the IT security of a company´s systems and data if CC is utilized as delivery model". Especially in cases where CC providers act globally and run their networks of datacenters worldwide, there are particular security risks. In addition, it seems not that such CC providers present a very special legal framework as to the liability for breaches of security (Marston et al. 2011; Brender and Markov 2013). In order to correctly assess these risks and to advise the respective process owners correspondingly, a fundamental IT security knowledge is indispensable. The security changes that come along with any offsite hosting of data and services (i.e., various kinds of outsourcing) involve assigning responsible people who have access to customer data, and who are proficient in omit service attack prevention, perimeter security policy, resource starvation, data backup, and compliance.

Based on the paper of Ackermann et al. (2012), Loske et al. (2014) found break of *confidentiality*[36] to be the most important IT *security risk*. Prior works and STS theory determine *uncertainty* as to the assessment of negative security consequences to be a critical factor in this context (e.g., Featherman and Pavlou 2003). Hence, on the basis of these valuable papers we grouped the mentioned items to the variable ***perceived IT security changes (PISC)*** induced by the adoption of SaaS.

In order to achieve a convenient data exchange, it is vitally important to obtain transparent and lucid interface configurations between the corporate and the provider system. The SaaS provider supplies its service via a standard interface. Customer-specific configurations are

[36] Ackermann et al. (2012) define confidentiality as "data can be read only by authorized users".

only possible at the meta-data layer above the common code using interfaces which are provided by the vendor (Benlian et al. 2010). This operational issue is further complicated when customized cross-company SaaS is used. It is through the interfaces with the external environment that organizations expose themselves to the associated technical uncertainty (Cegielski et al. 2012). Referring to the key issue as determined by Benlian et al. (2010), CC users have no choice but to adopt the upgrades and updates by the provider, because in most cases interfaces are not backward-compatible. This brings us to the variable ***perceived interface configuration changes (PICC)***. To be more specific, we aim to investigate this issue via the STS standard approach (e.g., Bala, 2013). Thus, in order to look into the interface configurations, we analyze the changes in *needed resources, needed information*, and *required work processes*.

Eventually, it is essential that the services and systems can be accessed across platforms and infrastructures and function smoothly together (beyond operational interface configuration). Thus, the basic precondition for taking advantage of features like easy data exchange, smooth access across physical servers, multiple entry points for users, and a system supporting a large selection of data types, is an appropriate IT landscape (Malladi and Krishnan 2012; Venters and Whitley 2012; Susarla et al. 2010). We operationalize this point as ***perceived IT architecture changes (PIAC)***. And again, the single items of the construct aim to analyze *changes in needed resources, needed information*, and *required work processes* with regards to PIAC.

Returning to the initial point in Fig.1, companies expect major benefits from public SaaS, for instance, cost benefits, a capable cross-company coordination, process performance increases, as well as a more process flexibility (Bharadwaj et al. 2013; Wind et al. 2012). There are several researchers who anticipate completely new and innovative capabilities for companies that adopt public SaaS (McAfee 2011; Marston et al. 2011). Therefore, the stimuli for the implementations of SaaS are diverse and cannot be generalized.

Yet, our study is not oriented towards macro-level findings; it rather aims at the individual level. At the organizational level of the study, the independent variable that mirrors the increased usage is operationalized as the ***company´s increasing SaaS usage (CISU) for core***

business processes. There is a variety of public SaaS solutions on the market, covering the wide spectrum from elementary supporting services to the extensive services which can support a company´s core processes. Next to the wish to become *more efficient* and *address key concerns* through CC, it is also possible that companies are forced to implement CC because of end users' requests (in terms of the items *lower internal/mental effort for end user* and *clear processes*). We assert that internal IT departments that apply public SaaS for their core processes face even greater modifications and challenges. In addition to SaaS usage in general, we claim that our subsequent constructs and causal relations hold especially true for cases where SaaS is applied for core business processes. Hence, we hypothesize:

- H4: *The higher the perceived task changes in (a) IT security, (b) interface configurations, and (c) IT architecture due to SaaS usage are, the more radical the perceived technical change will be.*
- H5: *The more intense the company´s public SaaS usage is, the higher will be the perceived changes in (a) security, (b) interface configurations and the overall (c) IT architecture, as well as (d) the perceived technical change radicality, and (e) the perceived IT organizational change.*

2.4 Research Model for Internal IT Professionals and End Users

In the prior section 2.3 we considered IT professionals only. As we assume that the implementation of SaaS has a particularly strong influence on the IT professionals' individual perceptions, we have deliberately chosen to adapt the research model to their specific working environments. However, as a result of this approach, we also risk an elite bias by neglecting the perceptions of other related individuals in user companies, e.g., end users.

Therefore, we extended the already presented research model (cf. Fig. 1) to the dimension "end users". Thus, we predefine the final constructs PIJO and PIPP as a basis and analyze these constructs from the two perspectives of internal IT professionals and end users. The important relation between the initial research model (cf. Fig. 1) and the add-on research model is depicted in Fig. 2.

Moreover, in section 2.3 we developed and derived hypotheses which we aim to test in a quantitative manner. Following Danermark (2002, pp. 153), in a second step, we applied qualitative research to “give a more profound description of some elements of what has been analyzed with the help of a quantitative method”.

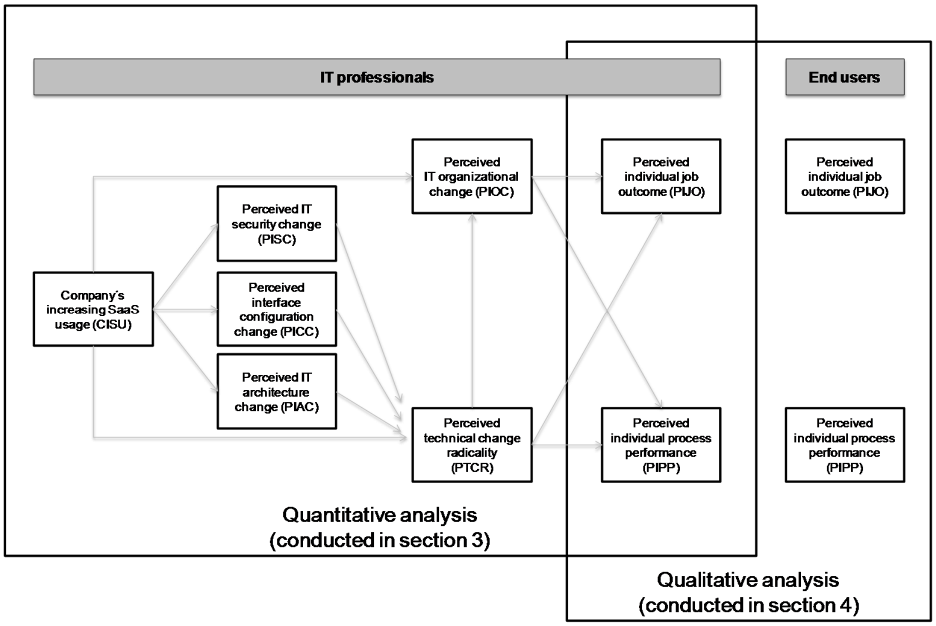


Fig. 2 Relation between research models

3 Quantitative Research

3.1 Quantitative Research Methodology

We consider the quantitative research to be the dominant study in our paper, while the qualitative study may be seen as an add-on explanation that also involves end users. In order to answer the research question and test our research model (see Fig. 1) in a quantitative manner, which allows for a statistical generalization of the outcomes, we performed a cross-sectional survey (Pinsonneault and Kraemer 1993).

Where feasible, we employed measurement items of the constructs based on existing research (cf. references in Table I in the appendix) and matched these with our context. All constructs are operationalized in the determined model as reflective constructs following the proposed decision criteria presented by Jarvis et al. (2003) and Petter et al. (2007). The constructs were measured with multiple items on five-point Likert scales (cf. appendix for details on single constructs).

The data collection was carried out online (via two social network platforms for professionals) and took place between April and August 2014. In particular, we sought IT professionals with at least two years' practical experience with SaaS implementations at companies using SaaS in German speaking countries (Germany, Austria, and Switzerland). Due to the fact that our research model is not adapted to the job situation of IT professionals of SaaS providers, we excluded them from our search.

Also, we concentrated on cases in which SaaS is employed for core business processes, as we judge such cases to be more sophisticated and consequently of greater interest not only for the company but also for IT departments. As we know that it is difficult to make the distinction between a core and a non-core business process, we left this decision to the IT professionals. Furthermore, we requested the interviewee to consider only "public" SaaS, as the other deployment models (Mell and Grance 2011) show a lower degree of outsourcing (private, hybrid, and community) and thus organizational changes of a minor nature.

Due to these tight searching restrictions, we only received 102 completed questionnaires from IT professionals. However, we had to exclude 21 of the respondents from our sample as they were insufficiently conversant with SaaS usage; they had had less than two years SaaS experience in their workplaces. Due to unreliable responses (i.e., answering all questions with 5), we excluded another 15 from the remaining 81 respondents during data screening (Marcoulides and Saunders, 2006).

Eventually, a sample of 66 usable and completed questionnaires was subjected to the data analysis, which corresponds to an actual response rate of 22.0 percent. The calculation of the statistical power (at least 80% according to Muthen and Muthen (2002)) indicated that the underlying sample has a sufficient size. Table 1 gives an overview of the respondents' profiles. Herein, the "IT" industry sector includes various industries, e.g., the printing industry.

For testing common method bias (CMB), we conducted a Harman´s single factor test in order to investigate if the majority of the covariance among the measures can be explained by one factor (Podsackoff et al. 2003). The outcome yielded 6 factors; the highest of these involves 36.12% of the variance, indicating that CMB is not an issue in our study.

Table 1 Profile of respondents (n=66)

Factor	Distribution							
Gender	Male: 63.6%				Female: 36.4%			
Age	20-29: 13.6%	30-39: 27.4%	40-49: 34.9%	50-59: 21.1%	> 60: 3.0%			
Position	Professional staff: 42.4%		First line supervisor:16.7%		Chief manager: 27.3%		Others: 13.6%	
IT job	IT consulting: 22.7%	IT infrastructure: 18.1%	IT architecture: 13.6%	Software engineering: 9.1%	IT service management: 9.1%	IT security: 9.1%	IT controlling: 7.6%	Others: 10.7%
Industry sector	Automotive: 22.7%	IT: 21.2%	Mechanical engineering: 16.7%	Banking: 12.1%	Chemical: 7.6%	Consumable goods: 7.6%	Others: 12.1%	

3.2 Data Analysis of the Quantitative Research

We employed the structural equation modeling (SEM) to test the measurement and structural models. In order to assess the measurement scales and to test the research hypotheses, we selected the component-based partial least squares (PLS) procedure. Contrary to other SEM procedures (e.g., LISREL), the PLS procedure does not necessarily presuppose that the response data follow a normal distribution (Chin, 1998). Since this is not the case with our data, we deliberately chose the PLS approach for the analyses. For evaluating the distribution of our construct indicators, we performed the Kolmogorov-Smirnov test as well as the Shapiro-Wilk test. To assess our model, we strictly adhered to the approaches of MacKenzie et al. (2011) and Burda and Teuteberg (2013).

For the evaluation of the measurement model assessment, we started to assess the individual item reliability and convergent validity of the defined constructs. To this effect, we examined the factor loadings of the respective items on their hypothesized constructs and the average variance extracted (AVE).

The next step was to analyze the discriminant validity of the defined constructs by comparing the square root of the AVE of each construct with all other inter-construct correlations. Thirdly, we explored the internal consistency and scale reliability by calculating the composite reliability (CR) and Cronbach’s alpha (CA) values (cf. Table 2). The tests undertaken reveal a sufficiently high degree of validity as well as an adequate reliability (Chin 1998; Fornell and Larcker 1981; Gefen et al. 2000). (cf. appendix for more details on the measurement model assessment)

Table 2 AVE, reliabilities and latent variable correlations

	AVE	CR	CA	PIJO	PIPP	PTCR	PIOC	PISC	PICC	PIAC	CISU
PIJO	0.75	0.90	0.83	0.86							
PIPP	0.77	0.91	0.85	0.53	0.88						
PTCR	0.72	0.89	0.81	0.65	0.34	0.85					
PIOC	0.59	0.85	0.77	0.62	0.40	0.64	0.77				
PISC	0.66	0.85	0.74	0.69	0.43	0.76	0.68	0.81			
PICC	0.64	0.85	0.75	0.48	0.32	0.40	0.33	0.45	0.80		
PIAC	0.65	0.85	0.73	0.49	0.42	0.51	0.48	0.56	0.68	0.81	
CISU	0.65	0.88	0.82	0.53	0.36	0.62	0.58	0.64	0.29	0.35	0.80

AVE: Average variance extracted, CR: Composite reliability, CA: Cronbach's alpha,
Shaded cells: Square root of AVE

For the purpose of testing the significance of our loadings and coefficients, we carried out the bootstrapping re-sampling technique with 66 cases and 5,000 samples (Hair et al. 2013). The estimates obtained within the framework of the PLS analysis are depicted in Fig. 3. Also involved are the standardized path coefficients, the significance of the paths (two-sided testing), and the amount of variance explained (R^2).

Fig. 3 demonstrates that, with respect to the R^2 values, the determined model accounts for 49.2 percent of the variance in job outcome, 17.1 percent of the variance in process performance, 61.9 percent of the variance in perceived technical change, and 46.4 percent of the variance in perceived organizational change. The profiles of the respondents served as control variables: added up, they account for an additional 2.9 percent in perceived job outcome and 0.9 percent in perceived process performance. Nevertheless, none of the path coefficients of our control variables on job outcome and process performance are significant.

Acknowledging the significant path coefficients in Fig. 3, Chin (1998) considers a range of above 0.2 to be substantial. For the significant path coefficients, we tested the related confidence intervals with a 95% level (i.e. significance level $\alpha = 0.05$) and none of the parameter values could be rejected. However, three paths (PICC>>PTCR, PIAC>>PTCR, PTCR>>PIPP) do not comply with Chin´s above stated condition. While the sizes of two of these paths coefficients present minor but significant effects, we performed pseudo F-tests to analyze whether the increase in the variance explained in PTCR and PIPP is considerably influenced by PIAC and PTCR, respectively. The test demonstrates a small but significant effect size of 0.040 ($F = 4.19$, $p < 0.050$) for the path PIAC>>PTCR. Herein, with a 95% level of confidence the parameter effect size ranges from 0.032 to 0.042 (confidence interval). Further, the path PTCR>>PIPP has no significant effect size. Summing up, hypothesis H4b and H2b (marked with "n.s." in Fig. 3) are not supported, whereas the remaining hypotheses are supported.

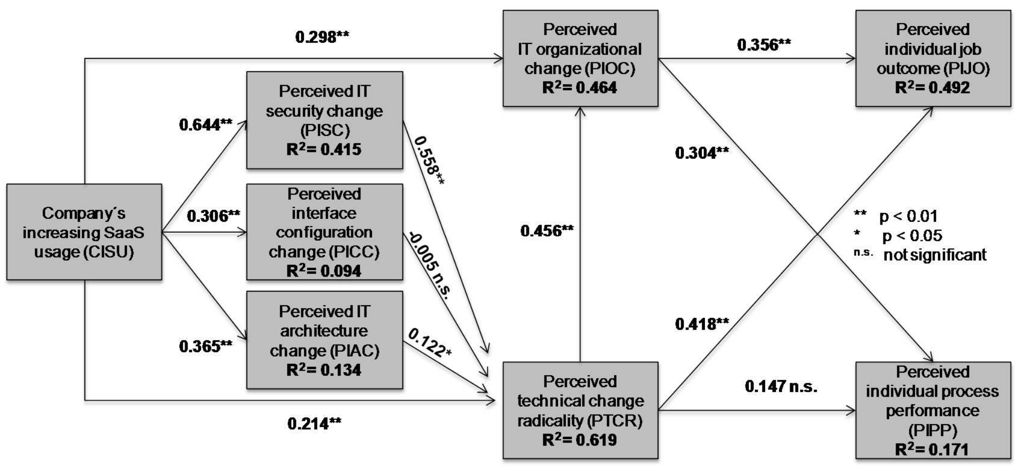


Fig. 3 Results of the research model

Drawing a preliminary conclusion, we examined the influence of the perceived technical task changes *(security, interfaces, architecture)* and *the company´s increasing SaaS usage* on *perceived technical change radicality* and *perceived IT organizational changes*, before analyzing the impact on individual IT professionals´ *perceptions of job outcomes* and *work process performance.*

It comes as no surprise that the *perceived IT organizational change* seems to have a trailing effect on *perceived technical change radicality* which shows the third highest significance path coefficient in our model. The modifications represent a general evaluation of the degree of perceived socio-technical change as a mechanism by which particularly the *perceived individual job outcomes* are adversely affected.

In addition, when the degree of perceived organizational changes rises due to SaaS usage, IT professionals notice that their *perceived individual process performance*, which is another subjective construct, diminishes. However, since this construct has a quite low R^2, it stands to reason that other factors, like “perceived usefulness”, are liable to affect the job performance far more severely. At any rate, in conformity with the STS theory and our research model, we detect that the use of public SaaS for core business processes has a significant negative affect on the social subsystem.

3.3 Major Limitations

One of the major limiting factors is that the sample is based on data which stems from interviewees from different German-speaking countries. Even if the survey sample shows a broad set of data with reference to the respondents’ characteristics, the findings should not be ***generalized to other regions and countries***.

Furthermore, the survey did not distinguish between the ***various points in time*** following the implementation. Additionally, despite the fact that SaaS is a particular development within the realm of CC, it is a relatively new IT paradigm whose exploitation is rising excessively (Van der Meulen and Rivera 2014). Thus, at this stage, the majority of companies has no or only little experience with SaaS “cultures and strategies” (Marston et al. 2011). According to existing research, the benefits from innovative information systems only occur after a certain time lag (Sykes et al. 2014). It is therefore likely that the perceived degree of changes due to SaaS in the perceived individual IT professional´s situation return to the level prior to the implementation after some time.

Moreover, we differentiated between SaaS when used for core and non-core processes, whereas we ***neglected any further service variations***. For this purpose, supply chain services could lead to other findings than SaaS for financials services. The single-informant method in the survey will be triangulated by investigating four SaaS cases from the perspective of IT professionals and end users in the next section.

4 Qualitative Research

4.1 Qualitative Research Methodology

As mentioned before, in section 3 we exclusively analyzed IT professionals. However, by doing so we risk an elite bias as we neglect the perceptions of other related individuals in companies using SaaS, e.g., end users. Therefore, we aim to equally consider the perspectives of end users and those of internal IT professionals in section 4. Subsequently, after having conducted a quantitative study in order to provide a more profound and comprehensive description of quantitative findings, we followed Danermark (2002) in applying a qualitative method. For the qualitative research we gathered data from in-depth expert interviews.

We followed the model by Kirsch (2004) that consists of three requirements: (i) identifying project cases, (ii) identifying whom to interview, and (iii) determining how the interviews are to be conducted. To gain a holistic picture, we interviewed an end user as well as an IT professional from each company. We found four case companies with headquarters in Germany that use SaaS for core business processes, and we interviewed the two related parties separately.

The eight interviews took place in March 2015 and lasted on average 70 minutes. We used a semi-structured guideline with open-ended questions (cf. appendix for details on questionnaire guideline). The questionnaire consisted of three phases: whereas phases one and two aimed at personal information and underlying SaaS context, phase three focused on the individual perceptions. Regardless of their profession, we applied the same questionnaire guideline for all interviewees, which is in line with the two fully dependent constructs of our research model: *PIJO* and *PIPP*.

The transcribed interviews were used for the analysis by means of open-coding processes that consisted of fracturing, reordering, and constant comparison (Locke 2001, Strauss and Corbin 1998, pp. 102). To do so, we selected the main statements in each transcript. Subsequently, we grouped these statements in order to reveal categories and subcategories. By relating categories to their subcategories a file of codes began to emerge, which facilitated the understanding of the relationships (Strauss and Corbin 1998, pp. 123) and enabled a more comprehensive evaluation of the constructs´ single items. Some excerpts of the interviews will be quoted below. The profile of the four cases is presented in Table 3.

Table 3 Profile of SaaS using cases

Characteristics	Case 1	Case 2	Case 3	Case 4
Industry sector	Consumable goods	IT service provider	Automotive	Automotive
SaaS field	Customer relationship management	Digital payment and invoicing	Supply chain management	Transportation and freight management
SaaS usage duration	3 years	2 years	3 years	2 years
Job of IT professional	IT infrastructure responsible	IT consultant and key user of SAP FI/CO module	Key user SAP SD module	Senior IT consultant
Job of end user	Regional sales director	Accountant	Customer service agent	Junior logistics manager

4.2 Data Analysis of the Qualitative Research

As mentioned before, we conducted eight expert interviews at four case companies for the qualitative data analysis. All four cases facilitate helpful empirical insights and fulfil the requirement of SaaS covering their core business processes.

In the *first case company* (cf. Table 3), the sales responsible initiated a SaaS implementation for customer relationship management (CRM). "*I was impressed by the idea of showing the customers on-site real time sales figures and developments*", and he continued "*I feel that this data availability and the easy short term data processing increased my professional recognition by the customers*". The IT professional confirms that the adopted SaaS outclassed the prior e-mail application based CRM tool. But at the same time he argues that huge efforts are needed for managing the data interfaces between the ERP system and the ever changing external CRM service requirements.

In the *second case*, the company implemented a SaaS for e-invoicing mainly in order to decrease the labour costs for leasing personnel who was responsible for manual billings and payments. The adoption of the SaaS arose from the company´s lean office initiative. The interviewed accountant was glad that the company used the service, because for the standardized invoices the manual workload had predominantly been replaced by the service. She stated "*to some degree my job switched from task work to coordination work*". In this case, the IT professional perceived no major changes compared to the state prior to SaaS usage. Even though he had data security concerns during the implementation phase, he experienced useful outsourcing of cumbersome IT tasks. Furthermore, he stated that "*with the standardized invoice formats, we have made a big step in the lean thinking process*".

In the *third case*, the OEM required the supplier case company to use a common SaaS in order to improve the supply chain stability. Using SaaS , the customer service agent was able to carry out the data administration online (delivery dates, article type, article amounts etc.) instead of sending and receiving specific Excel-files and using point-to-point EDI. The IT professional complained that "*they [the OEM] started with some minor administration requirements ... and now we have created an online monster*". He expressed his concern about the fact that he now has to handle new, time-consuming tasks.

In the *fourth and last case*, the company used SaaS for outbound shipments of finished goods. The flexible access to the data of the goods increased the transparency between the production and the selling sub-units of the company. Also, it helped to decrease freight costs due to efficient bundling. While the logistics representative experienced a strong support in his daily work and liked the "*fancier package*", the IT professional was extremely frustrated and stated that "*they [end users] come up with new concepts every week*". He set forth that "*we have been using cloud-like services for more than 15 years and nobody cared. Now, the massive marketing tours of CC providers and variety of online services create excessive expectations of end users*." Table 4 summarizes the results of the expert interviews.

Table 4 Results of the expert interviews

Case #	Job role	Perceived individual job outcome (*PIJO*)	Perceived individual process performance (*PIPP*)
Case 1	End user	Increase +1	Increase +1
	IT professional	Decrease -1	Unchanged +/-0
Case 2	End user	Increase +1	Increase +1
	IT professional	Unchanged +/-0	Increase +1
Case 3	End user	Decrease -1	Unchanged +/-0
	IT professional	Decrease -1	Decrease -1
Case 4	End user	Increase +1	Unchanged +/-0
	IT professional	Decrease -1	Unchanged +/-0
Sum	End user	Increase +2	Increase +2
	IT professional	Decrease -3	Unchanged +/-0

Based on the coding (cf. section 4.1), we valued the single items of the two constructs *PIPP* and *PIJO* prior to and following the SaaS implementation according to the experts´ statements (1 for increase, 0 for unchanged, and -1 for decrease). Afterwards, we asked the interviewees whether they agreed with that valuation. For each expert, we aggregated the individual answers to the overall construct perceptions (average of three single items). Finally, we added up the scores of all cases in order to obtain an overall picture.

5 Complementary Qualitative Findings and Discussion

5.1 Integration of Empirical Results

The empirical investigations provide several valuable insights. Venkatesh et al. (2013) propose a meta-inference analysis path for explaining the findings of mixed methods (quantitative findings > qualitative findings > meta-inferences). While we have already presented the quantitative and qualitative findings (cf. section 3.2 and 4.2), we now aim to derive the integration of both via meta-inferences.

As mentioned before, the quantitative analysis is our major field of study, while the qualitative analysis provides a differentiated perspective. When aiming to align both studies, there is one point of contact in the beginning of Fig. 1, namely the starting point *CISU*; and there is a clear intersection of both studies, namely the ending points *PIJO* and *PIPP* (cf. Fig. 2). However, the relationships between all the other constructs (apart from *CISU*, *PIJO*, and *PIPP*; cf. Fig. 1) are exclusively valid for IT employees and hence, the intended encapsulation of both studies makes it hard to align these other constructs.

For *CISU*, the qualitative study confirms that there is an increasing willingness of the investigated companies to implement SaaS. But the qualitative study reveals the important aspect that this willingness might be proactive (cases 1 and 4), reactive (case 2), or externally driven (case 3). These three variants may of course have strongly varying influence on the constructs within Fig. 3. For instance, externally driven SaaS implementations may not necessarily constitute the best solution for a company in itself (in terms of *PISC, PICC*, and *PIAC*), but it might be seen as a requirement for acting within the underlying supply chain network.

Considering *PIJO* and *PIPP*, we conclude that in fact there are significant differences between IT professionals and end users. IT professionals experience the effects of SaaS implementations and ongoing data migrations more keenly. Looking at the four cases, there is only one “increase” in performance with the IT professionals. In contrast, end users have mainly positive perceptions towards SaaS or tend to have neutral perceptions when the service was not initiated by them. Therefore, our research clearly shows: the negative impacts of a SaaS usage are particularly true for the perceptions of *internal IT professionals*.

From the methodological point of view, this result justifies the chosen mixed method research design. The *PIJO* and *PIPP* of IT professionals build the two intersections between the qualitative and quantitative analysis and at the same time represent the origins of the negative impacts, which cannot be considered independently from each other: On the one hand there is the increasing SaaS demand of end users (cf. *CISU* and Table 4), and on the other hand there are the internal structural changes (cf. Fig. 3).

Starting with the ***usefulness of STS*** theory for our research, the theory postulates that systems are networks of people that are primarily concerned with the impact on themselves and their work (Bala 2013). Our results show that the individuals have various preferences that are mostly not in line with each other. This mismatch can be explained by the individuals' cognitive limits and internal role/goal conflicts (e.g., using a new SaaS for short term tasks vs. adopting the SaaS with the goal of high quality). Against the background of normally *imperfect* SaaS implementation and use (cf. section 2.1), the task conflicts are even more intense. Herewith, STS theory constitutes a quite suitable framework for understanding these kinds of conflicts on an adequately detailed level.

Further, IT research stimulates authors to conduct more empirical studies with mixed-method approaches and calls for data and method triangulation in IT research (e.g., Loos et al. 2010, Venkatesh et al. 2013). We experienced ***triangulation*** to be extraordinarily important for our research, especially because of the selected design on individual level. This helped us to achieve a more comprehensive understanding of perceptions, and yet, to remain sensitive to different perspectives from the two related roles.

Our approach enabled us to switch between the perspectives of IT professionals and end users and to compare the respective results. By considering diverse kinds of core SaaS solutions, various organizations, as well as two specific roles, our study obtained a greater ***robustness***. Consequently, we are in line with the purposes of Venkatesh et al. (2013) for mixing research methods (e.g., ensuring complementary views, deriving a developmental design, compensating weaknesses).

Looking at the results, we would like to start with the two paths that are not significantly impacted by the increasing number of SaaS introductions (cf. *PICC>>PTCR, PTCR>>PIPP* in Fig. 3). Considering the required interface configurations, we assume that this factor is more dependent on the ***service update rate*** of the respective SaaS than on the other constructs. We have, however, not investigated to what extent the update rates of the respondents differed from each other.

Regarding the insignificant influence on decreasing individual performance, there are various possible argumentation lines. E.g., the SaaS success within the overall company might lead to an ***attenuating effect***, for instance driven by loyalty with the benefitting departments and the overall company. And as mentioned before, there may be other important factors (such as usefulness) which we did not test.

With reference to our research question (cf. section 1), there is obviously a ***clear separation*** between IT professionals and end users. Although it is only natural that a certain separation can be discovered in all IS matters, an implementation of SaaS seems to largely increase the gap between internal IT professionals and end users. However, the access to IT has been "democratized" and end users are becoming increasingly demanding as to functionalities (cf. *CISU* in Fig. 3). And while the use of more intuitive, mobile, up-to-date, and real-life IT can delight end users, it can at the same time ***frustrate*** IT professionals (cf. *PTCR* in Fig. 3). Moreover, this study goes in line with prior work (e.g., Benlian et al. 2010) by indicating that security and architectural changes constitute major challenges for internal IT employees (cf. *PISC* and *PIAC* in Fig. 3).

This research provides ***literature on STS theory and CC*** with an interesting finding. From the ideological view point, it is characteristic for IT professionals to proactively strive for the latest IT, to have innovative ideas, or to approach tasks open-mindedly. But this study indicates that the IT employees are particularly affected by the structural and organizational changes following a SaaS adoption, which leads to disruptions between the technical and the social subsystem. Thereby, the gap between the "ideal" and the affected IT employee might increase. As we have seen in the introductory section, these impacts have so far been assumed to be mainly argumentative-deductive. On the basis of prior research, this paper provides an empirical base for that assumption.

In accordance with STS theory, Burns and Stalker (1961, p. 120) provide a valuable concept that might encourage the understanding of this discovered separation phenomenon between IT employees and end users. They differentiate between ***organic and mechanistic structures***. While organic forms are characterized by being more unstructured, more uncertain, and more flexible, mechanistic structures possess a lower rate of changes and are more formal.

Burns and Stalker (1961) believe that mechanistic structures are more effective for ***administrational functions*** such as finance and sales. Transferring this concept to our results, we argue that end users do not have to change between organic and mechanistic structures, as the usage of SaaS brings about only minor (and in most cases helpful) changes for their daily tasks.

In contrast, due to the new daily tasks they are confronted with, IT professionals experience a higher rate of changes, which means that their existing organizational structure ***becomes unsuitable*** (cf. *PIOC* in Fig. 3). The probability that the new tasks will require a more organic structure is high, which, of course, involves some undesired and hidden changes for IT professionals. When working within a mechanistic structure (e.g., clear definition of rights and responsibilities; mainly vertical interaction; jobs perceived as distinct from an organization as a whole), although task fulfillment would require a more organic structure (e.g., working in networks for a common goal; more contacts with external partners; tasks with mutual adjustments), this might result in a lower individual job outcome (cf. *PIJO* in Fig. 3) and hence reinforce negative consequences such as dissatisfaction or lower job significance.

As mentioned before, companies typically do not succeed in managing organizational IT changes effectively (cf. section 2.1). The findings of this study show that organizational modifications are absolutely necessary when SaaS is intensely employed for core business processes, because the new SaaS tasks differ significantly from the previous tasks (cf. *PIOC* in Fig. 3). To a certain degree, the use of SaaS solutions involves a loss of authority/control in internal IT departments, and a ***hidden and reactive*** internal reorganization commences.

This can be detected from the individual perceptions within our model and is simultaneously in accordance with the established job characteristics of Probst (2003). For these reasons and given the countless changes, deliberate or hidden, we assert that the implementation of SaaS is far ***more challenging*** for companies than originally assumed.

However, in order to prevent productivity losses (cf. section 2.2), an active and adequate IT organizational ***restructuring process*** is required, which in turn is highly dependent on the degree of SaaS usage. For the redesign of affected IT jobs on an individual level, STS theory discusses three major areas (e.g., Venkatesh et al. 2010; Bala 2013): (i) control, (ii) working in groups, and (iii) multi-skilling. We would instead like to distinguish short-, mid-, and long term actions.

With respect to the first area covering the short-term action, we suggest to create a joint-optimization-usage-guideline for affected IT professionals and end users prior to the use of SaaS in order to reduce the radical nature of the perceived change. This includes a kind of social-technical risk management with ***variance control***, which could enhance the understanding between related individuals around a common core SaaS process and may smooth the demanding position of end users.

Considering the second area, the interviews indicate that IT professionals mainly feel left alone with the new issues. Therefore, we propose to form mid-term SaaS ***group councils*** in which members discuss issues and refine best practices and standards (e.g., checklists). In smaller enterprises, these councils could be implemented across companies. This can help to reduce job uncertainties.

Third, a long term ***multi-skilling strategy*** has to be introduced. Although the expert interviews did not reveal a lack of SaaS knowledge, which might be explained by the lower personal distance between interviewee and interviewer, the survey underlines the radically changed knowledge requirements. As the number of SaaS usages increases, organizations need to prepare themselves for the changed skill profiles which will become necessary. The importance of developments and operations will decrease while the demand for security and integration experts, service management specialists, and people with a thorough knowledge of the SaaS market will significantly increase. Companies have to address this in their long-term personnel and organizational development strategies. Due to the fact that more and more business processes will bypass the internal structures, it is of great importance to continually educate related stakeholders such as end users who are usually not IT professionals) about the risks of SaaS applications.

We want to conclude the implications with a lesson learned from prior IT outsourcing trends. The third field of related research (cf. section 2.1) has shown that in the 1990s the number of IT outsourcing arrangements was unreasonably high, which later led to a strong "***backsourcing***" trend (Hirshheim 1998). Thus, at some point in time, companies started to re-introduce their functions back in-house as soon as the outsourcing contracts ended. The reasons were, e.g., cost increases, poor services, or strategic directions. These companies experienced an insidious loss of IT competencies. The efforts needed for the rebuilding of internal knowledge and structures were excessively high. Looking at the present strongly increasing rates of SaaS adoptions, it is impossible for a company to predict its future IT structure. Hence, when investigating organic or mechanistic structures as well as areas for redesigning IT jobs, companies should always keep the backsourcing option in mind.

6. Conclusion

Research on SaaS and CC started with technical investigations, assessing risk factors such as data security and benefits such as scalability and virtualization (e.g., Youseff et al. 2008). This strictly technical view was criticized as soon as research started to include also the economic perspectives (e.g., Leimeister et al. 2010), discussing financial benefits such as the pay-as-you-go model.

Marston et al. (2011) wrote one of the first papers that motivated researchers to equally involve the environmental, cultural, and especially social perspective. So far, this has been done only occasionally and mainly in an argumentative-deductive manner. Our paper encourages the understanding that there are not only technical as well as economical risks and chances, but also social risks and chances.

Our empirical results indicate that especially individual IT professionals, who deal with such implementations, experience significant changes. SaaS is accompanied by advantages such as interoperability, performance increase, or updates for the internal IT professionals as well as for the remaining stakeholders. With this study we point to the circumstance that at present IT professionals are extremely aware of the risks that SaaS entails. This is why it is absolutely essential that management comprehends the two STS sub-systems to prepare a profound basis for a successful SaaS implementation and a sustainable SaaS usage. Therefore, when decision makers are about to adopt SaaS for core business processes, the social and organizational consequences have to be considered as one important decision dimension. This might ensure outsourcing services "without outsourcing social aspects".

Acknowledgement

This work is part of the project "Sustainable Consumption of Information and Communication Technologies in the Digital Society − Dialogue and Transformation through open innovation". The project is funded by the Ministry for Science and Culture of Lower Saxony and the Volkswagen Foundation (VolkswagenStiftung) through the "Niedersächsisches Vorab" grant program (grant number VWZN3037). Further, the authors would like to thank the anonymous reviewers and Ms. Marita Imhorst for their valuable help and substantive feedback.

References

Ackermann T, Widjaja T, Benlian A, Buxmann, P (2012) Perceived IT security risks of cloud computing: conceptualization and scale development. In: Proceedings of the 33rd ICIS, Orlando

Aiman-Smith L, Green S (2002) Implementing new manufacturing technology: the related effects of technology characteristics and user learning activities. Acad Manag J 45(2):421–430

Bala H (2013) The effects of IT-enabled supply chain process change on job and process outcomes: a longitudinal investigation. J Oper Manag 31(6):450–473

Bala H, Venkatesh V (2013) Changes in employees' job characteristics during anenterprise system implementation: a latent growth modeling perspective. MIS Q 37(4):1113–1140

Bashein BJ, Markus ML, Riley P (1994) Preconditions for BPR success and how to prevent failures. Inf Syst Manag 11(2):7–13

Beaudry A, Pinsonneault, A (2005) Understanding user responses to information technology: a coping model of user adaptation. MIS Q 29(3):493–525

Benlian A (2013) Effect mechanisms of perceptual congruence between information systems professionals and users on satisfaction with service. J Manag Inf Syst 29(4):63-96

Benlian A, Hess T (2011) Opportunities and risks of software-as-a-service: findings from a survey of IT executives. Decis Support Syst 52(1):232-246

Benlian A, Koufaris M, Hess T (2010) The role of SaaS service quality for continued SaaS use: empirical insights from SaaS using firms. In: Proceedings of the 31st ICIS

Blecker T, Kersten W (2006) Complexity management in supply chains: concepts, tools and methods. Schmidt, Berlin

Bharadwaj A, El-Sawy OA, Pavlou PA, Venkatraman N (2013) Digital business strategy: toward a next generation of insights. MIS Q 37(2):471–482

Bostrom, RP, Heinen JS (1977) MIS problems and failures: a socio-technical perspective. MIS Q 1(4):17–32

Boudreau M, Robey D (2005) Enacting integrated information technology: a human agency perspective. Organ Sci 16(1):3–18

Brender N, Markov I (2013) Risk perception and risk management in cloud computing: results from a case study of Swiss companies. Int J Inf Manag 33(5):726–733

Burda D, Teuteberg F. (2013) Towards understanding employee´s retention behavior: antecedents and implications for e-mail governance. In: Proceedings of the 34th ECIS

Burns T, Stalker GM (1961) The management of innovation. Tavistock, London

Campbell DJ (1988) Task complexity: a review and analysis. Acad Manag Rev 13(1):40–52

Cegielski C, Jones-Farmer L, Wu Y, Hazen B. (2012) Adoption of cloud computing technologies in supply chains: an organizational information processing theory approach. Int J Logist Manag 23(2): 184–211

Chin W. (1998) The partial least squares approach to structural equation modeling. In: Marcoulides G (ed) Modern methods for business research. Lawrence Erlbaum, Mahwah, pp 295–336

Danermark B. (2002) Explaining society: critical realism in the social sciences. Psychology Press

Featherman, MS, Pavlou PA (2003) Predicting e-services adoption: a perceived risk facets perspective. Int J Hum-Comput Stud 59(4):451–474

Fornell C, Larcker D (1981) Evaluating structural equation models with unobservable variables and measurement error. J Mark Res (XVII):39–50

Gefen D, Straub D, Boudreau M (2000) Structural equation modeling and regression: guidelines for research practice. Commun AIS 4: Article 7

Gersick CJG (1991) Revolutionary change theories: a multilevel exploration of the punctuated equilibrium paradigm. Acad Manag Rev 16(1):10–36

Gupta P, Seetharaman A, Raj J (2013) The usage and adoption of cloud computing by small and medium businesses. Int J Inf Manag 33(5):861–874

Hair JF, Hult GTM, Ringle CM, Sarstedt M (2013) A primer on partial least squares structural equation modeling. Sage

Herold DM, Fedor DB, Caldwell SD (2007) Beyond change management: a multilevel investigation of contextual and personal influences on employees'commitment to change. J Appl Psychol 92(4):942–951

Hirschheim R, Lacity M. (1998) Backsourcing: an emerging trend. J Strateg Outsourcing Inf 45(1):78–89

Hoberg P, Wollersheim J, Krcmar H (2012) The business perspective on cloud computing - a literature review of research on cloud computing. In: Proceedings of the 18th AMCIS

Holman D, Wood S, Wall T, Howard A (2005) Introduction to the essentials of the new workplace. In: Holman D, Wall TD, Clegg CW, Sparrow P, Howard A (eds) The essentials of the new workplace: a guide to the human impact of modern working practices, ii–xi. Wiley, New York

Hong K, Kim Y (2002) The critical success factors for ERP implementation: an organizational fit perspective. Inf and Manag 40(1):25–40

Janssen M, Joha A (2011) Challenges for adopting cloud-based software as a service (saas) in the public sector. In: Proceedings of the 19th ECIS

Jarvis CB, MacKenzie SB, Podsakoff PM (2003) A critical review of construct indicators and measurement model misspecification in marketing and consumer research. J Consum Res 30(2):199–218

Jede A, Teuteberg F (2015) Looking behind the stage: influence and effect of software-as-a-service on socio-technical elements in companies. In: Proceedings of the 36th ECIS

Kirsch LJ (2004) Deploying common systems globally: the dynamics of control. Inf Syst Res 15(4):374–395

Lee J, Miranda S, Kim Y (2004) IT outsourcing strategies: universalistic, contingency, and configurational explanations of success. Inf Syst Res 15(2):110–131

Lee S, Chae S, Cho K (2013) Drivers and inhibitors of SaaS adoption in Korea. Int J Inf Manag 33(3):429–440

Leimeister S, Boehm M, Riedl C, Krcmar H (2010) The business perspective of cloud computing: actors, roles and value networks. In: Proceedings of the 18th ECIS

Locke K (2001) Grounded theory in management research. Sage, London

Loos P, Fettke P, Weißenberger BE, Zelewski S, Heinzl A, Frank U, Iivari J (2011) What in fact is the role of stylized facts in fundamental research of business and information systems engineering? Bus Inf Syst Eng 3(2):107-125

Loske A, Widjaja T, Benlian A, Buxmann P (2014) Perceived IT security risks in cloud adoption: the role of perceptual incongruence between users and providers. In: Proceedings of the 22nd ECIS

Low C, Chen Y, Wu M (2011) Understanding the determinants of cloud computing adoption. Ind Manag Data Syst 111(7):1006–1023

Lyytinen K, Newman M (2008) Explaining information systems change: a punctuated sociotechnical change model. Europ J Inf Syst 17(6):589–613

MacKenzie S, Podsakoff P, Podsakoff N (2011) Construct measurement and validation procedures in MIS and behavioral research: integrating new and existing techniques. MIS Q 35(2):293–334

Marcoulides GA, Saunders C (2006) PLS: a silver bullet? MIS Q 30:iii-ix

Malladi S, Krishnan MS (2012) Cloud computing adoption and its implications for CIO strategic focus–an empirical analysis. In: Proceedings of the 33rd ICIS

Marston S, Li Z, Bandyopadhyay S, Zhang J, Ghalsasi A (2011) Cloud computing - the business perspective. Decis Support Syst 51(1):176–189

McAfee A (2011) What every CEO needs to know about the cloud. Harv Bus Rev 89(11):124–132

Mell P, Grance T (2011) The NIST definition of cloud computing. URL: http://pre-developer.att.com/home/learn/enablingtechnologies/The_NIST_ Definition_of_Cloud_ Computing.pdf. Accessed 30 March 2015

Meer D, Dutta K, Datta A (2012) A cost-based database request distribution technique for online E-commerce applications. MIS Q 36(2):479–507

Morgan L, Conboy K (2013) Factors affecting the adoption of cloud computing: an exploratory study. In: Proceedings of the 21st ECIS

Muthén LK, Muthén BO (2002) How to use a Monte Carlo study to decide on sample size and determine power. Struct Equ Model 9(4):599-620

Petter S, Straub D, Rai A (2007) Specifying formative constructs in information systems research. MIS Q 31(4):623–656

Pinsonneault A, Kraemer KL (1993) Survey research methodology in management information systems: an assessment. J Manag Inf Syst 10(2):75–105

Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP (2003) Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol 88(5):879–903

Polyviou A, Pouloudi N, Pramatari K (2014) Cloud adaption: relative advantage or IT fashion. In: Proceedings of the 22nd ECIS

Probst TM (2003) Exploring employee outcomes of organizational restructuring a Solomon four-group study. Group Organ Manag 28(3):416–439

Rousseau D (1977) Technological differences in job characteristics, employee satisfaction, and motivation: a synthesis of job design research and socio technical systems theory. Organ Behav Hum Perform 19(1):18–42

Schneider S, Sunyaev A (2016) Determinant factors of cloud-sourcing decisions: reflecting on the IT outsourcing literature in the era of cloud computing. J Inf Technol 31(1):1-31

Steers RM, Porter LW (1991) Motivation and work behavior. Sage, New York

Strauss A, Corbin J (1998) Basics of qualitative research: techniques and procedures for developing grounded theory, 2nd edn. Sage, Thousand Oaks

Susarla A, Barua A, Whinston AB (2010) Multitask agency, modular architecture, and task disaggregation in SaaS. J Manag Inf Syst 26(4):87–118

Sykes T, Venkatesh V, Johnson J (2014) Enterprise system implementation and employee job performance: understanding the role of advice networks. MIS Q 38(1):51–72

Van der Meulen R, Rivera J (2014) Gartner Says Worldwide Public Cloud Services Market to Total $ 131 Billion. http://www.gartner.com/newsroom/id/2352816. Accessed 15 October 2014

Venkatesh V, Bala H, Sykes T (2010) Impacts of information and communication technology implementations on employees' jobs in service organizations in India: a multi-method longitudinal field study. Prod Oper Manag 19(5):591–613

Venkatesh V, Brown SA, Bala H (2013) Bridging the qualitative–quantitative devide: guidelines for conducting mixed methods research in information systems. MIS Q 37(1):21–54

Venters W, Whitley E (2012) A critical review of cloud computing: researching desires and realities. J Inf Technol 27(3):179–197

Volkoff O, Strong D, Elmes M (2007) Technological embeddedness and organizational change. Organ Sci 18(5):832–848

Wang ETG, Klein G, Jiang JJ (2006) ERP misfit: country of origin and organizational factors. J Manag Inf Syst 23(1):263–292

Wang P, Ramiller NC (2009) Community learning in information technology innovation. MIS Q 33(4):709–734

Wang P (2010) Chasing the hottest IT: effects of information technology fashion on organizations. MIS Q 34(1):63–85

Webster J, Watson RT (2002) Analyzing the past to prepare for the future: writing a literature review. MIS Q 26(2):xiii–xxiii

Winkler TJ, Brown CV (2013) Horizontal allocation of decision rights for on-premise applications and software-as-a-service. J Manag Inf Syst 30(3):13–48

Wind S, Repschlaeger J, Zarnekow R (2012) Towards a cloud computing selection and evaluation environment for very large business applications. In: Proceedings of the 18th AMCIS

Wood R (1986) Task complexity: definition of the construct. Organ Behav Hum Decis Process 37(1):60–82

Yin RK (2003) Case study research: design and methods. Sage, Thousand Oaks

Youseff L, Butrico M, Da Silva D (2008) Toward a unified ontology of cloud computing. In: Grid Computing Environments Workshop 2008 (GCE), Austin

Appendix

All additional tables to this paper are available online and contain additional information:

Table I: Constructs and items contained in the research model
Table II: Cross loadings
Table III: Mean, standard deviation, loading, T-statistics
Table IV: Correlation matrix of constructs
Table V: Questionnaire guideline for expert interviews

Understanding Socio-Technical Impacts Arising from Software-as-a-Service Usage in Companies: A Mixed Method Analysis on Individual Level Data

Appendix

Table I: Constructs and items contained in the research model
Table II: Cross loadings
Table III: Mean, standard deviation, loading, T-statistics
Table IV: Correlation matrix of constructs
Table V: Questionnaire guideline for expert interviews

Table I Constructs and items contained in the research model

Construct	Item*	ID	Source of Items
Company´s increasing SaaS usage (CISU)	My company increases SaaS usage to solve problems if these services are effective.	CISU 1	(Autry et al. 2010)
	If there is a superior SaaS available, my company intends to use this service to address key concerns.	CISU 2	
	For the end user, working with a superior SaaS does not require much mental effort.	CISU 3	
	For the end user, a superior SaaS creates clear processes.	CISU 4	
Perceived IT security change (PISC)	Taking all factors into account that affect the overall IT security of the systems and data, security risk changes when using SaaS.	PISC 1	(Featherman and Pavlou 2003; Loske et al. 2014; Ackerman et al. 2012)
	Taking all factors into account that affect the overall IT security of the systems and data, uncertainty changes when using SaaS.	PISC 2	
	Taking all factors into account that affect the overall IT security of the systems and data, confidentiality changes when using SaaS.	PISC 3	
Perceived interface configuration change (PICC)	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other resources will be needed than before using SaaS.	PICC 1	(Cegielski et al. 2012; Benlian et al. 2010)
	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other information will be needed than before using SaaS.	PICC 2	
	Taking all factors into account that affect the overall IT interface configuration of the systems and data, other work processes will be needed than before using SaaS.	PICC 3	
Perceived IT architecture change (PIAC)	Taking all factors into account that affect the overall IT-architecture of the systems and data, other resources will be needed than before using SaaS.	PIAC 1	(Malladi and Krishnan 2012; Venters and Whitley 2012)
	Taking all factors into account that affect the overall IT-architecture of the systems and data, other information will be needed than before using SaaS.	PIAC 2	
	Taking all factors into account that affect the overall IT- architecture of the systems and data, other work processes will be needed than before using SaaS.	PIAC 3	
Perceived technical change radicality (PTCR)	Using SaaS, it is sometimes hard to understand the sequence of the relevant steps in specific core work processes.	PTCR 1	(Gupta et al. 2013; Loske et al. 2014; Cegielski et al. 2012)
	Using SaaS, it is sometimes hard to predict the relevant steps in specific core work processes.	PTCR 2	
	Using SaaS, the rate of technical changes increases.	PTCR 3	
Perceived IT organizational change (PIOC)	Using SaaS, specific core work processes are greatly different from what I used to perform before using SaaS.	PIOC 1	(Bala et al. 2013; Marston et al. 2011)
	Using SaaS, I need to use information for my tasks that I rarely used before using SaaS.	PIOC 2	
	Using SaaS, I need resources for my tasks that I rarely used before using SaaS.	PIOC 3	
	Using SaaS, my overall work processes are now different compared to my work processes prior to the SaaS implementation.	PIOC 4	
Perceived individual job outcomes (PIJO)	Using SaaS, my job satisfaction is lower than in the phase prior to SaaS usage.	PIJO 1	(Venkatesh et al. 2010)
	Using SaaS, my job acceptance is lower than in the phase prior to SaaS usage.	PIJO 2	
	Using SaaS, my job significance is lower than in the phase prior to SaaS usage.	PIJO 3	
Perceived individual process performance (PIPP)	Using SaaS, I believe that the ability to perform my tasks efficiently is lower than in the phase prior to SaaS usage.	PIPP 1	(Bala et al. 2013; Low et al. 2011)
	Using SaaS, I believe that the ability to perform my tasks effectively is lower than in the phase prior to SaaS usage.	PIPP 2	
	Using SaaS, I believe that the ability to meet the requirements of the tasks that are assigned to me is lower than in the phase prior to SaaS usage.	PIPP 3	

* When answering, the IT experts were asked to only consider public SaaS, which is used for core business processes.

Table II Cross loadings

	CISU	PISC	PICC	PIAC	PTCR	PIOC	PIJO	PIPP
CISU 1	0.768	0.480	0.252	0.246	0.398	0.335	0.376	0.178
CISU 2	0.851	0.574	0.234	0.310	0.514	0.508	0.495	0.285
CISU 3	0.832	0.537	0.277	0.387	0.497	0.524	0.419	0.370
CISU 4	0.759	0.470	0.180	0.172	0.567	0.473	0.414	0.292
PISC 1	0.436	0.802	0.342	0.427	0.533	0.534	0.510	0.305
PISC 2	0.496	0.752	0.335	0.334	0.584	0.458	0.485	0.259
PISC 3	0.611	0.872	0.415	0.569	0.715	0.650	0.672	0.449
PICC 1	0.212	0.364	0.784	0.533	0.294	0.262	0.360	0.244
PICC 2	0.348	0.400	0.808	0.544	0.344	0.352	0.432	0.314
PICC 3	0.139	0.335	0.837	0.583	0.326	0.179	0.359	0.208
PIAC 1	0.218	0.508	0.560	0.749	0.362	0.386	0.462	0.312
PIAC 2	0.425	0.458	0.483	0.810	0.452	0.412	0.281	0.352
PIAC 3	0.180	0.392	0.624	0.863	0.409	0.356	0.466	0.348
PTCR 1	0.652	0.694	0.463	0.495	0.850	0.616	0.566	0.297
PTCR 2	0.439	0.611	0.280	0.385	0.876	0.467	0.513	0.251
PTCR 3	0.472	0.625	0.250	0.400	0.820	0.528	0.559	0.317
PIOC 1	0.396	0.528	0.255	0.322	0.493	0.780	0.428	0.242
PIOC 2	0.472	0.546	0.323	0.447	0.527	0.778	0.446	0.275
PIOC 3	0.411	0.415	0.211	0.370	0.449	0.734	0.522	0.417
PIOC 4	0.510	0.616	0.228	0.326	0.501	0.790	0.514	0.280
PIJO 1	0.499	0.565	0.302	0.368	0.584	0.497	0.858	0.326
PIJO 2	0.429	0.675	0.530	0.457	0.583	0.597	0.884	0.443
PIJO 3	0.459	0.554	0.390	0.445	0.502	0.516	0.849	0.606
PIPP 1	0.271	0.293	0.241	0.238	0.225	0.332	0.440	0.864
PIPP 2	0.348	0.347	0.379	0.418	0.278	0.279	0.445	0.881
PIPP 3	0.323	0.453	0.234	0.426	0.370	0.410	0.488	0.883

Table III Mean, standard deviation, loading, T-statistics

Construct	Item	Mean	Standard deviation	Loading	T-Statistics
CISU	CISU 1	3.500	1.218	0.768	12.460
	CISU 2	3.712	1.064	0.851	18.904
	CISU 3	3.182	0.927	0.832	22.959
	CISU 4	3.561	0.879	0.759	12.058
PISC	PISC 1	3.652	0.953	0.802	15.220
	PISC 2	3.485	0.899	0.752	14.470
	PISC 3	3.742	0.917	0.872	23.640
PICC	PICC 1	3.288	0.780	0.784	7.728
	PICC 2	3.333	0.730	0.808	9.155
	PICC 3	3.424	0.703	0.837	12.813
PIAC	PIAC 1	3.485	0.932	0.749	10.788
	PIAC 2	3.288	0.799	0.810	13.402
	PIAC 3	3.258	0.810	0.863	14.784
PTCR	PTCR 1	3.788	1.045	0.850	23.872
	PTCR 2	3.712	0.941	0.876	17.303
	PTCR 3	3.727	0.921	0.820	12.180
PIOC	PIOC 1	3.833	0.887	0.780	12.153
	PIOC 2	3.894	0.897	0.778	10.542
	PIOC 3	3.591	0.784	0.734	7.655
	PIOC 4	3.742	0.933	0.790	12.869
PIJO	PIJO 1	3.652	0.903	0.858	21.443
	PIJO 2	3.530	1.084	0.884	32.460
	PIJO 3	3.758	0.929	0.849	17.860
PIPP	PIPP 1	3.621	1.106	0.864	8.249
	PIPP 2	3.561	1.010	0.881	8.577
	PIPP 3	3.652	0.850	0.883	11.600

Table IV Correlation matrix of constructs

	PIJO	PIPP	PTCR	PIOC	PISC	PICC	PIAC	CISU
PIJO	1.000							
PIPP	0.532	1.000						
PTCR	-0.263	-0.342	1.000					
PIOC	0.181	-0.075	-0.072	1.000				
PISC	0.526	0.372	-0.309	0.402	1.000			
PICC	0.487	0.327	-0.116	0.275	0.357	1.000		
PIAC	0.414	0.418	-0.127	0.334	0.387	0.662	1.000	
CISU	-0.487	-0.321	0.063	-0.427	-0.533	-0.355	-0.304	1.000

Table V *Questionnaire guideline for expert interviews*

Phase	Classification	Item
1	Personal	Name / Age / Gender
		How long have you been working with the company?
		What department are you working for?
		What is your specific job within the department?
2	SaaS usage	What kind of SaaS is your company using?
		How long is your company using this service?
		Who initiated the implementation?
3	Perceived individual job outcomes (PIJO)	Using SaaS, is your job satisfaction lower/higher than in the phase prior to SaaS usage?
		Using SaaS, is your job acceptance lower/higher than in the phase prior to SaaS usage?
		Using SaaS, is your job significance lower/higher than in the phase prior to SaaS usage?
	Perceived individual process performance (PIPP)	Using SaaS, do you believe that the ability to perform your tasks efficiently is lower/higher than in the phase prior to SaaS usage?
		Using SaaS, do you believe that the ability to perform your tasks effectively is lower/higher than in the phase prior to SaaS usage?
		Using SaaS, do you believe that the ability to meet the requirements of the tasks that are assigned to you are lower/higher than in the phase prior to SaaS usage?

References of Appendix

Ackermann T, Widjaja T, Benlian A, Buxmann P (2012) Perceived IT security risks of cloud computing: conceptualization and scale development. In: Proceedings of the 33rd International Conference on Information Systems, Orlando

Autry CW, Grawe SJ, Daugherty PJ, Richey RG (2010) The effects of technological turbulence and breadth on supply chain technology acceptance and adoption. J Oper Manag 28(6):522–536

Bala H (2013) The effects of IT-enabled supply chain process change on job and process outcomes: a longitudinal investigation. J Oper Manag 31(6):450–473

Benlian A, Koufaris M, Hess T (2010) The role of SaaS service quality for continued SaaS use: empirical insights from SaaS using firms. In: Proceedings of the 31st International Conference on Information Systems, Saint Louis

Cegielski C, Jones-Farmer L, Wu Y, Hazen B (2012) Adoption of cloud computing technologies in supply chains: an organizational information processing theory approach. Int J Logist Manag 23(2):184–211

Featherman MS, Pavlou (2003) Predicting e-services adoption: a perceived risk facets perspective. Int J Hum-Comput Stud 59(4):451–474

Gupta P, Seetharaman A, Raj J (2013) The usage and adoption of cloud computing by small and medium businesses. Int J Inf Manag 33(5):861–874

Loske A, Widjaja T, Benlian A, Buxmann P (2014) Perceived IT security risks in cloud adoption: the role of perceptual incongruence between users and providers. In: Proceedings of the 22nd European Conference on Information Systems, Tel Aviv

Low C, Chen Y, Wu M (2011) Understanding the determinants of cloud computing adoption. Indust Manag Data Syst 111(7):1006–1023

Malladi S, Krishnan MS (2012) Cloud computing adoption and its implications for CIO strategic focus – an empirical analysis. In: Proceedings of the 33rd international conference on information systems, Orlando

Marston S, Li Z, Bandyopadhyay S, Zhang J, Ghalsasi A (2011) Cloud computing – the business perspective. Decis Support Syst 51(1):176–189

Venkatesh V, Bala H, Sykes T (2010) Impacts of information and communication technology implementations on employees' jobs in service organizations in India: a multi-method longitudinal field study. Product Oper Manag 19(5):591–613

Venters W, Whitley E (2012) A critical review of cloud computing: researching desires and realities. J Inf Technol 27(3):179–197