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Deriving Trust Supporting Components for Ubiquitous Information Systems

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Geleitwort

Die Digitalisierung der Gesellschaft verändert die Art und Weise, wie wir arbeiten, leben, kommunizieren, miteinander interagieren und welche Produkte und Dienstleistungen wir wie und wann konsumieren und produzieren. Die Allgegenwärtigkeit von vernetzter Informationstechnik ist einer der Haupttreiber dieser Entwicklung und entsprechend sind ubiquitäre Informationssysteme einer der zentralen Forschungsgegenstände für die Wirtschaftsinformatik. Aus der Vergangenheit wissen wir, dass der Nutzen neuer Systeme nur dann gehoben werden kann, wenn sie auch genutzt werden. Einer der zentralen Treiber für die Nutzung von IT Innovationen ist das Vertrauen der Nutzer in die neuartigen Systeme.

Die vorliegende Dissertationsschrift von Matthias Söllner greift die Bedeutung von Vertrauen für den Erfolg von IT Innovationen auf. Das Ziel der Arbeit ist die Entwicklung einer Methode, die es ermöglicht, Erkenntnisse zur menschlichen Vertrauensbildung systematisch in die Entwicklung von ubiquitären Informationssystemen einfließen zu lassen. Hierzu werden die erforderlichen Grundlagen dargestellt, sowie die Besonderheiten von Vertrauen im Bereich ubiquitärer Informationssysteme dargestellt. Insbesondere wird gezeigt, dass die bisherigen theoretischen Erkenntnisse angereichert werden müssen, um eine vertrauenswürdigere Gestaltung von ubiquitären Informationssystemen zu ermöglichen. Im Rahmen der Dissertationsschrift wird daher ein eigener theoretischer Ansatz zur menschlichen Vertrauensbildung in ubiquitäre Informationssysteme präsentiert. Anschließend wird eine Methode entwickelt, mit deren Hilfe diese theoretischen Erkenntnisse in vertrauensunterstützende Komponenten für ubiquitäre Informationssysteme überführt werden können.

Die Arbeit ist sowohl für Praxis als auch Wissenschaft von hoher Relevanz. Sie zeigt, wie existierende theoretische Erkenntnisse zur menschlichen Vertrauensbildung systematisch in die Entwicklung innovativer Systeme einfließen können. Die geschaffenen Erkenntnisse können Entwickler ubiquitärer Informationssysteme bei der Gestaltung ihrer Systeme unterstützen und bieten viele Potentiale für weitergehende Forschung. Der Dissertationsschrift von Matthias Söllner wünsche ich daher die ihr gebührende Verbreitung.

Prof. Dr. Jan Marco Leimeister

Vorwort

Während zwischenmenschliche Vertrauensbeziehungen seit vielen Jahrzehnten intensiv beforscht werden, so steht die Beforschung von Vertrauensbeziehungen zwischen Mensch und Technik und der sich daraus ergebenden Implikationen für die Technikgestaltung noch am Anfang. Die Entwicklung eines theoretischen Ansatzes zur menschlichen Vertrauensbildung in ubiquitäre Informationssysteme und einer Methode, die es ermöglicht, diese Erkenntnisse systematisch in die Gestaltung dieser Systeme einfließen zu lassen, war daher nur mit tatkräftiger Unterstützung von mehreren Seiten möglich.

Mein Dank gilt allen, die mich im Laufe der Entstehung meiner Dissertation begleitet und unterstützt haben. An erster Stelle ist dies Prof. Dr. Jan Marco Leimeister, der mir im Dezember 2008 die Chance gegeben hat, in diesem Themenfeld zu promovieren. Zudem möchte ich mich bei ihm dafür bedanken, dass er mir in den letzten fünf Jahren genügend Zeit und Freiheit eingeräumt hat, um meinen eigenen wissenschaftlichen Interessen nachzugehen. Prof. Dr. Peter Eberl gilt mein Dank für die Übernahme des Zweitgutachtens und Prof. Dr. Alexander Roßnagel sowie Prof. Dr. Ivo Bischoff danke ich für die Mitgliedschaft in der Promotionskommission. Prof. Dr. Paul Pavlou gebührt mein Dank für die Vielzahl an Anregungen und Einblicken, die ich während meines Auslandsaufenthalts an der Temple University in Philadelphia gewinnen durfte.

Besonders Bedanken möchte ich mich bei meinen Kollegen Dr. Holger Hoffmann und Axel Hoffmann, die mit mir zusammen das Forschungsprojekt VENUS bearbeitet haben. Auch den restlichen „Bewohnern“ der VENUS danke ich für vier interessante Jahre mit vielen spannenden Herausforderungen und erzielten Erfolgen. In diesem Zusammenhang gilt mein Dank auch dem Hessischen Ministerium für Wissenschaft und Kunst für die Förderung des Projektes. Zudem danke ich auch den vielen Studierenden, die durch ihre Abschlussarbeiten zum Erfolg des Projektes beigetragen haben. Weiterhin danke ich den studentischen Hilfskräften, die mich während der letzten fünf Jahre bei der Erledigung meiner Aufgaben unterstützt haben. Hier ist vor allem Amanda Voss zu nennen, die mich fast seit Beginn meiner wissenschaftlichen Karriere zuverlässig unterstützt.

Weiterhin danke ich meinen Kollegen am Fachgebiet Wirtschaftsinformatik der Universität Kassel. Einerseits haben die vielen inhaltlichen Diskussionen und spannenden Paperprojekte zum Fortschritt der Arbeit sowie meiner persönlichen Entwicklung beigetragen. Andererseits haben die vielen Aktivitäten außerhalb der Arbeitszeit für die notwendige Ablenkung gesorgt. Hier sind vor allem Frau Lysann Gebauer und die Herren Philipp Bitzer, Michael Gierczak, Philipp Menschner, Andreas Prinz und René Wegener zu nennen.

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Matthias Söllner

Zusammenfassung

Problemstellung und Ziel der Arbeit: Einige Wissenschaftler erwarten, dass das verstärkte Aufkommen ubiquitärer Informationssysteme einen fundamentalen Paradigmenwechsel in der Wirtschaftsinformatik auslösen wird, da diese Systeme die Art der Interaktion zwischen Nutzer und Informationssystem grundlegend verändern. Bisherige Informationssysteme basieren auf einer aktiven Interaktion mit dem Nutzer und stehen damit oftmals im Fokus der Aufmerksamkeit. Ubiquitäre Informationssysteme hingegen sollen, durch Eigenschaften wie Kontextsensitivität und Selbst-Adaptivität, ihrem Nutzer eine an die aktuelle Situation angepasste Unterstützung zur Erreichung seiner Ziele zur Verfügung stellen. Dadurch soll der Fokus des Nutzers weg von der Interaktion mit dem Informationssystem, hin zur Erledigung der eigentlichen Aufgabe gelenkt werden, die dadurch besser oder schneller erledigt werden kann. Diesem zentralen Vorteil ubiquitärer Informationssysteme stehen jedoch auch Nachteile gegenüber. So agieren diese Systeme vorwiegend im Hintergrund und führen automatisiert verschiedene Aktivitäten durch, ohne dass der Nutzer davon zwingend Kenntnis erlangt. Weiterhin erfordert die situationsabhängige Unterstützung des Nutzers eine intensive Verarbeitung personenbezogener Daten. Diese beiden Umstände führen dazu, dass der Nutzer, zumindest zu einem gewissen Maße, die empfundene Kontrolle über diese Systeme und seine personenbezogenen Daten verliert und sie könnten dazu führen, dass potentielle Nutzer die Nutzung ubiquitärer Systeme ablehnen und die Potentiale dieser Systeme somit nicht gehoben werden können. In der Vergangenheit hat sich in vergleichbaren Systemen die Bildung von zusätzlichem Vertrauen in die neue Technologie als vielversprechender Problemlösungsansatz herausgestellt. In Bezug auf ubiquitäre Informationssysteme muss die Vertrauensforschung in der Wirtschaftsinformatik allerdings zuerst fünf Herausforderungen meistern, um Wissenschaftler und Praktiker besser dazu zu befähigen, vertrauenswürdigere ubiquitäre Informationssysteme zu entwickeln: 1) die Spezifikationsprobleme der aktuell eingesetzten Messmodelle für Vertrauen, 2) ein Mangel an formativen Messmodellen für Vertrauen, 3) fehlende Erkenntnisse zur Bedeutung von Vertrauen in verschiedene Stakeholder im Kontext der Adoption ubiquitärer Informationssysteme, 4) die Verwendung von theoretischen Grundlagen zu zwischenmenschlichem Vertrauen, bei der Analyse von Vertrauensbeziehungen zwischen Menschen und Informationssystemen und 5) ein Mangel an Methoden und

Techniken, die es Wissenschaftlern und Praktikern ermöglichen, die theoretischen Erkenntnisse anzuwenden, um vertrauenswürdigere Informationssysteme zu entwickeln. Entsprechend ist es das Ziel dieser Dissertation, zur Überwindung dieser fünf Herausforderungen beizutragen und damit die Entwicklung vertrauenswürdigerer ubiquitärer Informationssysteme zu unterstützen.

Forschungsdesign und –methodik: Um einen Beitrag zur Überwindung der fünf genannten Herausforderungen zu leisten, werden im Rahmen dieser Dissertation mehrere Forschungsmethoden miteinander kombiniert. Zuerst wird eine systematische Analyse der vertrauensbezogenen Forschungsbeiträge, die in den letzten 18 Jahren in den führenden internationalen Zeitschriften der Wirtschaftsinformatik veröffentlicht wurden, durchgeführt. Im Rahmen dieser Analyse werden die fünf vorgestellten Herausforderungen systematisch dargestellt. Anschließend wird auf experimentelle Laborforschung und Strukturgleichungsmodellierung zurückgegriffen, um zur Überwindung der ersten vier identifizierten Herausforderungen beizutragen. Um zur Überwindung des Mangels an Methoden und Techniken, die es Wissenschaftlern und Praktikern ermöglichen, vertrauenswürdigere ubiquitäre Informationssysteme zu entwickeln, beizutragen, wird anschließend auf Erkenntnisse zur gestaltungsorientierten Forschung und experimentellen Laborforschung zurückgegriffen.

Ergebnisse: Insgesamt werden in dieser Dissertation fünf Ergebnisse dargestellt. Das erste Ergebnis sind die fünf Herausforderungen, die im Rahmen der systematischen Analyse der Literatur dargestellt werden. Hierdurch wird aufgezeigt, welche Herausforderungen die vertrauensbezogene Forschung in der Wirtschaftsinformatik noch überwinden muss, um ihren Beitrag dazu zu leisten, dass die Potentiale ubiquitärer Informationssysteme gehoben werden können. Das zweite Ergebnis besteht in der Analyse, wie auf Basis existierender Erkenntnisse zur Vertrauensbildung ein korrekt spezifiziertes formatives Messmodell abgeleitet werden kann und dem Aufzeigen des Potentials eines solchen Messmodells für die vertrauenswürdige Gestaltung von Informationssystemen. Das dritte Ergebnis ist die Identifikation der verschiedenen Vertrauensbeziehungen, die für den Nutzer ubiquitärer Informationssysteme relevant sind und die Analyse, wie sich die verschiedenen Vertrauensbeziehungen gegenseitig, und auch zentrale Wahrnehmungen im Kontext der Adoption ubiquitärer Informationssysteme, beeinflussen. Hierbei wurde zum Beispiel identifiziert, dass der Vertrauensbeziehung zwischen dem Nutzer und dem ubiquitären Informationssystem die höchste Bedeutung zukommt, aber auch der

Vertrauensbeziehung zwischen dem Nutzer und dem Anbieter des Systems eine wichtige Rolle zuteil wird. Das vierte Ergebnis der Dissertation ist ein Modell, welches die menschliche Vertrauensbildung in ein ubiquitäres Informationssystem erklärt. Das Modell basiert im Schwerpunkt auf theoretischen Erkenntnissen zu Vertrauen in automatisierte Systeme und nicht, wie die bisherigen Modelle, auf Erkenntnissen zu zwischenmenschlichen Vertrauensbeziehungen. Im Rahmen der empirischen Evaluation des Modells wird gezeigt, dass es gut geeignet ist, um die menschliche Vertrauensbildung in ubiquitäre Informationssysteme zu erklären und vorherzusagen. Das fünfte Ergebnis ist eine Methode, mit deren Hilfe die theoretischen Erkenntnisse zur Vertrauensbildung in ubiquitäre Informationssysteme systematisch dazu verwendet werden können, um sogenannte vertrauensunterstützende Komponenten für ubiquitäre Informationssysteme abzuleiten. Die empirische Evaluation der vertrauensunterstützenden Komponenten zeigt, dass diese die adressierten Vertrauensdeterminanten, das Vertrauen des Nutzers und auch dessen Nutzungsintention erhöhen. Wissenschaftlern und Praktikern wird somit eine Methode zu Verfügung gestellt, um vertrauenswürdigere ubiquitäre Informationssysteme zu entwickeln, die mit höherer Wahrscheinlichkeit vom Nutzer adoptiert werden.

Theoretischer Beitrag: Basierend auf den erzielten Ergebnissen können drei zentrale theoretische Beiträge herausgestellt werden. Der erste theoretische Beitrag kann der Kategorie ‚Theory of Explanation and Prediction' zugeordnet werden. Dieser theoretische Beitrag umfasst die Identifikation von vier Vertrauenskonstrukten im Kontext der Adoption ubiquitärer Informationssysteme: Vertrauen in das ubiquitäre Informationssystem selbst, Vertrauen in den Anbieter des Systems, Vertrauen in die Gemeinschaft der Internetnutzer und Vertrauen in das Internet. Des Weiteren liefert dieser theoretische Beitrag Erkenntnisse über die Bedeutung der einzelnen Vertrauenskonstrukte. So werden die beiden Konstrukte Vertrauen in das ubiquitäre Informationssystem selbst und Vertrauen in den Anbieter des Systems als besonders bedeutsam identifiziert. Bezüglich des Vertrauens in die Gemeinschaft der Internetnutzer und des Vertrauens in das Internet konnte kein wichtiger Einfluss auf zentrale Wahrnehmungen wie Nützlichkeit oder Nutzungsintention festgestellt werden. Der zweite theoretische Beitrag kann ebenfalls der Kategorie ‚Theory of Explanation and Prediction' zugeordnet werden. Nachdem gezeigt wurde, dass dem Vertrauen in das ubiquitäre Informationssystem selbst die größte Bedeutung im Kontext der Adoption solcher Systeme zukommt, befasst sich der zweite theoretische Beitrag mit dem Zustandekommen dieses Vertrauens. Anders als konkurrierende Theorien basiert

dieser theoretische Beitrag nicht auf den Grundlagen zwischenmenschlicher Vertrauensbeziehungen. Vielmehr dienen Erkenntnisse zur Vertrauensbildung in automatisierte Systeme, die von Wissenschaftlern, die sich im Schwerpunkt mit Mensch-Maschine-Interaktion befassen, entwickelt wurden, als wesentliche Grundlage der im Rahmen dieser Dissertation entwickelten Theorie. Die Theorie liefert des Weiteren Erkenntnisse zum Einfluss der drei Vertrauensdimensionen: Performanz, Prozessnachvollziehbarkeit und Zweckklarheit. Alle drei Dimensionen haben einen bedeutenden Einfluss auf die Vertrauensbildung in ubiquitäre Informationssysteme, wobei der Zweckklarheit die größte Bedeutung zukommt, gefolgt von der Prozessnachvollziehbarkeit. Des Weiteren haben die Vertrauensdeterminanten mit Bezug zur Kontrolle und Sicherheit der personenbezogenen Daten einen sehr bedeutenden Einfluss auf die Bildung ihrer zugehörigen Vertrauensdimension und somit des Vertrauens in ubiquitäre Informationssysteme. Der dritte theoretische Beitrag kann der Kategorie ‚Theory of Design and Action' zugeordnet werden. Nachdem identifiziert wurde, wie sich das Vertrauen des Nutzers in ein ubiquitäres Informationssystem strukturell zusammensetzt, befasst sich der dritte theoretische Beitrag damit, wie diese Erkenntnisse dazu verwendet werden können, um ein konkretes ubiquitäres Informationssystem vertrauenswürdiger zu gestalten. Hierzu wird auf die Tatsache Bezug genommen, dass Vertrauen nur in Situationen, die durch Unsicherheit charakterisiert sind, relevant ist. Dieser Logik folgend, wird eine Methode entwickelt, mit Hilfe derer die Unsicherheiten, mit denen Nutzer bei der Verwendung des konkreten ubiquitären Informationssystems konfrontiert werden, identifiziert und anschließend theoriebasierte Gegenmaßnahmen abgeleitet, die sich in vertrauensunterstützenden Komponenten manifestieren. Die Anwendung der Methode und die damit verbundene Evaluation zeigen, dass die Methode dazu geeignet ist, konkrete vertrauensunterstützende Komponenten für ein ubiquitäres Informationssystem abzuleiten. Des Weiteren wird gezeigt, dass der Ansatz zur Entwicklung theoriebasierter Gegenmaßnahmen für die einzelnen Unsicherheiten funktioniert, da die adressierten Vertrauensdeterminanten, sowie das Vertrauen und die Nutzungsintention gesteigert werden können. Mit diesen theoretischen Erkenntnissen liefert die vorliegende Dissertation zudem einen Beitrag zur Behebung eines zentralen Mangels im Bereich der Wirtschaftsinformatik, denn die Methode zeigt nicht nur, dass ein Brückenschlag zwischen verhaltensorientierter Forschung auf der einen und gestaltungsorientierter Forschung auf der anderen Seite möglich ist, sondern auch welche Vorteile ein solcher Brückenschlag bietet.

Praktischer Beitrag: Der zentrale praktische Beitrag dieser Dissertation ist eine Methode zur Ableitung vertrauensunterstützender Komponenten für ubiquitäre Informationssysteme. Die Wirtschaftsinformatik definiert die Unterstützung von Praktikern bei der Entwicklung besserer Informationssysteme als eines ihrer Hauptziele. Dieses Ziel wird durch die Entwicklung der Methode adressiert. Mit Hilfe der Methode können Praktiker bei der Entwicklung von ubiquitären Informationssystemen auf Erkenntnisse der Vertrauenstheorie zurückgreifen und dadurch vertrauenswürdige Systeme entwickeln, die mit höherer Wahrscheinlichkeit vom Nutzer akzeptiert werden. Im Detail besteht die Methode aus fünf Entwicklungsaktivitäten. In der ersten Entwicklungsaktivität wird erläutert, warum Unsicherheiten, mit denen der Nutzer bei der Verwendung eines Systems konfrontiert ist, identifiziert und adressiert werden sollten. Des Weiteren wird aufgezeigt, wie diese Unsicherheiten identifiziert und priorisiert werden können. Anschließend wird in der zweiten Entwicklungsaktivität erklärt, wie mit Hilfe der Vertrauenstheorie die entsprechenden Vertrauensdimensionen identifiziert werden können, die helfen, den ausreichend hoch priorisierten Unsicherheiten entgegenzuwirken. In der dritten Entwicklungsaktivität wird beschrieben, wie die Determinante der relevanten Vertrauensdimension identifiziert werden kann, die sich am besten als Basis für die Ableitung einer konkreten Gegenmaßnahme für die zugehörige Unsicherheit eignet. Mit der Identifikation der geeigneten Vertrauensdeterminanten verlagert sich auch der Fokus der Methode, weg von der Vertrauenstheorie, hin zu Grundlagen des Requirement Engineerings. Dies ist notwendig, um sicherzustellen, dass die abstrakten Vertrauensdeterminanten, in der vierten Entwicklungsaktivität der Methode, vor dem Hintergrund des vorliegenden ubiquitären Informationssystems in konkrete vertrauensbezogene funktionale Anforderungen transformiert werden können. Diese Transformation stellt sicher, dass die Vorgaben aus der Theorie in jede gängige Softwareentwicklungsmethode einfließen können. In der fünften und abschließenden Entwicklungsaktivität der Methode wird erläutert, wie auf Basis der vertrauensbezogenen funktionalen Anforderungen konkrete vertrauensunterstützende Komponenten abgeleitet werden können, die das Vertrauen der Nutzer in das ubiquitäre Informationssystem und die Nutzungsabsicht positiv beeinflussen. Die Anwendbarkeit der Methode wird zusätzlich dadurch unterstützt, dass für jede Entwicklungsaktivität methodische Hinweise zur Durchführung gegeben und auch die zu erzielenden Ergebnisse definiert werden. Neben diesem zentralen praktischen Beitrag bietet diese Dissertation noch weitere praktische Beiträge: 1) Instrumente zur

Messung von Vertrauen, 2) die Identifikation der Bedeutung des Vertrauens in den Anbieter des Systems, woraus sich weitere Maßnahmen zur Vertrauensbildung ableiten lassen, 3) die identifizierten Determinanten von Vertrauen, die zum Aufbau von Vertrauen verwendet werden können und 4) vier konkrete vertrauensunterstützende Komponenten, die im Rahmen der Anwendung der Methode abgeleitet und evaluiert wurden. Je nach Art des ubiquitärem Informationssystems, das entwickelt werden soll, können diese vertrauensunterstützenden Komponenten mehr oder weniger leicht angepasst und eingesetzt werden.

Ausblick: Wie bereits betont wurde, ist es das Ziel dieser Dissertation, einen Beitrag zur Überwindung der fünf dargestellten Herausforderungen zu leisten, da es vermessen wäre, zu behaupten, dass diese im Rahmen einer einzigen Dissertation gänzlich überwunden werden können. Folglich schließt die Dissertation mit einer Reihe von Implikationen für zukünftige Forschung in diesem Bereich, von denen einige hier hervorgehoben werden. Erstes Potential für zukünftige Forschung bietet die Verbesserung der entwickelten Methode. In den letzten Jahren war beispielsweise zu beobachten, dass Erkenntnisse und Methoden, die dem Forschungsfeld ‚NeuroIS' zuzuordnen sind, an Bedeutung gewonnen haben. Diese könnten sich als wertvoll erweisen, um die Unsicherheiten des Nutzers in der ersten Entwicklungsaktivität der Methode noch objektiver und genauer zu identifizieren. Des Weiteren könnte die Nutzung von Design Pattern helfen, die Nachvollziehbarkeit der Ableitung der konkreten vertrauensunterstützenden Komponenten zu erhöhen. Weiteres Forschungspotential stellt die Überprüfung der Anwendbarkeit der Methode zur Ableitung von vertrauensunterstützenden Komponenten für andere Klassen von Informationssystemen dar. Dies sollte mit vergleichsweise geringem Aufwand möglich sein, da keine Entwicklungsaktivität spezifisch auf ubiquitäre Informationssysteme zugeschnitten ist. Ebenfalls kann überprüft werden, inwieweit die in der Methode verwendete Logik übertragbar ist, um konkrete Gestaltungsempfehlungen auf Basis anderer theoretischer Grundlagen abzuleiten. Dies sollte möglich sein, wenn geeignete Anknüpfungspunkte für die theoretische Herleitung von Gestaltungsempfehlungen identifiziert werden können – im Falle von Vertrauen sind dies die Unsicherheiten des Nutzers. Weiteres Potential stellt die Überprüfung der Übertragbarkeit der im Rahmen dieser Dissertation generierten Erkenntnisse, über die Phase des initialen Vertrauens hinaus, dar. Im Rahmen der Dissertation wurde sich auf diese Phase beschränkt; Forschungsergebnisse haben jedoch gezeigt, dass der Phase des initialen Vertrauensaufbaus und Adoption weitere Phasen, zum Beispiel die kontinuierliche Nutzung inklusive der Phasen

Vertrauenserhalt und Vertrauensrückgewinnung, folgen. Da die Vertrauensforschung gezeigt hat, dass sich die Einflussfaktoren mit zunehmender Dauer der Vertrauensbeziehung ändern können, könnten sich die aufgezeigten strukturellen Zusammenhänge zur Bildung von Vertrauen in späteren Nutzungsphasen verändern. Zuletzt soll das Potential für zukünftige Forschung durch die Untersuchung des Vertrauens in den Anbieter eines ubiquitären Informationssystems hervorgehoben werden. Im Rahmen der Dissertation wurde sich auf das Vertrauen des Nutzers in das ubiquitäre Informationssystem selbst beschränkt, da diesem Vertrauenskonstrukt auf Basis der Erkenntnisse der Dissertation die höchste Bedeutung zuzuschreiben ist. Darüberhinaus wurde das Vertrauen des Nutzers in den Anbieter des ubiquitären Systems als wichtiges Konstrukt identifiziert und eine Untersuchung, wie dieses Vertrauen zustande kommt und Erkenntnisse, wie es zur Vertrauensbildung verwendet werden kann, bieten weiteres Potential für die Entwicklung vertrauenswürdigerer ubiquitärer Informationssysteme.

Stichworte: Ubiquitäre Informationssysteme, Vertrauen, Vertrauen in unterschiedliche Stakeholder, Vertrauen in ubiquitäre Informationssysteme, Vertrauensunterstützende Komponenten, Methode zur Ableitung vertrauensunterstützender Komponenten für ubiquitäre Informationssysteme.

Abstract

Purpose: Ubiquitous information systems are proposed to represent a fundamental paradigm shift in IS research. Despite the advantages of such systems, they also come with disadvantages, such as their increasing automation and opaqueness. When aiming to develop ubiquitous information systems that are readily adopted and used by their intended users, those disadvantages need to be addressed. Building user trust in new technologies comparable to UIS has been shown to be a suitable approach in the past. However, IS trust research needs to overcome five challenges to empower researchers and practitioners to design more trustworthy ubiquitous information systems that are more readily adopted and used by their intended users: 1) measurement model mis-specification issues, 2) a lack of formative measurement models, 3) a lack of insights on the importance of different foci of trust, 4) the use of interpersonal trust theory when studying trust relationships between humans and IT artifacts, and 5) the lack of guidance of IT artifact design. These five challenges will be identified and addressed in this dissertation.

Methodology: This dissertation follows a multi-method approach aimed at identifying and helping to overcoming the five challenges. First, the five challenges are identified in a systematic literature review. Afterwards, three studies which rely on laboratory experimentation and structural equation modeling contribute to solving the first four challenges. Finally, a study combining design research and laboratory experimentation addresses the fifth challenge.

Findings: Among others, the dissertation provides three core findings. First, different foci of trust in the context of ubiquitous information systems adoption are identified and their importance is evaluated. Second, based on the first result, a model explaining the formation of trust in a ubiquitous information system is developed and evaluated. Third, a method which empowers researchers and practitioners to derive trust supporting components for ubiquitous information systems is developed. The application and evaluation of the method verifies that the method is suitable to develop effective trust supporting components for ubiquitous information systems, which, in turn, increase the trustworthiness of the system and the users' intention to use it.

Theoretical contribution: Related to the three core findings, the dissertation provides three core theoretical contributions. First, a theory of explanation and prediction of the

importance of different foci of trust in the context of ubiquitous information systems adoption is developed. According to this theory, trust in the system itself is the most important focus of trust followed by trust in the providers of the system. Second, a theory of explanation and predicting for the formation of trust in a ubiquitous information system is developed. The theory shows that trust in such a system consists of three dimensions – performance, process and purpose – which are formed by several antecedents. Third, a theory of design and action, showing how the theoretical insights on trust can be used to develop more trustworthy ubiquitous information systems is developed. Using this method, trust supporting components can be derived for a specific ubiquitous information system. Other theoretical contributions are the assessment of the current state of the art of IS trust research focusing on the readiness to inform the development of more trustworthy ubiquitous information systems, and the assessment of the value of formative measurement models for designing information systems.

Practical contribution: The method for deriving trust supporting components for ubiquitous information systems resembles the major practical contribution of this dissertation. The method empowers practitioners to derive trust supporting components for their specific ubiquitous information systems. They can rely on the presented method to guide them throughout the course of this process. The application and evaluation of the method shows that this will lead to the development of more trustworthy ubiquitous information systems that are more readily adopted and used by their intended users. Other practical contributions are the developed measurement instruments, the identification of the importance of trust in the provider of an ubiquitous information system, the identified antecedents of trust in ubiquitous information systems, and the four derived and evaluated trust supporting components.

Outlook: The dissertation provides future research possibilities in multiple areas. Regarding the refinement of the method, insights on NeuroIS and design patterns could further increase the rigor of development activities one and five. Regarding the applicability of the method, its suitability to derive trust supporting components for other classes of information systems should be assessed. Furthermore, it should be adaptable for deriving design elements related to other theoretical constructs when other suitable starting points can be identified; in the case of trust, these are the uncertainties. Regarding IS trust research, the importance of trust in the providers of ubiquitous information systems has been highlighted, and future research should investigate how this focus of trust forms and how it can be supported. The

identification of multiple foci also calls for an examination as to whether single foci can be isolated and studied without taking the others into account.

Key words: Ubiquitous information systems, trust, multifoci trust, trust in ubiquitous information systems, trust supporting components, method for deriving trust supporting components for ubiquitous information systems.

List of Publications

During my time as a PhD student, I authored and co-authored the following publications. Since most publications are related to the topic of my dissertation, the contents of my dissertation and publications might overlap. I will provide a note at the beginning of each section highlighting publications that significantly influenced the content of the specific section.

Manouchehri, S.; Söllner, M.; Leimeister, J. M. (2010): Trust as a Design Aspect of Context Aware Systems. In: Proceedings of the 23rd International Conference on Architecture of Computing Systems (ARCS 2010), Hannover, Germany, pp. 183-190.

Rudakova, L.; Söllner, M.; Leimeister, J. M. (2010): Warum Hochschulrechenzentren andere IT-Service-Management Konzepte brauchen - eine konzeptionelle Analyse. In: 40. Jahrestagung der Gesellschaft für Informatik 2010, Leipzig.

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Söllner, M.; Leimeister, J. M. (2010): 15 Years of Measurement Model Misspecification in Trust Research? A Theory-based Approach to Solve this Problem. In: European Academy of Management Annual Conference 2010, Rome, Italy.

Söllner, M.; Leimeister, J. M. (2010): Did They All Get it Wrong? Towards a Better Measurement Model of Trust. In: Academy of Management Annual Meeting 2010, Montréal, Canada.

Hoffmann, A.; Söllner, M.; Fehr, A.; Hoffmann, H.; Leimeister, J. M. (2011): Towards an Approach for Developing Socio-Technical Ubiquitous Computing Applications. In: 41. Jahrestagung der Gesellschaft für Informatik, Berlin, Germany.

Söllner, M.; Hoffmann, A.; Altmann, M.; Hoffmann, H.; Leimeister, J. M. (2011): Vertrauen als Designaspekt – Systematische Ableitung vertrauensunterstützender Komponenten am Beispiel einer mobilen Anwendung. In: VHB Jahrestagung 2011, Kaiserslautern, Germany.

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Gebauer, L.; Söllner, M.; Leimeister, J. M. (2012): Hemmnisse bei der Nutzung von Cloud Computing im B2B-Bereich und die Zuordnung dieser zu den verschiedenen Vertrauensbeziehungen. In: ConLife 2012 Academic Conference, Cologne, Germany.

Gierczak, M.; Söllner, M.; Leimeister, J. M. (2012): Untersuchung bestehender Geschäftsmodelle etablierter Cloud Anbieter. In: ConLife 2012 Academic Conference, Cologne, Germany.

Hoberg, S.; Schmidt, L.; Hoffmann, A.; Söllner, M.; Leimeister, J. M.; Voigtmann, C.; David, K.; Zirfas, J.; Roßnagel, A. (2012): Socially Acceptable Design of a Ubiquitous System for Monitoring Elderly Family Members. In: Proceedings of the 42. Jahrestagung der Gesellschaft für Informatik, Braunschweig, Germany.

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Söllner, M.; Hoffmann, A.; Hoffmann, H.; Leimeister, J. M. (2012): Vertrauensunterstützung für sozio-technische ubiquitäre Systeme. In: Zeitschrift für Betriebswirtschaft/Journal of Business Economics, Vol. 82 (2012) N. Supplement 4, pp. 109-140.

Söllner, M.; Leimeister, J. M. (2012): Opening up the Black Box: The Importance of Different Kinds of Trust in Recommender Systems Usage. In: 72nd Academy of Management Annual Meeting, Boston, Mass., USA.

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Hoffmann, A.; Hoffmann, H.; Söllner, M. (2013): Fostering Initial Trust in Applications - Developing and Evaluating Requirement Patterns for Application Websites. In: European Conference on Information Systems (ECIS), Utrecht, Netherlands.

Söllner, M.; Pavlou, P. A.; Leimeister, J. M. (2013): Understanding Trust in IT Artifacts - A New Conceptual Approach. In: Academy of Management Annual Meeting 2013, Orlando, FL, USA.

Söllner, M.; Leimeister, J. M. (2013): What We Really Know About Antecedents of Trust. In: Psychology of Trust: New Research. Ed.: Gefen, D. Nova Science Publishers, New York 2013, pp. 127-155.

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List of Abbreviations

AVE	Average Variance Extracted
CBSEM	Covariance-based SEM
CRM	Customer Relationship Management
ERP	Enterprise Resource Planning
FSE	Free Simulation Experiment
GUI	Graphical User Interface
HCI	Human Computer Interaction
IS	Information Systems
IT	Information Technology
ItU	Intention to Use
KAP	Knowledge, attitude, practice
MIS	Management Information Systems
ρ_c	Composite Reliability
PEOU	Perceived Ease of Use
PLS	Partial Least Squares
PU	Perceived Usefulness
RQ	Research Question
SCM	Supply Chain Management
SEM	Structural Equation Modeling
TAM	Technology Acceptance Model

TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
TSC	Trust Supporting Component
UIS	Ubiquitous Information Systems
VIF	Variance Inflation Factor

1 Introduction

1.1 Problem Statement

"One should expect trust to be increasingly in demand as a means of enduring the complexity of a future which technology will generate."
(Luhmann 1979, 16)

Ubiquitous information systems (UIS) are proposed to represent a fundamental paradigm shift in IS research (Vodanovic/Sundaram/Myers 2010). UIS are a specific sub-class of *information technology* (IT) artifacts, which are envisioned by Weiser (1991) to:

> "weave [themselves] into the fabric of everyday life until [they] are indistinguishable from it" (Weiser 1991, 78).

They are supposed to obtain and process information from the environment, and to use this information to adapt to the current situation, and especially, to the needs of the user by automatically providing the best possible support to the user in the given situation (Hoffmann et al. 2011). Thus, they resemble the continuation of the trend that the systems we use are becoming increasingly automated and opaque (Lee/See 2004). Examples of UIS range from systems ensuring that our mobile phones mute themselves when we enter a theatre to intelligent advertising pillars providing exactly the advertisement or news interesting and relevant to us or even to cars that drive completely autonomous based on the information they receive from the other participants, e.g., cars and pedestrians of the environment.

This trend has advantages, since new technologies are usually proposed to make life easier by supporting us in achieving our intended goals more efficiently. UIS are supposed to empower us to complete more tasks or to focus on more important ones in a given period of time at a given level of quality. However, using UIS also comes with disadvantages. UIS rely on intense interaction with the environment to automatically provide support to their users. Due to the increasing automation, the user of a UIS is decreasingly able to understand how the UIS works and what processes are used. Additionally, a user-centered adaptation and provision of support is only possible if the UIS has access to large amounts of personal user data. Consequently, the users of UIS also lose – at least to some extent – control over their personal data.

When aiming to develop UIS, we need to consider both, the advantages as well as the disadvantages. Otherwise, the developed systems will be refused by the intended users. Since the value of new technologies, such as UIS, can only be leveraged if they are accepted and used, developers of UIS need to develop their systems in a way that allows leveraging the advantages and accounts for disadvantages.

Sociologists, such as Luhmann, pointed out that trust is a useful mechanism to overcome situations of increasing complexity, e.g., generated by technology (Luhmann 1979). The value of trust has been shown in different areas of *information systems* (IS) research, such as e-commerce (Gefen/Straub 2004), virtual communities (Leimeister/Sidiras/Krcmar 2006), and generally the adoption of new technology (Gefen/Karahanna/Straub 2003a). As a consequence, different researchers emphasized the need for knowledge of the factors that build (Gefen/Karahanna/Straub 2003b) or support (Leimeister/Ebner/Krcmar 2005) trust. This need has been addressed by numerous contributions throughout the IS discipline, creating a huge body of knowledge on trust in IS research[1]. However, IS research still needs to overcome five challenges to further strengthen the existing insights which empower developers of UIS to develop their systems in a way that potential users trust the systems, hence increasing the systems' chances of being adopted and used[2].

One challenge is related to the fact that, thus far, the IS discipline's conceptualization of trust is mainly built on insights from sociology, psychology or management science, e.g., Mayer, Davis and Schoorman's (1995) work. Using this conceptualization, IS researchers have managed to create valuable insights, e.g., concerning online trust (McKnight/Choudhury/Kacmar 2002a; Benbasat/Gefen/Pavlou 2008). Nevertheless, this conceptualization has its limits, as it is based upon insights on trust in interpersonal relationships, e.g., trust between people, groups of people and organizations. This limitation is important, since this theoretical foundation has also been used to study trust relations between people and IT artifacts (Wang/Benbasat 2005; Komiak/Benbasat 2006). The adoption of this theoretical foundation is based on the computers are social actors paradigm (Nass/Moon 2000) purporting that people enter relationships with IT artifacts and respond to them in a way comparable to responding to other people (Nass/Steuer/Tauber 1994; Nass et al. 1995; Nass/Fogg/Moon 1996; Reeves/Nass 1996). However, this adoption has encountered

[1] See section 4 for a summary of the research on trust conducted in the IS discipline.
[2] The challenges presented in the next paragraphs will be derived in detail in the literature presented in section 4, and are based on information that will be provided in sections 2 and 3.

skepticism posed by some IS researchers (Friedman/Khan/Howe 2000; Gefen/Benbasat/Pavlou 2008). This becomes problematic when researching trust in UIS, because we now have to deal with a relationship between a human being and an IT artifact. Thus, the suitability of the predominant conceptualization of trust for studying such kinds of relationships is in question (Gefen/Benbasat/Pavlou 2008). Considering, e.g., using Mayer, Davis and Schoorman's (1995) interpersonal trust dimension benevolence to assess the trustworthiness of an IT artifact would imply that we assume that an IT artifact is able to actively decide whether to keep the interests of the trustor – its user – in mind or not. Söllner et al. (2012c) argue, e.g., that such a decision cannot be made by an IT artifact, as the artifact follows a specific predefined algorithm or logic. Thus, it is not capable of making choices comparable to human decision making. Consequently, it remains to be assessed whether the theoretical foundations of interpersonal trust are suitable to study trust relationships between people and IT artifacts – such as UIS – or whether another theoretical foundation is needed.

Another challenge is related to the increasing integration of IS in particular and the global economy in general. The management literature recently accounted for this issue by introducing multifoci research, accounting for the fact that, e.g., services are often times not provided by a single provider but a whole network of service providers (Leimeister 2012). Since, e.g., trust is a relational concept, the different trust relationships a user or a customer has to face should be investigated. Research following this approach is emerging in the management literature, and also in the IS literature, several contributions investigating multiple foci of trust, e.g., trust in the Internet and trust in a web vendor (McKnight/Choudhury/Kacmar 2002a). However, insights on the importance of different foci of trust in the context of IS adoption, especially increasingly automated IS such as UIS, is still missing. Consequently, it remains to be investigated which foci of trust are prevalent in the context of UIS adoption, and how important the single foci are.

Two further challenges are related to the fact that trust is conceptualized as a multidimensional construct (Mayer/Davis/Schoorman 1995; Jarvis/Mackenzie/-Podsakoff 2003; Lee/See 2004), consisting of different dimensions, like ability, that form trust. Despite the fact that this is known for more than one decade, research trying to zoom deeper into these dimensions of trust is missing. This problem has also been mentioned by Benbasat and Barki (2007), who call for a closer examination of

the formation of constructs like trust. The lack of research focusing on these aspects might be related to the fact that there is more information available on how to evaluate reflective measurement models rather than formative ones[3] (Jarvis/Mackenzie/Podsakoff 2003; Cenfetelli/Bassellier 2009). This has led to a dominance of reflective measurement models, resulting in some cases of measurement model mis-specification (Jarvis/Mackenzie/Podsakoff 2003; Petter/Straub/Rai 2007). Measurement model mis-specification is prevalent, when antecedents or dimensions of a construct are used as reflective (effect) indicators when operationalizing latent variables, like trust. The problem of measurement model mis-specification has already been identified and as a consequence trust researchers began to develop better measurement models for trust. Lowry et al. (2008) and Vance, Elie-Dit-Cosaque and Straub (2008), e.g., used reflective first-order, formative second-order measurement models (Jarvis/Mackenzie/Podsakoff 2003) to assess trust. Despite the fact that this is a step in the right direction and helps to overcome the issue of measurement model mis-specification, it does not allow researchers to gain closer insight into the single dimensions which form trust, since these dimensions are measured in a reflective way.

Last but not least, despite the numerous, mainly behavioral, publications dealing with trust in the IS domain, a method describing how to use the behavioral insights on trust theory to enrich IT artifact development in general and UIS development in particular is still missing. Up until now, most practical implications drawn for the behavioral results are on a very high level, and poorly suitable to serve as a basis for deriving detailed trust-related design choices for IT artifacts, so called *trust supporting components* (TSC) (Leimeister/Ebner/Krcmar 2005). Regardless of the numerous contributions on trust in IS literature, the question how the behavioral insights can be translated into design features for specific IS remains unanswered. Consequently, a method that describes how the behavioral insights regarding trust can be systematically used during UIS development is needed to ensure that the development of UIS can by enriched by TSCs.

1.2 Solution Statement and Research Questions

The aim of the proposed dissertation project is to contribute to IS research by helping to overcome the five challenges highlighted in section 1.1. To achieve this aim, the thesis poses and answers five *research questions* (RQ).

[3] See section 3.3.1 for a details on and differences between reflective and formative measurement models.

First of all, the current state of the art in IS trust research needs to be assessed. This synthesis of the current literature will create the basis for the successive steps contributing to overcome the three challenges. The review will provide insights on the trustees studied in IS trust research, the antecedents of trust that have been identified, as well as the quality of measurement model specification in IS trust research. Furthermore, insights on the theoretical foundation used to study trust in IT artifacts and the use of trust theory to design IT artifacts will be created.

RQ1: How ready is IS trust research for empowering developers of UIS to account for the increasing importance of trust during UIS development, in terms of the conceptualizations used, antecedents identified and types measurement models employed, as well as guiding designers to design more trustworthy UIS?

Method: Systematic literature review of the articles published in the journals included in the AIS senior scholars' basket of journals (Senior Scholars Forum 2007) between 1995 and 2012.

Results: Structuring of the current literature on trust in IS research. Identification of the next steps needed to further strengthen the value of IS trust research for UIS development.

One result of the review conducted for RQ1 is that formative measurement models are rarely used in IS trust research. Only few papers using a formative measurement approach were found. When reviewing these papers, it seemed that the advantages of assessing trust formatively were not highlighted. More even, formative measurement models appear to have only been used in these papers, because they enabled the authors to avoid measurement model mis-specification[4]. Consequently, RQ2 addresses how formative measurement models can help to avoid measurement model mis-specification and the value of assessing trust using a formative approach for developing IT artifacts.

RQ2: What is the value of using a formative measurement approach for trust when aiming to design trustworthy UIS?

[4] See section 3.3.1 for details on formative measurement models and measurement model mis-specification.

Methods: *Free Simulation Experiment* (FSE), *Structural Equation Modeling* (SEM), model comparison

Results: Quantitative comparison of formative and reflective measurement approaches for trust. Advantages of choosing a formative measurement approach for IT artifact design.

After showing the value of a formative measurement approach for the design of IT artifacts, RQ3 addresses the question whether different foci of trust are prevalent in the context of UIS adoption. Studies in the management disciplines followed this so-called multifoci approach, and identified the existence and distinct impact of several foci of trust in different contexts. An employee, e.g., can have different degrees of trust in his supervisor, his colleagues and the CEO of a company, and the different foci of trust could have distinct consequences[5]. Since IS trust research also studied trust in different targets – reflecting different foci of trust – this approach could help to enrich IS trust research findings concerning different foci of trust, their formation and consequences. Thus, RQ3 assesses the importance of different foci of trust in UIS adoption.

RQ3: Do users perceive different foci of trust in the context of UIS adoption, and if yes, do the different foci influence each other and do they have distinct effects on other constructs important for UIS adoption?

Methods: Analysis of the different foci of trust prevalent in UIS adoption, FSE, SEM

Result: Model explaining the importance of different foci of trust in UIS adoption

The results of the quantitative study conducted in RQ3 revealed that trust in the UIS itself is the most important focus of trust in UIS adoption in terms of impact on constructs such as *perceived usefulness* (PU) and *intention to use* (ItU). Consequently, RQ4 investigates the formation of trust in the UIS by developing and evaluating a formative first-order, formative second-order measurement model of trust in UIS.

RQ4: Which factors form trust and what impact do they have on the users' trust in a UIS?

[5] Details on this so-called multifoci approach to assess constructs such as trust are presented in section 2.4.6.

Method: Discussion of the suitability of different theoretical foundations, development of a formative first-order, formative second-order measurement model for the formation of trust in UIS, FSE, SEM

Result: Argumentation for the selection of a theory on trust in automation as a theoretical basis for assessing the formation of trust in UIS, Formative first-order, formative second-order measurement model for trust in UIS

After the acquisition of knowledge of the formation of trust in UIS in RQ4, it remains unclear how these insights can be systematically used during UIS development. Fostering clarity on this issue is important, since the behavioral insights alone cannot support developers of UIS in developing more readily adopted UIS. Consequently, RQ5 addresses this issue by developing and evaluating a method for deriving TSCs for UIS.

RQ5: How can the behavioral insights on the formation of trust in UIS be used to develop UIS which will be more readily adopted by their intended users?

Methods: Design Research, Laboratory Experiment, Regression Analysis

Result: Method for deriving TSCs for UIS

By posing and answering these five RQs, this thesis offers several contributions to IS trust research in particular and IS research in general.

A core goal of the IS discipline is supporting developers in developing IT artifacts that are accepted by their intended users (Benbasat/Zmud 2003). The objective of the proposed dissertation project is to contribute to solving the five challenges introduced in section 1.1. As a result, my dissertation has three core theoretical contributions to the IS discipline. The first one is a theory of explanation and prediction (Gregor 2006) of the impact of different foci of trust in the context of UIS adoption. The second one is a theory of explanation and prediction for the formation of trust in ubiquitous computing systems. The third contribution is a method for deriving trust supporting components for ubiquitous computing systems from trust theory that will assist developers in designing more trustworthy ubiquitous computing systems, increasing the probability that these will be accepted and adopted by the intended users. According to Gregor (2006), this is a theoretical contribution of the type of design and

action. Besides this core contribution, my dissertation offers several other contributions to theory and practice which are presented in sections 9.1 and 9.2.

1.3 Structure of the Dissertation

To achieve its goals and answer the RQs presented in section 1.2, the remainder of my dissertation is structured as follows (see Figure 1 for an illustration). First, I will provide the necessary theoretical (section 2) and methodological background (section 3) to answer my five RQs. Afterwards, a systematic literature review of the IS literature on trust will be conducted in section 4. Within this review, the five challenges described in section 1.1 will be derived, and guide the subsequent sections of my dissertation. In section 5, I will address the two methodological challenges, and show the value of using a formative measurement approach for developing trustworthy UIS. In section 6, I will identify the different foci prevalent in the context of UIS adoption and their importance in terms of impact on other foci and consequences of trust. In section 7, I will develop a formative first-order, formative second-order measurement model for the formation of trust in UIS. Finally, in section 8, I will develop a method empowering researchers and practitioners to use the acquired insights on the formation of trust in UIS to develop more trustworthy UIS. The dissertation closes with a summary of the theoretical and practical contributions as well as areas for future research in section 9.

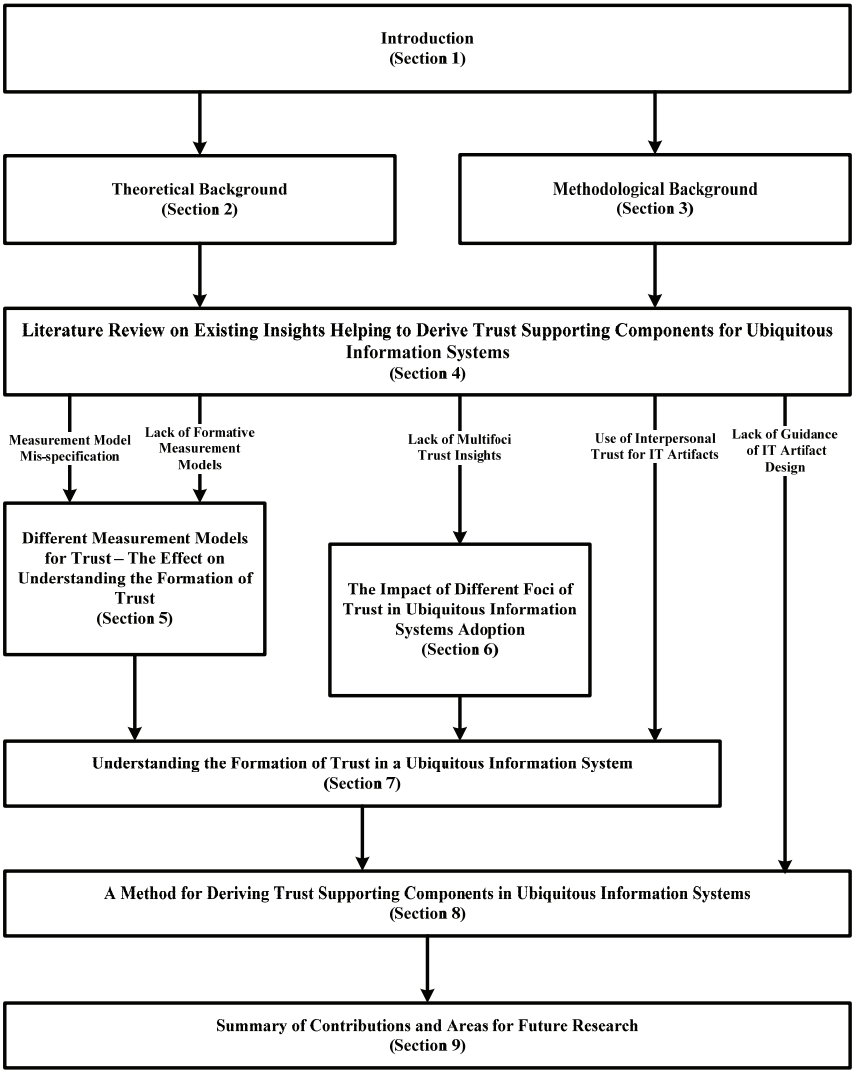


Figure 1: **Structure of my dissertation**
Source: Own illustration

2 Theoretical Background

2.1 Ubiquitous Information Systems

One major aim of IS research is to study information systems and their use in business and administration (WKWI 1994). The *Wissenschaftliche Kommission der Wirtschaftsinformatik* (WKWI) defines information systems as:

> „soziotechnische („Mensch-Maschine-“) Systeme, die menschliche und maschinelle Komponenten (Teilsysteme) umfassen und zum Ziel der optimalen Bereitstellung von Information und Kommunikation nach wirtschaftlichen Kriterien eingesetzt werden (WKWI 1994, 80).“

Following this definition, IS are characterized as having human und technical components and are used to effectively and efficiently provide information. The definition explicitly emphasizes that IS have a human and a technical component that interact with each other. A new class of IS, so-called UIS, have been proposed to represent a fundamental paradigm shift in IS research (Vodanovic/Sundaram/Myers 2010). UIS stem from Marc Weiser’s vision of ubiquitous computing:

> „The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it (Weiser 1991, 94).”

In accordance with this vision, technology becomes ubiquitous when it becomes part of everyday life of its users. In many cases, the users are no longer realizing the fact that they use some kind of technical artifact, because it has become so normal to them to do whatever the technical artifact enables the users to do (Demers 1994). In the beginning this might sound somehow strange, but Demers (1994) uses the example of the telephone to illustrate his thoughts. He argues that if I were to tell you “I spoke with my parents in Rehau yesterday evening,” you would implicitly understand that I used the telephone network to do so. Furthermore it would sound strange if I said something like “Yesterday evening, I operated my telephone set to speak with my parents in Rehau.”

Since the publication of Weiser’s (1991) article, numerous researchers used and extended his vision, and started to study *ubiquitous computing systems* (UCS) in different contexts. Due to this plethora of different studies, adopting and adapting

Weiser's vision, the exact scope of UCS is hard to define. In general, UCS can be divided into machine-machine UCS and human-machine UCS. A manufacturing plant that is run by robots that autonomously interact with each other, without the presence of any humans is, e.g., a machine-machine UCS. These systems are not dealt with in this thesis. This thesis focuses on UCS that are used by humans, and thus, fulfill the requirements of IS provided in the definition. Following Vodanovic, Sundaram and Myers (2010), I use the term UIS in the remainder of this thesis, since this term provides the best fit for the primary audience of this thesis – IS researchers.

Regarding the characteristics of UIS, Hoffmann et al. (2011) reviewed core papers on UIS and compared the different characteristics used to describe UIS (see Table 1).

Source	Focus of attention	Context adaptivity	Automated capture	Simplicity	Mobility	Communication/ connectivity	Implicit input
Abowd (1999)	●	●	●	-	-	●	-
Abowd and Mynatt (2000)	●	●	●	●	●	●	●
Bell and Dourish (2007)	-	-	-	-	●	●	-
Demers (1994)	●	-	-	-	●	●	-
Lyytinen and Yoo (2002)	●	●	-	-	●	●	-
Rekimoto and Naga (1995)	●	●	-	●	●	●	●
Robinson, Vogt and Wagealla (2005)	-	●	-	●	●	●	-
Schmidt (2002)	●	●	-	-	●	-	●
Weiser (1991)	●	●	-	●	-	●	-
Weiser and Brown (1996)	●	-	-	-	-	●	-
Weiser, Gold and Brown (1999)	-	-	-	●	-	-	-
● mentioned by author(s)			- not mentioned by author(s)				

Table 1: Key characteristics of UIS
Source: Adapted from Hoffmann et al. (2011)

Many authors consider the *focus of attention* as fundamental in their works. Basically, ubiquitous technology aims at lowering the user's technological awareness by providing natural interfaces and intuitive user guidance (Abowd 1999). In this regard, conventional technology is seen as a barrier (Abowd 1999) because it must become second nature to the user to comply with the requirements of ubiquitous technology (Demers 1994). As a consequence, technology disappears into the background and the user concentrates on the actual task in the real world instead (Abowd/Mynatt 2000). To put it in a nutshell, only if a tool is mastered, it can disappear from the user's

awareness (Weiser 1991). Thus, ubiquitous technology should be designed for user requirements, like task orientation and ease of use (Schmidt 2002).

The feature *context adaptivity* is another crucial aspect of ubiquitous technology because it supports the user. A context aware ubiquitous device is able to sense information from the physical and computational environment (Abowd 1999) so as to dynamically configure its services accordingly (Lyytinen/Yoo 2002) and enable rapid personalization (Abowd 1999). The user's situation is automatically sensed by a range of recognition methods in order to assist without explicitly being instructed to do so (Rekimoto/Nagao 1995). However, the user's expectation of a system and the anticipation of the reaction of it highly depend on the situation, environment and prior experience (Schmidt 2002).

Only Abowd (1999) and Abowd and Mynatt (2000) name the feature *automated capture*, which describes the permanent capture of the environment to allow users to access past situations. While the system is waiting in the background, always ready for action, the user can receive support whenever necessary.

According to many authors and users, *simplicity* is one key to success. It therefore plays a prominent role in the design of ubiquitous technology (Abowd/Mynatt 2000). Today's high-tech society increasingly desires a reduction of complexity in computing operations. As a consequence, one of ubiquitous technology's initiatives is to effectively make the complex mass of technology transparent to the user, especially to those with limited technical know-how (Robinson/Vogt/Wagealla 2005). The presence of a high level of ubiquitous technology in our environment will make everyday life easier, and obtaining information will become trivial (Weiser 1991). New technology, like natural interfaces (Abowd/Mynatt 2000) and implicit input (Rekimoto/Nagao 1995), contribute to a general ease of use. Still, maintaining simplicity and control simultaneously remains one of the major concerns ubiquitous technology research faces.

Today, we can observe the rapid emergence of an infrastructure that enables mobile computation in nearly every place of the world. *Mobility*, in this context, is the capability to access computing services everywhere (Lyytinen/Yoo 2002), and yet, to work with familiar user interfaces and applications (Robinson/Vogt/Wagealla 2005). While users shift between different activities and environments, the available computing resources need to dynamically adapt (Abowd/Mynatt 2000). However, this

inevitably requires a smooth networking of devices in an environment (Demers 1994) and creates the challenge to combine large-scale mobility with pervasive computing (Lyytinen/Yoo 2002).

The research field of ubiquitous technology also requires taking *communication* and *connectivity* into account. Ubiquitous technology not only tries to connect physical and virtual worlds (Abowd/Mynatt 2000) by means of bidirectional communication between devices and the environment (Lyytinen/Yoo 2002), but also poses further challenges in connecting hardware and software (Weiser 1991). Idealistically, there should be seamless interoperation between devices and homogeneity in communication (Bell/Dourish 2007).

Today's hectic high-tech society lets *implicit input* gain in importance because it minimizes user intervention in everyday life (Abowd/Mynatt 2000). A ubiquitous system can perceive the user's interaction with the physical environment and assess the overall situation (Schmidt 2002). Anticipating the user's goals, the device is able to assist in further processes without explicitly being instructed to (Rekimoto/Nagao 1995) or can even perform tasks autonomously (Abowd/Mynatt 2000).

2.1.1 Context-Adaptive Systems

As shown in the previous section, a plethora of research on UIS exists, and there is no consensus about the key characteristics. In this thesis, several prototypes of UIS developed within the interdisciplinary research project VENUS[6] will be used to evaluate single theoretical contributions. The specific prototypes will be introduced in the related section of the thesis. They all have context-aware and self-adaptive traits in common, and thus, are so called *context adaptive systems* (CAS). CAS [7] are seen as a first step towards the ubiquitous information systems envisioned by Weiser (1991) (Abowd/Mynatt 2000), and thus allow drawing UIS-related conclusions. CAS are defined as "computer-based systems that are capable of recognizing changes in the domain they share and interface with, and at the same time being able to change their behavior to adapt to the changing conditions without necessary direct user interaction"

[6] VENUS is a research cluster at the interdisciplinary Research Center for Information System Design (ITeG) at Kassel University. I thank Hesse's Ministry of Higher Education, Research, and the Arts for funding the project as part of the research funding program "LOEWE – Landes-Offensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz". For further information, please visit: http://www.uni-kassel.de/eecs/en/iteg/venus/

[7] There are several synonyms such as context-aware adaptive systems, context-aware, self-adaptive systems or context-adaptive information systems. I decided to follow the term context-adaptive systems, since it contains the same information – the system adapts based on the given context – in less words.

(Chin/Thatcher/Wright 2012, 593). Based on this definition, two core challenges of CAS can be identified: 1) CAS need to assess and correctly interpret the context of the user, and 2) CAS need to adapt to changes in the context to support their user.

In order to assess and correctly interpret the context of the user, CAS usually rely on a number of different sources. Examples include sensors (e.g., temperature or brightness), computational and physical environmental information (e.g., the weather, time, location or bandwidth), or user information (e.g., the user's calendar) (Schilit/Adams/Want 1994; Dey 2001). Using one or more of these, CAS are able to correctly identify the user's context. A user could, e.g., have an appointment in his or her calendar that he or she will be at a movie theater this evening. By combining the calendar information with the current time and location of the user, the CAS is able to evaluate whether the appointment in the calendar is correct.

After having assessed and correctly interpreted the context of the user, the CAS needs to adapt properly. The adaptation is usually more complex than the context interpretation since the preferences of the user in the specific situation as well as available third party services or user-generated content need to be considered. In the best case scenario, detailed information is available to ensure a successful adaptation. The user has defined the movie he or she wants to watch, the time that the movie will begin, the exact address of the movie theater, and provided appropriate information as to whether he or she will walk or travel by car. In possession of this information, the CAS can, e.g., remind the user in time and provide navigation information. However, in practice this information is usually incomplete, which suggests that the CAS would need to adapt differently to support a user. Assuming the user has not yet decided which movie to watch, the CAS can search for a third party service provided by the movie theater offering the current program in combination with viewer ratings from IMDb for each movie. If such a service is available, the CAS would automatically integrate the service to help the user to find the most suitable film.

The examples I have used to illustrate CAS – what they are and how they work – show that CAS, in most cases, need to rely on other factors (such as third-party providers offering services, and people providing user-generated content) to provide support to their users.

2.1.2 Socio-Technical System Design

„If a technical system is created at the expense of a social system, the results obtained will be sub-optimal."
(Mumford/Weir 1979)

Socio-technical system design focuses on the design of a technical system which is supposed to be used by human users in a social system. Consequently, every time a social system is developed, its impact on the respective social system it shall be used in needs to be considered. As a result, the design parameters of a socio-technical system go beyond purely technical design components, and include incentive structures which ensure that users are more readily willing to effectively use the system. The ultimate goal of socio-technical system design is to develop a reliable technical system which is eagerly adopted and used by the intended users, and also fulfills the social and economic requirements posed by the social system it is supposed to be used in (Leimeister/Krcmar 2006).

This dissertation aims at contributing to develop UIS in such a way that they are more willingly adopted and used by their intended users. Since UIS pose new challenges in social areas, such as user privacy (Diekmann 2007; Söllner et al. 2012c), considering the social system is especially important when developing UIS. Consequently, it is important to consider relationships of cause and effect between the technical and social system in early stages of the development process of a UIS. Since I aim to contribute to the development of UIS that are more readily adopted and used, and because it is very hard to define the scope of a social system, this thesis especially focuses on the relationship between the potential users and the technical system. As a result, relying on knowledge of factors that enhance the users' willingness to adopt and use a UIS, such as the focus of this thesis, namely *trust*, is important when developing a socio-technical system, like a UIS. Considering such aspects during the development of UIS increases the chance that the developed UIS will be adopted and used by numerous intended users. Furthermore, focusing on both, social and technical aspects during system development will ensure that using the UIS will come with the intended advantages and the risk of potential negative impacts on the social system it is used in are minimized.

Figure 2 illustrates the information provided in this section by highlighting the different design parameters of a socio-technical system. Using this knowledge of socio-technical system design as a basis, I especially focus on addressing the

components of a technical system (Pree 1997; Szyperski 2002), and the technical system as a whole.

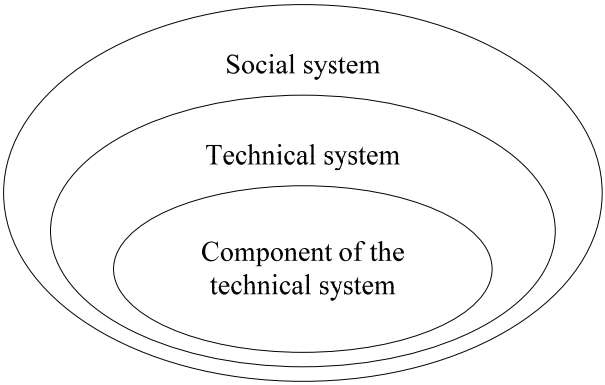


Figure 2: Design parameters of a socio-technical system
Source: Adapted from Söllner et al. (2012b)

2.2 The Interplay Between Behavioral and Design Research

In the previous section, I highlighted the importance of considering relationships of cause and effect between the social and the technical system when developing UIS that are readily adopted and used by their intended users. Consequently, we face two distinct challenges in developing such UIS: finding or creating the respective relationships of cause and effect, and using these insights during the development process. When examining the global IS community, both challenges fall into different sub-communities. There are different ways to break the global IS community down into different sub-communities. I will follow Hevner et al.'s (2004) differentiation between behavioral and design research.

The behavioral research paradigm stems from the natural science research. Its goal is to develop and evaluate theories (often containing relationships of cause and effect) that explain or predict organizational and human behavior in the context of IS development and use. The theories inform researchers and practitioners of the relationship among people, technology, and organizations. On the one hand, insights from these theories can be the source for justifying specific design decisions during IS development. On the other hand, experiences concerning the use of IS in practice may provide new insights that challenge existing theory, and call for an adaptation of the same (Hevner et al. 2004). The design research paradigm stems from engineering and

sciences of the artificial (Simon 1996). This paradigm aims at solving real-world problems by developing new artifacts, such as UIS. These artifacts are not built without relying on any theory. In fact, developers usually rely on so-called kernel theories that are applied, tested, and modified based on their application and experiences gathered in practice (Walls/Widmeyer/El Sawy 1992; Markus/Majchrzak/Gasser 2002; Hevner et al. 2004). Figure 3 shows the interplay between the two paradigms.

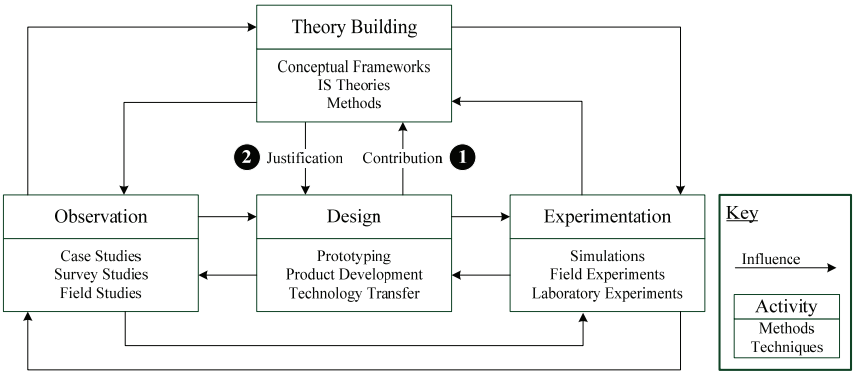


Figure 3: Interplay between behavioral and design research
Source: Adapted from Gehlert et al. (2009)

2.3 Research on Information Systems Acceptance

After having addressed what UIS are and what should be considered during UIS development, this section provides theories on how and why a developed UIS is adopted and used by its intended users or not, and how adoption and use can be positively influenced. First, I will present two theories from psychology which serve as a basis for different theories explaining why people use IT artifacts, such as IS and UCS. Afterwards, I will explain the different stages a person passes through when deciding whether to adopt and use a specific technology. Next, I will present theoretical findings regarding what drives the users' adoption and use of IT artifacts. These insights show that trust is a major driver of users' adoption and use. Consequently, I present different theoretical insights dealing with trust that will be used in the remainder of my dissertation. The theoretical background closes with a description of how precise TSCs for UCS can be derived based on the plethora of theoretical information about trust.

2.3.1 Theory of Reasoned Action

Most of the models and theories frequently used to explain the adoption and usage of IS rely on foundations described in the theory of reasoned action (TRA) (Fishbein 1967; Ajzen/Fishbein 1973; Fishbein/Ajzen 1975). According to the TRA, human behavior can be rationally explained and has its roots in beliefs, attitudes and intentions.

Beliefs are the fundamental building blocks of the TRA. People form various beliefs about an object based on observations or received information. That means they associate the object with different attributes. Similarly, people also form beliefs about themselves, other people, behaviors, organizations, etc. The different beliefs are listed in Figure 4, and it is crucial to stress that different beliefs might influence each other. The attractiveness of a specific woman or man, e.g., might be influenced by the respective group the woman or man belongs to. For example, Italian women and men were voted the most attractive women and men in Europe (Abendzeitung München 2009; Zoover 2011). Consequently, an unknown Italian woman or man could be viewed as being more attractive just because Italian women and men are regarded as more attractive in general. All beliefs combined serve as a basis for determining a person's attitudes, intentions and behaviors (Fishbein/Ajzen 1975).

While people form multiple beliefs about an object, they are supposed to form only one attitude per object. *Attitudes* are the aggregates of the different beliefs toward an object. Consequently, people will form a positive attitude toward an object if the beliefs are mainly associated with favorable attributes. Beliefs which are mainly associated with unfavorable attributes will lead to a negative attitude.

Based on their attitude, people develop different *intentions* to perform various behaviors with respect to an object. A favorable attitude toward Wikipedia could, e.g., result in intentions such as willingly relying on Wikipedia, or donating money to Wikipedia.

Each intention is related to its respective *behavior*. As stated in the TRA, people will behave consistent to their intentions. Consequently, a person that intends to donate money to Wikipedia will actually donate money (Fishbein/Ajzen 1975).

As Figure 4 shows, the described process is not as linear as the description implies. Usually, behavioral experiences made with respect to an object might update one or

more of the initial beliefs about that object. In the same way, the attitude toward an object can influence the way new information or observations related to the object are interpreted. This can influence the beliefs formed based on this new information or these observations (Fishbein/Ajzen 1975).

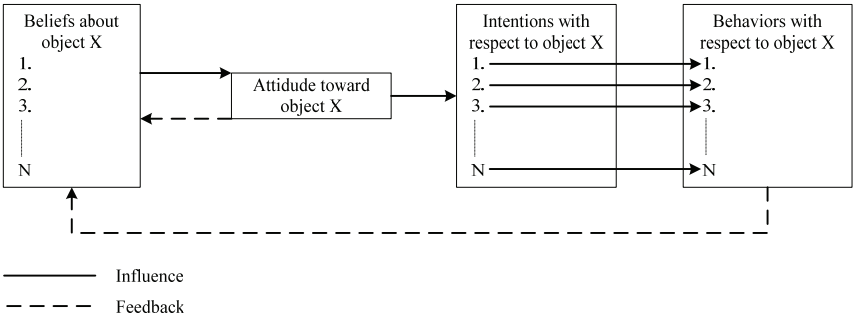


Figure 4: **Schematic presentation of the conceptual framework relating beliefs, attitudes, intentions and behaviors with respect to a given object**
Quelle: Fishbein and Ajzen (1975, 15)

The TRA has been used in various contexts to predict specific behaviors. Researchers usually focus on one specific intention and behavior (e.g., use of an IS). Another factor is of importance for predicting behaviors, namely *subjective norm*. Subjective norm represents the different beliefs associated with the environment of a person. A child might want to behave like its parents do, or not at all. In combination with the attitude toward a specific behavior, subjective norm is considered a main driver of people's intention to display this behavior. While subjective norm is formed through normative beliefs about a behavior, the attitude toward a behavior is formed based on the beliefs about the consequences of that behavior. In the context of IS, such beliefs about consequences could be, e.g., that the IS will be useful, easy to use and is trustworthy (see sections 2.3.4 and 2.3.5 for further details). Both, the beliefs about the consequences and the normative beliefs about a behavior might by updated based on experiences of performing the respective behavior (see Figure 5) (Fishbein/Ajzen 1975).

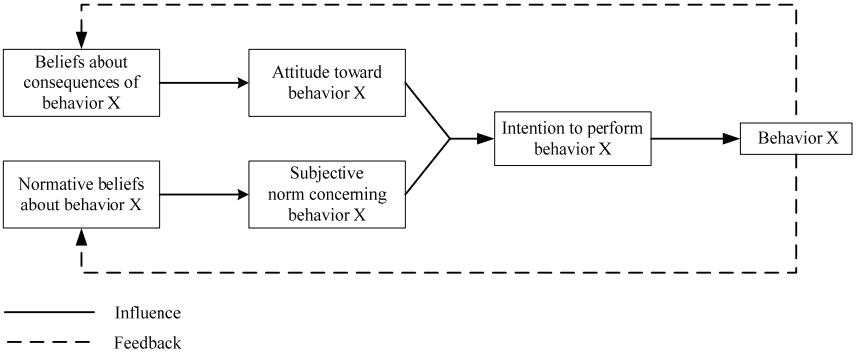


Figure 5: **Schematic presentation of the conceptual framework for the prediction of specific intentions and behaviors**
Source: Fishbein and Ajzen (1975, 16)

2.3.2 Theory of Planned Behavior

The application of the TRA in various contexts has provided empirical support for most parts of the theory, but also highlighted several limitations. Limitations of the TRA are that attitudes can oftentimes easily be reframed as norms and vice versa. Furthermore, the TRA posits that an intention will always lead to the respective behavior. In reality, numerous constraints such as limited time, environmental limits and unconscious habits exist and limit people's freedom to act. In order to resolve these limitations, the *theory of planned behavior* (TPB) (Ajzen 1985; Ajzen 1991) was developed (Eagly/Chaiken 1993).

The core innovation of the TPB is the introduction of the construct *perceived behavioral control*. Contradictory to the TRA, the TPB hypothesizes that a behavior is not only determined by the intention. According to the TPB behavior is determined by the intention and the perceived behavioral control. Perceived behavioral control reflects the resources and opportunities available to a person. In an organizational context, e.g., an employee is sometimes forced to use a specific IS. In these situations, the employee would use the IS even if he himself has a mainly negative attitude toward the IS. Similarly, numerous people would buy a Ferrari if they could. In this case, we can assume that there is a mainly positive attitude toward buying a Ferrari and also a high willingness to do so. However, a Ferrari is usually quite expensive and many people cannot afford to buy one. These two examples show that a lack of

behavioral control can force people to display, or to deny a specific behavior (Ajzen 1991).

Besides having an impact on actual behavior, perceived behavioral control is also supposed to be the third predictor of an intention. Consequently, the TPB posits that all three predictors of an intention are formed by a different set of beliefs. Behavioral beliefs are supposed to form a person's attitude toward a behavior. Normative beliefs are supposed to determine the construct subjective norm, and control beliefs are supposed to form perceived behavioral control. Furthermore, the three predictors are believed to influence each other (see Figure 6). Being forced to use an IS in the organizational context could, e.g., cause an employee to accept that he needs to use this IS, to achieve the possible results in this situation. This could have a positive influence on the employee's attitude toward the IS. The TPB is well supported by empirical evidence, and serves in combination with the TRA as the theoretical foundation for the following models and theories for the adoption and use of technical innovations such as UIS (Ajzen 1991).

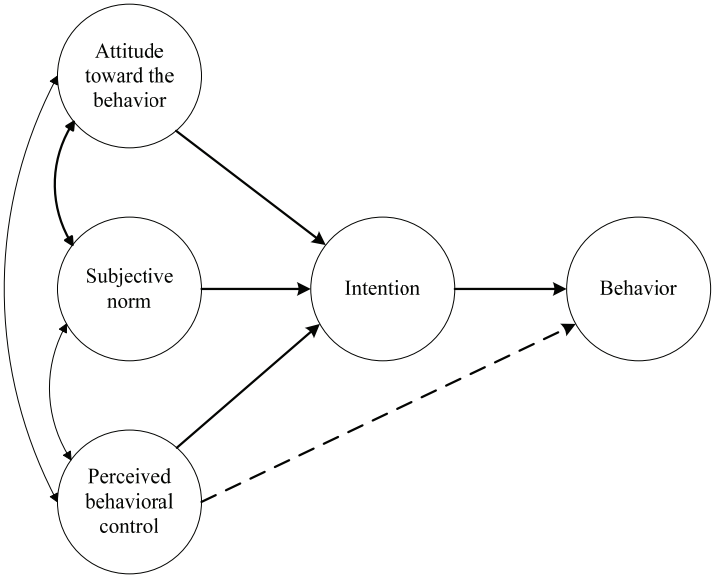


Figure 6: **Theory of planned behavior**
Source: Ajzen (1991, 182)

2.3.3 The Innovation-Decision Process

When aiming to understand why a user decides to adopt and use an innovation – such as a UIS – previous research quickly recognized the value of following a process-based view (Ryan/Gross 1943), and developed different models, such as the innovation-decision process (Rogers 2003).[8] This model encompasses the whole process beginning with the user gaining knowledge of the innovation, proceeding to the continued adoption or rejection of the system. It consists of a total of five stages (see Figure 7).

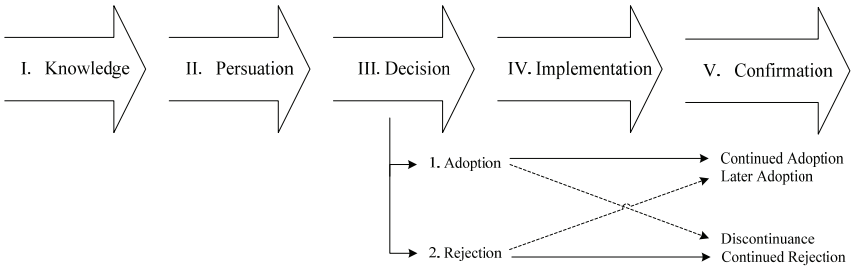


Figure 7: **The innovation-decision process**
Source: Adapted from Rogers (2003, 170)

The Knowledge Stage. This stage is the first in the innovation-decision process. It begins when a potential user is exposed to the existence of an innovation and starts to understand how it works (Rogers 2003).

The potential user can take an active or passive role when being exposed to an innovation. An active potential user faces a specific problem or need and is looking for solutions to solving the problem or fulfilling the need. Assuming that I wish to move out of my apartment into a better one, I will check the internet for websites that aggregate listings of available apartments and might find a website unknown to me. In the case of a passive user, the potential user does not face a specific problem or need. He is confronted with an innovation by chance, and this exposure creates a need to gather more information about the innovation. Apple's iPhone is a good example for this case. Most of the first iPhone customers were hardly actively looking for a device as the iPhone. However the advertising of this new smartphone and its potential value made lots of people buy the iPhone (Rogers 2003).

[8] A more detailed description of the innovation-decision process can be found in Roger's (2003, 168-218).

During the decision to adopt or reject an innovation, the potential user usually tries to gather information about the advantages and disadvantages of the innovation. When gathering information, the potential user is guided by questions such as “What is the innovation?” “How do I use it?” and “How does it work?” These questions resemble three different types of knowledge the potential user seeks to gain: awareness knowledge, how-to knowledge and principles knowledge. Awareness knowledge represents information about the existence of an innovation. This knowledge comes first and may motivate the potential user to seek for the two other types of knowledge. How-to knowledge represents knowledge about how to use the innovation properly. The amount of information that needs to be gathered to gain a necessary amount of how-to knowledge is directly connected to the complexity of the innovation. From my personal experience, I can say that it took me a lot more time to gather enough how-to knowledge about my network-attached storage system compared to the iPhone. The third type, principles knowledge represents information on the functioning underlying principles of an innovation. Such knowledge helps the potential user to judge the quality of the innovation. This information is especially important in the professional context. In the private context, most potential users do not have enough background knowledge on the vast amount of possible underlying principles to appropriately judge the quality of an innovation. Moreover, this type of knowledge is not that important in the private context. It is usually enough for the potential user to understand what his TV, smartphone or personal computer does and how these devices have to be used (Rogers 2003).

Seeking information to acquire these three types of knowledge is typical for the knowledge stage of the innovation-decision process. However, in most cases, it also continues during the persuasion and decision stages (Rogers 2003).

The Persuasion Stage. After the potential user has gathered a first set of information to acquire the three different types of knowledge, he or she enters the persuasion stage. In this stage, the potential user builds a favorable or unfavorable attitude toward the innovation. Rogers’s defines an attitude as

> „a relatively enduring organization of an individual’s beliefs about an object that predisposes his or her actions (Rogers 2003, 174-175).”

When forming this attitude, the potential user combines his or her different beliefs about the innovation that were mainly cognitively built during the acquisition of knowledge in the previous stage. Furthermore, besides the cognitive beliefs, affective

perceptions (such as feelings) are also incorporated into the favorable or unfavorable attitude toward the innovation. This attitude is the main outcome of this stage of the innovation-decision process. Based on the TRA and TPB, this attitude is assumed to lead to related behavior in the decision stage (favorable attitude is assumed to lead to the decision to adopt the innovation and vice versa). However, empirical evidence shows a discrepancy between attitude and actual behavior, known as the *knowledge, attitudes, practice* (KAP)-gap. Rogers et al. (1999) report that almost all people in childbearing age are informed about the different family planning methods and have a favorable attitude toward using them. However, only about 15-20 percent actually used contraceptives. This example shows that a favorable or unfavorable attitude toward an innovation does not automatically lead to an adoption or rejection (Rogers 2003).

The Decision Stage. The formation of a favorable or unfavorable attitude toward an innovation is followed by activities that lead to the decision to adopt or reject the innovation. The two core terms of this stage – adoption and rejection – are defined by Rogers as follows:

> "Adoption is a decision to make full use of an innovation as the best course of action available (Rogers 2003, 177)."

> "Rejection is a decision not to adopt an innovation (Rogers 2003, 177)."

A common way to decide whether to adopt or reject an innovation is to try it out on a partial basis. Actually, hardly any potential user adopts an innovation without trying the innovation to sharpen the perception about the innovation's usefulness for the specific situation they intend to use it in. Whether trying an innovation leads to its adoption depends mainly on the perceived relative advantage of the innovation compared to a situation in which the innovation is not available for use. Nevertheless, the innovation-decision process can result in the decision to accept or reject an innovation. More precisely, every stage in the process is a potential rejection point. In the knowledge and persuasion stages, a potential user could, for instance simply forget the innovation he was exposed to. This case is called passive rejection, since the potential user never really considered using the innovation. In the decision stage, the potential user could come up with the decision to reject the innovation. This is called active rejection, since the potential user actually makes the decision not to adopt the

innovation. Even after adopting the innovation, the user can change his mind during the implementation and confirmation stage (Rogers 2003).

The Implementation Stage. In this stage, the user puts the innovation to use. Entering this stage represents a shift in the innovation-decision process from primarily thinking and deciding towards a more practice-focused exercise. In the implementation stage, the user usually still faces some uncertainty about the usefulness of the innovation. Thus, the user seeks to answer such questions as "How do I use the innovation?" and "Which problems am I likely to encounter during usage, and how can I solve them?" Consequently, comparable to the knowledge stage, the implementation stage includes intense information seeking behavior to answer such questions (Rogers 2003).

In the private context, the implementation stage is, in most cases, relatively unproblematic. This is different in an organizational context, since decision makers and users of innovations are usually different sets of people. This can cause huge problems, e.g., when the decision makers do not consider the needs of the intended users (Rogers 2003). Despite that fact that this information has been available for decades, the rejection of innovations by organizational users is still a major problem in practice, and a specific field of literature deals with this phenomenon (see, e.g., Rivard and Lapointe (2012)). I also had to face several situations of this kind during my time as a research assistant. One situation can really be used a prototype on how it should not be done. This dissertation resulted from my research in the VENUS project. This project is quite big, and involves seven departments. Additionally, at the end of the project, several experts from the ministry visited us and reviewed our results. In the course of this visit, almost every research assistant was asked to design a poster summarizing his research. To ensure a common design of the posters, a group consisting of one professor and several research assistants had to decide which software should be used for designing the posters. While the professor wanted the research assistants to use a particular software, almost all of the research assistants wished to use a different software. Ultimately, the professor ordered that his choice of software had to be used. This resulted in numerous problems during the design of the poster, and, in the end, an additional expert, who was trained to use this particular software, had to be paid to ensure the uniformity of the posters.

The Confirmation Stage. This stage represents the last in the innovation-decision process. In this stage, the user (or the potential user who decided to reject the innovation) seeks reinforcement for the decision already made.

There are four possible scenarios in this stage that can be illustrated using the example of the iPhone. In the first scenario, the user selected the iPhone and now his cell phone contract is about to expire. He has the options to continue using his iPhone for a bonus on his monthly fee, or he can buy a new phone for a special price. If the user decides to continue using this iPhone, it is called continued adoption. If the user decides to stop using his iPhone and buys a new phone, it is called discontinuance. For scenarios three and four, we assume that the user made the decision to use an Android smartphone instead of the iPhone, and faces a similar decision. If the user decides to stop using his Android smartphone and buys an iPhone, it is referred to as a later adoption of the iPhone. If the user decides to continue using his Android smartphone, it is called continued rejection of the iPhone. These four scenarios could become prevalent for any innovation in the confirmation stage in the innovation-decision process. Regarding the example of the software for designing posters, I think it is possible to deduce which scenario occurred. All research assistants stopped using the software they were forced to use by the professor.

2.3.4 Technology Acceptance Model

Research on technology acceptance is a core stream in IS research, since some of the few native IS theories were developed within this stream (Straub 2012). Providing a detailed overview on technology acceptance research could easily be the topic of a whole dissertation. Thus, I will only present the very fundamental aspects of this research to illustrate why I focused on deriving trust supporting components in this dissertation.

The first core contribution of technology acceptance research is the *technology acceptance model* (TAM) (Davis 1986; Davis 1989; Davis/Bagozzi/Warshaw 1989). Based on Davis's doctoral dissertation (Davis 1986), two articles were published in major academic journals. Davis, Bagozzi and Warshaw (1989) adapted the TRA and presented as well as evaluated the TAM. Davis (1989) focuses on developing valid and reliable scales for two core TAM constructs: *perceived usefulness* (PU) and *perceived ease of use* (PEOU).

The goal of TAM is to explain the determinants of computer acceptance across various end-user computing technologies and user populations, and to be parsimonious and theoretically justified at the same time. Furthermore, the results created by investigating a specific technology should inform researchers and practitioners about

the quality of the technology and enable them to derive measures to improve end-user acceptance (Davis/Bagozzi/Warshaw 1989).

To fulfill its purpose, TAM aims to provide a basis for tracing the impact of external variables on beliefs (PU and PEOU), the attitude toward using the technology, the intention to use the technology and actual use (see Figure 8).

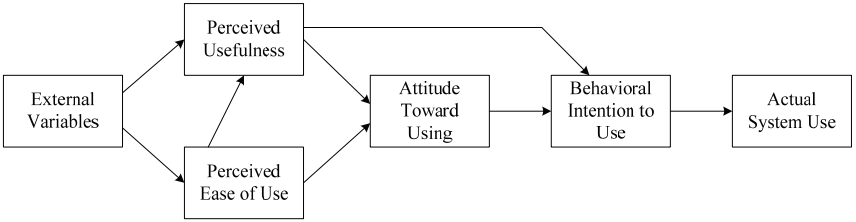


Figure 8: **Technology acceptance model**
Source: Davis, Bagozzi and Warshaw (1989, 985)

Following the TAM, PU and PEOU are the two drivers for technology acceptance behavior.

> PU "is defined as the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context (Davis/Bagozzi/Warshaw 1989, 985)."

> PEOU "refers to the degree to which the prospective user expects the target system to be free of effort (Davis/Bagozzi/Warshaw 1989, 985)."

Comparing Figure 5 and Figure 8, we can identify several adaptations of the TRA in the TAM. Besides graphical adaptations such as an interrelationship between PU and PEOU, which is in line with the TRA and the inclusion of external factors that form the two beliefs, there are also two divergences in content. First, the TAM omits the construct subjective norm. Davis, Bagozzi and Warshaw (1989) provide several argumentations and empirical results questioning the construct subjective norm. Furthermore, they conduct an empirical test, and show that subjective norm has no significant impact on the intention to use. Second, the TAM introduces a direct relationship between the belief PU and intention to use, and is hereby based on empirical evidence (Davis/Bagozzi/Warshaw 1989).

The first version of the TAM has had a huge impact on research in IS. It has been cited twice as often as any other MIS Quarterly article (MIS Quarterly 2012). Furthermore it has been updated several times (Venkatesh/Davis 2000; Venkatesh et al. 2003; Venkatesh/Bala 2008), and numerous studies focused on extending the different TAM versions, e.g., by adding new beliefs which drive system usage (Gefen/Karahanna/Straub 2003b; Pavlou 2003). The interested reader is invited to revisit these articles for further details on technology acceptance research. Within the context of my dissertation only one detail is important, since it could cause confusion in the next section. In the first update of the TAM (Venkatesh/Davis 2000), attitude was omitted and the different beliefs are proposed to directly influence intention to use. This adaptation was adopted by the majority of subsequent works.

2.3.5 Trust-TAM

A prominent adaptation of the TAM is the so-called Trust-TAM (the respective paper is the fifth most cited MIS Quarterly paper (MIS Quarterly 2012)). Gefen, Karahanna and Straub (2003b) integrated trust as the third belief in the TAM, and aim to study the importance of trust in the context of online shopping adoption. This so-called Trust-TAM (see Figure 9) was later successfully adopted by Wang and Benbasat (2005) to study the importance of trust in the context of recommender agents adoption.

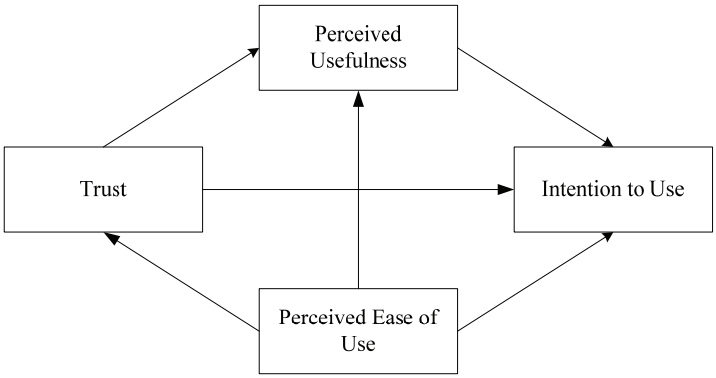


Figure 9: **Trust-TAM**
Source: Adapted from Gefen, Karahanna and Straub (2003b) and Wang and Benbasat (2005)

Following the Trust-TAM, trust[9] is a crucial factor which fosters technology acceptance in situations characterized by interactions between, e.g., a buyer and a vendor (Gefen/Karahanna/Straub 2003b), or a user and an IS (Wang/Benbasat 2005).

Trust helps people to reduce the complexity they face when interacting with other people or IS (Gefen/Karahanna/Straub 2003b). Thus, trust encourages them to adopt and use an IS, such as a recommendation agent, or to participate in an IT mediated transactional relationship, e.g., with an e-vendor. Additionally, people will perceive a vendor or IS they trust to be better suited to help them achieve their goals, which has a positive influence on their PU. Furthermore, if they perceive the website of an e-vendor or an IS to be easy to use, they will perceive the e-vendor or the IS as more trustworthy, since they would question the ability of a website or an IS to support them effectively if they would perceive it as not being easy to use (Gefen/Karahanna/Straub 2003b; Wang/Benbasat 2005).

Both Gefen, Karahanna and Straub (2003b) and Wang and Benbasat (2005), as well as subsequent studies (Söllner et al. 2010; Söllner/Leimeister 2011) provided empirical support for the importance of trust in the context of technology acceptance.

To address an important detail regarding Trust-TAM and technology acceptance, I compare the trust foci, PU and PEOU and behavioral intentions studied by Gefen, Karahanna and Straub (2003b) and Wang and Benbasat (2005) (see Table 2).

	Gefen et al. (2003b)	**Wang and Benbasat (2005)**
Trust focus	e-vendors	Recommender agents
PU and PEOU targets	e-vendor websites	Recommender agents
Behavioral intentions	Intentions to use a website and purchase on this website	Intentions to use a recommendation agent to get shopping advice

Table 2: Differences between the two Trust-TAM studies
Source: Adapted from Wang and Benbasat (2005)

The comparison shows that both studies address comparable PU and PEOU targets and behavioral intentions. Both studies focus on PU and PEOU related to an IS, and on the intention to use the IS to purchase or to obtain advice. The difference lies within the foci of trust both studies address. Gefen, Karahanna and Straub (2003b) study interpersonal trust relationships between potential buyers and e-vendors; Wang and

[9] Trust is the core construct of my dissertation. Since section 2.4 will present the trust-related theoretical foundations of my thesis, I will omit some theoretical details on trust presented by the Trust-TAM authors.

Benbasat (2005) focus on trust relationships between a user and an IS, in their case a recommendation agent. Since the theoretical foundations on trust in the context of technology acceptance were not yet presented, the reader might not perceive this difference as essential. This should change after reading the respective theoretical foundations in the next section.

2.4 Trust Theory

2.4.1 Definition of Trust

In the 1990s, the number of articles dealing with trust grew dramatically throughout various disciplines (Ebert 2009). This increasing interest is also reflected by several special issues in major journals in fields such as management (Rousseau et al. 1998), information systems (Benbasat/Gefen/Pavlou 2008; Benbasat/Gefen/Pavlou 2010), and human computer interaction (Corritore/Kracher/Wiedenbeck 2003). One reason for this development is that trust has been identified as an effective means for overcoming the increasing complexity of technology, organizations, and interpersonal interactions practitioners had to face (Lee/See 2004). The importance of trust for IS research has been shown in different domains, such as e-commerce (Gefen/Straub 2004; Pavlou/Dimoka 2006), virtual communities (Leimeister/Sidiras/Krcmar 2006), and, generally, in the adoption of new technologies (Gefen/Karahanna/Straub 2003b; Wang/Benbasat 2005). The importance of trust is manifold, ranging from a

> "key to understanding the relationship development process" (Morgan/Hunt 1994, 32)

to being

> "a glue that holds the relationship together" (Singh/Sirdeshmukh 2000, 156).

Additionally, the concept of trust is widely used in many different research disciplines, such as marketing, psychology, information systems and strategic management (Ebert 2009). As a result, even within the IS discipline, multifarious research approaches to study trust and trust relationships exist (McKnight/Choudhury/Kacmar 2002b; Gefen/Karahanna/Straub 2003b; Wang/Benbasat 2005; McKnight et al. 2011).

The variety of viewpoints on trust has also led to a plethora of definitions of trust. Nevertheless two critical components can be identified throughout the various

definitions: confident expectations and a willingness to be vulnerable (Rousseau et al. 1998). In this thesis, I use an adaptation of the definition by Mayer, Davis and Schoorman (1995), since it covers both critical components, and is the most frequently cited definition of trust (Rousseau et al. 1998). Consequently, trust is defined as

> "the willingness of a trustor to be vulnerable to the actions of a trustee based on the expectation that the trustee will perform a particular action important to the trustor, irrespective of the ability to monitor or control the trustee (Mayer/Davis/Schoorman 1995, 712)."

In the original definition, Mayer, Davis and Schoorman (1995) did not use the terms *trustor* and *trustee* as frequently as I do in my definition. They often used the term *party* to represent the trustor or the trustee. I decided to avoid using the term *party*, since I encountered criticism for using party when relating to IT artifacts. Since it does not change the content of the definition and even makes the definition more precise, I decided to use the terms trustor and trustee more frequently instead.

Furthermore, trust depends very much on a specific context. Abdul-Rahman and Hailes (2000) use the example of a mother who has high trust in her car mechanic to repair her car. However, when it comes to babysitting her child, she would not trust the car mechanic, since she does not trust the mechanic in all contexts, but only in the context of repairing her car.

A third important point when defining trust is whether it is a static phenomenon or develops in different phases. Today, there is abundant evidence that trust changes over time in the organizational and societal contexts (Fukuyama 1995; Miles/Creed 1995; Rousseau et al. 1998). Rousseau et al. (1998) differentiate between three phases of trust:

- *building*, where trust is built and rebuilt,
- *stability*, where trust already exists, and
- *dissolution,* the phase in which trust declines.

Despite these three phases, most publications on trust focus on only one phase (Rousseau et al. 1998). However, there are also contributions which focus on multiple phases, e.g., trust building and dissolution (Bigley/Pearce 1998; Jones/George 1998). In my dissertation, I focus on how trust in UIS is built, since building trust in UIS

reflects the current challenge. More precisely, I focus on initial trust that is formed after users have a first experience with such increasingly automated IT artifacts (McKnight/Choudhury/Kacmar 2002b). Despite that fact that I am aware that trust building is a dynamic process, my focus on initial trust can be justified using two reasons (Wang/Benbasat 2005). First, when users interact with an IT artifact they are not familiar with, for example a UIS, their perceptions of uncertainty and risk which correspond with using the IT artifact are especially salient (McKnight/Choudhury/Kacmar 2002b). Consequently, sufficient initial trust is needed to overcome these perceptions. Although trust research has shown that initial trust beliefs may change over time (Rempel/Holmes/Zanna 1985; McKnight/Cummings/Chervany 1998), users will first rely on initial trust to determine the extent to which future interactions will take place (McKnight/Choudhury/Kacmar 2002b; Koufaris/Hampton-Sosa 2004). Second, low switching costs, high pressure of competition, and vendors' high expenses to attract new customers increase the importance of gaining high initial trust from users (Koufaris/Hampton-Sosa 2004). Consequently, I consider examining initial trust in UIS as significant, and therefore, focus on this kind of trust in my dissertation.

2.4.2 IT Artifacts and Trust Relationships

Following my definition, trust resembles a relationship between a trustor and a trustee. IS trust research analyzes two different kinds of trust relationships. When referring to *trust relationships,* IS researchers usually mean relationships among human beings that are mediated by IT (Söllner et al. 2012c) (Mediator Role, Figure 10). Jarvenpaa and Leidner (1999) focused on communication behaviors that build trust between global virtual team members. However, due to developments such as increasing automation (Lee/See 2004), IT artifacts can take another role in a trust relationship. In addition to mediating trust relationships between human beings, IT artifacts can become part of the trust relationship itself. Enterprise resource planning (ERP) systems (Gefen 2004) or recommendation agents (Wang/Benbasat 2005) are not used to mediate a trust relationship between human beings, but to support their users in achieving a specific goal. Thus, they become trustees in a trust relationship between the human user and the IT artifact (Söllner et al. 2012c) (Trustee Role, Figure 10). Since my dissertation deals with user trust in UIS – a specific class of IT artifacts – I focus on the latter kind of trust relationships.

While researchers mostly agree on the value and dimensionality of trust in the IT-mediated relationships between humans, this is not the case in the context of relationships between human beings and IT artifacts (Gefen/Benbasat/Pavlou 2008). Some researchers provide arguments supporting the view that trust is a suitable concept when studying relationships between humans and IT artifacts (Nass/Steuer/Tauber 1994; Wang/Benbasat 2005); others criticize the use of trust when studying such relationships (Friedman/Khan/Howe 2000).

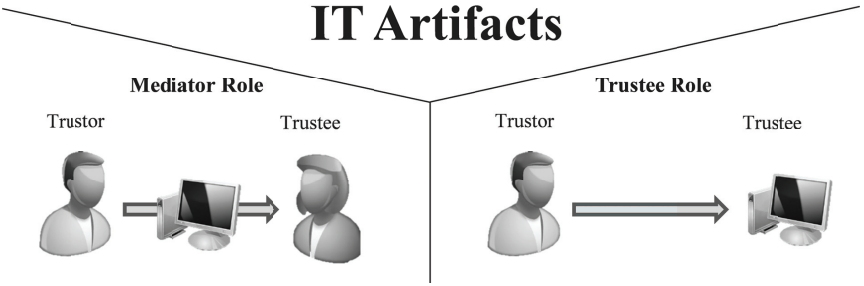


Figure 10: **Two possible roles of IT artifacts in IS trust research**
Source: Söllner et al. (2012c, 2)

According to Friedman, Khan and Howe (2000),

> "we trust when we are vulnerable to harm from others yet believe these others would not harm us even though they could" (p. 34).

Furthermore, they argued that the ability to trust depends on three assessments that need to be made (p. 36):

- the harm that might occur to the trustor,
- the good will the trustee has towards the trustor, which might affect the trustee's efforts to protect the trustor from harm, and
- whether or not harm that does occur lies outside the parameters of the trust relationship.

The authors argued that these assessments require consciousness and agency, and that these characteristics cannot be attributed to an IT artifact. Based on this argumentation,

they concluded that trust is not a suitable concept to study relationships between users and technology, and posit:

> "people trust people, not technology" (p. 36).

A different approach is taken by researchers following the *computers are social actors* paradigm (Nass/Steuer/Tauber 1994). This paradigm is based on experimental findings that humans treat IT artifacts as if they were human beings, rather than simple tools (Wang/Benbasat 2005). Nass, Steuer and Tauber (1994) showed that participants in a computer tutoring session provided more positive feedback when they had to provide feedback directly after the tutoring session on the same computer compared to an evaluation on another computer or a paper-based evaluation. This effect is comparable to the effect that humans tend to be more polite when they are directly asked for feedback compared to being indirectly asked. For example, students tend to provide more positive feedback towards a lecturer if the lecturer asks them directly versus an indirect online or paper-based evaluation. However, researchers emphasized that this behavior does not mean that users think that technological artifacts are really human. It should sooner be interpreted that people interact with technology in a way comparable to their interaction with other human beings and apply social rules to them (Nass/Steuer/Tauber 1994; Kiesler/Sproull 1997; McKnight et al. 2011).

Wang and Benbasat (2005) relied on these results to verify that trust is a suitable concept when researchers trust in IT artifacts such as recommender systems. Apart from the above-mentioned studies, the authors also cited a word-elicitation study that showed that participants used words such as *integrity*, *honesty*, *cruelty*, and *harm* to characterize trust-related behavior of IT artifacts (Jiun-Yin/Bisantz/Drury 2000). Based on this argumentation, the authors concluded that trust is a suitable concept when analyzing relationships between humans and IT artifacts such as online recommendation agents.

I argue that both views are not as conflictive as described by Wang and Benbasat (2005) and McKnight et al. (2011), and agree with some arguments presented in both, and think that they can be combined into a single integrative view. I agree with Friedman, Khan and Howe's (2000) argumentation that both consciousness and agency cannot be attributed to technology. However, I disagree with their conclusion that the concept of trust is therefore generally unsuitable when studying relationships

between human beings and technology, because I believe this conclusion is logically flawed.

Considering trust relationships, we need to keep in mind that there are two roles a party can take in a trust relationship: the *trustor*, namely the party who judges the trustworthiness of the trustee and decides whether or not to give trust and accept vulnerability, and that of the *trustee*, who receives trust from the trustor. As outlined above, following Friedman, Khan and Howe's (2000) argumentation, trust relies on the ability to make the following three assessments:

- the harm that might occur to the trustor,
- the good will the trustee has towards the trustor, which might affect the trustor's efforts to protect himself from harm, and
- whether or not harm that does occur lies outside the parameters of the trust relationship.

Since IT artifacts lack consciousness and agency, they cannot make such assessments. However, recalling the two roles in a trust relationship – trustor and trustee – I argue that all three assessments need to be made by the trustor when deciding whether or not to trust the trustee. Consequently, an IT artifact *cannot take the role of a trustor* in a trust-relationship between a human and an IT artifact, since it cannot make the assessments to judge whether trusting is a good idea or not. However, the whole argumentation does not address the suitability of an IT artifact to *take the trustee's role*. As a result, I disagree with Friedman, Khan and Howe's (2000) conclusion that the trust concept in general is unsuitable for relationships between human beings and IT artifacts. Based on Friedman, Khan and Howe's (2000) argumentation, I believe a more suitable conclusion is that trust is a suitable concept for studying such relationships as long as a *human being takes the role of a trustor and the IT artifact takes the trustee's role* in this relationship.

Friedman, Khan and Howe (2000) discussed the characteristics of a trustor in a trust relationship between a human being and technology, however, the computers are social actors paradigm focuses on how a human trustor perceives IT artifacts taking the trustee's role. All of the reviewed experiments which rely on the computers are social actors paradigm addressed the question how human beings perceive IT artifacts. The word elicitation study by Jiun-Yin, Bisantz and Drury (2000) examined how a

human trustor perceives an IT artifact taking the trustee's role. The results show that humans do not consider IT artifacts as human. Nevertheless, they respond socially to IT artifacts, e.g., by being polite, and viewing them as teammates (Wang/Benbasat 2005).

In sum, I argue that the argumentations provided by each view can be integrated into a shared conceptualization of the suitability of using the concept of trust when studying relationships between humans and IT artifacts. I agree with Friedman, Khan and Howe (2000) that the trustor needs to have agency and consciousness. Consequently, an IT artifact cannot be a trustor in a trust relationship between a human and an IT artifact. Only human beings can take the trustor's role. Nevertheless, research dealing with the computers are social actors paradigm shows that people respond to IT artifacts in a way comparable to responding to other humans. Consequently, I agree with researchers such as Wang and Benbasat (2005) and McKnight et al. (2011) that trust is a suitable concept for studying such relationships as long as the IT artifact takes on the trustee's role.

2.4.3 Interpersonal Trust

The first important kind of trust when studying trust in IT artifacts taking the trustee role is interpersonal respectively interorganizational trust, developed, e.g., by Mayer, Davis and Schoorman (1995). These insights were adopted for studying trust relationships among human beings that are mediated by IT, and have proven to be very valuable for explaining the success of IS-related phenomena, such as e-commerce (Gefen/Karahanna/Straub 2003b) and virtual communities (Leimeister/Ebner/Krcmar 2005). Due to the intense use of this knowledge in IS research, a huge pool of theoretical insights was successfully developed (McKnight/Choudhury/Kacmar 2002a; McKnight/Choudhury/Kacmar 2002b; Gefen/Karahanna/Straub 2003b; Pavlou/Gefen 2004), and future research can build upon these insights. Furthermore, this theoretical foundation has been used in a large number of IS studies. Thus, there are plenty of evaluated measurement instruments ready to be used in future research.

A well-established model of the causality which is the basis of interpersonal trust theory is illustrated in Figure 11. This model was developed by Mayer, Davis and Schoorman (1995) and shows that trust is determined by the three factors of trustworthiness – the so called dimensions of trust in the remainder of this dissertations: ability, benevolence and integrity.

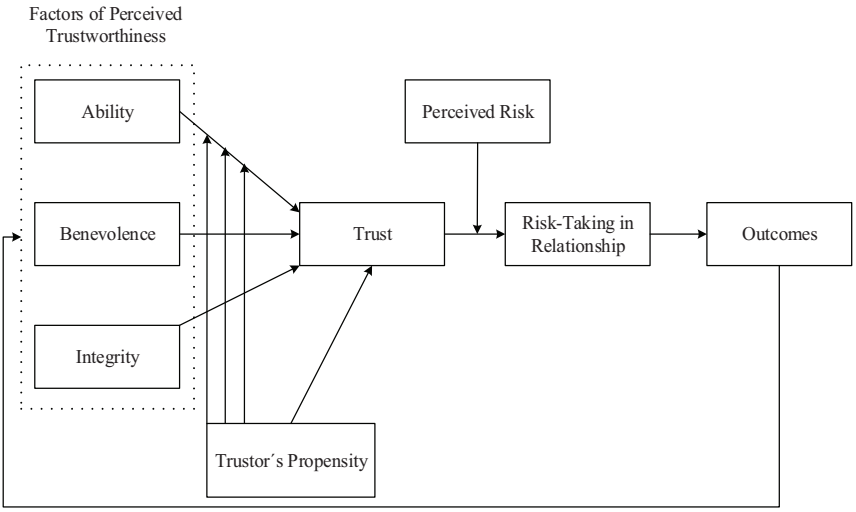


Figure 11: Causal model of trust
Source: Mayer, Davis and Schoorman (1995, 715)

Ability reflects the trustor's perception that the trustee has the necessary skills, competencies, and characteristics to provide him with influence in a specific domain. *Benevolence* reflects the trustor's perception that the trustee does not only follow an egocentric profit motive, but also wants to do good to the trustor. *Integrity* reflects the trustor's perception that the trustee adheres to a set of principles that is acceptable for the trustor (Mayer/Davis/Schoorman 1995). Some researchers extend these dimensions, e.g., by adding predictability (Gefen/Straub 2004), or reduce them by omitting one of the three, e.g., integrity (Singh/Sirdeshmukh 2000). Nevertheless, the underlying logic is to use these or related dimensions. Besides the different dimensions of trust, another factor is supposed to influence the formation of trust, the so-called trustor's propensity. This factor reflects a person's general willingness toward trusting (Mayer/Davis/Schoorman 1995), and is supposed to be built in early childhood (Erikson 1968). Consequently, this factor determines a trustor's trust, and also moderates the impact of the dimensions of trust.

The consequence of trust is *risk-taking in relationships*. This term represents a group of actions that depend on the situation that the trustor is in. As an example, Mayer, Davis and Schoorman (1995) describe a supervisor who allows an employee to handle an important account rather than handling it personally. Another example could be the decision to transact with an online store (Gefen/Karahanna/Straub 2003b). Whether

trust leads to risk-taking also depends on the perceived risk involved. Assuming a given level of trust, the trustor might, e.g., be willing to provide information such as his address to a trustee, but not more critical information, such as credit card information. After taking a risk, the trustor will experience a positive or negative outcome of this decision. Based on this experience, the trustor will update his perceptions about the dimensions of trust.

Despite the fact that this theoretical foundation is the most commonly used foundation in IS trust research, it is worth noting that its use for studying trust relationships in which IT artifacts take the trustee role has recently been criticized (Gefen/Benbasat/Pavlou 2008; McKnight et al. 2011; Söllner et al. 2012c), and other theoretical foundations should be evaluated regarding their suitability for studying such trust relationships.

2.4.4 Trust in Automation

The second important kind of trust when studying trust in IT artifacts which take on the trustee role is trust in automation. Since the late 1980s, HCI researchers have been conducting research on trust in automation (Muir 1987). Lee and See define automation as

> "technology that actively selects data, transforms information, makes decisions, or controls processes (Lee/See 2004, 50)."

This stream of research focused on trust of human operators in very complex and automated technology, like systems running in a nuclear power plant (Muir 1994). Nevertheless, nowadays more and more IT artifacts studied in IS research match the definition of automation. An example are recommender agents (see Wang and Benbasat (2005), Wang and Benbasat (2007), and Wang and Benbasat (2008)), since they are defined as software programs that carry out a set of operations on behalf of the users, and provide decision advice based on users' needs, preferences, profiles or previous activities (Ansari/Essegaier/Kohli 2000; Wang/Benbasat 2008). Therefore, with the advent of ubiquitous computing, it can be expected that trust in automation will become more and more important in the IS discipline as technology will become more and more automated.

The conceptualization of trust in automation is mainly built upon two sources: Rempel, Holmes and Zanna's (1985) work on the evolution of trust over time and

Barber ‘s (1983) trust expectations, which are conceptually comparable to the factors ability, benevolence and integrity that Mayer, Davis and Schoorman (1995) identified for interorganizational trust. In order to study trust in automated systems, Lee and Moray (1992) adapted Barber’s (1983) model to reflect characteristics of technical systems instead of human character traits, and proposed the dimensions: performance, process and purpose. These dimensions serve as the basis for Lee and See’s (2004) conceptualization of trust in automation, which I will rely on throughout the course of this dissertation.

Performance refers to the competence demonstrated by the IT artifacts’ ability to help the user to achieve his goals. Since this dimension focuses on specific qualities of the IT artifact allowing the user to assess what the system does, they argued that this dimension can be compared to the interpersonal dimension ability (Lee/See 2004). *Process* refers to algorithms and operations of the IT artifact, describing how it works and how it aims at supporting the user in achieving his goal. They argued that this dimension is comparable to the interpersonal dimension integrity, since both dimensions address the question how the trustee behaves to support the trustor (Lee/See 2004). *Purpose* refers to the degree to which the user has understood why the designers of the IT artifact decided to develop it. This allows the user to assess whether the IT artifact was designed for the purpose the user wants to use it for. The authors argued that this dimension is related to the interpersonal dimension benevolence, since well provided information on the purpose of the IT artifacts helps the user to quickly judge whether the IT artifact is useful for his purposes or not. Since the ultimate goal is to support the user in solving his problem, the interests of the user are kept in mind (Lee/See 2004).

2.4.5 Institution-based Trust

The third kind of trust of significance when studying trust in IT artifacts that function as the trustee is institution-based trust. This kind of trust refers to trust in the structural conditions prevalent (McKnight/Choudhury/Kacmar 2002a). In the case of UCS, communication among the single distributed components is essential. In most cases, the components use the Internet to communicate with each other. Consequently, a user will only trust an UCS if he also trusts the Internet to a certain extent, since private information of the user is transmitted using the Internet.

The concept of institution-based trust has its origins in sociology, which deals with topics such as the structures that make an environment feel trustworthy (e.g., a legal

system ensuring that private property is protected) (Zucker 1986). In the context of the Internet, research on e-commerce showed that institution-based trust in the Internet is an important driver for e-commerce adoption and use by end-users (McKnight/Choudhury/Kacmar 2002b). Institution-based trust has two dimensions: structural assurance and situational normality.

Structural assurance refers to a person's belief that appropriate structures, such as guarantees, regulations and legal resources, are in place to promote successful interaction in a particular environment (Zucker 1986; Shapiro 1987). With regard to the Internet, an example for structural assurance is the existence of legal and technical measures such as data encryption which protect the user from losing privacy or money (McKnight/Choudhury/Kacmar 2002a).

Situational normality refers to a person's belief that taking a risk in a particular environment will likely lead to a successful outcome (Garfinkel 1963; Lewis/Weigert 1985; Baier 1986). In the context of e-commerce, a person that perceives situational normality to be high would belief that the Internet is a well-structured environment, and that doing business on the Internet is, in general, a good idea, since the vendors in this environment are perceived to display trustworthy attributes like ability, benevolence and integrity (McKnight/Choudhury/Kacmar 2002a).

2.4.6 Multifoci Trust

As previously mentioned, trust is commonly conceptualized as part of the relationship between people, groups of people and organizations, or between users and information systems. In correlation with the increasing complexity of organizations and technology (Lee/See 2004), more and more relationships to distinct entities need to be considered during decision making. This observation has led to a new stream of research in management literature, which follows a so-called multifoci approach. Publications contributing to this stream of research follow the argumentation that the impact of relational constructs – such as fairness, trust and justice – and their emergence, need to be studied based on their focus. Lavelle, Rupp and Brockner (2007) study justice, trust, social exchange and citizenship behavior using a multifoci approach, and develop a framework arguing that different foci of each construct have a distinct impact on the other foci of the same construct as well as other constructs. Regarding multifoci trust, a number of studies from organizational behavior research provide empirical support for this argumentation, showing that employees evaluate different

foci of trust reflecting different authority referents inside an organization, and that these different foci of trust differ in their impact on dependent constructs (Aryee/Budhwar/Chen 2002; Stinglhamber/Cremer/Mercken 2006). Lance Frazier et al. (2010) show that an employee's ability to focus on the most important tasks depends on his trust in the section leader, but not on his trust in the director of the organization. A related result was also observed in the context of trust in web vendors. McKnight, Choudhury and Kacmar (2002b) showed that both a user's institution-based trust in the Internet as well as his trust in a specific web vendor need to be in place before he is willing to conduct business with this specific vendor via the Internet.

Taking the differentiation between various kinds of trust one step further, Muir (1994) argues that in complex situations, human trust in the actual system is only one element of a whole trust network (see Figure 12).

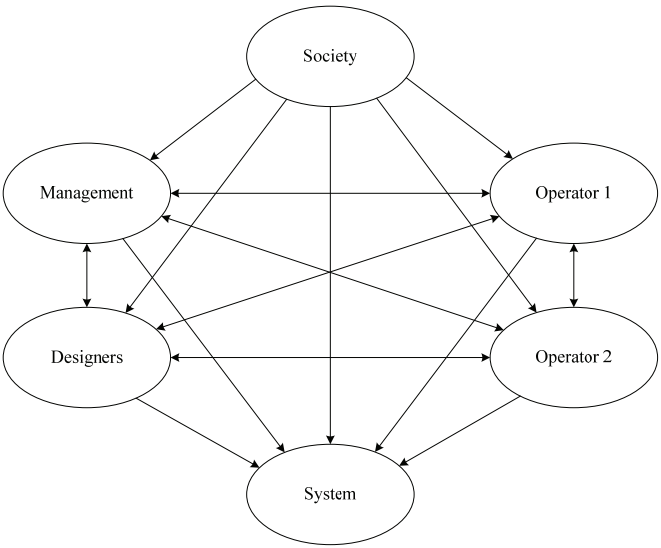


Figure 12: Network of trust in supervisory control systems
Source: Muir (1994, 1907)

Despite the fact that Muir (1994) has researched automated systems, such as supervisory control systems for nuclear plants, I argue that this logic is appropriate for many other modern technical systems, such as recommendation systems and UIS. The argument is based upon Lee and See's (2004) definition of automation as "technology that actively selects data, transforms information, makes decisions or controls

processes (p. 50).” According to this definition, recommender systems are automated systems, since they gather data from different sources, and transform them into information that helps the user during decision making. In accordance with Muir, I argue that researchers should consider the whole trust network when researching UIS adoption.

2.4.7 Trust Support

In my dissertation, I aim to use the plethora of behavioral insights on trust to develop a method that will allow the derivation of detailed TSCs for specific UCS. However, the underlying idea to use behavioral insights for deriving detailed design elements is not novel. Leimeister et al. (2009), for instance, derive activation support components for idea competitions based on the motive-incentive-activation-behavior model (Rosenstiel 2007). In the context of trust, Leimeister, Ebner and Krcmar (2005) derived TSCs for virtual communities based on trust theory. The goal of this section is to build on these insights, and to show how theoretical insights, such as the presented insights on trust, can be used to develop TSCs, which positively influence the users’ trust in UCS.

It is important to understand that trust is interpreted as a latent variable (Söllner/Leimeister 2010b). Consequently, trust cannot be measured directly but needs to be measured using multiple directly measurable, related variables (Backhaus et al. 2006). More precisely, trust is considered to be a so-called multidimensional construct (Jarvis/Mackenzie/Podsakoff 2003). That means that the latent variable trust is formed by multiple different dimensions. These different dimensions are again latent variables, and cannot be measured directly. For this reason, the directly measurable antecedents of the different dimensions need to be identified for measuring the dimensions and trust (Christophersen/Grape 2007).

Another reason why the identification of the different directly measureable antecedents is obligatory, is the aim to influence trust very precisely. After the identification of the antecedents, TSC need to be derived that positively influence the different antecedents, and thus, positively influence their respective dimensions and trust. It is important to mention that it is not my intention to say that trust cannot be influenced on the dimensional or even variable level. My argument is that relying on directly measurable antecedents will enable the derivation of more precise TSCs, since latent variables are

unclear in comparison to directly measurable variables. Figure 13 summarizes and illustrates my thoughts on how to derive TSCs for UIS.

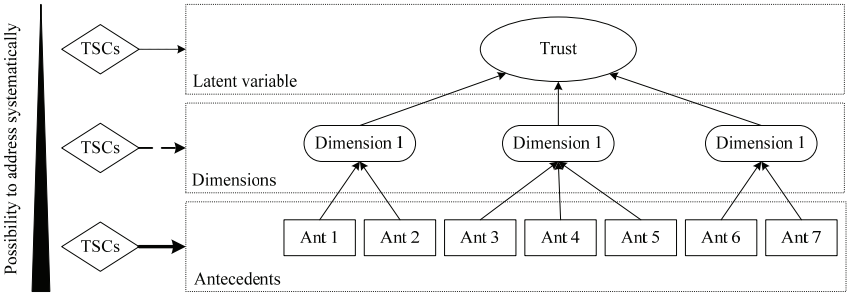


Figure 13: **Trust support via trust supporting components**
Source: Adapted from Söllner et al. (2012b)

3 Methodological Background

In this section, I will provide the necessary background of the advanced research methods I use to answer my research questions. Advanced research methods means that I will focus on the research methods that are usually not taught in bachelor or master courses in business administration or information systems (e.g., I do not present details on regression analysis, since this topic should be covered in the statistics courses). In particular I present details on conducting a systematic *literature review* in section 3.1 (this method is used in section 4), *laboratory experimentation* in section 3.2 (this method is used in sections 5-8), *structural equation modeling* with a focus on *partial least squares* in section 3.3 (this method is used in section 5-7), and *design research* in section 3.4 (this method is used in section 8).

3.1 Literature Review

> *"A review of prior, relevant literature is an essential feature of any academic project. An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed."*
>
> (Webster/Watson 2002, xiii)

Literature reviews have become increasingly important. Fettke (2006) argue that this increasing importance has four reasons:

1. More and more books, journals and conferences are published or organized (Fettke 2006).
2. The number of papers published per year by a single journal increases. Peffers and Wendy (2003) showed that ten of the leading IS journals published 38% more papers between 1997 and 2001 compared to the period from 1987 to 1991.
3. The length of the published papers increases (Peffers/Wendy 2003).
4. The complexity of research in a specific field increases over time (Mertens 2005).

Due to these developments, the importance of conducting a structured literature review before starting a new research project has increased. A structured literature review helps researchers to avoid redundant studies, and the omission of important insights for their own research (Fettke 2006).

When reviewing literature on how to conduct a literature review, different approaches become available for selection. Cooper (1988) argues that a literature review must contain at least 2 elements:

1. It relies on primary sources, but does not provide new primary scholarship itself, and

2. The goal of a literature review is to describe, summarize, evaluate, clarify or integrate the results reported in the primary sources.

In their guidelines for authors aiming to publish in the Theory and Review section of the IS journal Management Information Systems Quarterly, Webster and Watson (2002) provide a different view. They argue that the main goal of a literature review is not to review and summarize past research, but to develop an agenda for future research.

Based on the different views on literature reviews, Fettke (2006) develops a framework for identifying different kinds of literature reviews (see Table 3). I will use this framework in section 4.3 for classifying my literature review. For a detailed description of the different characteristics please see Fettke (2006, 258-260).

TYPE		natural language				mathematical-statistical	
FOCUS		research results	research method			theory	experience
TARGET	FORMULATION	not explicit				explicit	
	CONTENT	integration		criticism			central topics
PERSPECTIVE		neutral				position	
LITERATURE	SELECTIONS	non explicit				explicit	
	EXTENSIVENESS	foundations		representative		selective	complete
STRUCTURE		historical		thematically		methodical	
TARGET GROUP		common public		practitioners		common researcher	specialized researcher
FUTURE RESEARCH		not explicit				explicit	

Table 3: Categories for classifying literature reviews
Source: Adapted from Buckl (2011) and Fettke (2006)

Furthermore, Webster and Watson (2002) highlight that a literature review should be concept-centric. That means that different concepts discussed in the literature should be used to organize the review (see Table 4). This approach is contrary to an author-centric approach, which focuses on presenting a summary of relevant articles. Since the goal of a literature review should be not only to describe, but also to synthesize and integrate prior research, a literature review relying on the author-centric approach often times fails to fulfill its purpose (Cooper 1988; Webster/Watson 2002).

Articles	**Concepts**				
	A	B	C	D	…
1		●	●		●
2	●	●			
…			●	●	

Table 4: **Template of a concept matrix**
Source: Webster and Watson (2002, xvii)

3.2 Laboratory Experimentation

In my dissertation, I will rely on laboratory experimentation methods in the course of answering my research questions two, three, four and five in sections 5-8. According to Fromkin and Streufert (1976), the aim of laboratory experimentation is to identify cause-effect relationships, and consists of two distinct but important components, which are often confused on the literature: the research setting (laboratory), and the research strategy (experimentation). As a result of the confusion of both components in the literature, the three principal characteristics of laboratory experimentation used in the literature all relate to the experimentation component. First, the experimenter does not wait until a specific event occurs, but creates a specific treatment which resembles the desired event. Second, the experimenter controls the source of the variation. As a result, changes in the behavior of the participants can be traced back to the variation caused by specific treatments. Third, the experimenter needs to ensure to choose an environment that allows him to precisely measure the variables. The last characteristic and the distinction between the laboratory and the experimentation underlines the fact, that effective experimentation can also be conducted outside the laboratory, e.g., in so-called field experiments[10]. Nevertheless, artificial laboratory

[10] I will not go into greater detail regarding the different research methods of social science available. I will focus on explaining, why I chose laboratory experimentation methods in my dissertation. The interested reader can find detailed insights on the different research methods in works such as Bortz and Döring (2005) and Trochim and Donelly (2008).

environments are usually regarded as being the most suitable environments, especially in terms of the second characteristics – controlling the source of variation. This research setting has the advantage of a high internal validity (allowing to identify cause-effect relationships instead of correlations) but is often criticized for its lack of external validity (allowing to conclude that the observed results will hold in a real-world setting) (Fromkin/Streufert 1976).

In my dissertation, I mainly focus on identifying cause-effect relationships between trust and its consequences in the context of UIS adoption, as well as cause-effect relationships between trust and the dimensions and antecedents forming trust (sections 5-7). In section 8, I focus on investigating whether my derived TSCs will actually make UIS as being perceived more trustworthy by intended users. Consequently, laboratory experimentation methods provide the best fit comparing the advantages of these methods – high internal validity, allowing establishing cause-effect relationships – and my research goals. In particular, I will rely on two different laboratory experiment methods in my dissertation: the *standard laboratory experiment* and the *free simulation experiment*.

3.2.1 Standard Laboratory Experiment

The standard laboratory experiment usually aims at influencing one or more independent variables by using different treatment and non-treatment conditions. The key to a successful standard laboratory experiment is to ensure that nothing but the treatment causes any changes in the behavior of the subjects. Otherwise, it is hard to establish the desired cause-effect relationship, since the cause cannot be exactly defined (Fromkin/Streufert 1976; Boudreau/Gefen/Straub 2001). I will conduct a standard laboratory experiment to answer my fifth research question in section 8. I will only use one treatment and thus have two experimental conditions. In the non-treatment conditions, the participants will use a version of a UIS in which my TSCs are not yet implemented. In the treatment condition, the participants will use the same UIS but including four TSCs. Besides the TSCs, all other functionalities and also the design was not altered to ensure that the observed effect can be traced back to the TSCs[11]. In both conditions the participants will first receive an introduction on the purpose of the UIS, the functionality and how they can operate the UIS. Then they have to complete a defined set of tasks using the UIS and afterwards complete a

[11] More details on the research design are provided in section 8.4.

questionnaire allowing me to capture the necessary data. During the whole experiment, all changes are only related to the absence or presence of the TSCs, e.g., the introduction in the treatment condition will also cover the implemented TSCs. This approach allows me to draw conclusions on whether the artifacts created using my method – the four TSCs – will make the UIS more trustworthy and increase the participants' intention to use it. This allows me to draw conclusions on the quality of my method (Hevner et al. 2004; Gregor 2006). It is important to notice that this approach does not enable me to draw any conclusion about which TSC has the highest effect, since my two treatments only include no TSCs at all or all TSCs at the same time. However, as I pointed out, I did not aim to evaluate my single TSCs, but the method used to derive the TSCs. So this approach is suitable to achieve my research goal.

3.2.2 Free Simulation Experiments

Whereas standard laboratory experiments rely on a treatment to vary one or more independent variables, free simulation experiments expose the participants to a number of realistic events during a specified amount of time. In my dissertation those realistic events are different usage situations a user of a particular UIS would face when actually using the UIS. This method is used to answer my research questions two to four in sections 5-7. One core feature of free simulation experiments is that the realistic events are designed by the experimenter, but due to the feature that they are free to behave in certain boundaries the participants could create additional realistic events on their own (Fromkin/Streufert 1976). In my free simulation experiments, the participants receive an introduction explaining them the purpose of the UIS, the functionality and how they can operate the UIS. This introductory phase is followed by the free simulation phase, where the participants will receive some tasks they need should fulfill using the UIS. The tasks cover all core functionality of the UIS ensuring that the participants will get to know the whole UIS. Besides completing the tasks, the participants are free to use all functionality provided by the UIS. After this phase, the participants receive a questionnaire that serves as my data collection instrument[12].

[12] More details on the research designs are provided in sections 5.3, 6.4 and 7.3.

3.3 Structural Equation Modeling

Structural equation modeling (SEM) methods have become the methods of choice in analyzing cause-effect relationships when these involve latent variables with multiple indicators in the IS discipline in particular and in social sciences in general. Latent variables (LV) are theoretical constructs that can typically not be measured directly (e.g., intentions and feelings), but only indirectly through characteristics we attribute to them (Gefen/Rigdon/Straub 2011). Trust resembles such a LV studied in the IS discipline (all of the reviewed papers in section 4 considered trust to be a LV).

One major advantages of SEM is that it allows to simultaneously assess the measurements (the so-called measurement model) and the hypothesized causal paths (the so-called structural model) (Gefen/Rigdon/Straub 2011).

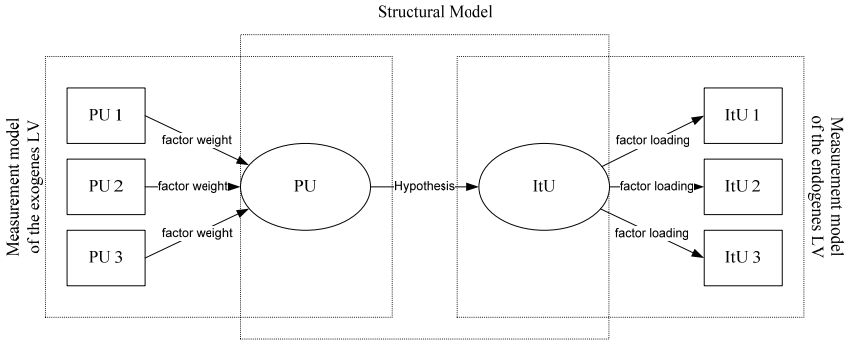


Figure 14: Structure of a causal model (error terms and correlations are omitted in the illustration for the sake of understandability)
Source: Adapted from Nitzl (2010)

Figure 14 graphically illustrates a typical causal model that can be analyzed using SEM. The model includes the two LVs Perceived Usefulness (PU) and Intention to Use (ItU), their measurement models, and a hypothesized causal path between both LVs (H1). In this example PU is called an exogenous or independent LV, because it is not influenced by any other LV in the model, whereas ItU is called a dependent or endogenous LV, because it is influenced by PU. Both LVs are measured using three indicators (PU1-3 and ItU1-3). After a comparable model has been defined, SEM methods can be used to assess the quality of the measurement models and the hypothesized causal paths. In the literature, two major SEM methods are prevalent: *covariance-based SEM* (CBSEM) and *partial least squares* (PLS). CBSEM has its origins in the papers by Jöreskog (1973) and Wiley (1973). It uses a maximum

likelihood function and aims at minimizing the difference between the sample covariances and those predicted by the theoretical model. To achieve this goal, the parameter estimation process attempts to reproduce the covariance matrix of the observed measures. Due to this process, CBSEM is best suited for testing theories or causal models (Chin/Newsted 1999). PLS was developed by Herman Wold (Lohmöller 1989). Instead of minimizing the differences in covariances, the PLS algorithm aims to predict how the endogenous LVs form and to maximize the variance explained. Consequently, PLS is better suited for research aiming to understand how specific LVs form and can be influenced (Chin/Newsted 1999).

Criterion	**PLS**	**CBSEM**
Objective:	Prediction oriented	Parameter oriented
Approach:	Variance based	Covariance based
Assumptions:	Predictor specification (nonparametric)	Typically multivariate normal distribution and independent observations (parametric)
Parameter estimates:	Consistent as indicators and sample size increase (i.e., consistency at large)	Consistent
Latent variable scores:	Explicitly estimated	Indeterminate
Epistemic relationship between a latent variable and its measures:	Can be modeled in either formative or reflective mode	Typically only with reflective indicators
Implications:	Optimal for prediction accuracy	Optimal for parameter accuracy
Model complexity:	Large complexity (e.g., 100 constructs and 1000 indicators)	Small to moderate complexity (e.g., less than 100 Indicators)
Sample size	Power analysis based on the portion of the model with the largest number of predictors. Minimal recommendations range from 30 to 100 cases.	Ideally based on power analysis of specific model – minimal recommendations range from 200 to 800.

Table 5: Comparison of PLS and CBSEM
Source: Chin and Newsted (1999, 314)

Whereas both methods are often viewed as competing methods, Chin and Newsted (1999) argue that they are complementary in terms of research objectives, data conditions, and modeling. Table 5 provides a comparison of PLS and CBSEM. In my dissertation, I will rely on PLS due to the following three main reasons:

1. In my dissertation, I aim at developing TSCs increasing the users' trust in UIS. Consequently, insights that predict how trust forms and can be influenced are especially valuable for achieving this goal. Since the objective of PLS is to predict how LVs form, the objective of PLS and the aim of my dissertation show a good fit.

2. To create detailed insight on the formation of trust, I focus on using a formative measurement model for trust[13], and PLS is better suited for analyzing causal models that include formative measurement models.

3. I rely on data collected in different kinds of experiments that include a limited number of participants. Consequently, the number of observations in my data sets range from 143 to 284, and thus show a better fit with the sample size requirements of PLS.

3.3.1 Defining the Measurement Models

"The reason for drawing a distinction between the measurement model and the structural model is that proper specification of the measurement model is necessary before meaning can be assigned to the analysis of the structural model."
(Anderson/Gerbing 1982, 453)

"Convergence in measurement should be considered a criterion to apply before performing a causal analysis because it represents a condition that must be satisfied as a matter of logical necessity."
(Bagozzi 1981, 376)

The two quotes by Anderson and Gerbing (1982, 453), and Bagozzi (1981, 376) highlight the importance of using valid and reliable measurement models, since they resemble the foundation for the analysis of the causal paths in the structural model. One focus of my dissertation – in particular in sections 5 and 7 – is which kind of measurement model should be used to assess trust for creating detailed knowledge on the formation of trust that is especially valuable for the latter derivation of TSCs. As a result, I will quite intense discuss the differences between different kinds of

[13] Please see section 3.3.1 for further information on different kinds of measurement models.

measurement models, how to distinguish between them and the consequences of using a wrong kind of measurement model.

First of all, the two major quality criteria for measurement models need to be defined: *validity* and *reliability*. Validity refers to construct validity and is defined as:

> „the degree to which inferences can legitimately be made from the **operationalizations** in your study to the theoretical construct on which those operationalizations are based (Trochim/Donelly 2008, 57)."

Following the definition, a measurement model is valid, when a suitable operationalization of the theoretical construct (LV) is used. The term operationalization refers to the indicators used to measure the LV. Reliability refers to the quality of the measurement and is defined as:

> "the degree to which a measure is consistent or dependable; the degree to which it would give you the same result over and over again, assuming the underlying phenomenon is not changing (Trochim/Donelly 2008, 80)."

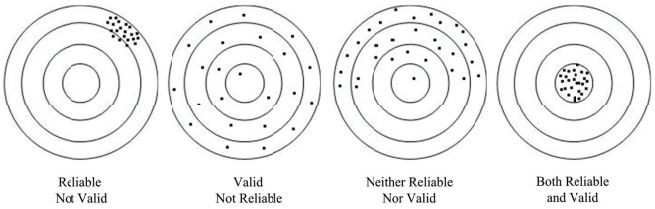


Figure 15: The shooting-target metaphor for reliability and validity of measurement
Source: Trochim and Donelly (2008, 93)

According to this definition, a measurement model is only reliable if it provides the same measurement for its LV across different studies. Figure 15 illustrates the relationship between validity and reliability using the metaphor of a shooting-target and four different situations. In the first situation, you consistently hit the shooting-target, but not the center. Such a measurement is reliable, but not valid. In the second situation, you always hit the target but the hits are spread over the whole target. Such a measure is valid, since on average, you get the right answer from the group, but not very well for individuals. In the third situation, all hits are spread in the upper half of the target. Such a measure is neither valid nor reliable, since you don't even get the right answer relying on the average of all individuals. In the fourth situation, you

consistently hit the center of the shooting-target. This measurement is valid and reliable and can be used to measure its intended LV (Trochim/Donelly 2008).

In general, researchers can choose between two different types of measurement models for LVs: the principal factor (reflective) model and the composite latent variable (formative) model (Jarvis/Mackenzie/Podsakoff 2003). Figure 16 illustrates the core difference in the reflective and formative measurement philosophy.

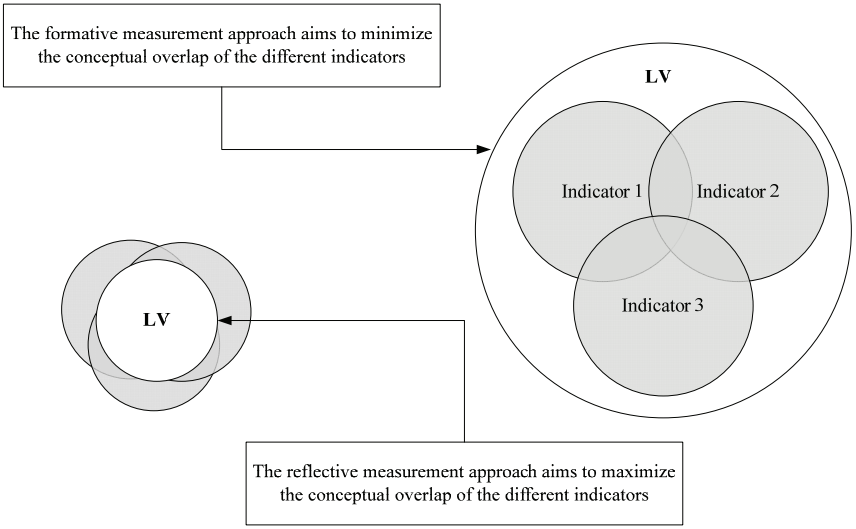


Figure 16: Reflective versus formative measurement philosophy
Source: Adapted from Nitzl (2010)

If researchers follow the reflective approach, their aim is to maximize the conceptual overlap of the different indicators, since the underlying assumption is that the single indicators correlate highly with each other and that this correlation is caused by the underlying latent variable. This means that a change in the latent construct is reflected by a change in all of the respective indicators (Fornell/Bookstein 1982; Jarvis/Mackenzie/Podsakoff 2003).

When using the formative measurement approach instead, researchers aim to minimize the conceptual overlap of the different indicators, since the underlying assumption in this case is that the latent variable is defined and thus caused by its indicators that resemble different dimensions. Thus the causal logic is the opposite as in the reflective measurement model. In the formative model, a change in the underlying indicators

causes a change in the latent variable (Fornell/Bookstein 1982; Diamantopoulos/Winklhofer 2001; Jarvis/Mackenzie/Podsakoff 2003).

The example presented Figure 17 further illustrates the major differences between formative and reflective measurement models.

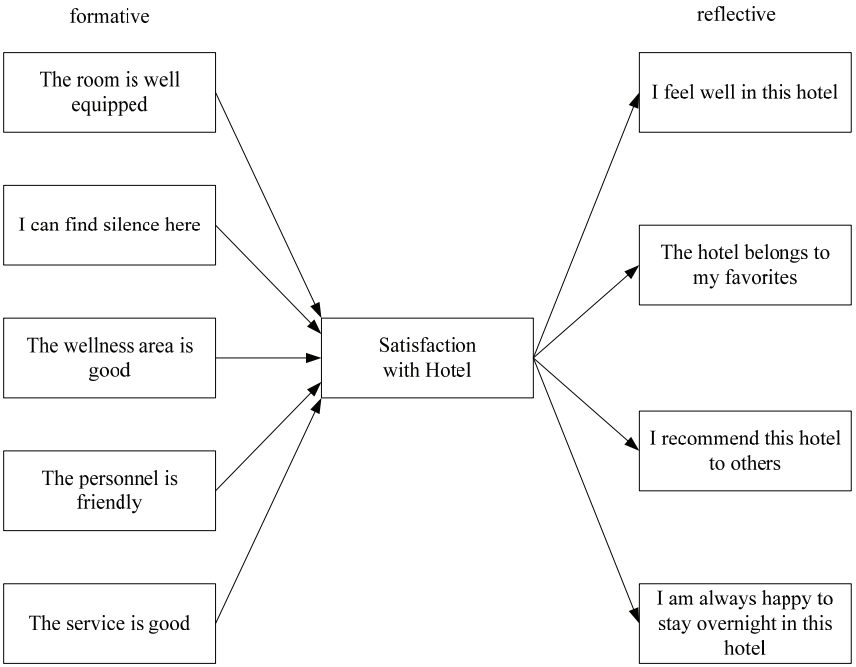


Figure 17: Satisfaction as a formative and reflective construct
Source: Albers and Hildebrandt (2006, 12) and Albers (2010, 412)

Figure 17 deals with different types of measurement models for the latent variable *satisfaction with hotel*. On the left side, five formative indicators are presented. These indicators are supposed to resemble distinct facets that cause satisfaction, and that need not to be highly correlated with each other. A hotel could, e.g., have a bad wellness area but very well equipped rooms. On the right side, four reflective indicators of satisfaction with hotel are presented. These indicators resemble indicators that are caused by the latent variable, and are supposed to correlate highly with each other. Thus, when the latent variable changes, all indicators are supposed to change in a comparable way. If a customer is, e.g., satisfied with the hotel, he should report to

feel well in this hotel and to recommend the hotel to others (Albers 2010). Based on these theoretical differences Jarvis, Mackenzie and Podsakoff (2003) have created four guidelines to decide whether an existing measurement model should be interpreted as reflective or formative (see Table 6).

		Formative model	**Reflective model**
1.	Direction of causality from construct to measure implied by conceptual definition	Direction of causality is from items to construct	Direction of causality is from construct to items
	Are the indicators (items) (a) defining characteristics or (b) manifestations of the construct?	Indicators are defining characteristics of the construct	Indicators are manifestations of the construct
	Would changes in the indicators/ items cause changes in the construct or not?	Changes in the indicators should cause changes in the construct	Changes in the indicator should not cause changes in the construct
	Would changes in the construct cause changes in the indicators?	Changes in the construct do not cause changes in the indicators	Changes in the construct do cause changes in the indicators
2.	Interchangeability of the indicators/items	Indicators need not be interchangeable	Indicators should be interchangeable
	Should the indicators have the same or similar content?	Indicators need not have the same or similar content/ indicators need not share a common theme	Indicators should have the same or similar content/ indicators should share a common theme
	Would dropping one of the indicators alter the conceptual domain of the construct?	Dropping an indicator may alter the conceptual domain of the construct	Dropping an indicator should not alter the conceptual domain of the construct
3.	Covariation among the indicators	Not necessary for indicators to covary with each other	Indicators are expected to covary with each other
	Should a change in one of the indicators be associated with changes in the other indicators?	Not necessarily	Yes
4.	Nomological net of the construct indicators	Nomological net for the indicators may differ	Nomological net for the indicators should not differ
	Are the indicators/items expected to have the same antecedents and consequences?	Indicators are not required to have the same antecedents and consequences	Indicators are required to have the same antecedents and consequences

Table 6: Decision criteria for distinguishing between formative and reflective measurement models
Source: Jarvis, Mackenzie and Podsakoff (2003, 203)

Jarvis, Mackenzie and Podsakoff (2003) base their decision criteria upon four sets of questions. First, the direction of causality between the latent variable and the indicators

needs to be investigated. The measurement model is a reflective model if the causality flows from the latent variable to the indicators, and is a formative model if it flows from the indicators to the latent construct. Second, whether the indicators are interchangeable or if dropping an indicator causes a conceptual problem must be determined. For reflective measurement models, the indicator should be interchangeable because a change in the latent variable causes changes in all of the indicators. Due to the fact that formative indicators define and cause the latent variable, they cannot be interchangeable because dropping an indicator would change the definition of the latent variable. The third step for researchers is to investigate whether the indicators should correlate with each other or not. In reflective measurement models, the indicators need to correlate highly with each other because changes in the latent variable are supposed to cause changes in all respective indicators. In the case of formative measurement models, a correlation is not forbidden, but correlations between two indicators that are too high would suggest that both cover a rather similar aspect and could therefore be redundant. As a fourth and final step, the antecedents and consequences of the single indicators need to be examined. Reflective indicators should all have the same antecedents and consequences, because they should be interchangeable and reflect the whole variable. Formative indicators, in contrast, need not have the same antecedents and consequences due to the fact that they usually capture different aspects of the whole latent variable.

After having introduced unidimensional formative and reflective measurement models, we need to account for the fact that many constructs – e.g., trust – are not defined as being unidimensional. As pointed out in section 2.4, trust is supposed to have different dimensions such as ability, benevolence and integrity (Mayer/Davis/Schoorman 1995) or performance, process and purpose (Lee/See 2004). These dimensions are usually also considered to be latent variables. Consequently, to measure such constructs, so-called multidimensional measurement models need to be used. Jarvis, Mackenzie and Podsakoff (2003) provide a good overview of the different types of multidimensional measurement models. Since I will develop a formative first-order, formative second-order measurement model, I will focus on describing this type of measurement model. The underlying assumption when using a formative first-order, formative second-order measurement model is that the second-order construct – e.g., trust – is caused by several first-order constructs – e.g., performance, process and purpose – which are measured using formative indicators (see Figure 18). Compared to the other options,

this type of measurement model offers the most detailed insights on the formation of a construct, which are of high value for IS design.

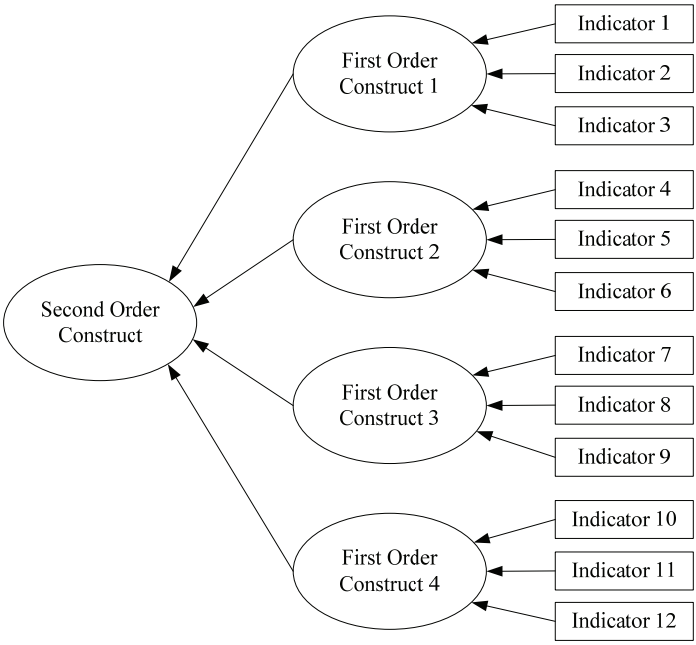


Figure 18: **Formative first-order, formative second-order measurement model (error terms and correlations are omitted in the illustration for the sake of understandability)**
Source Jarvis, Mackenzie and Podsakoff (2003, 205).

I decided to spend that much space for explaining the different types of measurement models and how to distinguish between them, since recent studies showed that choosing the correct type of measurement model is very important, since the wrong choice can cause serious problems regarding the validity and reliability of the results regarding the causal paths of the structural model.

In their analysis of the quality of the specification of measurement models in the literature, Jarvis, Mackenzie and Podsakoff (2003) found that about 30% of all measurement models used in top marketing journals between 1977 and 2000 were mis-specified. Petter, Straub and Rai (2007) adapted this analysis for the IS discipline and found similar results concerning the measurement models used in two IS journals MISQ and ISR between 2003 and 2005. Both papers highlight that the main source for measurement model mis-specification is using conceptually formative indicators in a

reflective measurement model. Concerning the consequences of using mis-specified measurement models, Jarvis, Mackenzie and Podsakoff (2003) state:

> "Our simulation results provide strong evidence that measurement model misspecification of even one formatively measured construct within a typical structural equation model can have very serious consequences for the theoretical conclusions drawn from that model. The entire model could appear to adequately fit the data, even though the structural parameter estimates within that model exhibit very substantial biases that would result in erroneous inferences. This is not simply a measurement model or construct validity problem, because its effects clearly extend into the estimates of the structural parameters that drive the development and testing of marketing theory. More specifically, the results indicate that paths emanating from a construct with a misspecified measurement model are likely to be substantially inflated, thus leading to Type I errors. However, paths leading into a construct with a misspecified measurement model are likely to be deflated, thus leading to Type II errors (Jarvis/Mackenzie/Podsakoff 2003, 212)."

"A Type I error means that paths are labeled as statistically significant when there is actually no relationship between the constructs whereas a Type II error means that paths are labeled as statistically non-significant when there is actually a relationship between the constructs" (Petter/Straub/Rai 2007). Therefore, measurement model misspecification puts the investigated model into question as a whole, and strongly weakens the results of the study. Additionally due to the fact that the results are usually integrated in the theory, this leads to the problem that the whole conceptual understanding of trust is damaged by these measurement errors. To avoid Type I and Type II errors, the researchers choice of measurement model and the underlying theory need to be in line (see Table 7) (Diamantopoulos/Siguaw 2006).

		'Correct' Auxiliary Theory	
		Reflective	Formative
Researcher's Choice of Measurements Perspective	Reflective	Correct Decision	Type I Error
	Formative	Type II Error	Correct Decision

Table 7: **Choosing a measurement perspective**
Source: Diamantopoulos and Siguaw (2006, 266)

3.3.2 Model Evaluation

After the necessary theoretical foundations on the structural and measurement models have been provided, it remains to be discussed how such models can be evaluated using empirical data. I already argued that a high quality of the measurement models is essential for ensuring the validity and reliability of the results drawn based on the evaluation of the structural model. Consequently, the measurement models need to be evaluated before the structural model. Furthermore, due to the differences between reflective and formative measurement models, they need to be evaluated using different quality criteria. After the measurement models and the structural model are evaluated, conclusions about the overall model can be drawn (see Figure 19) (Nitzl 2010). Due to the fact that there are no well-accepted quality criteria to evaluate the overall model in PLS (Huber et al. 2007), the quality of the overall model is based on the different quality criteria of the measurement models and the structural models (Weiber/Mühlhaus 2010).

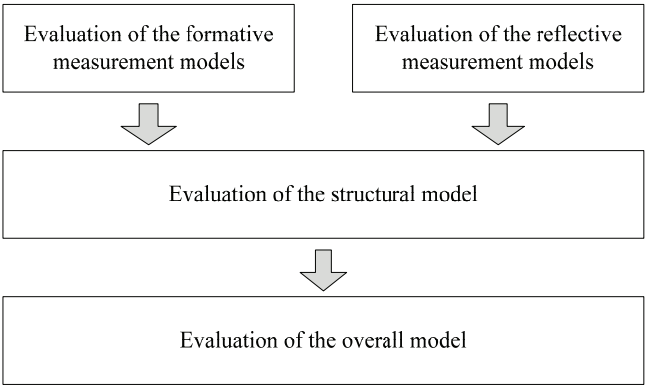


Figure 19: Evaluation procedure in SEM
Source: Adapted from Nitzl (2010)

3.3.3 Quality Criteria for Reflective Measurement Models

Following the requirement that measurement models need to be valid and reliable, four different quality criteria need to be evaluated: *internal consistency reliability*, *indicator reliability*, *convergent validity* and *discriminant validity* (Henseler/Ringle/Sinkovics 2009).

Internal consistency reliability. This criterion provides an estimate for the reliability based on the intercorrelations of the different indicators used to measure a LV. The

traditional criterion for internal consistence is Cronbach's α (Cronbach 1951), but this criterion tends to provide a severe underestimation of the internal consistency reliability when using PLS path models. Consequently, it is more appropriate to rely on the *composite reliability* (ρ_c), since this criterion takes into account that the different indicators can have different loadings. According to Nunally and Bernstein (1994), the value for the internal consistency reliability should be above 0.7 but must not be below 0.6 (Henseler/Ringle/Sinkovics 2009).

Indicator reliability. Whereas the internal consistency reliability assesses the reliability of the measurement model as a whole, the indicator reliability criterion focuses on the reliability of each single indicator in a measurement model. Since a LV is supposed to explain at least 50% of the variance of each of its indicators, the correlation between the LV and each indicator (the absolute standardized outer loading) should be higher than 0.707. A measurement model is only reliable if both criteria – internal consistency reliability and indicator reliability – are fulfilled (Chin 1998; Henseler/Ringle/Sinkovics 2009).

Convergent validity. After the reliability of a measurement model has been assessed, its validity needs to be investigated. The first validity criterion is the convergent validity that is usually measured using the *average variance extracted* (AVE) (Fornell/Larcker 1981). The value for the AVE should at least exceed 0.5 to indicate a sufficient convergent validity (Chin 1998; Henseler/Ringle/Sinkovics 2009).

Discriminant validity. Whereas the convergent validity investigates whether the set of indicators represents one and the same underlying LV, discriminant validity focuses on whether two theoretically distinct constructs are sufficiently different based on their measurement models. In PLS, two measures for discriminant validity are used: the *Fornell-Larker criterion* and the *cross-loadings*. The Fornell-Larker criterion (Fornell/Larcker 1981) postulates that a LV needs to share more variance with its respective indicators than with any other latent variable. Consequently, the AVE of each LV needs to be higher than the correlation between the LV and any other reflectively measured LV. Instead of focusing on the correlations among the LVs, the cross-loadings focus on correlations between the single indicators. This criterion requires each indicator to show the highest correlation with its desired LV (Chin 1998; Henseler/Ringle/Sinkovics 2009).

3.3.4 Quality Criteria for Formative Measurement Models

Whereas the quality criteria for reflective measurement models are well-accepted in the literature, this is not the case for formative measurement models. The challenge when evaluating formative measurement model lies within the fact that traditional validity assessments and classical test theory cannot be used for formative measurement models (Bollen 1989). Reliability, e.g., becomes irrelevant, since using a formative measurement model comes with the assumption that the indicators can be captured without any measurement error (Diamantopoulos/Siguaw 2006). To overcome the challenge of a missing coherent set of quality criteria for evaluating formative measurement models, Cenfetelli and Bassellier (2009) developed six guidelines for assessing the quality of formative measurement models.

Multicollinearity among the indicators. One thread regarding the validity of formative measurement models is multicollinearity. In contrast to reflective indicators, formative indicators should explain unique variance of a LV. Consequently, high correlations between formative indicators are not expected or even undesirable if the correlations are too high. If the correlations are too high, redundant effects or multicollinearity is prevalent. As a consequence, the weights of the formative indicators might be unstable and the influence of each indicators on the LV cannot be distinctly identified (Bollen 1989). To account for this challenge, the first guideline by Cenfetelli and Bassellier (2009) is to investigate the existence of multicollinearity. Therefore they recommend conducting one of two statistical tests. First, the *variance inflation factor* (VIF) can be computed. Currently, there are different standards for acceptable VIF values. The most rigorous cut-off criteria is 3.33 (the lower the better) provided by Diamantopoulos and Siguaw (2006). The second option is computing the Eigenvalues of the predictors and to check whether they significantly depart from 1.00. If multicollinearity is prevalent, indicators causing this issue need to be identified and removed. Here, researchers need to keep in mind that removing a formative indicator might alter the meaning and definition of a LV and needs to be discussed (Cenfetelli/Bassellier 2009).

Number of indicators and non-significant weights. Whereas reflective indicators are supposed to reflect changes in their respective LV, formative indicators are supposed to explain such changes. Since no more than 100% of the variance of a LV can be explained, a huge number of formative indicators can lead to low and non-significant indicator weights that weaken the validity of the formative measurement model. If researchers use a high number of formative indicators and observe non-significant

indicator weights (Chin (1998), e.g. used seven formative indicators for his construct *resources* and observed three non-significant indicators), they should check whether a second-order measurement approach or splitting the construct in two distinct constructs can be justified by theory. If these two options are not suitable, and all indicators are grounded in theory, the researchers should keep the non-significant indicators and discuss their findings. If the insignificance of the same indicators remains prevalent across multiple studies, this resembles evidence against the theoretical foundation suggesting this indicator (Cenfetelli/Bassellier 2009).

Co-occurrence of negative and positive indicator weights. When evaluating formative measurement models, it is possible that both, statistically significant positive and negative indicator weights can be observed for the same LV. A negative indicator weight implies that an increase in the indicator will cause a decrease in its respective LV. However, this is likely not the case, since negative indicator weights are in most cases the result of the pattern of correlations among all indicators. Thus, negative indicator weights usually are an indication that suppressor effects are prevalent (Cohen/Cohen 1983). A suppressor effect means that one formative indicator explains a significant amount of variance of another formative indicator, but this explained variance is not related to the LV. Consequently, this effect can lead to a decrease in the correlation between the formative indicators and the LV. As a result, Cenfetelli and Bassellier (2009) recommend to check for suppressor effects if positive and negative indicator weights co-occur. If a suppressor can be identified, and these suppressors are collinear with other formative indicators, the suppressor may be removed from the analysis. If the negatively weighted indicators are no suppressors or not collinear with other formative indicators, they should be kept in the analysis, and only removed if the effect holds over time. If formative indicators with negative weights have a positive bivariate correlation with the LV, they should be included and interpreted as having a negative effect on the LV when controlling for the effects of all other formative indicators (Cenfetelli/Bassellier 2009).

Absolute versus relative indicator contributions. When interpreting the statistical results, the difference between absolute and relative indicator contributions needs to be considered. The relative contribution resembles the contribution of a formative indicator holding all other indicators constant (Nunally/Bernstein 1994). It is measured using the indicator weight and it resembles the unique importance of this particular indicator for the formation of the LV. The absolute contribution instead focuses on the

contribution of a formative indicator ignoring all other indicators. It is measured using the indicator loading and resembles the contribution of this particular indicator across different sets of formative indicators. Ignoring the absolute contribution might result in misinterpretation of the statistical results, since an indicator might have a low or non-significant relative contribution and thus might be viewed as being not important and possibly removed from the analysis. However, this indicator could still show a high absolute contribution reflecting that it is important despite its low relative contribution. Only if both contributions – relative and absolute – are found to be low and or not significant, it should be questioned whether the indicator is an important component of the LV. In general it can be concluded that all indicators should be kept when their weights are significant. If an indicator shows a non-significant weight but a high loading, it should be interpreted as having a small relative but high absolute contribution. In this case, it should be investigated whether the indicator theoretically overlaps with other indicators and could be removed. Depending on the outcome of this analysis, the indicator should either be removed – if theoretical overlap is identified – or kept – in case there is no overlap. Assuming that both contributions are not significant, there is no empirical support for this indicator and its theoretical relevance should be questioned. However, it is questionable to remove a theoretically justified indicator based on results of a single study. Consequently, the indicator should only be removed if similar results can be observed in multiple studies (Cenfetelli/Bassellier 2009).

Nomological network effects and construct portability. Construct portability is another critical issue when interpreting formative measurement models. In general, it is desired that the indicator weights remain constant in different nomological networks – resembling structural models including other dependent and independent variables. However, the estimation of a formative measurement model always depends to a certain degree on the other constructs in the model (Diamantopoulos/Siguaw 2006). Consequently, it needs to be assessed how reliable the indicator weights are across different situations, since the importance of an indicator can hardly be assessed if, e.g., one indicator has a high weight in one context and a low one in another context. One possibility to assess construct portability, which is important for my dissertation, is to conduct a MIMIC (CBSEM) or redundancy (PLS) analysis. Since I will rely on PLS in the remainder of my dissertation, I will focus on describing the redundancy analysis[14].

[14] I used a redundancy analysis to assess the quality of my formative first-order, formative second-order measurement model in section 7.

Here, two sets of indicators – one formative and one reflective – are used to measure the same LV. Since current PLS software cannot handle different kinds of indicators for the same LV, two distinct LVs have to be modeled, one measured using the formative indicators and the other measured using the reflective ones. The structural path between both LVs should show a magnitude of 0.8 or above (resembling a R^2 value of 0.64 or above) (Chin 1998). To assess construct portability, Cenfetelli and Bassellier (2009) recommend to compare the indicator weights observed with weights observed in previous studies. If the weights differ substantially or the construct is new, a MIMIC or redundancy analysis should be conducted.

The choice of method. The last guideline is related to the choice of SEM method. Since I will use PLS in my dissertation, I will only address the PLS-related issue. When using CBSEM, it is possible to model a construct error term. Consequently, such an error can be measured and addressed. This is not possible when using PLS, since the LV is computed only based on the formative indicators. As a result, the indicator weights computed in PLS might be higher than they actually are if the measurement error would be taken into account. Thus, this limitation of the PLS-approach needs to be mentioned and the results should be interpreted considering this issue (Cenfetelli/Bassellier 2009).

3.3.5 Quality Criteria for the Structural Model

Despite the fact that numerous indicators for assessing the quality of the structural model exist – see Nitzl (2010) for an overview – most articles in major IS journals limit this part of the evaluation to assessing the R^2 value of their core constructs and coefficients of the structural paths between the LVs. Consequently, I will follow this lead and focus on these two quality criteria that will be presented subsequently.

R^2 value. The R^2 value is an important criterion for assessing the quality of the structural model. It resembles which part of the overall variance of a LV (100%) is explained by its structural antecedents. Consequently, the R^2 value lies between 0 and 1, and a value of, e.g., 0.5 means that 50% of the overall variance of the LV is explained by the antecedents used in the structural model. Chin (1998) defines that R^2 values of 0.17, 0.33 and 0.67 resemble weak, moderate and substantial values. However, the question how high the R^2 should be depends foremost on the purpose of the research. In section 7, e.g., I develop a formative measurement model for trust and use a redundancy analysis to assess its quality – as requested in the fifth guideline by

Cenfetelli and Bassellier (2009). For being able to show that such a measurement model is valid, the R^2 value should at least exceed 0.64, since most of the variance of the reflectively measured LV needs to be explained by the formatively measured one (Chin 1998; Cenfetelli/Bassellier 2009). In section 6, e.g., I investigate the impact of different foci of trust in the context of UIS adoption. Here, lower R^2 values are sufficient, since I only need to show that the different foci of trust have an important impact on, e.g., PU, but it would be suspicious rather than positive if I would observe an R^2 value of 0.64 or higher, since trust is only one antecedent of PU. However, since the goal of my research is to understand how trust in UIS is formed and can be influenced, and is based on previous findings pointing out that trust is an important driver for IS adoption, weak R^2 values would be problematic for two reasons. First, weak R^2 values in consequences, such as PU, would question the importance of trust in my particular context and thus question the general approach of my dissertation. Second, a weak R^2 value in my trust constructs in section 7, e.g., that my understanding of the formation is quite low since a lot of variance cannot be explained using my measurement model. Consequently, it could be questioned whether my measurement model is suitable to serve as the foundation for deriving TSCs in section 8. As a result, in my dissertation, I would expect all relevant R^2 values to reach the moderate level (0.33). In section 7, I would expect a R^2 value of at least 0.64 (Nitzl 2010).

Path coefficients. The path coefficients in the structural model are essential for evaluating the defined hypotheses, since most hypotheses are directly related to relationships between two LVs, e.g., postulating that an increase in one LV will lead to an increase in another LV. The standardized path coefficients range between -1 and 1, with high positive or negative values indicating a high impact and with values close to 0 indicating a small impact. Usually, values below -0.2 or above 0.2 are considered to be relevant (Chin 1998). Besides the path coefficients, the significance of the paths is important for the evaluating of the hypotheses. A hypothesis should be rejected if no statistically significant effect related to the hypotheses can be found. In particular, if a positive relationship is postulated in a hypothesis, the hypothesis needs to be rejected, if a non-significant path coefficient – either positive or negative – or if a significant negative path coefficient is observed. If a significant and positive path coefficient is

observed, the hypothesis can be empirically confirmed or supported[15] based on the collected data.

3.3.6 Common Method Variance

Recently, a number of researchers have brought up the problem of common method variance in behavioral research (Podsakoff et al. 2003; Sharma/Yetton/Crawford 2009). These publications point out that a significant amount of variance explained in a model is attributed to the measurement method rather than to the constructs the measures represent (Podsakoff et al. 2003). In extreme cases even more than 50% of the explained variance can result from common method variance (Sharma/Yetton/Crawford 2009).

Common method variance might be prevalent in studies that collect data on the independent and dependent variable from the same respondent, in the same measurement and item context. Furthermore, the item characteristics themselves may induce common method variance. To enable researchers to assess whether common method variance might be an issue on their studies, and to derive countermeasures, Podsakoff et al. (2003) provide a decision tree consisting of several questions (see Figure 20).

Throughout my studies, I cannot collect the data for my independent and dependent variables from the different sources. Furthermore, I cannot collect the data in different contexts. Next, I cannot identify the source of common method variance, since there are no insights indicting that e.g., the existence of existent theories or factors such as social desirability, influence my results. Consequently, situation 7 is relevant for all studies of my dissertation. Thus, Podsakoff et al. (2003) recommend using all procedural remedies related to questionnaire design, separating the measurement of independent and dependent variables psychologically and guarantee anonymity, as well as use the single-common-method-factor-approach. Furthermore, Harman's single factor test can be used to gather statistical insights on the degree of common method variance. Here, all items are included in an exploratory factor analysis and if a single factor emerges, common method variance is especially high. However, this test alone is only a weak predictor, since it only identified situations in which common

[15] More precisely, a hypothesis cannot be confirmed. Instead, the null hypothesis resembling the hypothesis that there is no significant positive relationship between the LVs can be rejected. Nevertheless, usually statements in the literature relate to finding support or confirming the hypothesis, so I adapt to this practice.

method variance is high enough that only one common factor emerges. Thus, it should only be used as an add-on, not the single common method variance test (Podsakoff et al. 2003). Whereas two measures to account for common method variance in situation 7 have been explained, the procedural remedies related to questionnaire design and the single-common-method-factor-approach still need to be explained.

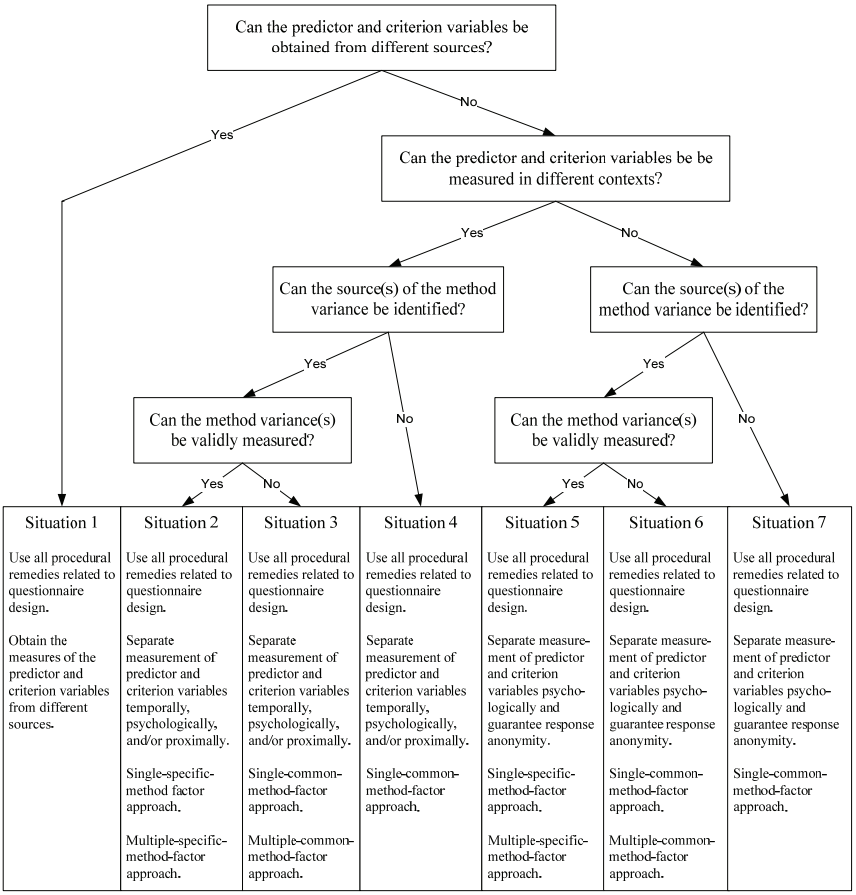


Figure 20: Recommendations for controlling for common method variance in different research settings
Source: Adapted from Podsakoff et al. (2003, 898)

Procedural remedies related to questionnaire design. Podsakoff et al. (2003) present several remedies that help to avoid common method variance in a study. First, the question order should be counterbalanced to avoid mood-related or priming effects

caused by the sequence the questions are presented. Second, the scale items should be improved in terms of defining unclear terms, avoiding vague concepts, keeping questions simple, avoiding double-barred questions, avoiding questions related to more than one concept, avoiding complicated syntax, avoiding questions that include socially desirable or demanding answers, using different scale anchors for independent and dependent variables and providing verbal labels for the extreme and mid-points of the scales and avoiding bipolar numerical scale values. Lastly, Podsakoff et al. (2003) point out that before adapting all remedies researchers should assess whether altering scale formats, anchors and values might create scale validity issues.

Single-common-method-factor-approach. For conducting the single-common-method-factor approach, an unmeasured latent method factor is added to the structural model and is supposed to influence all indicators of all measurement models. If a high relationship between this factor and the measurement items can be observed, common method variance is likely to be present. Whereas Podsakoff et al. (2003) recommend using this approach, Chin, Thatcher and Wright (2012) recently criticized that this approach is not reliable for identifying common method variance.

To avoid common method variance in my dissertation, I thus, took the following counter-measures: First, I assured anonymity to the participants by explicitly stating in the introduction of the questionnaire that all answers would be anonymous, and no relationship between any answers and a participant would be established. Second, the introduction also stated that there were no right or wrong answers, emphasizing that I was interested in the participants' honest opinions. Third, I provided verbal labels for the extreme points and the midpoints of the scales, and avoided bipolar numerical scale values. Fourth, I developed a cover story for the questionnaire in order to make it appear to the participants that the independent and dependent constructs were not connected. Fifth, the question-order was randomized among several LVs. Sixth, I especially focused on improving my scale items to ensure that they are easily comprehensible by the participants and thus do not create any undesired effects. Although it is hardly possible to ensure that common method variance is no problem at all, since no established statistical remedies exist (Chin/Thatcher/Wright 2012), I argue that common method variance is not a major problem in my dissertation, since I used available recommended countermeasures.

3.4 Design Research

For answering the last research question of my dissertation, I will use design research, to develop and evaluate a method for deriving TSCs for UIS. As outlined in section 2.2, design research is well-accepted paradigm in IS research, and numerous contributions describing how to conduct and present design research can be found (Hevner et al. 2004; Peffers et al. 2006; Gregor/Hevner 2013). In my dissertation, I will follow the design science research process model by Peffers et al. (2006) for developing and evaluating my method (see Figure 21).

The design science research process model consists of six steps that need to be conducted (Peffers et al. 2006):

1. *Problem identification and motivation*: In this step, the research problem and its importance need to be defined.

2. *Objectives of a solution*: Afterwards, the objectives of a solution need to be identified to guide the subsequent process steps and to serve as a benchmark for the developed solution.

3. *Design and development*: In the third step of the process, the actual solution – in my case the method for deriving TSCs for UIS – is designed and developed.

4. *Demonstration*: After a solution has been developed, its suitability to solve the targeted problem needs to be demonstrated.

5. *Evaluation*: In this step, the observations made in the demonstration step are analyzed regarding how suitable the solution is to solve the problem (in terms of effectiveness and efficiency). The results of this step can be used to improve the initial design and development of the solution.

6. *Communication*: The last step of the process addresses the publication of the result. It focuses on both, scholarly publications as well as professional publications. In this step, implications for the objectives, design and development of a better solution can also be formulated.

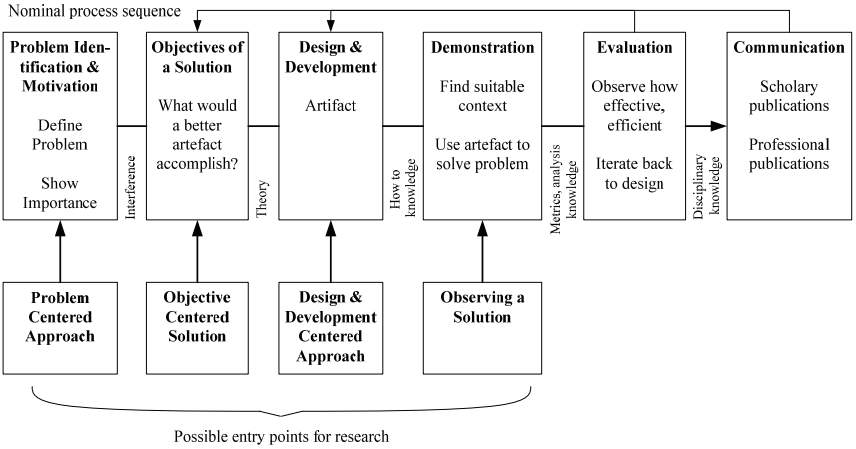


Figure 21: Design science research process model
Source: Peffers et al. (2006, 93)

Furthermore, four possible entry points for research can be identified: *problem centered approach*, *objective centered solution*, *design and development centered approach* and *observing a solution*. In my dissertation, I aim at developing a method allowing researchers and practitioners to derive TSCs for UIS based on insights of IS trust research. This resembles a primarily problem centered approach, since my method will be the first of its kind and I mainly aim at providing a suitable solution for the identified problem, instead of improving existing methods.

4 Literature Review on Existing Insights Helping to Derive Trust Supporting Components for Ubiquitous Information Systems[16]

4.1 Introduction

In this section of my dissertation, I will address my first research question:

> "How ready is IS trust research for empowering developers of UIS to account for the increasing importance of trust during UIS development, in terms of the conceptualizations used, antecedents identified and types measurement models employed, as well as guiding designers to design more trustworthy UIS?"

Answering this RQ resembles the starting point for my dissertation. Only, if I know how ready IS trust research is for empowering developers to develop trustworthy UIS, I can determine the next steps necessary to further increase the value of IS trust research for UIS development.

Consequently, in this section I aim at understanding the current state-of-the-art of IS trust research in several specific areas.

While former literature reviews concerning trust have mainly focused on different dimensions of trust (Bhattacherjee 2002; Gefen/Straub 2004), I will first focus on trust theory. More specifically, I will concentrate on the existence of multifoci trust studies (see section 2.4.6), the theoretical foundation used for studying trust in IT artifacts (see sections 2.4.3 - 2.4.5), and the antecedents for trust studied in the literature. Second, I will pick up the issue of measurement model mis-specification and investigate the quality of measurement model specification in IS trust research resembling the reliability of the published results. Third, I will focus on identifying contributions that use trust theory to design IT artifacts or even provide an approach how these insights can be used during the development of IT artifacts.

To answer my RQ, I will conduct a systematic literature review (Webster/Watson 2002). I will review the papers published in the eight journals of the AIS senior scholars' basket of journals (Senior Scholars Forum 2007) between 1995 and 2012. I

[16] The insights presented in this section are partly based on different papers on this topic (Söllner/Leimeister 2010b; Söllner/Leimeister 2010a; Söllner/Leimeister 2013). I thank my collaborators, the reviewers and attendees of the AOM Annual Meeting 2010, the EURAM 2010 and David Gefen for the valuable feedback on my work.

focus on the contributions since 1995 because many researchers build upon the theory provided by Mayer, Davis, & Schoorman (1995) or base their measurement models on the work of McAllister (1995).

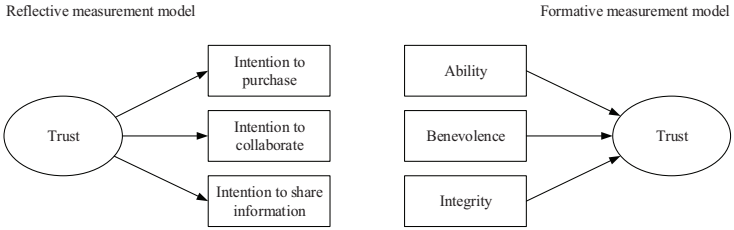
In the remainder of this section, I will provide details on the methodology of my literature review first. Afterwards, the results of the review will be presented. Based on the results, I will derive five challenges that will be addressed in the rest of my dissertation.

4.2 Combining Trust and Measurement Theory

Based upon the provided trust theory (section 2.4) and the background on measurement models (section 3.3.1) I will now evaluate what type of measurement is suitable for trust.

Following trust theory, the flow of causality is coming from the dimensions (e.g., ability, benevolence, integrity) leading to trust and from there on proceeds to trust's consequences (grouped as risk taking in relationships). Following the criteria by Jarvis, Mackenzie and Podsakoff (2003) presented in section 3.3.1 a formative measurement model should be used to measure trust using indicators like ability, benevolence, integrity and propensity to trust – whereas a reflective measurement model should be used to measure trust using risk-taking-related indicators, like intention to purchase or intention to share information. Figure 22 illustrates the way these two types of measurement are usually visualized in the literature (without including measurement error or correlation between indicators), and provides an evaluation of both types using the decision rules by Jarvis, Mackenzie and Podsakoff (2003).

My evaluation of both types of measurement models shows that the formative as well as the reflective measurement models derived from theory fulfill all four aspects found in the guidelines and hence are correctly specified. In accordance with this theory based understanding of trust measurement, I will review trust measurement models found in the literature in order to get an insight about the reliability of the presented results.



1. Causality flows from the latent variable to the indicators → reflective approach appropriate
2. Indicators are interchangeable, e.g., intention to share information could be replaced by intention to rely on information from the Internet without altering the definition of the latent variable → reflective approach appropriate
3. Indicators are supposed to correlate highly with each other, if someone, e.g., has a high amount of trust in an e-vendor his or her intention to purchase from, to collaborate with and to rely on the e-vendor should also be high → reflective approach appropriate
4. Indicators show a higher overlap in terms of antecedents and consequences, since they are all caused by the same latent variable and are supposed to be interchangeable → reflective approach appropriate

1. Causality flows from the indicators to the latent variable → formative approach appropriate
2. Indicators are not interchangeable because removing, e.g., ability would alter the definition of the latent variable → formative approach appropriate
3. Indicators are not supposed to correlate highly with each other, e.g., high ability does not necessarily imply high benevolence → formative approach appropriate
4. Indicators do not necessarily share the same antecedents or consequences, e.g., an antecedent of competence is not necessarily an antecedent of benevolence or integrity → formative approach appropriate

Figure 22: Reflective and formative measurement models for trust derived from trust theory
Source: Söllner and Leimeister (2013)

4.3 Methodology of the Literature Review

As pointed out in section 3.1, systematic literature reviews have gained more and more importance due to the increasing number of books, journals, conferences and workshops. A literature review should describe, summarize, assess, appraise, resolve or integrate selected research results with a focus on the methodology, theory, content or other aspects. The aim of a literature review is the analysis of relevant work with special focus on specific research questions (Webster/Watson 2002).

Due to the huge number of contributions on trust and the argument that the major contributions will probably be found in leading journals (Webster/Watson 2002, xvi), I

limited my review to the eight journals of the Senior Scholars' Basket of Journals (Senior Scholars Forum 2007). I reviewed the papers published on these journals from 1995 on, since the number of articles on trust has greatly increased from 1995 on (Ebert 2009) and Mayer, Davis and Schoorman's (1995) work is used as the foundation of many IS contributions on trust. In detail, I reviewed the following journals and issues:

- European Journal of Information Systems (EJIS), Volume 4 (Issue 1) – 21 (6)
- Information Systems Journal (ISJ), 5 (1) – 22 (6)
- Information Systems Research (ISR), 6 (1) – 23 (4)
- Journal of the Association of Information Systems (JAIS), 1 (1) – 13 (12)
- Journal of Information Technology (JIT), 10 (1) – 27 (4)
- Journal of Management Information Systems (JMIS), 12 (1) – 29 (2)
- Journal of Strategic Information Systems (JSIS), 4 (1) – 21 (4)
- Management Information Systems Quarterly (MISQ), 19 (1) – 36 (4)

To identify relevant papers in these journals, I conducted a database search using the Business Source Premier database by EBSCO as my default database. Due to availability restrictions, the following adaptations to the search process had to be made: For the ISJ issues 5 (1) – 7 (4), and all JIT issues, I checked the websites of the journals. For all JSIS issues, I used the ScienceDirect database by Elsevier. For the JAIS issues 1 (1) – 3 (1), I used the AIS eLibrary. Independent of the journal or database, I always searched for the term "trust" in the title, abstract and keywords of every paper. Following this method, 167 papers were identified. For addressing the design related part of my research question, all 167 were first screened regarding information whether trust has been used to design IT artifacts. Afterwards the 167 papers were screened regarding their fit for answering the theory- and methodology-related parts of the research question. For example, the JMIS published a special issue on trust in online environments in 2008. This special issue came with an editorial (Benbasat/Gefen/Pavlou 2008) and a research agenda (Gefen/Benbasat/Pavlou 2008). Such articles were not considered in the review, since they did not present original research, but summarize the articles in the special issue or resemble the opinion of the

authors on future research necessary. Furthermore, my focus was on insights that have been empirically tested. Consequently, I did not consider qualitative papers in this literature review. After conducting this first check, 77 papers remained. Figure 23 provides a graphical distribution of the papers on the different journals.

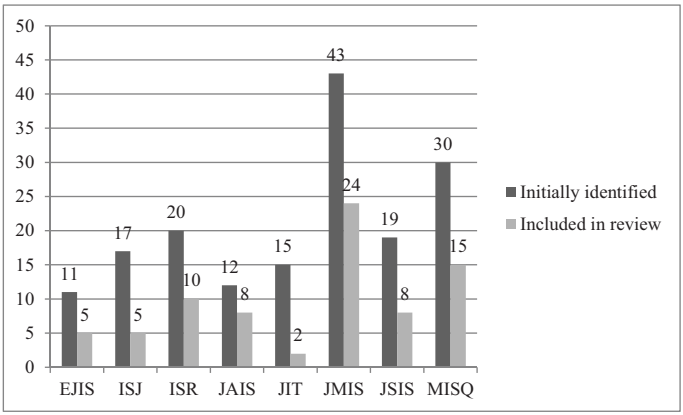


Figure 23: Graphical illustration of the distribution of the initially identified and reviewed papers among the eight journals
Source: Söllner and Leimeister (2013)

Figure 23 shows that I initially identified at least ten papers in each journal based on my search criteria. This shows that trust studies have been published in all major journals throughout the IS discipline. Figure 24 shows the distribution of the papers over time. This illustration shows that trust started to become a major IS construct in 2002 with a peak of trust-related papers in 2008. This peak is related to a big special issue of the JMIS (Benbasat/Gefen/Pavlou 2008) which accounts for eight of the 14 reviewed papers in 2008. After 2008, the interest in trust-related research decreases until 2011. In 2012, another increase of trust-related research can be observed. However, even though the amount of the initially identified papers increases from six to 13 comparing 2011 and 2012, the number of papers I included in the review remained constant (four). Despite the fact that this observation is only based on one year, it could be a hint for a methodology-related change in IS trust research. The special issue of the MISQ in 2010 (Benbasat/Gefen/Pavlou 2010), e.g., did not publish traditional empirical papers, as have been published in the 2008 special issue of JMIS. Instead, papers reporting results based on NeuroIS (Dimoka 2010; Riedl/Hubert/Kenning 2010; Dimoka/Pavlou/Davis 2011) studies have been published.

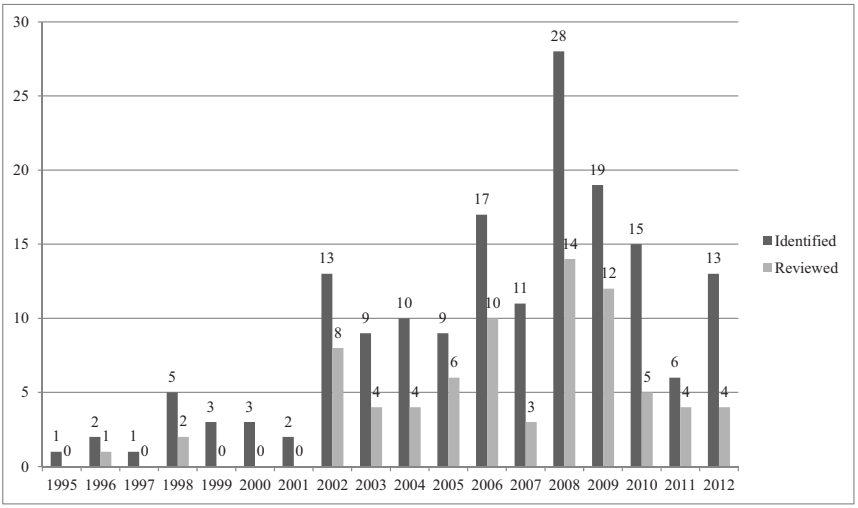


Figure 24: **Graphical illustration of the distribution of the initially identified and reviewed papers between 1995 and 2012**
Source: Söllner and Leimeister (2013)

Regarding the operationalization of the literature review, Swanson and Ramiller (1993, 301) reviewed the abstract, introduction, discussion section and conclusion in their literature review. With my interest in details on theory, methodology and results, I had to expand this method; I thus, additionally checked the theory, research design, research method and results sections of all remaining papers. The results of the review will be captures using the concept matrix (Webster/Watson 2002) shown in Figure 25.

	Antecedents of trust			Measurement model specification			TSCs	
Paper	Trustee(s)	Theoretical foundation	Antecedents	Measurement model(s) used for trust	Correctly specified?	Reason	Used to design a specific IT Artifact?	Approach for using insights to design presented?
A								
B								
C								

Figure 25: **Concept matrix of my literature review**
Source: Own illustration

Regarding the literature review categories of Fettke (2006) presented in section 3.1, I rely mainly on mathematical-statistical indicators in my review but will also use natural language in some sections. Following my research question, I focus on research results (antecedents and consequences of trust), research method (measurement models used) and theory (conceptualization of trust). Answering my research question resembles the target of my review and I aim at integrating IS trust research, but based on the results, will also criticize prior research. I take a neutral

role, not favouring any conceptualization or research method. I explicitly limit my literature review to the eight journals of the Senior Scholars' Basket of Journals and use a keyword-based database search, making it a selective approach. I structure my review mainly thematically, but will in some passages also use a methodical structure. My target groups are specialized researchers and researchers in general. My review closes with future research challenges which will be addressed in my dissertation. Table 8 provides a graphical illustration of my type of literature review.

TYPE		natural language		mathematical-statistical	
FOCUS		research results	research method	theory	experience
TARGET	FORMULATION	not explicit		explicit	
	CONTENT	integration	criticism	central topics	
PERSPECTIVE		neutral		position	
LITERATURE	SELECTIONS	non explicit		explicit	
	EXTENSIVENESS	foundations	representative	selective	complete
STRUCTURE		historical	thematically	methodical	
TARGET GROUP		common public	practitioners	common researcher	specialized researcher
FUTURE RESEARCH		not explicit		explicit	
		= categories used in my literature review			

Table 8: Classification of my literature review
Source: Own illustration

4.4 Results

4.4.1 Trustees Studied in the Information Systems Literature

Trust is usually viewed as being part of a relationship between a trustor and a trustee. The trustor is usually a human being trusting different kinds of trustees (e.g., the Internet or a vendor (McKnight/Choudhury/Kacmar 2002b)). Based on the results of my review, I identified four different categories of trustees:

- Human beings
- Organizations
- Institutions
- IT artifacts

Human beings as trustees. One part of IS trust research investigates trust relationships among human beings that are mediated by IT. Jarvenpaa, Knoll and Leidner (1998) and Kanawattanachai and Yoo (2007), e.g., focus on trust among members of virtual teams, wheras Chai, Das and Rao (2011) investigate the trust among different bloggers. I only applied this category if I was absolutely sure that the trustee was another person. There are, e.g., some papers investigating trust between buyers and sellers on marketplaces such as eBay. Here I decided to use the category *organization*, since the trustees might be persons but also organizations.

Organizations as trustees. Based on the number of antecedents identifed, the biggest part of IS trust research focuses on trust relationships between human beings and organizations. Examples are eBay (Ba/Pavlou 2002), Amazon (Van Slyke et al. 2006) or web vendors in general (McKnight/Choudhury/Kacmar 2002b). As already pointed out, I applied this category as soon as the trustee could be not a single person but also an organization, e.g., a seller on eBay. Furthermore, I used this category for communities of organizations, e.g., the community of sellers (Pavlou/Gefen 2005), as long as these communities did not act as institutions.

Institutions as trustees. Besides human beings and organizations, IS trust research also investigates trust relationships between human beings and institutions. Dinev et al. (2006), e.g., focus on the impact of perceived risk on trust in the Internet, and Kim, Shin and Lee (2009) investigate trust in mobile banking. The example of Kim, Shin and Lee (2009) illustrates how I decided to use the category institutions instead of organizations. Kim, Shin and Lee (2009) focus on mobile banking as a whole, like the Internet, and not on single organizations offering mobile banking. Thus, they focus the trust relationship between human beings and mobile banking as an institution.

IT artifacts as trustees. The fourth kind of trust relationships investigated in IS trust research are relationships between human beings and IT artifacts. Cyr et al. (2009), e.g., address the question how a web site needs to be designed for being perceived as trustworthy and Wang and Benbasat (2008) focus on understanding human trust in recommendation agents. I used this category if I was sure – based on the information provided in the papers – that the trustee was the IT artifact itself and not the entity providing the IT artifact. Lots of studies on trust in e-commerce use experimental designs including web sites but focus on the trust relationship between the human being and the organization providing the web site, not the web site itself (e.g., Lim, Sia, Lee and Benbasat (2006)).

4.4.2 Multifoci Trust Studies in the Information Systems Literature

As pointed out in section 2.4, trust is a part of a relationship between a trustor and a trustee, and literature on multifoci trust pointed out that multiple trust relationships might be important in a given context. Thus, I investigated which of the reviewed papers address multiple foci of trust – in particular whether trust in two different trustees is studied. According to my results, 16 of the reviewed papers address at least two foci of trust (McKnight/Choudhury/Kacmar 2002a; Pavlou/Gefen 2004; Verhagen/Meents/Yao-Hua 2006; Kim/Ahn 2007; Bélanger/Carter 2008; Li/Hess/Valacich 2008; Lowry et al. 2008; Turel/Yuan/Connelly 2008; Vance/Elie-Dit-Cosaque/Straub 2008; Hess/Fuller/Campbell 2009; Klein/Rai 2009; Teo/Srivastava/Jiang 2009; Krasnova et al. 2010; Sun 2010; Chai/Das/Rao 2011; Messerschmidt/Hinz 2012).

A common research approach is to investigate two foci of trust by combining institution-based trust – e.g., in the Internet – and trust in a specific trustee of this environment - e.g., web vendors (McKnight/Choudhury/Kacmar 2002a), IT artifacts (Lowry et al. 2008), and the government (Bélanger/Carter 2008). Another common research approach combines trust in an online marketplace or an online social network – e.g., eBay or Facebook – and trust in actors on the marketplace or in the online social network – e.g., sellers or members. For example, Pavlou and Gefen (2004) investigate the impact of trust in the intermediary – in their case Amazon – on trust in the community of sellers in this marketplace. Krasnova et al. (2010), instead, focus on the impact of trust in other members of online social networks and trust in the provider of the online social network on the perceived privacy risk. Furthermore, one paper investigated three different foci of trust. Teo, Srivastava and Jiang (2009) focus on the impact of trust in the government and trust in technology – in their case the Internet – on trust in a specific e-government website.

Summing up, different multifoci trust studies can be found in the IS trust literature. However, multifoci trust insights including trust in IT artifacts are sparse (Li/Hess/Valacich 2008; Lowry et al. 2008; Vance/Elie-Dit-Cosaque/Straub 2008; Hess/Fuller/Campbell 2009; Teo/Srivastava/Jiang 2009; Messerschmidt/Hinz 2012), and mostly focus on IT artifacts, such as websites which can hardly be compared to UIS. Furthermore, I could not identify a multifoci trust study that systematically identifies which different foci of trust could be prevalent – e.g., using a trust network based approach as Muir (1994) suggests. Consequently, insights focusing on the

importance of different kinds of trust in the context of UIS adoption can hardly be found in the IS trust literature.

4.4.3 Conceptualizations Used for Studying Trust in IT Artifacts

In sections 2.4.2 - 2.4.5, I pointed out that it is suitable to study trust in trust relationships between human beings and IT artifacts as long as the IT artifact takes the trustee role. Furthermore, I introduced different possible theoretical foundations for studying such trust relationships. In my literature review, I identified 17 papers that investigated a trust relationship in which an IT artifact took the trustee role (Pennington/Wilcox/Grover 2003; Wang/Benbasat 2005; Choudhury/Karahanna 2008; Cyr 2008; Li/Hess/Valacich 2008; Lowry et al. 2008; Vance/Elie-Dit-Cosaque/Straub 2008; Zahedi/Song 2008; Cyr et al. 2009; Hess/Fuller/Campbell 2009; Kim/Benbasat 2009; Sia et al. 2009; Teo/Srivastava/Jiang 2009; Chan et al. 2010; Al-Natour/Benbasat/Cenfetelli 2011; Benlian/Titah/Hess 2012). The results of the analysis of the theoretical foundations used confirm the observation of, e.g., Gefen, Benbasat and Pavlou (2008) that insights on interpersonal trust are usually used to study such trust relationships (15 out of the 17 papers used this theoretical foundation). Furthermore, none of the reviewed papers used a theoretical foundation especially designed for studying trust in technology. As a result, the call to investigate the suitability of other theoretical foundations for studying such trust relationships (Gefen/Benbasat/Pavlou 2008) still needs to be addressed.

4.4.4 Antecedents of Trust Identified in the Information Systems Literature

After presenting the results regarding the different trust relationships studied and theoretical foundations used for studying trust in IT artifacts in IS trust research, this section focuses on the existing insights on how each trust relationship can be built or supported. Since building or supporting trust requires knowledge about factors impacting trust, I reviewed all papers regarding the antecedents of trust they investigated. Table 3 shows the results of this analysis. I only reported antecedents that were found to be significant at least at the level of 0.05. Due to the plethora of different antecedents, I tried to avoid redundant antecedents – e.g., I did not report ‘propensity to trust’ and ‘disposition to trust’ as two antecedents, since both constructs differ only in wording. Furthermore, I did not highlight ‘popular’ antecedents that have been more frequently used.

Trustee(s)	Antecedents (at least significant at the level of 0.05)
Human beings	Ability (Jarvenpaa/Knoll/Leidner 1998) Benevolence (Jarvenpaa/Knoll/Leidner 1998) Collaborative values (Stewart/Gosain 2006) Early communication level (Jarvenpaa/Shaw/Staples 2004) Executive's communication (Iacovou/Thompson/Smith 2009) Executive's knowledge (Iacovou/Thompson/Smith 2009) Forking norm (Stewart/Gosain 2006) Freedom beliefs (negative) (Stewart/Gosain 2006) Initial trustworthiness (Jarvenpaa/Shaw/Staples 2004) Integrity (Jarvenpaa/Knoll/Leidner 1998) In-group bias (Robert Jr/Dennis/Hung 2009) Named credit norm (negative) (Stewart/Gosain 2006) Perceived control (Krasnova et al. 2010) Process beliefs (Stewart/Gosain 2006) Propensity to trust (Jarvenpaa/Knoll/Leidner 1998) Reciprocity (Chai/Das/Rao 2011) Social ties (Chai/Das/Rao 2011) Task-oriented communication (Kanawattanachai/Yoo 2007)
Organizations	Actualized benefits (Montoya/Massey/Khatri 2010) Assurance (Gefen 2002) Buyer's past experience (Pavlou/Gefen 2005) Calculative-based (Gefen/Karahanna/Straub 2003b) Characteristic-based mode (Gefen 2004) Cognitive trust in buyers (Sun 2010) Customer endorsement (Lim et al. 2006) Customer satisfaction (Kim/Xu/Koh 2004) Disposition to trust (Bélanger/Carter 2008) Distributive justice (Turel/Yuan/Connelly 2008) Familiarity (Bhattacherjee 2002) Harmonius conflict resolution (Goo et al. 2009) Informational justice (Turel/Yuan/Connelly 2008) Information quality (Kim/Xu/Koh 2004) Institution-based mode (Gefen 2004) Institution-based situational normality (Gefen/Karahanna/Straub 2003b) Institution-based structural assurance (Gefen/Karahanna/Straub 2003b) Mutual dependence (Goo et al. 2009) Negative ratings (negative) (Ba/Pavlou 2002) Perceived business tie (Stewart 2006) Perceived control (Krasnova et al. 2010) Perceived ease of use (Awad/Ragowsky 2008) Perceived effectiveness of escrow services (Pavlou/Gefen 2004) Perceived effectiveness of feedback mechanism (Pavlou/Gefen 2004) Perceived effectiveness of institutional structures (Pavlou/Gefen 2005) Perceived site quality (McKnight/Choudhury/Kacmar 2002b) Perceived usefulness (Awad/Ragowsky 2008) Portal affiliation (Sia et al. 2009) Positive ratings (Ba/Pavlou 2002) Privacy concern (Kim 2008) Procedural justice (Turel/Yuan/Connelly 2008) Process-based mode (Gefen 2004) Propensity to trust (Kim/Ahn 2007) Psychological contract violation (negative) (Pavlou/Gefen 2005) Referral (Kim 2008)

	Reliability (Gefen 2002) Reputation (Kim/Xu/Koh 2004) Responsiveness (Gefen 2002) Security protection (Kim 2008) Service level (Kim/Xu/Koh 2004) Social influence (Montoya/Massey/Khatri 2010) Structural assurance (McKnight/Choudhury/Kacmar 2002b) Supplier commitment (Hart/Saunders 1998) System reliability (Kim 2008) System trust (Pennington/Wilcox/Grover 2003) Third-party seal (Kim 2008) Training (Montoya/Massey/Khatri 2010) Trusting beliefs in vendor (McKnight/Choudhury/Kacmar 2002b) Trust in e-customer service provider (Turel/Yuan/Connelly 2008) Trust in intermediary (Pavlou/Gefen 2004) Trust in market-maker (Kim/Ahn 2007) Trust in service representative (Turel/Yuan/Connelly 2008) Web Security (Kim/Ahn 2007) Web Usability (Kim/Ahn 2007) Word-of-mouth quality (Awad/Ragowsky 2008)
Institutions	Disposition to trust (McKnight/Choudhury/Kacmar 2002a) Perceived internet privacy risk (negative) (Dinev/Hart 2006) Perceived risk (negative) (Dinev et al. 2006) Relative benefits of mobile banking (Kim/Shin/Lee 2009) Structural assurance of mobile banking (Kim/Shin/Lee 2009) Trust in Internet (Bélanger/Carter 2008)
IT artifacts	Brand Awareness (Lowry et al. 2008) Brand Image (Lowry et al. 2008) Calculative reason (Wang/Benbasat 2008) Cost/benefit calculation (Li/Hess/Valacich 2008) Culture uncertainty avoidance (Vance/Elie-Dit-Cosaque/Straub 2008) Dispositional reason (Wang/Benbasat 2008) Ease of use (Vance/Elie-Dit-Cosaque/Straub 2008) Guarantees (Pennington/Wilcox/Grover 2003) Image appeal (Cyr et al. 2009) Information design (Cyr 2008) Institution-based trust (Lowry et al. 2008) Interactive reason (Wang/Benbasat 2008) Knowledge-based reason (Wang/Benbasat 2008) Navigational design (Cyr 2008) Perceived decision process similarity (Al-Natour/Benbasat/Cenfetelli 2011) Perceived social presence (Cyr et al. 2009) Product type (negative) (Benlian/Titah/Hess 2012) Online product recommendation use (negative) (Benlian/Titah/Hess 2012) Reputation (Li/Hess/Valacich 2008) Situational normality (Li/Hess/Valacich 2008) Subjective norm (Li/Hess/Valacich 2008) Trust in government (Teo/Srivastava/Jiang 2009) Visual appeal (Vance/Elie-Dit-Cosaque/Straub 2008) Visual design (Cyr 2008) Web site quality (Lowry et al. 2008)

Table 9: Antecedents of trust identified in IS trust literature
Source: Söllner and Leimeister (2013)

The results presented in Table 9 show that a plethora of different antecedents has been identified in IS trust literature. Furthermore, they show that most unique antecedents have been identified for the trust relationship between human beings and organizations, and that comparably few antecedents have been identified for the trust relationship between human beings an institutions. Another interesting point is that several antecedents were identified for multiple trust relationships. Disposition – or propensity – to trust, e.g., has been identified as an antecedent for every trust relationship. Based on these results, I can conclude that a lot of insights on how trust can be built across the different trust relationships exist.

4.4.5 Reliability of the Reported Results according to Measurement Theory

Since Petter, Straub and Rai (2007) showed that mis-specification is prevalent in some IS studies and may impact the reliability of the observed structural relationships, I investigated the reliability of the results reported in the previous section by analyzing how trust has been measured in each of the 77 reviewed papers. For assessing the quality of the specification of the measurement models, I relied on the decision rules provided by Jarvis, Mackenzie and Podsakoff (2003). If multiple trust constructs were used in a study, I assessed each construct seperately. If the assessment produced varying results, I reported assessments for each construct. If the assessement of the different constructs did produce consistent results, I did not differentiate between the different constructs in the presentation of my results. Regarding the measurement models used, I first relied on information provided by the authors of each paper. However, the details of information on the choice of measurement model varied highly. In many studies, I could not find any information regarding the choice of measurement model. In other studies, e.g., Gefen (2004), detailed information on the choice of measurement models and discussions why these choices are appropriate can be found. If I could not find any explicit statement, I focused on the results presented in the studies. If reflective quality criteria such as Cronbach's alpha or the composite reliability were reported, I concluded that a reflective measurement model had been used. The results of my analysis are presented in Table 10.

Paper	Measurement model(s) used for trust	Correctly specified?	Reason
Al-Natour, Benbasat and Cenfetelli (2011)	Reflective	No, should be formative	Items address different characteristics

Awad and Ragowsky (2008)	Reflective	No, should be formative	Items address different characteristics
Ba and Pavlou (2002)	Reflective	No, should be formative	Items address different characteristics
Bélanger and Carter (2008)	Reflective	Disposition to trust: Yes Trust in Internet and Trust in Government: No, should be formative	Items focus on consequences Items address different characteristics
Bélanger, Hiller and Smith (2002)	Reflective	No, should be formative	Items address different characteristics
Benlian, Titah and Hess(2012)	Reflective	No, should be formative	Items address different characteristics
Bhattacherjee (2002)	Reflective	No, should be formative	Items address different characteristics
Carter and Bélanger (2005)	Reflective	No, should be formative	Items address different characteristics
Chai, Das and Rao (2011)	Reflective	No, should be formative	Scale is based on different dimensions
Chan et al. (2010)	Reflective	No, should be formative	Items address different characteristics
Choudhury and Karahanna (2008)	Reflective	No, should be formative	Items address different characteristics
Cyr (2008)	Reflective	?, items not reported	
Cyr et al. (2009)	Reflective	No, should be formative	Items address different characteristics
Dinev et al. (2006)	Reflective	Propensity to trust: Yes Institutional trust: No, should be formative	Items focus on consequences Items address different characteristics
Dinev and Hart (2006)	Reflective	No, should be formative	Items address different characteristics
Everard and Galletta (2005)	Reflective	No, should be formative	Items address different characteristics
Gefen (2002)	Reflective	Yes	Focuses mainly on trust itself and consequences
Gefen (2004)	Reflective	No, should be formative	Items address different characteristics
Gefen, Karahanna and Straub (2003b)	Reflective	No, should be formative	Items address different characteristics
Goo et al. (2009)	Reflective	No, should be formative	Items address different characteristics
Hart and Saunders (1998)	Reflective	No, should be formative	Items address different characteristics
Heeseok and Byounggu (2003)	Reflective	No, should be formative	Items address different characteristics
Hess, Fuller and Campbell (2009)	Reflective	No, should be formative	Items address different characteristics
Huand, Davison and Gu (2011)	Reflective	Affect-based: Yes Cognition-based: No, should be formative	Items focus on consequences Items address different characteristics

Iacovou, Thompson and Smith (2009)	Reflective	No, should be formative	Items address different characteristics
Jarvenpaa, Knoll and Leidner (1998)	Reflective	Trust and Trustworthiness: Yes Disposition to trust: No, should be formative	Items focus on consequences Items address different characteristics
Jarvenpaa, Shaw and Staples (2004)	Reflective	Yes	Items focus on consequences
Kanawattanachai and Yoo (2002)	Reflective	No, should be formative	Items address different characteristics
Kankanhalli, Tan and Kwok (2005)	Reflective	No, should be formative	Items address different characteristics
Kim, Xu and Koh (2004)	Reflective	No, should be formative	Items address different characteristics
D. J. Kim (2008)	Reflective	?, items not reported	
D. Kim and Benbasat (2009)	Formative	Yes	Items address different characteristics
D. J. Kim, Ferrin and Rao (2009)	Reflective	Disposition to trust: Yes Consumer Trust: No, should be formative	Items focus on consequences Items address different characteristics
Kim, Shin and Lee (2009)	Reflective	Propensity to trust : Yes Initial Trust: No, should be formative	Items focus on consequences Items address different characteristics
Kim and Ahn (2007)	Reflective	Propensity to trust: Yes Trust in market-makers and trust in sellers: No, should be formative	Items focus on consequences Items address different characteristics
Klein and Rai (2009)	Second-order – formative + reflective	Yes	Reflective measurement of the different formative dimensions
Krasnova et al. (2010)	Reflective	No, should be formative	Items address different characteristics
Li, Hess and Valacich (2008)	Second-order – reflective + reflective	No, should be Second-Order – formative + reflective	Reflective measurement of different formative dimensions
Lim et al. (2006)	Reflective	No, should be formative	Items address different characteristics
Lowry et al. (2008)	Second-order – formative + reflective	?, items not reported	
McKnight, Choudhury and Kacmar (2002b)	Reflective	Trusting beliefs: No, should be formative Trusting intention: Yes	Items address different characteristics Items focus on consequences
McKnight, Choudhury and Kacmar (2002a)	Second-order – reflective + reflective	Disposition to trust, Insitution-based trust and trusting beliefs: No,	Reflective measurement of different formative dimensions

		should be second-order – formative + reflective Trusting intentions: Yes	 Reflective measurement of different reflective dimensions
Messerschmidt and Hinz (2012)	Second-order – formative + reflective	No, several problems: Each dimension should be formative + Dimensions are different constructs, since they refers to different trustees	Items address different characteristics
Mithas, Jones and Mitchell (2008)	Reflective	No, should be formative	Items address different characteristics
Montazemi, Pittaway, Qahri, Saremi and Wei (2012)	Reflective	?, items not reported	
Montoya, Massey and Khatri (2010)	Reflective	No, should be formative	Items address different characteristics
Nelson and Cooprider (1996)	Reflective	No, should be formative	Items address different characteristics Furthermore, partly measuring reputation not trust.
Nicolaou and McKnight (2006)	Reflective	No, should be formative	Items address different characteristics
Pavlou (2002)	NA	NA	Focus on dimensions benevolence and credibility
Pavlou and Dimoka (2006)	NA	NA	Focus on dimensions benevolence and credibility
Pavlou and Fygenson (2006)	Reflective	No, should be formative	Items address different characteristics
Pavlou and Gefen (2004)	Reflective	No, should be formative	Items address different characteristics
Pavlou and Gefen (2005)	Reflective	No, should be formative	Items address different characteristics
Pavlou, Huigang and Yajiong (2007)	Reflective	No, should be formative	Items address different characteristics
Pennington, Wilcox and Grover (2003)	Reflective	No, should be formative	Items address different characteristics
Posey, Lowry, Roberts and Ellis (2010)	Reflective	?, items not reported	Items address different characteristics
Qureshi et al. (2009)	Reflective	No, should be formative	Items address different characteristics
Ridings, Gefen and Arinze (2002)	NA	NA	Focus on dimensions of trust
Robert Jr., Dennis and Hung (2009)	Reflective	Disposition to trust: No, should be formative Trust belief and trust intentions: Yes	Items address different characteristics Items focus on consequences
Rustagi, King and	Reflective	No, should be	Items address different

Kirsch (2008)		formative	characteristics
Sia et al. (2009)	Reflective	No, should be formative	Items address different characteristics
Son, Narasimhan and Riggins (2005)	Reflective	No, should be formative	Items address different characteristics
Staples and Webster (2008)	Reflective	Yes	Items focus on consequences
Stewart (2006)	Reflective	No, should be formative	Items address different characteristics
Stewart and Gosain (2006)	Reflective	Affective trust: Yes Cognitive trust: No, should be formative	Items focus on consequences Items address different characteristics
Sun (2010)	Reflective	Affective trust: Yes Cognitive trust: No, should be formative	Items focus on consequences Items address different characteristics
Teo, Srivastava and Jiang (2009)	Reflective	No, should be formative	Items address different characteristics
Turel, Yuan and Connelly (2008)	Reflective	No, should be formative	Items address different characteristics
Van der Heijden, Verhagen and Creemers (2003)	Reflective	No, should be formative	Items address different characteristics
Van Slyke et al. (2006)	Reflective	No, should be formative	Items address different characteristics
Vance, Elie-Dit-Cosaque and Straub (2008)	Second-order – formative + reflective	Yes	Reflective measurement of the different formative dimensions
Venkatesh and Bala (2012)	Second-order – formative + reflective	Yes	Reflective measurement of the different formative dimensions
Venkatesh et al. (2011)	Reflective	No, should be formative	Items address different characteristics
Verhagen, Meents and Yao-Hua (2006)	Reflective	No, should be formative	Items address different characteristics
Wang and Benbasat (2005)	Second-order – reflective + reflective	No, should be second-order- formative + reflective	Reflective measurement of different formative dimensions
Wang and Benbasat (2008)	Reflective	No, should be formative	Items address different characteristics
Zahedi and Song (2008)	Reflective	?, items not reported	

Table 10: Quality of the measurement model specification in the reviewed papers
Source: Söllner and Leimeister (2013)

The results of my analysis of the quality of the measurement model specification in IS trust research show that measurement model mis-specification might be a serious issue in IS trust research. In the majority of the reviewed papers, formative indicators were used for a reflective measurement of the respective trust constructs. Despite this

negative observation, I also found several measurement models that are correctly specified based on the decision rules provided by Jarvis, Mackenzie and Podsakoff (2003). According to measurement theory, these measurement models should ensure a valid and reliable measurement of trust in related studies.

4.4.6 Trust and IT Artifact Design

Regarding the use of theoretical insights on trust for designing IT artifacts, I found 12 out of the 167 initially identified papers that at least use insights on trust to design, e.g., different treatments for their study (Pennington/Wilcox/Grover 2003; Everard/Galletta 2005; Leimeister/Ebner/Krcmar 2005; Kim/Benbasat 2006; Komiak/Benbasat 2006; Stewart 2006; Cyr et al. 2009; Hess/Fuller/Campbell 2009; Kim/Benbasat 2009; Sia et al. 2009; Dimoka 2010; Rice 2012).

Whereas most papers briefly use theoretical insights to design treatments for their experiments (Pennington/Wilcox/Grover 2003; Sia et al. 2009; Dimoka 2010), Leimeister, Ebner and Krcmar (2005) focus on deriving TSCs for a virtual community for cancer patients and quite intensely rely on theoretical insights to design the virtual community.

Nevertheless, none of the papers presents an approach enabling researchers and practitioners to systematically use theoretical insights on trust when designing a specific IT artifact.

4.5 Discussion

The goal of this literature review was to assess the readiness of IS trust research to guide the trustworthy design of UIS. Based on the results presented in this section, I think it is reasonable to claim that IS trust research has created a respectable knowledge base and that this knowledge base will help overcoming future challenges, e.g., regarding the design of increasingly automated IT artifacts. Nevertheless, IS trust research should not lean back, since, e.g., Luhmann (1979) pointed out that the technological development will make trust even more important. Thus, further trust research will be necessary to overcome the trust-related challenges created, e.g., by the current trend towards increasingly automated, opaque and ubiquitous information systems. Especially the gaps in the literature which were identified in this review should be filled.

I identified four trustees that are investigated in IS trust research: human beings, organizations, institutions and IT artifacts. Since my dissertation focuses on trust in UIS, I investigated the theoretical foundations used when studying trust relationships in which IT artifacts take the trustee role. My results show that 14 of the 16 identified papers rely on interpersonal trust theory when assessing trust, and none of the papers relies on foundations which are especially designed for such trust relationships (Lee/See 2004; McKnight et al. 2011). As a result, this gap in the literature still needs to be filled.

Furthermore, I identified a lack of research on multifoci trust in the context of IT artifact adoption. Consequently, future research needs to address this gap and create insights on the importance of different kinds of trust in the context of the adoption of IT artifacts, such as UIS.

Regarding the antecedents identified, I found that a plethora of different antecedents has been investigated in IS trust literature. However, I also identified measurement model specification issues that might lead to Type I errors and thus weaken the existing knowledge base. The main problem is the use of formative indicators for a reflective measurement of trust.

Last but not least, I focused on identifying insights on trustworthy IT artifact design. Besides several papers that used insights on trust theory to broadly develop different treatments for their studies, I did not find any papers specifically focusing on using insights from trust theory to design IT artifacts. Consequently, none of the reviewed papers provides an approach empowering researchers and practitioners to systematically use insights on trust to design a specific IT artifact. This resembles another gap in the IS literature that will be addressed in my dissertation.

4.6 Limitations

My review is not without limitations, which I shortly want to highlight in this section.

First, my assessment of the quality of the measurement models is only based on the decision rules provided by Jarvis, Mackenzie and Podsakoff (2003). I am aware of argumentation, e.g., by Gefen (2004) that a reflective approach is appropriate since the respondents can hardly differentiate between the ability, benevolence and integrity of a vendor. Nevertheless, I decided to stick to a given evaluation instrument and presented

the results I observed when reviewing whether the measurement model fulfilled these guidelines.

Second, I did not rely on any quantitative quality criteria for assessing the measurement models. Papers such as Cenfetelli and Bassellier (2009), Gefen, Ridgon and Straub (2011) and Ringle, Sarstedt and Straub (2012) provide insights on the most recent quality criteria for both, formative as well as reflective measurement models.

4.7 Conclusion

In this section I addressed the first research question of my dissertation:

> "How ready is IS trust research for empowering developers of UIS to account for the increasing importance of trust during UIS development, in terms of the conceptualizations used, antecedents identified and types measurement models employed, as well as guiding designers to design more trustworthy UIS?"

Concerning the conceptualizations of trust used in IS research, I found that the vast majority of the contributions investigating trust in IT artifacts relies on interpersonal trust theory. Furthermore, only few papers conduct multifoci trust studies in the context of IT artifact adoption. Thus, insights on the importance of different foci of trust in the context of IT artifact adoption in general and UIS adoption in particular are sparse.

Regarding the measurement models used to assess trust, I identified measurement model specification problems in a lot of IS trust papers. In the majority of the papers, the measurement approach used does not fulfill the guidelines by Jarvis, Mackenzie and Podsakoff (2003).

Focusing on the guidance for IT artifact designers, I found that hardly any paper uses trust insights to design an IT artifact. Only very few papers, e.g., Leimeister, Ebner and Krcmar (2005) explicitly rely on trust theory to derive design elements for a virtual community for cancer patients. However, they do not provide a detailed approach or method guiding other researchers or practitioners in designing trustworthy IT artifacts.

Summing up, I identified several challenges that to need to be overcome to strengthen the value of IS trust research with regard to guiding the design of trustworthy UIS.

Helping to overcome these challenges is the goal of my dissertation. Thus, addressing these challenges will structure the remainder of my dissertation.

In section 5, I will focus on the methodological weakness and investigate whether the predominant interpersonal trust theory can be used to derive a formative measurement model of trust. The decision to develop a formative measurement model is based on the advantage that such measurement models will create more detailed insights on how the measured construct is built. This model will afterwards be compared with a reflective measurement model as has been used in prior literature. In the comparison I focus on the reliability and validity of the reflective measurement model, and the impact of the choice of measurement model on antecedents and consequences of trust in the structural model, as well as the value for understanding how to design trustworthy IT artifacts.

Section 6 and 7 focus on the two conceptual challenges I identified in the literature review. First, I investigate whether the user considers different foci of trust when deciding whether to adopt a UIS or not. This study is presented in section 6 and mainly addresses the weakness that other disciplines have argued and found that studying different foci of trust is valuable but hardly any study has been conducted in the context of trust in IT artifacts. However, it also scratches the question, which conceptualization of trust should be used when studying trust relationships between humans and IT artifacts such as UIS. This question will be addressed in greater detail in the study presented in section 7.

In section 8, I will focus on the question, how insights on building trust in IT artifacts – such as UIS – can be used to design more trustworthy UIS. The study presented in this section will cover the development of a method for deriving TSCs for UIS based on insights from trust theory. The method will be used to derive four TSCs for a specific UIS. The TSCs and the method will afterwards be evaluated. Figure 26 provides a graphical illustration of the challenges identified in this literature review and how these challenges guide the remainder of my dissertation.

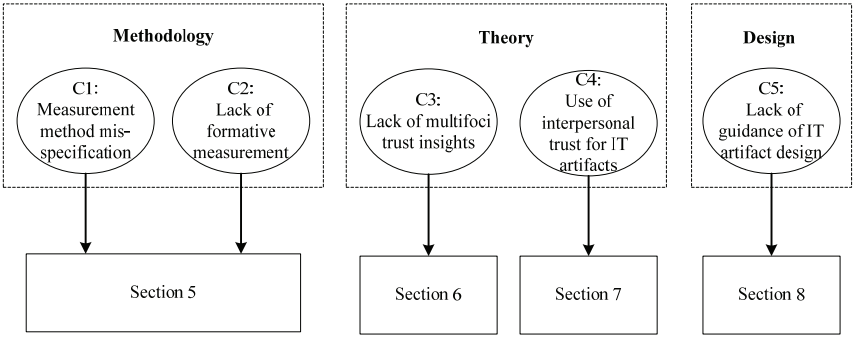


Figure 26: **Structure of the remainder of the dissertation based on the results of the literature review**
Source: Own illustration

5 Different Measurement Models for Trust – The Effect on Understanding the Formation of Trust[17]

5.1 Introduction

In this section of my dissertation, I will address my second research question:

> "What is the value of using a formative measurement approach for trust when aiming to design trustworthy UIS?"

In the previous section, I identified that IS research on trust predominantly relies on using reflective measurement models. Furthermore, I identified that many of the reflective measurement models are mis-specified, since causal indicators are used for a reflective measurement.

In the methodological background in section 3.3.1, I highlighted the difference between formative and reflective measurement approaches, and pointed out the value of formative approaches when it comes to creating deeper insights on the formation of a construct. As pointed out in the theoretical background in section 2.4.7, increasingly detailed knowledge of trust allows the derivation of more precise TSCs.

Consequently, in this section, I will investigate whether the predominant conceptualization of trust by Mayer, Davis and Schoorman (1995) can be used to derive a valid and reliable formative measurement model for trust. If this investigation is successful, it would show that the issue of measurement model mis-specification can be avoided without needing to identify another theory. Furthermore, it would provide new information on how trust can be generated using a formative measurement approach. In order to show that the insights created using a formative measurement approach are more detailed than insights created with a reflective measurement approach, I will compare the formative approach to a reflective approach as applied in the literature. Furthermore, I also investigate whether the choice of measurement model - formative or reflective – has an impact on the structural model the formatively or reflectively measured construct is embedded in.

[17] The insights presented in this section are partly based on a publication on this topic (Söllner et al. 2010). I thank my collaborators, as well as the reviewers and attendees of the Bled eConference 2010 for their valuable feedback on my work.

The remainder of this section is structured as follows. First, I present the hypotheses of my formative measurement model, and provide the structural context in which the formative measurement model for trust will be studied. Afterwards I will present details on the research method employed in this section. Next I will present the results obtained using the reflective measurement approach, as it has also previously been done in the literature. This section is followed by a presentation of the results acquired using the newly developed formative measurement model. Subsequently, the differences between the two measurement models and the impact of the selection of the according measurement model in the structural model will be discussed. This section closes with a conclusion and thoughts concerning the next steps that should be taken in the future.

5.2 Towards a Formative Measurement Model for Trust

Using trust and measurement theory as a basis, I now explain how I derive a simple formative measurement model for trust. Mayer, Davis and Schoorman (1995) provide three dimensions of trustworthiness they consider to be very important for determining trust: the trustee's ability, benevolence, and integrity (Figure 11). I use these three factors to measure trust in a formative way.

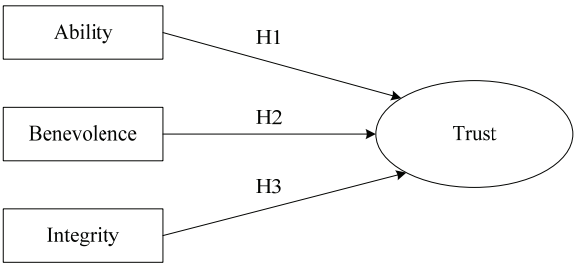


Figure 27: Hypotheses for the formative measurement model
Source: Adapted from Söllner et al. (2010)

Thus, in this section I test three main hypotheses, as shown in Figure 27:

H1: Perceived ability will positively affect trust.

H2: Perceived benevolence will positively affect trust.

H3: Perceived integrity will positively affect trust.

Using these three indicators, I am able to capture the three dimensions that Mayer, Davis and Schoorman (1995) consider to be very important for trust.

I evaluate the formative measurement model by including it into the structural model used in Wang and Benbasat (2005), see Figure 28. My focus was not on the evaluation of the structural paths, therefore, I decided not to add additional hypotheses. This approach also allows me to gather the desired knowledge concerning the impact of the selection of the measurement approach on the structural model.

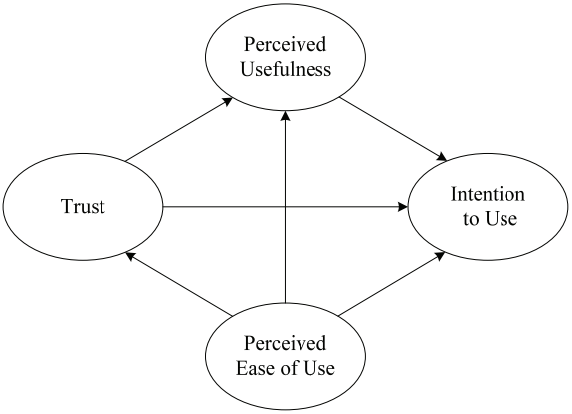


Figure 28: Research model of section 5
Source: Adapted from Gefen, Karahanna and Straub (2003b) and Wang and Benbasat (2005)

5.3 Research Method

To gather the data for the analysis, I conducted a free simulation experiment with undergraduate students at a German university. The students were asked to use a UIS that allowed them to gather and share real time recommendations for event locations in an urban area for 10 minutes. Afterwards, they were asked to fill out a survey. Responses were recorded on a seven-point Likert response format, with the endpoints labeled as “extremely disagree” and “extremely agree”. Moreover, there was the additional option for students to answer “I do not know” when they did not want to rate a statement. Overall, 192 undergraduate students took part in the free simulation experiment. So as to achieve high quality results, I decided to exclude all cases where a participant checked “I do not know” even once, as well as cases that were obviously not to be taken seriously (e.g., always “extremely disagree” or “extremely agree”). After eliminating these cases, I had a total of 153 cases that were included in the

analysis. Due to the early stage of my research and the use of formative indicators, I decided to use the Partial Least Squares (PLS) approach (Chin/Newsted 1999; Albers 2010). I used SmartPLS 2.0 (Ringle/Wende/Will 2005) for my analysis. All measures of the latent variables were adopted from the literature (see the appendix for further details).For the formative trust measurement model, I decided to use one indicator each for ability, benevolence, and integrity which were determined by Wang and Benbasat (2007). This is appropriate, because Wang and Benbasat (2007) showed that all trust measurements were reliable, meaning that every indicator belonging to the same group had a high reliability in measuring its related latent variable.

5.4 Results Obtained Using the Reflective Measurement Model for Trust

First, I shall highlight the quality criteria for the reflective measurement models in order to assess the reliability of my measurements. Table 11 shows the composite reliability (ρ_c) and the cross-loadings for the single indicators (Chin 1998).

	Perceived Ease of Use ($\rho c = 0.9747$)	**Intention to Use** ($\rho c = 0.9841$)	**Trust** ($\rho c = 0.9058$)	**Perceived Usefulness** ($\rho c = 0.9824$)
PEOU1	**0.9623**	0.2689	0.3361	0.3606
PEOU2	**0.9708**	0.3226	0.3385	0.3653
PEOU3	**0.9563**	0.3155	0.3216	0.3734
ItU1	0.3117	**0.9759**	0.6462	0.5929
ItU2	0.2968	**0.9821**	0.6457	0.6047
ItU3	0.3129	**0.9719**	0.6496	0.5937
Ability	0.3851	0.6558	**0.9360**	0.7560
Benevolence	0.2826	0.5599	**0.8940**	0,6172
Integrity	0.2092	0.5063	**0.7835**	0.4836
PU1	0.3888	0.5929	0.7164	**0.9672**
PU2	0.3743	0.5920	0.7036	**0.9736**
PU3	0.3486	0.6020	0.6912	**0.9816**

Table 11: Cross-loadings and composite reliability for the reflective measurement used in section 5
Source: Söllner et al. (2010, 72)

The results presented in Table 11 show that all loadings are greater than 0.707 and every indicator has the highest loading on its desired variable. Therefore, the measurement models fulfill the desired quality criteria (Chin 1998). Additionally, I

need to check the Average Variance Extracted (AVE) and the correlation among the latent variables. The AVE should be greater than 0.5, and, additionally, exceed any correlation with other latent variables (Chin 1998). The AVE and correlations among the latent constructs are presented in Table 12 and show that the measurement models fulfill these two criteria as well.

	Perceived Ease of Use	**Intention to Use**	**Trust**	**Perceived Usefulness**
Perceived Ease of Use	**0.9277**			
Intention to Use	0.3145	**0.9538**		
Trust	0.3447	0.6627	**0.7631**	
Perceived Usefulness	0.3805	0.6114	0.7225	**0.9490**

Table 12: **AVE and correlation among construct scores (AVE in diagonals) for the reflective measurement used in section 5**
Source: Söllner et al. (2010, 72)

The results of my evaluation of the structural model using the reflective measurement model are shown in Figure 29. The R^2 scores for *intention to use* ($R^2 = 0.4788$) and *perceived usefulness* ($R^2 = 0.5417$) are both at a moderate level. For *trust,* the R^2 score is only 0.1188, and does not even reach the score for a weak level (Chin 1998). A bootstrapping test shows that the direct effect of the *perceived ease of use* on the *perceived usefulness* is significant at 0.05. In contrast, the direct effect of the *perceived ease of use* on the *intention to use* is not significant. The path between the *perceived usefulness* and the *intention to use* is significant at the level of 0.01, and the other three paths are significant at 0.001. These results are now compared with the structural model using my formative measurement model of trust.

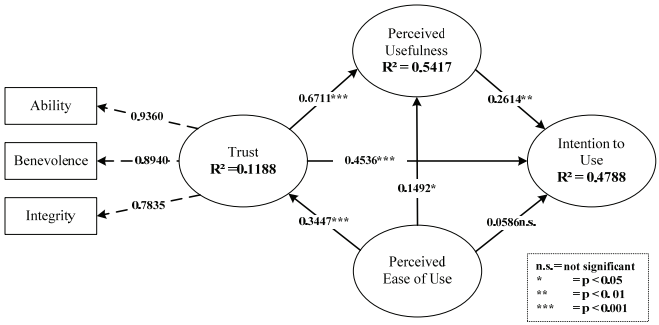


Figure 29: **Evaluation results of the research model of section 5 using the reflective measurement model**
Source: Söllner et al. (2010, 73)

5.5 Results Obtained Using the Formative Measurement Model for Trust

Due to the fact that the structural model now includes reflective as well as formative measurements, I need to assess the quality of both kinds of measurement models. I begin with the reflective models providing p_c, the cross-loadings, the AVE and the correlation with other latent variables as shown above. The results are presented in Table 13 and Table 14, and show that the reflective measurement models are reliable.

	Perceived Ease of Use ($\rho c = 0.9746$)	**Intention to Use** ($\rho c = 0.9841$)	**Perceived Usefulness** ($\rho c = 0.9824$)
PEOU1	**0.9629**	0.2688	0.3606
PEOU2	**0.9707**	0.3226	0.3652
PEOU3	**0.9558**	0.3155	0.3734
ItU1	0.3114	**0.9762**	0.5930
ItU2	0.2966	**0.9821**	0.6047
ItU3	0.3127	**0.9715**	0.5938
PU1	0.3889	0.5929	**0.9674**
PU2	0.3742	0.5919	**0.9733**
PU3	0.3484	0.6020	**0.9817**

Table 13: **Cross-loadings and composite reliability for the formative measurement used in section 5**
Source: Söllner et al. (2010, 74)

	PEOU	**ItU**	**PU**
PEOU	**0.9276**	0	0
Intention to Use	0.3142	**0.9538**	0
PU	0.3804	0.6114	**0.9490**

Table 14: **AVE and correlation among construct scores (AVE in diagonals) for the formative measurement using in section 5**
Source: Söllner et al. (2010, 74)

For the evaluation of my formative measurement model of trust, I follow the guidelines provided by Cenfetelli and Bassellier (2009). According to the first guideline, I need to check if there is multicollinearity among the indicators. Multicollinearity arises from conceptual redundancies and can lead to the misinterpretation of factors as unimportant or invalid facets of the construct's domain. I computed the Variance Inflation Factor (VIF) to check my measurement model. The highest VIF calculated was 1.561 (Table 15). Thus, it was below the upper border recommended by Diamantopoulos and Siguaw (2006).

	VIF	Factor weights	p-value	Factor loadings
Ability	1.561	0.7516	< 0.001	
Benevolence	1.561	0.3122	< 0.001	
Integrity	1.395	0.0499	< 0.50	0.5900

Table 15: VIF, factor weights, p-value and factor loadings for the formative measurement model of trust used in section 5
Source: Adapted from Söllner et al. (2010)

The second guideline assumes that a large number of indicators will cause many non-significant weights. Due to the fact that my measurement model consists of only four formative indicators, this test is not necessary.

Guideline three assumes the co-occurrence of negative and positive indicator weights, which could lead to a misinterpretation of the results. In my case, I discovered only positive weights (Table 15), and the suppressor effect was therefore not tested.

The fourth guideline discusses the absolute versus the relative indicator contribution. Indicators with a non-significant or low weight can still provide an important, absolute contribution. All related indicators must be independently assessed from other indicators to prevent misinterpretation of formative indicator results. As the results presented in Table 15 show, the factor weights of *ability* and *benevolence* are significant, obtaining a value of 0.01. *Integrity,* however, was not found to be significant and the absolute contribution, resembled by the factor loading, is also quite low (Table 15) (Chin 1998). Thus, according to Cenfetelli and Bassellier (2009), the theoretical relevance of this indicator should be questioned if similar results are achieved in other studies, because a theoretical overlapping can be excluded due to the provided trust theory by Mayer, Davis and Schoorman (1995).

Considering the fifth guideline, I was not able to conduct a nomological network analysis to further strengthen my results. A possibility suggested by Cenfetelli and Bassellier (2009) is to conduct a MIMIC analysis to assess how well the new formative measurement model captures the facets of a well-defined reflective measurement model. I decided not to conduct such an analysis, because, based upon my trust and measurement theory, the reflective measurement model used by Wang and Benbasat (2005) is mis-specified due to the fact that they used antecedents instead of consequences of trust for a reflective measurement. Thus, it is inappropriate as a benchmark for the formative model. Nevertheless, future research should address this lack and include a nomological network analysis.

According to the last guideline, I need to mention that the choice of the PLS technique can lead to inflated weights (meaning that they are slightly higher compared to using a CB technique).

Based on these results, I can now investigate whether my hypotheses can be supported. Table 16 provides the results of the evaluation of the hypotheses. Since the hypotheses are closely related to the formative indicators, the results are very comparable. Ability and benevolence were found to have a significant impact on trust, therefore, H1 and H2 are supported. H3 cannot be supported by the data since integrity was not found to have a significant impact on trust.

	Hypothesis	**Supported / not supported**	**Factor weight**	**t-value**	**p-value**
H1	Perceived ability will positively affect trust	Supported	0.7516	9.2041	< 0.001
H2	Perceived benevolence will positively affect trust	Supported	0.3122	3.3754	< 0.001
H3	Perceived integrity will positively affect trust	Not supported	0.0499	0.7322	**< 0.50**

Table 16: Evaluation of the hypotheses of section 5
Source: Adapted from Söllner et al. (2010)

After showing that my measurement model fulfills the guidelines (guideline 5 could not be tested) established by Cenfetelli and Bassellier (2009), I now continue with the interpretation of the structural model (Figure 30).

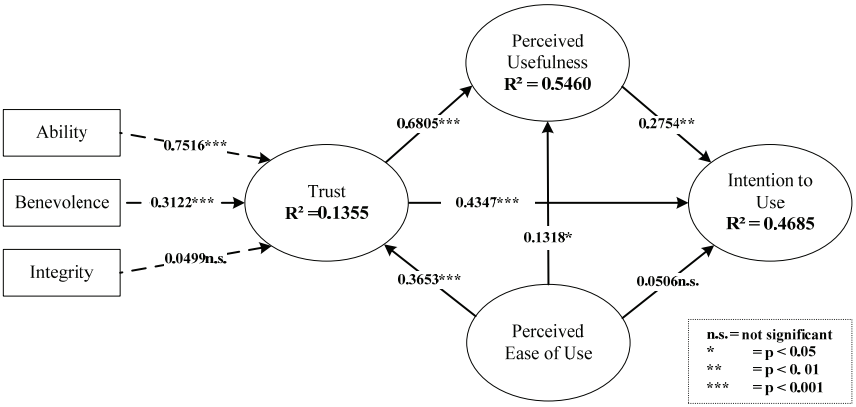


Figure 30: Results for the structural model using the formative measurement model in section 5
Source:Adapted from Söllner et al. (2010)

Concerning the evaluation of the structural model, the R^2 of *perceived usefulness* (R^2 = 0.5460) and *intention to use* (R^2 = 0.4685) are again moderate. With regards to the standardized path coefficients, a bootstrapping test reveals that the direct effect of the *perceived ease of use* on the *perceived usefulness* is significant at 0.05. The direct effect of the *perceived ease of use* on the *intention to use* is not significant. The path between *perceived usefulness* and *intention to use* is significant, reaching a value of 0.01. Also the other three paths are significant, obtaining a value of 0.001. The value of the formative measurement model and the impact of the choice of measurement approach are now discussed by comparing the formative and reflective measurement models.

5.6 Discussion

First, I need to point out several limitations of this study. I had only students as participants; thus, the results and the interpretation are limited to this group, and, therefore, cannot be generalized. Nevertheless, I do not consider this to be a problem because the aim of this study was not to achieve a statement of cause and effect concerning the structural model, but to show the value of a formative measurement.

Regarding the value of a formative measurement approach, Figure 31 provides a comparison of the two measurement models used. When using a reflective measurement model, I could only state that ability, benevolence and integrity are important parts of trust. When using a formative approach, I can state that ability has the highest influence on trust, and that the relation between integrity and trust was found to be not significant. Nevertheless, I decided to include integrity in my formative measurement model, because Cenfetelli and Bassellier (2009) also state that an indicator should only be dropped if multiple studies provide evidence that the theoretical basis used to justify this indicator seems flawed. Consequently, as measurement theory points out, the big advantage of my formative measurement model is that I achieved a higher level of detail with only very little effort, because I did not need to gather new data, that is, I simply combined the indicators in a different way. From a design-oriented point of view, I can now state that practitioners should focus on design aspects that support the user's belief that the UIS has a very high ability, instead of focusing on aspects supporting the belief of integrity.

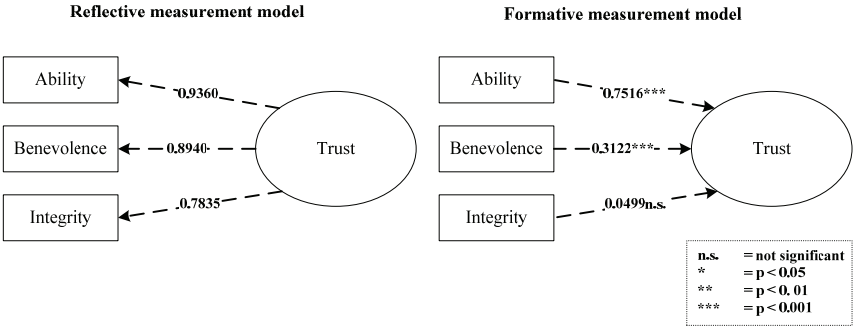


Figure 31: Reflective versus formative trust measurement model
Source: Adapted from Söllner et al. (2010)

Regarding the impact of the choice of measurement model on the structural model, Figure 32 shows a comparison of my two structural models. As can be seen in the figure, there are only minor changes made to the structural model when using my formative measurement model (Figure 30) instead of the reflective one (Figure 29). As a consequence, I can conclude that the choice of measurement model has hardly any impact on the structural model. Researchers can rely on formative measurement models without being afraid that this choice might impact their results.

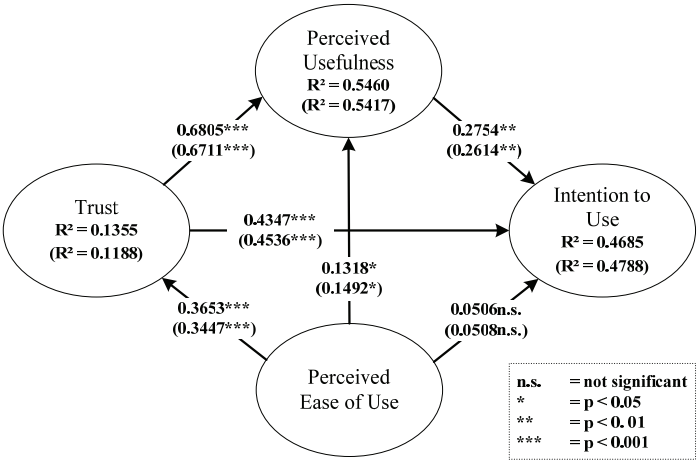


Figure 32: Comparison of the two structural models
Source:Own illustration

5.7 Conclusion

In this section, I aimed to answer the second research question of my dissertation:

> "What is the value of using a formative measurement approach for trust when aiming to design trustworthy UIS?"

The results of the study in this section show that using formative measurement models allows deeper insights into the formation of the construct of interest. Based on the results of the formative measurement model, I could, e.g., state that ability has by far the highest impact on trust. When using the reflective approach, such a statement cannot be made. Since I pointed out in section 2.4.7 that increasingly detailed insights into the formation of trust will enable the derivation of more precise TSCs, using a formative measurement approach is highly valuable when designing trustworthy UIS. Furthermore, I showed that the choice of measurement model has hardly any impact on the structural model in terms of path coefficients and R^2. Thus, formative measurement models can be used without having to fear that their use might alter the structural results which are the focus of most studies.

Regarding the aim of my dissertation, I need to point out that this section only provides evidence that a formative measurement approach for trust provides additional value when aiming to design trustworthy IT artifacts such as UIS. However, there are still questions that need to be addressed before aiming to derive TSCs from trust theory. As pointed out in section 2.4.6, trust has recently been studied using a multifoci approach. Even though this approach has hardly been used in the IS discipline yet, I argue that it is important to identify which foci of trust are important from the users' perspective, since the most important focus should be addressed first when aiming to design UIS that shall be perceived as trustworthy, and will thus be adopted and used by the intended users. In accordance with the identification of the most important focus of trust, how this type of trust forms and can be built needs to be investigated. Only after these foundations have been created, I can aim at designing trustworthy UIS based on theoretical knowledge of trust.

6 The Impact of Different Foci of Trust in Ubiquitous Information Systems Adoption[18]

6.1 Introduction

In this section, I aim at answering the third research question of my dissertation:

> "Do users perceive different foci of trust in the context of UIS adoption, and if yes, do the different foci influence each other and do they have distinct effects on other constructs important for UIS adoption?"

In section 2.1, I argued that UIS rely on intense interaction with different actors of their environment to effectively support the user by adapting to the user's context (Chin/Thatcher/Wright 2012). However, the concept of relying on other actors is not an innovation created by the advent of ubiquitous computing. In fact, my whole economy is built upon the division of work. Consequently, companies rely on other companies to build products they need for providing value. Even within companies, employees usually need to rely on colleagues to do preliminary work for them. Business trends like focusing on core competencies of the company and purchasing everything that is not part of the core competencies from partners or the phenomenon of crowdsourcing in different contexts, lead to an increasing division of the value provision and an increasing number of actors contributing to it. As pointed out in section 2.4.1, trust research in domains related to IS addressed this issue and argued that trust – as a relational concept – needs to be investigated based on its focus.

For taking the next step toward the goal of this dissertation - deriving TSCs for UIS – I will now identify the different foci of trust prevalent in the context of UIS adoption, their impact on each other and on other relevant constructs, such as PU and PEOU.

To evaluate whether different foci of trust prevalent in context-adaptive systems adoption influence each other and whether they have distinct effects on dependent constructs, I follow an approach consisting of three steps: First, I identify the different foci of trust, using a trust network. Second, I embed the different foci of trust in the Trust-TAM (Gefen/Karahanna/Straub 2003b) to generate my research model including hypotheses on the interplay between different foci of trust as well as their relationships

[18] The insights presented in this section are partly based on a paper I presented at the AOM Annual Meeting 2012 (Söllner/Leimeister 2012). I thank my collaborator, as well as the reviewers and attendees of the AOM Annual Meeting 2012 for the valuable feedback on my work.

to other constructs important in technology adoption. Third, I evaluate my model and hypotheses using a free simulation experiment.

Using this approach, I increase the IS discipline's understanding of the nature of trust in UIS by showing that different foci of trust are prevalent and that they have distinct impacts on other constructs important in UIS adoption. According to Gregor (2006), this is a theoretical contribution of the type explanation and prediction. These insights will afterwards serve as a basis for deciding which focus of trust should be addressed with priority, since the potential users perceive it as most important in the context of UIS adoption.

The remainder of this section is structured as follows. First, I build a user-centered trust network for UIS that serves for the identification of the different trust relationships the users have to face when using UIS. Next, I develop the hypotheses for my free simulation experiment and present details on my research design. Finally, I present and discuss the results and limitations of the experiment and draw a conclusion for this section.

6.2 Network of Trust for Ubiquitous Information Systems

In order to build a network of trust for UIS, I first need to identify the individual entities involved. The first two entities of the network of trust for UIS are: the user and the UIS itself. This is consistent with previous contributions on trust in systems that focus on the trust relationship between these two entities (Wang/Benbasat 2005; Komiak/Benbasat 2006; Wang/Benbasat 2007).

Regarding e-commerce adoption, McKnight, Choudhury and Kacmar (2002a) argue that users' perception of the environment in which they interact – in their case the Internet – can influence perceptions regarding a specific party – in their case a specific e-commerce vendor – acting in this environment. In a follow-up study, they were able to confirm their argumentation, indicating that institution-based trust in the Internet and initial trust in a specific vendor influence each other and both need to be in place for a successful e-commerce adoption (McKnight/Choudhury/Kacmar 2002b). Building on McKnight, Choudhury and Kacmar's results, Vance, Elie-Dit-Cosaque and Straub (2008) show that institution-based trust in the Internet influences users' trust in Amazon's mobile commerce portal. Since UIS also use the Internet environment, e.g., for identifying and communicating with other actors to effectively support their users, I include the Internet in the network of trust for UIS.

Additionally, we recognize from e-commerce research that users' trust in, e.g., a vendor's website is not only determined by characteristics of this specific website, but also depends on the people or organization running the website (Cyr et al. 2009). Marketing literature has also shown that a relationship exists between customers' trust in a brand or company and their willingness to buy other products from the same brand or company (Chaudhuri/Holbrook 2001). This suggests that the perceptions of the brand or company selling the product influence the perceptions about the product itself. Since the effectiveness of the support that UIS can offer to its user depends on the interaction with other suitable actors and data sources, the effectiveness of a UIS is influenced by the people or organization responsible for the UIS. Thus, I include the entity providers of the UIS in the network of trust for UIS.

Last but not least, UIS rely on third-party services or user-generated content to support their users. Providers offering complementary services and users providing user-generated content resemble other users in the Internet environment. Only if the community of providers and users offer valuable services or information, UIS can provide effective support to their users. This is comparable to argumentations and results of contributions on online marketplaces (see, e.g., Pavlou and Gefen (2004)) or online social networks (see, e.g., Krasnova et al. (2010)). Customers or online social network users need to trust the community of sellers of an online marketplace, such as eBay or other members of an online social network such as facebook. Otherwise, they would not be willing to buy in online marketplaces or use online social networks; consequently, these institutions would disappear. Since the effectiveness of the support a UIS can offer to its users depends on the reliance on services or content not generated by the current user in most cases, the UIS, the provider of the UIS and the community of Internet users who potentially contribute to the UIS need to be included in the network of trust.

Altogether, five parties are involved in the trust network for UIS: the user, the UIS itself, the Internet, the provider of the UIS and the community of Internet users contributing to the effective support of the user of a UIS (Figure 33).

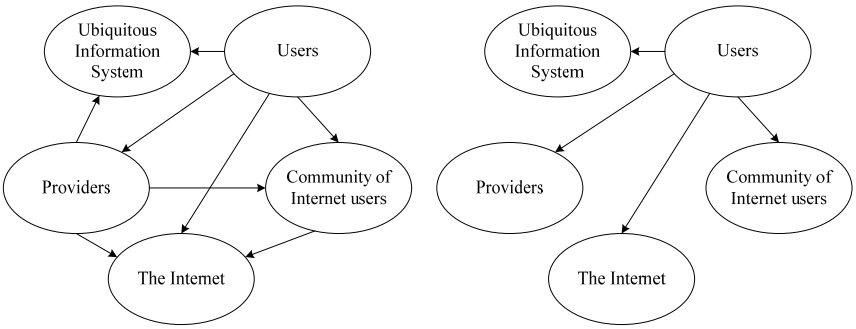


Figure 33: Complete (left) and user-centered (right) network of trust for UIS
Source: Own illustration

The left side of Figure 33 shows all the different trust relationships existent in UIS adoption. The users have to trust the community of Internet users because a UIS heavily relies on data or services provided by the community of Internet users. Additionally, the users need to trust the providers to have the ability to provide a UIS that offers effective support. The providers also need to trust the community of Internet users to provide valuable data or services supporting the effectiveness of the UIS to ensure system success. Further, providers and users need to trust the UIS. The providers need to trust their UIS, since good or poor system performance will partly be attributed to them. Thus, the providers would not provide a UIS they do not trust. For the users, the UIS is a tool which helps to make their life easier and more comfortable, the price being decreasing control over the actions of the technology they are using (Lee/See 2004). Clearly, they would not use a UIS if they did not trust it. Last but not least, the providers, the users and the community of Internet users need to trust the Internet, since a UIS relies on the Internet environment when supporting its users.

To answer my research question regarding the importance of the different foci of trust in UIS adoption, I need to consider the trust relationships a user is engaged in as a trustor. The right side of Figure 33 shows that I need to consider four trust relationships when investigating the user's trust in UIS adoption, namely, a user's trust in:

- the UIS itself,
- the providers,
- the community of Internet users and

- the Internet.

In the next section, I will embed these four different foci of trust in Gefen, Karahanna and Straub's (2003b) Trust-TAM. Based on the modified model, I will evaluate whether the different foci of trust influence each other, and examine if they have an impact on other Trust-TAM constructs.

6.3 Hypotheses Development

I have mentioned that the importance of trust in the adoption of new technology has already been discussed in many previous contributions. (Gefen/Karahanna/Straub 2003b) integrated trust as the fourth construct into Davis's (1989) TAM to study the importance of trust in the context of online shopping adoption. This so-called Trust-TAM was later successfully adopted by Wang and Benbasat (2005) to study the importance of trust in the context of recommender agents adoption. Recommender agents and UIS have the aim to support their users in common. Thus, I use the Trust-TAM as a foundation for my research on the importance of different foci of trust in UIS adoption. Table 17 points out the differences and similarities between my study and previous Trust-TAM studies.

	This study	**Wang and Benbasat (2005)**	**Gefen et al. (2003b)**
Trust focus / foci	Multiple: • the UIS • the designers • community of other Internet users • the Internet	Recommender agents	e-vendors
PU and PEOU targets	Ubiquitous information systems	Recommender agents	Websites
Behavioral intentions	Intention to adopt UIS	Intentions to adopt agents to get shopping advice	Intentions to use a website and purchase on this website

Table 17: Differences and similarities between the study presented in section 6 and previous Trust-TAM studies
Source: Adapted from Wang and Benbasat (2005)

As Table 17 points out, the two key differences of my study are that I adopt the Trust-TAM to the context of UIS adoption, and use a multifoci approach for assessing the importance of different foci of trust in UIS adoption. Consequently, my hypotheses

can be divided into two categories: The hypotheses known from previous Trust-TAM research and the hypotheses I derived based on my multifoci approach of trust.

According to TAM, UIS that are easy to use and useful will be more readily used by potential users. Additionally, a system that is easier to use will be perceived as more useful by users (Davis, 1989). Thus, the first three hypotheses are:

H1: The PU of a UIS will positively affect users' intention to use the system.

H2: The PEOU of a UIS will positively affect users' intention to use the system.

H3: The PEOU of a UIS will positively affect users' PU of the system.

Gefen, Karahanna and Straub (2003b) followed Davis' (1989) call to identify other variables influencing the TAM construct, and integrated the trust construct into the TAM. Since the previous Trust-TAM studies did not follow a multifoci approach, I first need to clarify to which foci of trust the trust construct in previous Trust-TAM studies relates. Since Wang and Benbasat (2005) used the Trust-TAM to study the users' trust in recommendation agents which, like UIS, aim to support their users, I will follow their interpretation. As Table 17 illustrates, the focus of trust in their study is the recommendation agent itself. Consequently in my case, the trust-related hypotheses derived from the Trust-TAM relate to the users' trust in the UIS itself. According to the Trust-TAM, trust helps users to reduce the complexity they face when using a UIS, and thus encourages them to adopt the UIS. Additionally, users will perceive the UIS they trust to be better suited to support them, which has a positive influence on their PU of the UIS. Furthermore, if they perceive the UIS to be easy to use, they will perceive the systems as more trustworthy, since they would question the ability of the UIS to support them effectively if they did not perceive the UIS as easy to use (Gefen/Karahanna/Straub 2003b; Wang/Benbasat 2005). Consequently, hypotheses four to six are:

H4: The users' initial trust in a UIS will positively affect their intention to use the system.

H5: The users' initial trust in a UIS will positively affect their PU of the system.

H6: The PEOU of a UIS will positively affect users' initial trust in the system.

After adapting the Trust-TAM, I need to embed the three remaining foci of trust into the research model. I start with the construct *trust in the Internet*. The Internet serves as an environment which enables the use of UIS. Consequently, users need to trust the Internet before using Internet-based applications, such as UIS. This argumentation is based on works by sociologists that studied so-called institution-based trust of people in institutional structures, such as the legal or financial systems. They point out that people will more likely decide to interact in an environment they perceive as trustworthy (see, e.g., Zucker (1986)). If they do not perceive the environment as trustworthy, their perceptions regarding single actors in the environment are of minor importance. A comparable argumentation was used by McKnight, Choudhury and Kacmar (2002b; 2002a) regarding the importance of institution-based trust in the Internet for successful e-commerce adoption. Focusing on initial trust in a web vendor, they argued and empirically showed that institution-based trust in the Internet is especially important when deciding whether or not to interact with an unfamiliar web vendor. In such a case, the user's initial perceptions of the web vendor will be based on his or her perception on the vendor's environment. The essence of sociologists' argumentation on institution-based trust in general and McKnight, Choudhury and Kacmar's adaption to the Internet environment is that people will be more likely to trust other actors if these act in an environment they perceive as trustworthy. Since UIS also rely on the Internet environment, I follow this argumentation, leading to three additional hypotheses, each reflecting the effect of trust in the Internet on one of the three other entities of the network of trust for UIS:

H7: The users' trust in the Internet will positively affect their trust in the community of Internet users.

H8: The users' trust in the Internet will positively affect their trust in UIS.

H9: The users' trust in the Internet will positively affect their trust in the providers of UIS.

I continue with the embedding of the construct *trust in the community of Internet users*. This construct is important, since UIS rely on services as well as content provided by members of the community of Internet users for effective support for their

users. Relying on services or content provided by other members of an environment has proven to be a promising approach. Apple, for example, provides detailed guidelines helping external developers to create their own apps and to share them with other members of the Apple ecosystem. As a result, Apple users can choose from a vast number of different apps, and Apple participates in the revenue created by each single app. This example demonstrates the potential of integrating services provided by members of the community.

The value of user-generated content can be illustrated by using the example of user ratings in the Internet. Many websites rely on or enrich their offers using such user ratings. IMDb, for example, is a widely known website which relies completely on user ratings to build a ranking of movies. Recent surveys suggest that user-generated content is an effective means in situations where information such as personal experience is not available, since participants state that they have a high amount of trust in ratings from other Internet users (Forrester Research 2009; Nielsen 2009). Since UIS rely on services or content provided by members of the community of Internet users, I would expect that the users' trust in a particular UIS will increase, along with their trust in the community of Internet users. As a result, I derive another hypothesis:

> H10: The users' trust in the community of Internet users will positively affect their trust in UIS.

Last but not least, I need to embed my construct *trust in the provider*. This construct has hardly been studied in related IS research, focusing on the adoption of new systems such as UIS. However, comparable constructs have been included in other trust studies, e.g., in the marketing discipline where the relationships between trust in a brand or company and the brand loyalty – resembling the willingness to buy other products of the same brand or company – have been investigated. Chaudhuri and Holbrook (2012) showed that brand trust has a strong effect on the purchase loyalty of customers. The loyalty then has an effect on the market share of the brand, verifying that loyal customers buy other products of the same brand. Comparable results have been reported by Ba and Pavlou (2002) and Pavlou and Dimoka (2006). They purport that buyers in an online marketplace are willing to pay price premiums to sellers they trust. These results imply that customers' trust in a brand or seller positively affects their trust in other products of the same brand or offered by the same seller. Transferring this implication to my context of UIS adoption, trust in the provider of

the UIS should positively affect users' initial trust in the UIS. As a result, I derive another hypothesis:

> H11: The users' trust in the providers of a UIS will positively affect their trust in the UIS itself.

After arguing that trust in the provider should positively affect users' initial trust in a particular UIS of the same provider, I argue that this is not the only construct affected by the users' trust in the provider. In addition to showing the effects of brand trust on loyalty and market share, the literature on brand trust also points to how brand trust is built. An important factor for building brand trust are the perceived differences of one brand compared to those of other brands. These perceived differences cover key performance-related attributes such as quality and reliability (Chaudhuri/Holbrook 2002). Consequently, the customers build trust in a brand because they perceive their products to have attributes like high quality and reliability. When faced with a purchase decision, this brand trust has a positive effect on the probability that customers will buy another product of the same brand, since they expect that the new product will have attributes comparable to the previously purchased product (Doney/Cannon 1997; Chaudhuri/Holbrook 2002). In the domain of technology adoption, this implies that users of a particular system will build trust in the provider of a system if they perceive the key performance-related attributes to be high. Davis (1989) introduced two of these key performance-related attributes of technology acceptance: PU and PEOU. Consequently, if users experience a system they use to have high PU and PEOU, they will build trust in the provider of this system, and expect future systems of the same provider to have comparable PU and PEOU. Regarding the initial trust in UIS, this implies that the users' trust in the provider of a context-adaptive system will positively affect their PU and PEOU of the UIS. Based on this argumentation, I derive the last two hypotheses:

> H12: During the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PU of the UIS.

> H13: During the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PEOU of the UIS.

Figure 34 presents a graphical summary of my research model, categorizing my 13 hypotheses into relationships known from prior TAM and Trust-TAM research and relationships derived using my multifoci investigation of trust.

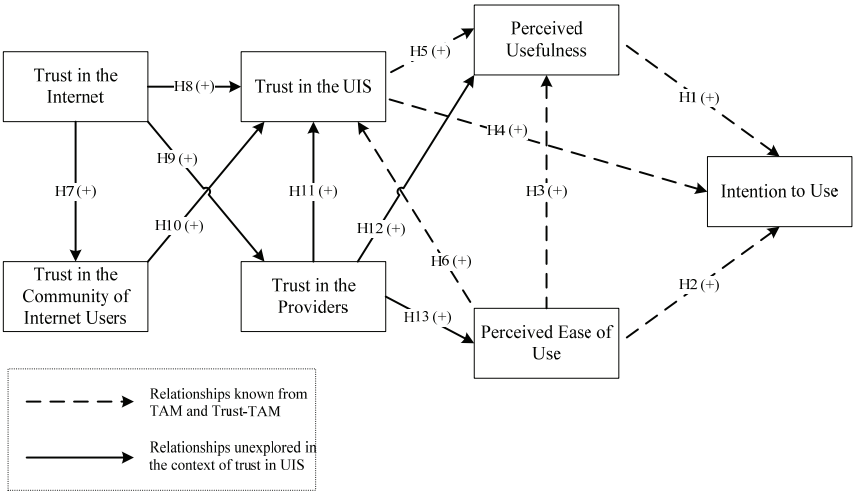


Figure 34: **Research model of section 6**
Source: Own illustration

6.4 Research Method

I used a free simulation experiment with 173 undergraduate students to evaluate the model. The experiment was divided into sessions attended by at most 25 students. Eight experimental sessions with 15-25 students were conducted. The decision to use a free simulation experiment (Jenkins 1985; Gefen 2000) was based on the advantage that I was able to control for external factors, since all participants were in the same environment, and used the same UIS as well as Android devices.

6.4.1 The Ubiquitous Information System Used in the Study

Translation from German:

Name of the prototype

Upcoming Events

Name, location and date

Active invitations

No active invitations

My Events, Contacts, My Profile

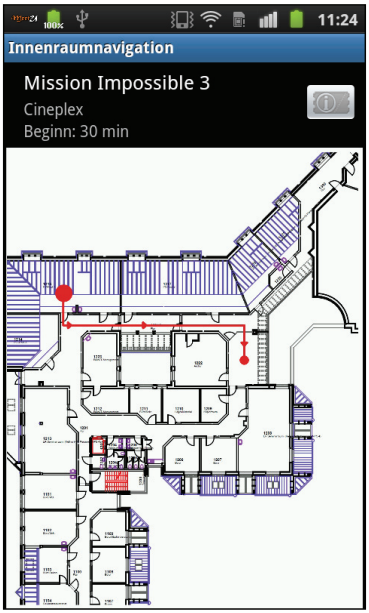
Search, History, Privacy Policy

Visibility of the current location (is on, can be turned off)
Address

Figure 35: Dashboard of the prototype that was used by the participants
Source: Own illustration

The participants used a prototype of a UIS that was developed within a multi-disciplinary research project (Figure 35 shows the dashboard of the prototype). This information was also given to the participants, and thus, in effect, my project partners and I took on the role of the providers of the UIS in the experiment. The aim of the UIS was to support users in organizing and arranging meetings and events with their friends. The goal was to effectively support users in every situation, but, at the same time, the users should not feel disturbed by the UIS. The users were supported not only during the planning of an event, but also on the way to an event, as well as at the event itself. They could provide private data, such as their date of birth, and indicate interests to improve recommendations for events or people with similar interests. Users could register for public events or create private events where they could invite other people to join them. When planning to visit a public event, the system created recommendations of possibly interesting events, based on private data of the users – such as their preferred leisure activities – and user-generated content that was related to the available events – such as the viewers' rating for a movie in IMDb. Assuming a

user wanted to create a private event, the system would provide recommendations regarding which of his or her friends should be invited, based on the characteristics of the event and information about his or her friends. When an event appointment approaches, the system reminds users, and provides, e.g., navigation information. At the event site, the UIS would recognize available third-party services and integrate these services. Examples of such services are a ticketing service and an event map including the points of interest when visiting a music festival. The system the participants used was a UIS, since it assessed its users' context and adapted properly to effectively support them, e.g., by integrating third-party services or relying on user-generated content.



Translation from German:
Indoor navigation

Name, location and time left until event begins

Simulation of indoor navigation during the free simulation experiment.

The map is a real floor-plan of the location of the evaluation. The big dot marks the start of the navigation (the PC lab of the university) and the small dot marks the event location. Altogether three different events existed that were recommended to the users based on their preferences and user-generated content.

In the case of outdoor navigation, GoogleMaps showing the route would be displayed.

Figure 36: GUI showing the simulated indoor navigation used in the FSE
Source: Own illustration

Within the free simulation experiment, the students received information about the UIS, how it worked, and how to interact with the system. Afterwards, the students were asked to complete four predefined tasks using the previously described system, ensuring that participants recognized all functionalities of the system:

Task 1: They had to create a profile and enter all of the required information.

Task 2: They had to add three to four other students in their group as their friends.

Task 3: They had to create a private event entering all possible information and invite some of their friends.

Task 4: They had to participate (confirm their participation and navigate to the event, see Figure 36 for the GUI of the simulated indoor navigation) in one of three predefined public events that were recommended to them.

It took participants about 25 minutes to complete all tasks. The following sections provide information regarding my data collection and analysis techniques, measurement instrument, as well as actions taken to prevent common method variance.

6.4.2 Data Collection and Analysis Techniques

After the participants completed their tasks, they were asked to fill out a questionnaire, including the statements as presented in Appendix 1. Responses were recorded on a bipolar 9-point Likert response format, with the endpoints labeled as "extremely disagree" and "extremely agree," and the midpoint labeled as "partly." All 173 possible data sets were included in the analysis (average age of the participants was 23.75 years, 88 were females). I used the PLS approach (Chin 1998) to analyze my data. This decision was based on the fact that the PLS algorithm is better suited to analyze models including formative constructs (Chin/Newsted 1999). I used SmartPLS 2.0 (Ringle/Wende/Will 2005) and SPSS 20 for my analysis.

6.4.3 Instrument Development

During the last years, a number of publications have raised the problem of measurement model mis-specification in behavioral research. The major observation these studies make is that causal indicators are used for a reflective measurement of their desired construct (Jarvis/Mackenzie/Podsakoff 2003; Petter/Straub/Rai 2007). The authors of these studies point out that measurement model mis-specification ultimately leads to unreliable results when analyzing the structural model, and thus is a major problem for behavioral research. To avoid measurement model mis-specification in my dissertation, I decided to only use indicators which fulfilled Jarvis, Mackenzie and Podsakoff's (2003) four guidelines for correct formative and reflective

indicators. This led to the use of formative measurement models for operationalizing my four constructs which represent the different foci of trust. For measuring the constructs PU, PEOU and intention to adopt, I followed a reflective measurement approach. The appendix provides an overview of the indicators used to measure my constructs, including the related statements in the questionnaire, the source and the information of whether the construct was measured in a formative or reflective way.

6.5 Results

Due to the fact that I used reflective and formative measurement models, and that both need to be evaluated using different quality criteria (Chin 1998), I separately assessed the quality of the reflective and formative measurement models. Beginning with the evaluation of the reflective measurement models, I first checked the composite reliability (ρc) and the cross-loadings for the single indicators of the reflective measurement models (Table 18).

	Intention to Use (ρc = 0.9634)	**Perceived Ease of Use** (ρc = 0.8997)	**Perceived Usefulness** (ρc = 0.9335)
ItU1	**0.9445**	0.3560	0.6651
ItU2	**0.9519**	0.3808	0.6244
ItU3	**0.9460**	0.3314	0.7326
PEOU1	0.3107	**0.8944**	0.4868
PEOU2	0.2544	**0.8216**	0.4832
PEOU3	0.3925	**0.8798**	0.4764
PU1	0.6611	0.3279	**0.8942**
PU2	0.6662	0.3938	**0.9420**
PU3	0.6139	0.3832	**0.8860**

Table 18: **Cross-loadings and composite reliability for the reflective measurement models used in section 6**
Source: Own illustration

The results presented in Table 18 show that all loadings are higher than 0.8 (should be above 0.707), and every indicator has the highest loading on its desired construct. Additionally, the composite reliability for all constructs is higher than 0.89 (should be above 0.707). Thus, the reflective measurement models fulfill these two quality criteria (Chin 1998).

Next, I evaluate the Average Variance Extracted (AVE) for each construct, and the correlation among all reflective constructs (Table 19). Since the AVE for all constructs is higher than 0.7 (should be above 0.5), and the AVE for each construct is higher than

any correlation with another construct, the reflective measurement models also fulfill these two quality criteria (Chin 1998).

	Intention to Use	Perceived Ease of Use	Perceived Usefulness
Intention to Use	**0.8978**		
Perceived Ease of Use	0.3751	**0.7497**	
Perceived Usefulness	0.7131	0.4059	**0.8240**

Table 19: AVE and correlations among construct scores (AVE bold in diagonals) for the reflective measurement models used in section 6
Source: Own illustration

After having shown that the reflective measurement models fulfill the desired quality criteria, I now focus on the evaluation of the formative measurement models. For this evaluation, I rely on the six guidelines for evaluating formative measurement models presented by Cenfetelli and Bassellier (2009); a summary of the key indicators is presented in Table 20.

Construct	Indicator	VIF	Factor weights	p-value	Factor loadings
Trust in the UIS	performance	1.704	0.7128	< 0.001	
	process	1.301	0.2662	< 0.01	
	purpose	1.363	0.3101	< 0.001	
Trust in the Internet	sitnormality	2.023	0.6398	< 0.001	
	structassurance	1.909	0.4835	< 0.001	
Trust in the Providers	provability	1.527	0.3050	< 0.01	
	provbenevolence	1.705	0.5700	< 0.001	
	provintegrity	1.821	0.3646	< 0.01	
Trust in the Community of Internet Users	userability	1.775	-0.1789	n.s.	0.1146
	userbenevolence	1.198	0.8872	<0.001	
	userintegrity	1.783	0.2383	n.s.	0.6429

Table 20: VIF, factor weights, p-value and factor loadings for the indicators of the formative measurement models used in section 6
Source: Own illustration

According to the first guideline, I checked for multicollinearity by computing the Variance Inflation Factor (VIF). The results indicate that multicollinearity is not a problem in my study because the highest VIF value (2.023) is below the limit of 3.33 (Diamantopoulos/Siguaw 2006).

In their second guideline, Cenfetelli and Bassellier (2009) state that a large number of indicators will cause many non-significant weights. Since I observed only two non-significant weights (at 0.05, marked with "n.s." in Table 20), and their inclusion is based upon theory, I decided not to drop any indicators. This decision is based on the argument that this is the first study of its kind, and it should be checked whether this lack of significance could be observed in different studies before questioning the relevance of these indicators (Cenfetelli/Bassellier 2009).

The third guideline deals with the co-occurrence of positive and negative weights. Due to the fact that the only indicator with a negative weight was not found to be significant, there was no need to worry about this point in my study (Cenfetelli/Bassellier 2009).

Guideline four suggests that researchers should check the indicator loadings when observing indicators that have a low indicator weight. As a reason, Cenfetelli and Bassellier (2009) point out that the indicator could have only a small formative impact on the construct (shown by a low weight), but it still could be an important part of the construct (shown by a high loading). If this is the case, the indicator is important and should be included in the measurement model (Cenfetelli/Bassellier 2009). Chin (1998) stipulates that a loading of 0.5 is weak but still acceptable. Observing the results presented in Table 20, I can see that the loadings of the two indicators with non-significant weights vary highly, whereas the indicator *userintegrity* shows a loading above the threshold ($0.6429 > 0.5$), the indicator *userability* shows a loading below the threshold ($0.1146 < 0.5$). As a result, the indicator *userability* has a non-significant weight and a low loading. Nevertheless, since this is the first study of this kind, and the inclusion of the indicator is based on a solid theoretical basis, I follow Cenfetelli and Bassellier's (2009) advice and do not drop the indicator. However, the observation that the indicator *userability* shows a non-significant, negative weight and a low loading challenges the theoretical basis, and, if similar results can be observed in future studies, the indicator should be dropped, and the suitability of the theoretical basis suggesting this particular relationship should be investigated.

In the fifth guideline, Cenfetelli and Bassellier (2009) recommend testing for nomological network effects and construct portability. They suggest comparing the factor weights of the indicators across different studies. Due to the fact that, to the best of my knowledge, this is the first study investigating different foci of trust in

technology adoption, and, additionally, following a formative measurement for each, a comparison of factor weights across different studies is not possible.

The sixth guideline cautions that the indicator weights can be slightly inflated when using the PLS technique (Cenfetelli/Bassellier 2009). Since I used the PLS technique, this is a limitation of my study.

In sum, the evaluation of my formative measurement models shows that the models fulfill the requirements posed by the guidelines of Cenfetelli and Bassellier (2009). Thus, I can now confidently move on to the evaluation of my hypotheses (see Table 21 for a structured evaluation).

Altogether, I could find support for ten of my 13 hypotheses. H1 suggests that the PU of a UIS will positively affect the users' intention to use the system. I found a significant relationship (path coefficient = 0.523, $p < 0.001$) between the PU of a UIS and the users' intention to use the UIS. Thus, H1 is supported by my data. H2 suggests that the PEOU of a UIS will positively affect users' intention to use the system. I did not find a significant relationship (0.000, n.s.) between the PEOU of a UIS and the users' intention to use the system. Thus, H2 is not supported by my data. H3 suggests that the PEOU of a UIS will positively affect the users' PU of the system. I found a significant relationship (0.165, $p < 0.05$) between the PEOU of a UIS and the users' PU of the system. Thus, H3 is supported by my data. H4 suggests that the users' initial trust in a UIS will positively affect their intention to use the system. I found a significant relationship (0.336, $p < 0.001$) between the users' initial trust in the UIS and their intention to use the system. Thus, H4 is supported by my data. H5 suggests that the users' initial trust in a UIS will positively affect their PU of the system. I found a significant relationship (0.369, $p < 0.001$) between the users' initial trust in a UIS and their PU of the system. Thus, H5 is supported by my data. H6 suggests that the PEOU of a UIS will positively affect users' initial trust in the system. I found a significant relationship (0.307, $p < 0.001$) between the PEOU of a UIS and users' initial trust in the system. Thus, H6 is supported by my data. H7 suggests that the users' trust in the Internet will positively affect their trust in the community of Internet users. I found a significant relationship (0.554, $p < 0.001$) between the users' trust in the Internet and their trust in the community of Internet users. Thus, H7 is supported by my data. H8 suggests that the users' trust in the Internet will positively affect their initial trust in a UIS. I did not find a significant relationship (-0.020, n.s.) between the

users' trust in the Internet and their initial trust in a UIS. Thus, H8 is not supported by my data.

	Hypothesis	Supported / not supported	Path coefficient	t-value	p-value
H1	The PU of a UIS will positively affect users' intention to use the system.	Supported	0.523	8.181	< 0.001
H2	The PEOU of a UIS will positively affect users' intention to use the system.	Not supported	0.000	0.004	n.s.
H3	The PEOU of a UIS will positively affect users' PU of the system.	Supported	0.165	2.292	< 0.05
H4	The users' initial trust in a UIS will positively affect their intention to use the system.	Supported	0.336	4.802	< 0.001
H5	The users' initial trust in a UIS will positively affect their PU of the system.	Supported	0.369	4.013	< 0.001
H6	The PEOU of a UIS will positively affect users' initial trust in the system.	Supported	0.307	4.827	< 0.001
H7	The users' trust in the Internet will positively affect their trust in the community of other Internet users.	Supported	0.554	8.823	< 0.001
H8	The users' trust in the Internet will positively affect their initial trust in a UIS.	Not supported	-0.020	0.379	n.s.
H9	The users' trust in the Internet will positively affect their trust in the providers of a UIS.	Supported	0.262	3.246	< 0.01
H10	The users' trust in the community of other Internet users will positively affect his trust in a UIS.	Not supported	0.014	0.306	n.s.
H11	The users' trust in the providers of a UIS will positively affect his trust in the UIS.	Supported	0.529	9.285	< 0.001
H12	During the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PU of the UIS.	Supported	0.185	2.034	< 0.05
H13	During the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PEOU of the UIS.	Supported	0.337	4.276	< 0.001

Table 21: Evaluation of the hypotheses of section 6
Source: Own illustration

H9 suggests that the users' trust in the Internet will positively affect their trust in the providers of a UIS. I found a significant relationship (0.262, $p < 0.01$) between the

users' trust in the Internet and their trust in the providers of a UIS. Thus, H9 is supported by my data. H10 suggests that the users' trust in the community of Internet users will positively affect their trust in a UIS. I did not find a significant relationship (0.014, n.s.) between the users' trust in the community of Internet users and their trust in a UIS. Thus, H10 is not supported by my data. H11 suggests that the users' trust in the providers of a UIS will positively affect their trust in the UIS. I found a significant relationship (0.529, $p < 0.001$) between the users' trust in the providers of a UIS and their trust in the UIS. Thus, H11 is supported by my data. H12 suggests that during the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PU of the UIS. I found a significant relationship (0.185, $p < 0.05$) between the users' trust in the providers of a UIS and their PU of the UIS. Thus, H12 is supported by my data. H13 suggests that, during the initial phase of usage, the users' trust in the providers of a UIS will positively affect their PEOU of the UIS. I found a significant relationship (0.337, $p < 0.001$) between the users' trust in the providers of a UIS and their PEOU of the UIS. Thus, H13 is supported by my data. Figure 37 summarizes my evaluation results providing a graphical illustration of my evaluated research model.

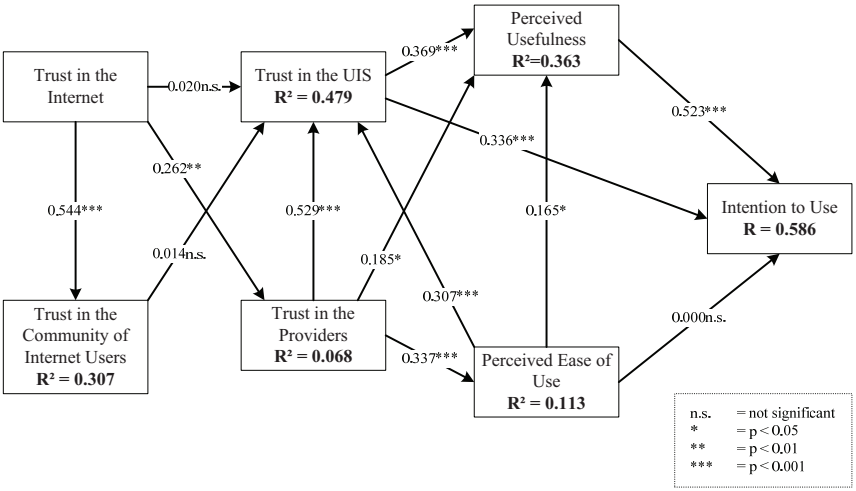


Figure 37: Research model of section 6 including the standardized path coefficients and statistical significance
Source: Own illustration

6.6 Discussion

Ubiquitous information systems are proposed to represent a fundamental paradigm shift in IS research (Vodanovic/Sundaram/Myers 2010). In order to be able to design UIS in a way so that they are more readily adopted by potential users, we need to understand why users decide to adopt such systems or refuse to do so. Trust has been shown to be a major factor in technology adoption research, and the characteristics of UIS seem to make trust even more important, questioning the currently predominant interpretation of trust in information system adoption as a single relationship between the user and the system. As a result, the goal of this section was to answer three research questions: a) Which foci of trust are prevalent in the context of UIS adoption? b) What impact do single foci of trust have on other foci? c) What impact do single foci of trust have on dependent constructs known from technology adoption research?

Regarding research question 1, I built a trust network, and identified four foci of trust the user of a UIS needs to consider in UIS adoption: the UIS itself, the providers, the community of Internet users and the Internet. Considering research question two, I observed that the four different foci of trust influence each other (see hypotheses 7 – 11). I found, e.g., that trust in the Internet has a positive impact (path coefficient = 0.262 , $p < 0.01$) on trust in the provider, and trust in the provider has a strong positive impact (0.529, $p < 0.001$) on trust in the UIS. Thus, I obtained empirical evidence that the different foci of trust are important for understanding why users trust a particular UIS, or not. Regarding research question three, I found that both, trust in the provider and trust in the UIS have a distinct and significant impact on different TAM constructs (see hypotheses 4, 5, 12 and 13). Trust in the provider has a positive impact on both, the PU (0.185, $p < 0.05$) and PEOU (0.337, $p <0.001$), and trust in the UIS has a positive impact on the PU (0.369, $p < 0.001$) and intention to adopt (0.336, $p < 0.001$). These observations highlight the importance of assessing different foci of trust to correctly understand not only how trust in a particular UIS is built, but also why, or why not, users decide to adopt a UIS.

Regarding prior IS research on trust in information systems, I enrich the existing results. Prior research has focused on investigating the importance of trust in the system itself, and how trust in the system itself can be built (see, e.g., different contributions in the context of trust in recommender agents (Wang/Benbasat 2005; Komiak/Benbasat 2006; Wang/Benbasat 2007)). In my study, I observed that trust in the UIS itself is the most important focus of trust prevalent in UIS adoption in terms of impact on the core TAM constructs such as PU and intention to use. Thus, my study

provides empirical support for the decision of previous research to focus on the trust relationship between the user and an information system. However, my results indicate that when studying UIS or increasingly ubiquitous information systems in general, the users' trust in the provider also plays an important role in the context of UIS adoption. This observation has a simple practical implication. Providers should communicate information which signals that users can trust them, in order to increase the chance that their UIS will be adopted by the intended users. However, the question regarding which exact information should be provided cannot be answered thoroughly; in fact, this is an important question from a practitioner's point of view. Consequently, future research should investigate how trust in the provider of a UIS can be built, so as to better understand this phenomenon, and to provide valuable information to practitioners. Thus, allowing them to systematically signal their trustworthiness to potential users of their systems to increase the chance of adoption.

My results, as well as those by McKnight, Choudhury and Kacmar (2002b), suggest that different foci of trust exist, and have a distinct importance in different areas of trust research. Thus, I recommend to other researchers interested in trust to assess whether trust in the provider of an information system or other foci of trust are also important in their field of interest. I followed the idea of building a network of trust to identify the different foci of trust prevalent in UIS adoption. I perceived building a trust network to be very handy for identifying the different foci of trust that should be considered when studying UIS adoption. As a result, I recommend interested researchers to follow this logic when aiming to assess the importance of different foci of trust in their field of interest.

As pointed out earlier, following a multifoci approach is not limited to trust research. In management literature, many studies following a comparable approach for different relational constructs can be found (Aryee/Budhwar/Chen 2002; Stinglhamber/Cremer/Mercken 2006; Lance Frazier et al. 2010). Consequently, I think other areas of IS research dealing with relational constructs could profit by following a comparable logic to identify all the different foci of their relational constructs of interest. I believe that, e.g., research on the effectiveness of distributed or virtual teams could benefit from following such an approach, since numerous relationships between the different team members and members from other hierarchical levels could exist.

Apart from the fact that I observed support for my two claims, I also found some unexpected results which are worth mentioning. I did not find support for three of my hypotheses (H2, 8 and 10). H2, taken from prior Trust-TAM research, was also found to not be significant in Wang and Benbasat's (2005) study, and was discussed while assessing guideline five of Cenfetelli and Bassellier's (2009) guidelines for formative measurement models. Here, I will focus on discussing hypotheses 8 and 10 in this section.

Regarding hypothesis 8, I could not find a relationship between the user's trust in the Internet and his or her trust in the UIS in my data. This observation is interesting, since the other two related hypotheses (regarding a positive impact on trust in the Internet in the community on other Internet users (H7), as well as the providers of the UIS (H9)) were supported by my data. I believe that a reasonable explanation for this observation is that the statement that people tend to trust other actors of a trusted environment more readily than actors of a non-trusted environment only holds for human actors of a trusted environment, but not for technology available in the environment. In fact, the original literature on institution-based trust (Lewis/Weigert 1985; Zucker 1986) only addresses trust relationships between people, groups of people or organizations, and was adapted by McKnight, Choudhury and Kacmar (2002a; 2002b) for studying comparable IT-mediated trust relationships.

If I analyze the trust relationships underlying the three hypotheses, I can see that the two supported hypotheses address trust relationships between people that are mediated by IT, whereas the hypotheses that could not be supported relate to a trust relationship between a user and technology. Thus, it seems that an adoption of this theoretical foundation for trust relationships between users and technology is not suitable. This observation supports argumentations by, e.g., Gefen, Benbasat and Pavlou (2008) and McKnight et al. (2011), questioning the suitability of relying on theoretical insights on trust relationships between people, groups of people or organizations when studying trust relationships between users and technology. Assuming that the current trend towards increasingly automated and ubiquitous information systems continues (Lee/See 2004; Vodanovic/Sundaram/Myers 2010), I propose that it is important to determine the degree to which existing insights on interpersonal trust can be adopted for studying trust relationships between users and technology. This analysis will allow me to identify areas where additional theoretical insights need to be added.

The observation that my data does not support hypothesis 10, which proposes a positive impact of the user's trust in the community of other Internet users and his or her trust in a specific UIS, is surprising since recent surveys show that people value anonymous user ratings on the internet (Forrester Research 2009; Nielsen 2009). My explanation for this observation is that relying on ratings or information provided by other users has become normality for most Internet users, and, thus, does not play an important role when deciding whether or not to use a specific system. This explanation can be seen with regard to Gefen's (2000) description of the interplay of familiarity and trust. Both are mechanisms to reduce social or technical complexity; meaning, if familiarity or trust are in place, we are able to suppress all possible unfavorable behaviors other people show. Thus, allowing us to depend on other people in uncertain situations (Luhmann 1979; Gefen 2000). In my case, I would argue that users are familiar enough with relying on ratings or information from other Internet users when making decisions regarding, e.g., which film to watch or restaurant to visit, causing familiarity alone to reduce enough of the existing complexity, and, thus, making trust a minor factor in this particular context.

Last but not least, this section offers a methodological contribution in terms of using formative indicators to measure the different kinds of trust. This is important, since contributions such as Jarvis, Mackenzie and Podsakoff (2003) and Petter, Straub and Rai (2007) showed that measurement model misspecification, specifically that the use of causal indicators in a reflective measurement model leads to Type I and II errors. Thus, making it necessary to question the reliability of the obtained theoretical implications. I was able to show that it is not a major problem to avoid measurement model misspecification. I used the causal indicators from theory for a formative measurement of my different kinds of trust, and could show that these measurement models fulfill the guidelines by Cenfetelli and Bassellier (2009). In addition to the fact that this approach helps to avoid measurement model misspecification and its consequences, using formative indicators offers additional value for designing new systems. A formative measurement approach allows me to better understand how the measured constructs are formed (Söllner et al. 2012c). I can identify the indicators which have the highest impact on their construct (see Table 21). In my case, I observed that performance has the highest impact on a user's trust in the UIS, and that benevolence and integrity of the provider have a higher impact on the user's trust in the provider than does the ability of the provider. Further, because they provide more detailed insights into the nature and formation of constructs, formative measurement

approaches are especially valuable for practitioners, enabling researchers and practitioners to make more detailed design choices (Söllner et al. 2012b). Assuming I would have used reflective measurement models for my trust constructs, I would have only been able to say that trust in the provider is important. Now, however, I can tell that the benevolence of the provider is the most influential factor for forming trust in the provider. Moreover, researchers and practitioners can derive more detailed design choices, not only addressing trust in the provider in general, but also their benevolence. Finally, enabling trust to be built. Since guiding practitioners in IT artifact design is a core goal of our discipline (Benbasat/Zmud 2003), the insights created using formative measurement approaches in suitable situations are very valuable, particularly in terms of increasing the practical impact of research insights.

6.7 Limitations

This study is not without limitations, which also provide opportunities for future research. First of all, this study is one among very few to use a formative measurement approach for the different kinds of trust. There have been other studies following a formative measurement approach (Lowry et al. 2008; Vance/Elie-Dit-Cosaque/Straub 2008). However, since these papers were published before the most recent guidelines for evaluating formative measurement models (Cenfetelli/Bassellier 2009), they did not report the quality criteria necessary for a comparison. Consequently, I cannot compare my quality criteria, such as indicator weights and VIF, to their results. This is a limitation of my study. However, I used the suggested quality criteria to evaluate my formative measurement models as rigorously as I could. Future research should try to evaluate the construct portability of my formatively measured constructs to further assess their validity and reliability (Cenfetelli/Bassellier 2009; Ringle/Sarstedt/Straub 2012).

To the best of my knowledge, this is the first study identifying different foci of trust in technology adoption. I used a trust network to identify the different foci of trust used in my study. Despite the fact that I believe that a trust network is, in general, a helpful tool to identify the prevalent trust foci in a specific situation, my trust network cannot be generalized to all kinds of technology due to the context-sensitivity of trust (Abdul-Rahman/Hailes 2000). It might be that a specific focus important for another research area within technology adoption is missing in my trust network, as well as it is possible that foci I used are irrelevant to other areas. For instance, the trust in the community of Internet users might be irrelevant when researching systems that are

completely autarkic. Consequently, the trust network needs to be adapted to the specific context under investigation, in order to ensure that all relevant trust foci have been considered.

Furthermore, I mentioned in the beginning that my study focuses on initial trust in the context of UIS adoption. However, technology adoption is a dynamic process and successful adoption ends with the acceptance of a system in terms of continuous use. Consequently, future research should address the importance of trust in later phases of the adoption process, e.g., investigating the importance of trust for continuous usage (Ortiz de Guinea/Markus 2009).

Additionally, there are some limitations related to the participants that took part in my free simulation experiment. Recent research points out that cultural effects affect trust (see e.g., Kim (2008)). Since my participants are all undergraduate business students from a German university, I did not control for cultural effects. Additionally, the generalizability of results obtained using undergraduate students as subjects is often questioned. Gordon, Slade and Schmitt (1986) argue that the results will hold across a more general population based on the extent to which undergraduate business students are typical of users of the studied systems. Since my participants are comparable to the targeted user group of the application used in my study and comparable applications in general, I argue that my participants are a reasonable reflection of the population. Furthermore, since I used the PLS approach, my factor weights could be slightly inflated (Cenfetelli/Bassellier 2009). However, future research should address these limitations to further assess the generalizability of my results across different cultures and groups of users.

Last but not least, some limitations arise based on the evaluation method I selected. In addition to the advantages of the free simulation experiment – e.g., the ability to use a laboratory setting to control for external factors, such as different usage behaviors, different mobile devices – this choice could threaten the external validity of the study. Specifically, I used one particular mobile, context-adaptive application, and one usage setting, namely my predefined tasks, to collect my data. When reviewing other papers, such an approach is common practice. Nevertheless, it remains to be confirmed that the results are applicable to different kinds of technology, in different laboratory settings, as well as in other types of studies (e.g., field studies).

6.8 Conclusion

In this section, I aimed to answer the third research question of my dissertation:

> "Do users perceive different foci of trust in the context of UIS adoption, and if yes, do the different foci influence each other and do they have distinct effects on other constructs important for UIS adoption?"

For identifying the different foci of trust in the context of UIS adoption, I built a trust network for UIS, indicating that four different foci of trust are prevalent from a UIS user's point of view. Based on these four foci, I derived four distinct trust constructs, and integrated these constructs into Trust-TAM research in order to evaluate their impact on each other and on constructs such as PU und ItU. Afterwards, I used a free simulation experiment to evaluate my hypotheses. The results indicate that different foci of trust are important when researching the adoption of systems such as UIS. In addition to the focus that has already been addressed in the IS adoption literature, trust in the system itself, I was able to show that especially the users' trust in the provider of the UIS plays a slightly less important role in the context UIS adoption, but should not be omitted.

Regarding the aim of my dissertation, the results presented in this section show that two foci of trust play an important role in the context of UIS adoption. According to its impact on core consequences, such as PU and ItU, the user's trust in the UIS itself was identified to be the most important focus. Consequently, in the remainder of my dissertation, I will address this focus of trust. In section 7, I will aim at understanding how the user's trust in a UIS is formed and which dimensions and antecedents have the highest impact on trust in a UIS. In section 8, I will aim at developing a method empowering researchers and designers to use the insights on the formation of trust in a UIS to develop more trustworthy UIS.

7 Understanding the Formation of Trust in a Ubiquitous Information System[19]

7.1 Introduction

In this section, I aim at answering the fourth research question of my dissertation:

> "Which factors form and what impact do they have on the users' trust in a UIS?"

The results presented in section 6 show that trust in a UIS itself is the most important focus in the context of UIS adoption. Thus, in this section I will concentrate on how this focus forms and what impact the different factors forming trust in a UIS have. This goal is challenging, since trust in a UIS resembles a trust relationship between a human and an IT artifact and as shown in section 4, such trust relationships have not been extensively studied in the IS discipline and researchers are not yet able to agree upon which theoretical foundation should be used to study such trust relationships.

Consequently, I will again follow a three step approach to create detailed insights into the formation of trust in a UIS. First, I discuss which of the possible theoretical foundations is the most suitable to study such kinds of trust relationships (the different possibilities are presented in section 2.4). Second, I will use the insights related to the chosen theoretical foundation and from security and privacy literature to derive a formative first-order, formative second-order measurement model for trust in a UIS[20]. This approach allows the creation of more detailed insights into the formation of trust than alternative measurement approaches (Petter/Straub/Rai 2007; Albers 2010). Third, I will evaluate the measurement model using a FSE with the same UIS as presented in the previous section, and will conduct a redundancy analysis with a reflective measurement model published in prior literature.

Using this approach, I increase the IS discipline's understanding of the formation of trust in a UIS. According to Gregor (2006), this is a theoretical contribution of the type explanation and prediction. The achieved results are valuable for the goal of this dissertation, since they provide detailed insights on the formation of trust in a UIS.

[19] The insights presented in this section are partly based on different publications on this topic (Söllner et al. 2011b; Söllner et al. 2012c). I thank my collaborators, as well as the reviewers and attendees of the SIGHCI 2011 and the ICIS 2012 for the valuable feedback on my work.

[20] See section 3.3.1 for an explanation of the different kinds of measurement models.

Following the logic of trust support (see section 2.4.7), these insights can be used to derive detailed TSCs which increase the perceived trustworthiness of UIS.

To achieve the presented aims, the remainder of the paper is structured as follows. First, I will discuss which possible theoretical foundation of trust is most suitable to study the formation of trust in a UIS. Afterwards, I will build the formative first-order, formative second-order measurement model for trust in a UIS. After presenting details on my research method used to evaluate my model, I will present and afterwards discuss the results of the evaluation. In the end, I will discuss the limitations of the study presented in this section, and outline areas for future research.

7.2 Formation of Trust in a Ubiquitous Information System

The first possible theoretical foundation for studying trust in IT artifacts taking the trustee role are the insights on trust between humans and organizations created by Mayer, Davis and Schoorman (1995). One advantage of this theoretical foundation is that IS trust research has used this theory for a decade, creating a huge pool of theoretical insights (McKnight/Choudhury/Kacmar 2002a; McKnight/Choudhury-/Kacmar 2002b; Gefen/Karahanna/Straub 2003b; Pavlou/Gefen 2004) future research can build upon. Another advantage is that due to the fact that this theoretical foundation has been used in a large number of studies, there are plenty of evaluated measurement instruments that can be used in future studies. The main disadvantage of this theoretical foundation is that it is designed to study trust relationships between people, groups of people, or organizations. Even when we assume that the computers are social actors paradigm is true, it remains questionable that the dimensions of trustworthiness by Mayer, Davis and Schoorman (1995) are suitable for studying trust relationships between users and IT artifacts, since some dimensions resemble human character traits of a trustee. Considering, e.g., using Mayer, Davis and Schoorman's (1995) dimension benevolence to assess the trustworthiness of an IT artifact would imply that we assume that an IT artifact is able to actively decide whether to keep the interests of the trustor, its user, in mind or not. I argue that such a decision cannot be made by an IT artifact, because the artifact follows a specific predefined algorithm or logic, and, thus, is not comparable to human decision making. Additionally, using the dimensions of trustworthiness by Mayer, Davis and Schoorman (1995) would imply the assumption that a users' decision whether or not to trust an IT artifact relies on the same dimension as people deciding whether or not to trust other people, or organizations. However, recent NeuroIS studies question whether this assumption is

true. Riedl et al. (2011), e.g., show that the human brain distinguishes between humans and human-like avatars, since different brain regions are especially active during the decision phase to trust a human in comparison to a human-like avatar. Since Dimoka, Pavlou and Davis (2011) point out that brain regions are related to cognitive processes, whether people rely on the same dimensions of trustworthiness when deciding whether or not to trust other people or organizations compared to deciding whether or not to trust an IT artifact is questioned.

The second possible theoretical foundation for studying trust in IT artifacts is based on the insights on trust in automated systems created, e.g., by Lee and Moray (1992), Muir and Moray (1996), and Lee and See (2004). The main advantage of this theoretical foundation is that it was especially designed for studying trust relationships between operators (users) and automated systems (IT artifacts). As a result, the dimensions by Lee and Moray (1992) – performance, process, and purpose – were specifically selected to resemble properties of a technical system. The main disadvantage is that this theoretical foundation is new to IS research. Consequently, there are fewer theoretical insights we can build upon. Additionally, since the HCI discipline uses different evaluation methods, there are fewer evaluated measurement instruments available compared to the first possible theoretical foundation.

For my study, I decided to build upon the second possible theoretical foundation for studying the formation of trust in IT artifacts taking the trustee role, namely insights on trust in automated systems. I argue that the disadvantages are outweighed by the main advantage of this theory, which is the fact that it was especially designed for researching trust in trust relationships between operators and an automated system. In my opinion they are comparable to trust relationships between users and UIS. This argumentation is based on the facts that a) a technical system takes the role of a trustee in both, trust relationships between operators and automated systems as well as in trust relationships between users and UIS, and b) automated systems are comparable to UIS artifacts serving as tools to support their users. Consequently, I expect the dimensions by Lee and Moray (1992) to be better suited for understanding the formation of user trust in UIS taking the trustee role, since they all resemble properties of a technical system, instead of human character traits.

I aim at creating detailed insights into the formation of trust in UIS, and at generating detailed design knowledge for UIS designers. Consequently, I decide to build a

formative first-order, formative second-order measurement model for trust in a UIS, since the double formative measurement provides insights into the formation of the dimensions of trust, and trust itself (Jarvis/Mackenzie/Podsakoff 2003; Petter/Straub/Rai 2007).

As stated above, I use the theoretical insights on trust in automation as a foundation for my study, and, consequently, a formative first-order, formative second-order measurement model for trust in a UIS. The three dimensions for studying the formation of trust in automation, which are well accepted within literature on trust in automation are performance, process and purpose (Lee/Moray 1992; Lee/See 2004). These three dimensions will serve as a basis for the formative second-order part of my measurement model. For identifying suitable formative indicators for these dimensions, I use Lee and See's (2004) work as a basis, since they conducted a thorough literature review summarizing the numerous constructs they found in published studies under Lee and Moray's (1992) dimensions performance, process and purpose.

Since I am aware of the already discussed measurement model mis-specification problem (Jarvis/Mackenzie/Podsakoff 2003; Petter/Straub/Rai 2007), I checked the constructs summarized under each dimension for the suitability of being a formative indicator for that dimension, and for redundancy among the different indicators. Additionally, more recently, issues such as security, and especially privacy of IT artifacts have gained growing attention. One reason for this development is the increasing automation of IT artifacts, making it harder for users to understand, what the IT artifact does exactly (see e.g., Spiekermann (2007)). Consequently, I use insights from this stream of research to enrich the formative indicators that I identified based on Lee and See's (2004) literature review.

I use the three formative indicators for the performance dimension: *responsibility*, *information accuracy*, and *reliability*. *Responsibility* covers the users' perception whether the IT artifact has all functionalities necessary for achieving the users' goal. This is essential, since missing functionalities would hinder the users from achieving their intended goal. *Information accuracy* deals with the users' perception whether the information provided by the IT artifact is accurate. Both automated systems, as well as IT artifacts provide information for supporting their users, e.g., when controlling a power plant (Muir 1994) or trying to find a suitable digital camera (Wang/Benbasat 2005). *Reliability* concerns the users' perception whether the IT artifact can be relied

on to perform its task. Since UIS are comparable to tools used to support their users to achieve a certain goal, it is important that they can be relied upon. Otherwise the users will abandon the UIS (Muir 1994).

I use five formative indicators for the process dimension: user *authenticity*, *understandability*, *predictability*, *confidentiality*, *authorized data usage*, and *data integrity*. *User authenticity* refers to the users' perception that no one can act in his name unauthorized. This is important, since in Muir's (1994) nuclear power plant example, only specific users will have access to view or change specific, important or sensitive data. *Understandability* has to do with the users' perception regarding his understanding on how the IT works. For example in the case of Wang and Benbasat (2005), this has to do with how recommendations for suitable digital cameras are generated. Spiekermann's (2007) work indicates that this is important, because the users want to understand how a specific technology – in her case RFID – works. Otherwise, they remain unable to recognize malfunctions of a system (see e.g., Lee/See (2004)). *Predictability* focuses on the users' perception of how good they are able to predict the next action of the IT artifact. Since the users want to understand how a UIS works and perceive themselves as being in control, it is important for the users to be able to predict the next actions of a system to some degree (Muir/Moray 1996). *Confidentiality* is connected to the users' perception that he or she can control whoever else is able to access their data (e.g., Pfleeger/Pfleeger (2011)). This is also related to the users' wish to understand how an IT artifact works, and being in control. *Data integrity* covers the users' perception that his or her personal data cannot be changed without being noticed (e.g., Pfleeger/Pfleeger (2011)). This is important, since the users' personal data are usually used to provide tailored information or recommendations. Accordingly, each user wants to be in control of the data used.

The following three formative indicators were employed in the purpose dimension: *authorized data usage, benevolence of the designers*, and *faith*. *Authorized data usage* concentrates on the users' perception whether the data he or she provides is only used as indicated or expected (e.g., Andress (2011)). This is important, since in providing his or her data, the user makes himself or herself vulnerable to possible misuse of his or her data by the recipients. *Benevolence of the designers* is related to the users' perception whether the designers of the IT artifact keep the interests of the users in mind. This is important, since it is possible, for instance, that the recommendation system used by Wang and Benbasat (2005) would always recommend cameras of a

certain company, since they pay the designers of the recommender system. This would represent a definite ignoring of the interests of the user. *Faith* refers the users' perception whether the IT artifact can be relied upon in the future. My complete formative first-order, formative second-order measurement model for trust in a UIS is presented in Figure 38.

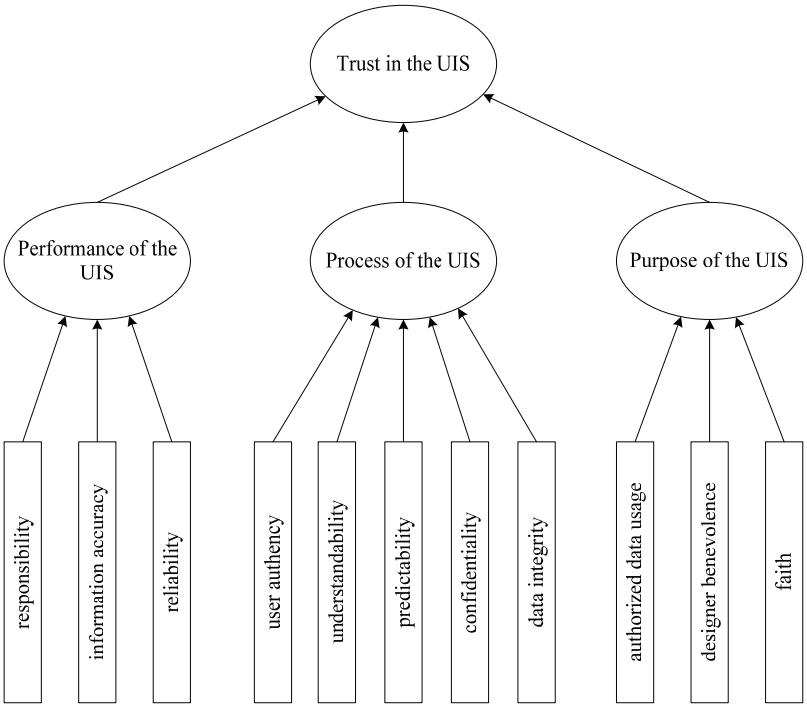


Figure 38: Formative first-order, formative second-order measurement model for trust in UIS
Source: Söllner et al. (2012c, 7)

7.3 Research Method

I used a free simulation experiment with 284 undergraduate business students to evaluate the impact of the single indicators and dimensions on trust in IT artifacts using my formative first-order, formative second-order measurement model for trust in IT artifacts. This decision is based on the fact that when using a free simulation experiment, I am able to control for external factors, since all participants were in the same environment, used the same UIS on the same devices, and completed the same tasks. The participants used the UIS and the research setting described in section 6.4.1.

The following sections provide information regarding my data collection and analysis techniques, measurement instrument, as well as actions taken to prevent common method variance.

7.3.1 Data Collection and Analysis Techniques

After the participants completed their tasks, they were asked to fill out a questionnaire, including the statements presented in the appendix. Responses were recorded on a bipolar 9-point Likert response format, with the endpoints labeled as "extremely disagree" and "extremely agree," and participants could also answer "I do not know" when they did not want to rate a statement. To achieve high quality results, I implemented several reverse coded items into the questionnaire, and checked all cases regarding the consistency of the answers given to the items relevant for my data analysis and the reverse coded control items. I decided to use the PLS approach (Chin 1998) to analyze my data, since the PLS algorithm is better suited to analyze models which include formative indicators (Chin/Newsted 1999; Ringle/Sarstedt/Straub 2012). I used SmartPLS 2.0 (Ringle/Wende/Will 2005) and SPSS 20 for my analysis. In order to assess the quality of my formative first-order, formative second-order measurement model, I used a redundancy analysis as used in Chin (1998), and recommended by Cenfetelli and Bassellier (2009), and Ringle, Sarstedt and Straub (2012) for assessing the quality of a newly introduced formative measurement model. When carrying out my redundancy analysis, I followed Cenfetelli and Bassellier (2009), and modeled the three dimensions as separate exogenous latent constructs with formative indicators and trust as my endogenous latent construct with reflective indicators.

7.3.2 Instrument Development

In order to conduct a redundancy analysis, I needed to measure trust in a formative as well as reflective manner. Since the reflective measurement serves as a benchmark for assessing the quality of the formative measurement model, I used indicators that were recently reported in major journals, and not mis-specified according to the guidelines by Jarvis, Mackenzie and Podsakoff (2003) and Petter, Straub and Rai (2007). The formative indicators were already identified in the previous section. If accessible, I used the statements as provided in the original sources of the indicator. Otherwise, I formulated new indicators based on the definition of the indicators as provided in the previous section. All statements including their sources can be found in the appendix.

7.4 Results

Due to the fact that I used a reflective measurement model for trust as a benchmark for my formative measurement model (Cenfetelli/Bassellier 2009), I first needed to assess the quality of the reflective measurement model. I checked the average variance extracted (AVE), the composite reliability and the indicator loadings as quality criteria (Chin 1998; Gefen/Rigdon/Straub 2011). As I only have one reflective construct, I did not need to check for cross-loadings or the correlation between the reflectively measured constructs. The evaluation showed that all values were well above the necessary thresholds. The AVE for trust was 0.7810(> 0.5), the composite reliability for trust was 0.9144 (> 0.6), and the lowest indicator loading was 0.8249 (> 0.7). Thus, the reflective measurement is suitable to serve as a benchmark for my formative measurement model.

Construct	Indicator	VIF	Factor Weights	p-value
Performance	Responsibility	2.158	0.211	< 0.05
	Information accuracy	1.697	0.209	< 0.05
	Reliability	2.631	0.718	< 0.001
Process	User authenticity	1.681	0.340	< 0.001
	Understandability	1.585	0.211	< 0.01
	Predictability	1.485	0.152	< 0.05
	Confidentiality	2.052	0.371	< 0.001
	Data integrity	2.143	0.316	< 0.001
Purpose	Authorized data usage	2.373	0.593	< 0.001
	Designer benevolence	1.638	0.253	< 0.001
	Faith	2.548	0.374	< 0.001

Table 22: VIF, factor weights and p-value for the indicators of the formative measurement model used in section 7
Source: Söllner et al. (2012c, 9)

After having shown that the reflective measurement model fulfills the desired quality criteria, I now focus on the evaluation of the formative first-order, formative second-order measurement model. I will start with the formative second-order part of my measurement model. For this evaluation, I rely on the six guidelines for evaluating formative measurement models presented by Cenfetelli and Bassellier (2009); a summary of the key indicators is presented in Table 22. According to the first guideline, I checked for multicollinearity by computing the Variance Inflation Factor (VIF). The results show that multicollinearity is not a problem in my study, because the highest VIF value (2.631) is below the limit of 3.33 (Diamantopoulos and Siguaw

2006). In their second guideline, Cenfetelli and Bassellier (2009), state that a large number of indicators could cause many non-significant weights. Since I observed no non-significant weights (at the level of 0.05), this issue is not a problem in my study. The third guideline deals with the co-occurrence of positive and negative weights. Due to the fact that I did not observe any indicator with a negative weight, there was no need to worry about this point in my study (Cenfetelli and Bassellier 2009). Guideline four suggests that researchers should check the indicator loadings when finding indicators that have only a small indicator weight. As a reason, they propose that the indicator could only have a small formative impact on the construct (shown by a low weight), but could still be an important part of the construct (shown by a high loading). Since all factor weights are significant, there is empirical support to keep all indicators. For this reason, I do not need to check the indicator loadings (Cenfetelli and Bassellier 2009). In the fifth guideline, Cenfetelli and Bassellier (2009) recommend testing nomological network effects and construct portability. They advise comparing the factor weights of the indicators across different studies. Due to the fact that, to the best of my knowledge, this is the first study using these indicators and dimensions to assess trust in IT artifacts, I cannot compare the factor weights across different studies. Nevertheless, for this particular case, Cenfetelli and Bassellier (2009) and (Ringle/Sarstedt/Straub 2012) recommend using a redundancy analysis as a substitute to assess the validity of the formative measurement model. The results of my redundancy analysis will be presented in the subsequent paragraphs. The sixth guideline warns that the indicator weights can be slightly inflated when using the PLS technique (Cenfetelli and Bassellier 2009). Since I used the PLS technique, this is a limitation of my study. In sum, the evaluation of the formative second-order part of my measurement model shows that this part fulfills the requirements posed by the guidelines of Cenfetelli and Bassellier (2009).

I can now confidently turn to the evaluation of the formative first-order part of my measurement model. Here, I observed that all three dimensions of trust in IT artifacts had a significant impact on trust. Purpose (0.356, $p < 0.001$) was the most important dimension, followed by process (0.337, $p < 0.001$), and performance (0.233, $p < 0.001$).

I conducted a redundancy analysis using an evaluated reflective measurement model as a benchmark for the evaluation of our whole formative first-order, formative second-order measurement model for trust in a UIS. As stated above, my reflective

measurement model fulfills all the necessary quality criteria, and, thus, may serve as a benchmark. The observed R^2 value of trust in IT artifacts is 0.673, which is a good result, since a formative measurement model for a construct should at least explain 64% of the variance of the reflectively measured benchmark (Chin 1998). Based on this evaluation, I can conclude that my formative first-order, formative second-order measurement model fulfills all the quality criteria. Consequently, I can state that the conceptualization used for developing my formative first-order, formative second-order measurement model is suitable for studying trust in IT artifacts. The results of the whole evaluation are summarized in Figure 39.

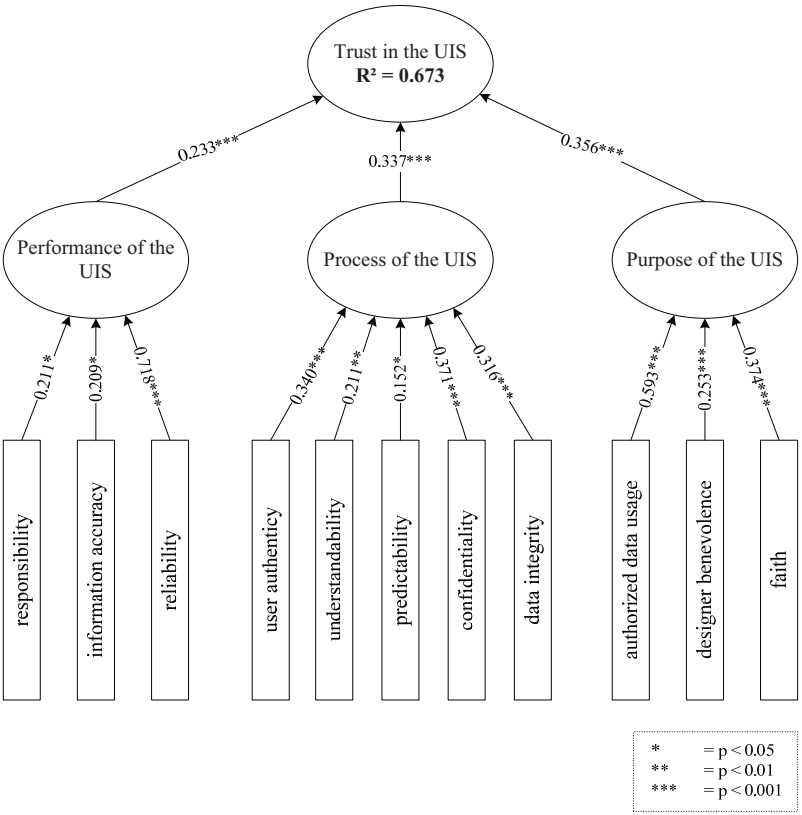


Figure 39: Evaluated formative first-order, formative second order measurement model for trust in a UIS
Source: Söllner et al. (2012c, 7)

7.5 Discussion

This study makes several important contributions. I compare the suitability of two theoretical conceptualizations for studying trust relationships between users and IT artifacts. I conclude that the conceptualization of trust in automation from the HCI discipline is more suitable for studying such kinds of trust relationships than the foundations of interpersonal trust. My main argument is that IT artifacts cannot be compared to human beings in any way necessary for relying on the foundation of interpersonal trust. In accordance with Gefen, Benbasat and Pavlou (2008), I argue that the computers are social actors paradigm has its limitations, and even if the paradigm holds true, it remains questionable whether the interpersonal dimensions of trustworthiness – ability, benevolence and integrity – can be used to assess trust in IT artifacts, since they rate human character traits. I argue in particular that benevolence - the decision whether to keep the interests of the trustor in mind or not (Mayer/Davis/Schoorman 1995) – cannot be made by an IT artifact, since it follows predefined algorithms or logic, and cannot actively make decisions like human beings. This argumentation is backed by the results of Riedl et al. (2011), who showed that the human brain distinguishes between humans and human-like avatars, e.g., by attributing different characteristics to a human compared to a human-like avatar. As a consequence, I use the three dimensions from Lee and Moray (1992), performance, process and purpose, to assess trust in IT artifacts, since these dimensions are conceptualized to rate characteristics of technology.

Using this theoretical foundation, I was able to develop a formative first-order, formative second-order measurement model that explains 67.3% of the variance in trust in a UIS which is a good result considering Chin's (1998) statement that a formative measurement model should explain at least 64% of a construct's variance.

I am aware of the fact that this R^2 value is high, compared to R^2 values reported in other studies throughout the IS discipline. Consequently, I addressed the common method variance issue raised by Podsakoff et al. (2003) and Sharma, Yetton and Crawford (2009), and used procedural remedies prior to data collection to prevent the occurrence of common method variance, and the Harman's single factor test afterwards to check for common method variance. The results of the test indicate that common method variance is not a serious issue in my study. Although it is hardly possible to ensure that common method variance is no problem at all in a study, I argue that common method variance is not a significant problem in my study.

I am aware of the fact that the discussion about the best theoretical foundation for studying trust in IT artifacts is an ongoing and vivid discussion within our discipline. Based on my study, I cannot prove that the theoretical foundation I have chosen is the better one. Nevertheless, the results of my study show that it is suitable for studying trust in a UIS, because it explains a high amount of variance.

Since one aim of my study was to create detailed insights into the formation of trust in IT artifacts, I argued that a formative first-order, formative second-order measurement model is best suited to achieve this goal. Consequently I developed such a formative measurement model, using existing theoretical knowledge of trust in automation, as well as insights from privacy and security research. The evaluation of my measurement model shows that it fulfills Cenfetelli and Bassellier's (2009) guidelines for a valid and reliable formative measurement model. Regarding the impact of the single dimensions on trust in a UIS (see Figure 39), I show that all dimensions had a significant and comparable impact. Purpose proved to have the highest impact, and was followed by process and performance. This result confirms my assumption that the three dimensions of trust in automation are suitable for studying the formation of trust in a UIS.

When checking the impact of the single indicators, I can observe that among the six indicators with the highest impact on their dimensions four indicators are related to the user data: user authenticity, confidentiality, data integrity and authorized data usage. I argue that this reflects that task solving alone is no longer the most important aspect as observed by Muir and Moray (1996). Instead the question "how?" is becoming increasingly important. The users, of course, expect a UIS to help them achieve their goal, but they also want to be able to understand and, in some way, control how the support is provided.

My results help designers of IT artifacts taking the trustee role by identifying the importance of single factors for the formation of trust. Information on how these factors can be addressed during IT artifact design is provided by other studies. For example, my results suggest that confidentiality and authorized data usage are crucial for the formation of initial trust. Wang and Benbasat (2007) showed that explanations help reduce the information asymmetry between a user and an online recommender agent. Thus, increasing the users' trust in the generated recommendations. Focusing on website design, e.g., Cyr et al. (2009) found out that a high level of perceived social presence will increase a user's trust in the website, and that a high level of perceived

social presence can be reached by increasing the human appeal of a website. Furthermore, Riedl et al. (2011) studied whether users have a higher trust in humans or human-like avatars, and found out that users trust both to a similar degree. Combining these insights, detailed design implications for designers of IT artifacts can be derived. Since it is hard for the user to follow whether he or she can really control who is able to access his or her data, and whether his or her data is only used for the intended purposes, the IT artifact should provide explanations regarding how confidentiality, and authorized data usage are ensured. Since human appeal increases perceived social presence, and accordingly also the users' trust, these explanations should be provided by either a human or a human-like avatar, since both increase the human appeal of the IT artifact, and do not differ regarding the degree of trust. Since I studied the formation of initial trust, this explanation of a human or human-like avatar should be presented right when the user starts using the IT artifact.

This example demonstrates the contribution of my results as well as the interaction with existing insights. My results on the formation of trust in a UIS provide detailed insights regarding which factors should be addressed to create trust. Based on my results I can derive that an IT artifact needs to be reliable, provide accurate information, should ensure that the users' data is safe, and only used for the intended purposes. Also, we roughly know how important each of these factors is. These insights needs to be enriched by existing works which focus on "how" such factors should be addressed. Consequently, I contribute to IS research by providing detailed information on which factors should be addressed to build trust. This also contributes to practice, since detailed design implications to empower designers to create a more trustworthy UIS can be derived.

7.6 Limitations

This study is not without limitations. Therefore, it also provides opportunities for future research. Trust building is a dynamic process (see e.g., Lewicki and Bunker (1996), and Singh and Sirdeshmukh (2000)), and I focused on initial trust in this study. Consequently, the results are limited to this trust building phase. Insights on interpersonal trust (see e.g., Rempel, Holmes and Zanna (1985) showed that the importance of the single dimensions changed as the relationship matures. This observation could also hold true for the relationship between users and a UIS. Thus, future research should empirically investigate whether the importance of single dimensions or indicators changes as the relationship matures.

I accounted for the increasing importance of privacy and security issues regarding the users' data by integrating related indicators into my formative first-order, formative second-order measurement model. Nevertheless, I am aware of the fact that not all IT artifacts taking the role of a trustee in a trust relationship between a user and an IT artifact include the provision of user data. Using a navigation system, e.g., does not include the provision of a comparable amount of user data like, e.g., using Facebook. As a consequence, my measurement model for studying the formation of trust in a UIS needs to be adapted for studying IT artifacts taking the trustee role, but must work without user data.

To the best of my knowledge, this study is the first to use insights on trust in automated systems to build a formative first-order, formative second-order measurement model for trust in a UIS. Even though I reviewed an extensive number of contributions, and the statistical results are good, I cannot rule out that there are additional formative indicators that should be included in the measurement model. As a result future research should identify additional formative indicators, and test whether they enrich my model.

Furthermore, numerous recent contributions on trust have shown that factors like gender and culture affect trust (Gefen/Ridings 2005; Awad/Ragowsky 2008; Cyr 2008; Kim 2008; Vance/Elie-Dit-Cosaque/Straub 2008; Riedl/Hubert/Kenning 2010). Since I did not examine gender or cultural effects, this is another limitation of my study. Future research should investigate whether factors like gender or culture affect, e.g., the impact of single indicators on the dimensions or the impact of the dimensions on trust.

Additionally, some portion of the indicator weights should be expected to vary based on the structural model the construct is embedded in (Diamantopoulos/Siguaw 2006; Howell/Breivik/Wilcox 2007). As Cenfetelli and Bassellier (2009) point out, large changes would indicate a lack of portability of the construct and, thus, threaten the generalizability of the formative measurement model. Since I developed my formative first-order, formative second-order measurement model for trust in a UIS in this paper, and applied it for the first time using a redundancy analysis, I cannot test for construct portability. Nevertheless, Cenfetelli and Bassellier (2009) point out that conducting a redundancy analysis is the right choice when a new formative measurement model is introduced. Furthermore Ringle, Sarstedt and Straub (2012) recently called for the employment of a redundancy analysis to test the construct validity when using a

formative construct. Consequently, my approach to use a redundancy analysis to assess the quality of my formative measurement model was right, but future research should embed the model in different structural models to test for construct portability and generalizability.

Finally, several limitations are caused by my research method which I used to evaluate my model. These limitations might threaten the external validity of the study. First, for collecting my data I conducted a free simulation experiment with undergraduate business students. The results will be applicable to a more general population only to the extent that undergraduate business students are comparable to typical users (Gordon/Slade/Schmitt 1986). Remus (1986) found that business students were good surrogates for managers, but I could not find any insights regarding their suitability to serve as surrogates for users of IT artifacts in general. Second, I used only one particular IT artifact – a UIS – and one usage setting to collect my data. When reviewing other papers, this is common practice. Nevertheless, it remains to be confirmed that the results are applicable to different UIS, IT artifacts, and different laboratory settings, as well as other types of studies (e.g., field studies).

7.7 Conclusion

The aim of this section was to answer the fourth research question of my dissertation:

> "Which factors form and what impact do they have on the users' trust in a UIS?"

The results presented in this section show that the formative first-order, formative second-order measurement model for trust in a UIS which I built from insights on trust in automation and security and privacy literature is suitable to study the formation of trust in UIS. All three dimensions – performance, process and purpose – were found to have a strong and significant impact on trust in a UIS. Furthermore, I identified three to five factors which form each dimension. In sum, I created very detailed information on the formation of the single dimensions of trust in a UIS and trust itself.

Regarding the aim of my dissertation, the results presented in this section resemble the detailed insights on the formation of trust in UIS which are valuable for deriving TSCs following the logic of trust support presented in section 2.4.7. However, up to this point I did not contribute much to overcoming the gap between behavioral and design research. Despite all the contributions in this and the previous sections, up until now

and from a very critical point of view, this is just ‘yet another behavioral trust study’ like lots of the 167 papers I reviewed in section 4. To address this critique and further strengthen the contribution of my dissertation, the following section will address the next step that was mostly ignored by prior IS research on trust. In the next section, I will present how the behavioral insights on trust in general, more precisely the insights generated in this section, can be used to derive detailed TSCs for a specific IT artifact in general, but in particular for a specific UIS. This step resembles my approach to overcome the gap between behavioral and design research, and to design more trustworthy IT artifacts, such as UIS, that are more readily adopted and used by their intended users.

8 A Method for Deriving Trust Supporting Components in Ubiquitous Information Systems[21]

8.1 Introduction

In this section, I aim at answering the fifth and final research question of my dissertation:

> "How can the behavioral insights on the formation of trust in UIS be used to develop UIS which will be more readily adopted by their intended users?"

The results presented in section 7 show which factors form trust and what impact the single factors have on trust in UIS. In this section, I will develop a method which enables the use of these theoretical insights for the derivation of TSCs for a specific UIS. This goal is challenging, since I can hardly build on any existing works in the field of trust. Despite the vast amount of publications on trust, knowledge regarding how the numerous theoretical insights into the formation of trust can be used to derive specific design elements for IT artifacts hardly exist – I call these elements TSCs. This indicates problems in the interplay between trust-related behavioral and design research which has been described in section 2.2.

Consequently, I will rely on insights from trust theory, requirements engineering, as well as system design and development to develop my method for deriving TSCs for UIS. The method consists of five development activities with distinct development products. To show the applicability of my method, I will afterwards use my method to derive four TSCs for the UIS *'DinnerNow'*. My method will be evaluated by assessing the quality of the derived TSCs. For evaluating the quality of the TSCs, I conduct a laboratory experiment with 166 undergraduate business students.

By developing, applying and evaluating my method, I am able to show that my method delivers TSCs which are regarded as important by intended users of the UIS. Furthermore, the derived TSCs increase their respective antecedents, trust itself and the intention to use the UIS. According to Gregor (2006), this is theory of design and action. This theoretical contribution resembles the final theoretical contribution of my

[21] The insights presented in this section are partly based on different publications on this topic (Söllner et al. 2011a; Söllner et al. 2012a; Söllner et al. 2012b; Hoffmann/Söllner 2014). I thank my collaborators, as well as the reviewers and attendees of the VHB Jahrestagung 2011 and the CHI 2012 as well as the reviewers of the Journal of Business Economics and Personal and Ubiquitous Computing for the valuable feedback on my work.

thesis. Figure 40 provides a graphical illustration for my research approach used to answer my final research question following the design science research process by Peffers et al. (2006). The single phases of the process also guide the structure of the remainder of this section.

The underlying problem has already been motivated and identified, and the objectives of the solution were defined in the previous parts of my dissertation (mainly in section 4). Thus in the remainder of section 8, I will develop my method including five development activities and the development products of each activity (*Design & Development*). Afterwards I will use my method to derive four TSCs for the UIS 'DinnerNow' (*Demonstration*). Next, I provide details on the laboratory experiment conducted to evaluate my method, before I present the limitations of this evaluation (*Evaluation*). The section closes with a conclusion and a presentation of avenue for future research.

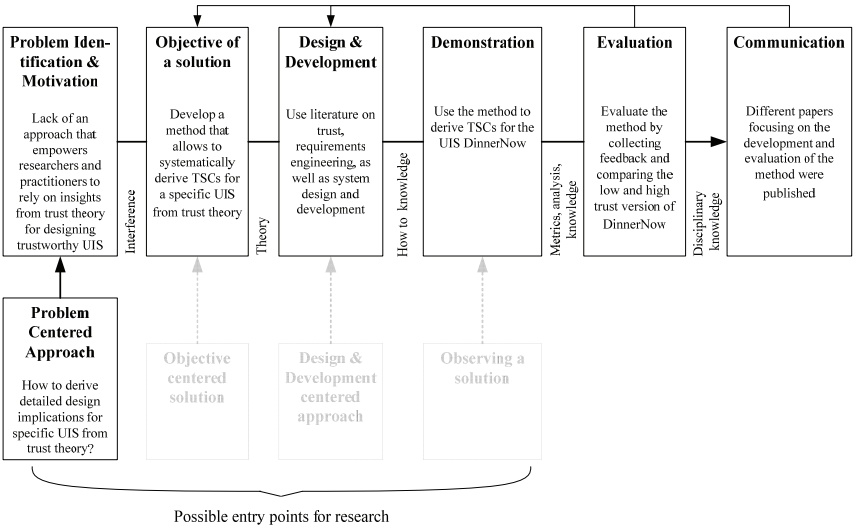


Figure 40: **Research approach for developing the method for deriving TSCs for UIS**
Source: Adapted from Peffers et al. (2006)

8.2 Developing the Method

Regarding the term *method*, I rely on the definition by Brinkkemper (1996, 275-276):

> „A method is an approach to perform a systems development project, based on a specific way of thinking, consisting of directions and rules, structured in a

systematic way in development activities with corresponding development products.“

In accordance with this definition, a method is used in system development, and follows a specific way of thinking. To support the development of a system, it follows a defined structure which is described by development activities that produce different development products. In the remainder of this section, I will focus on the single development activities and their desired products.

Overall, I propose a method consisting of five development activities that enables developers to systematically derive TSCs from trust theory for their specific UIS to render it more trustworthy for the users. My method covers aspects of trust theory as well as requirements engineering and system design, taking users' uncertainties which were pinpointed in the application context with the users' help as a basis to identify antecedents from behavioral trust theory as remedial measures that help overcome the uncertainties, and, hence foster users' trust. These antecedents are then translated into functional requirements, which serve as an input for arriving at concrete TSCs in the final development activity.

While the process is intended to deliver tangible TSCs that can be directly integrated into a system, it is also possible to only perform steps 1-4, and use the resulting functional requirements as input for a traditional system development process. Decoupling the procedure from the conventional software engineering process has two advantages. First, it does not interfere with different process styles, and can be used in projects following a rigid structure like the V-Model XT as well as agile projects, e.g., using SCRUM. Second, this stand-alone process can be used ex-post, i.e. it can be applied to an existing system that needs improvement.

8.2.1 Identifying and Prioritizing Uncertainties

As pointed out in section 2.4.1, trust is based on positive expectations under uncertain conditions and depends heavily on the given context (Rousseau et al. 1998; Abdul-Rahman/Hailes 2000). Consequently, the context of the users has to be captured in order to identify their expectations and the uncertainties they have to face when using the UIS. This should be documented in a way that it can be used as a basis in later activities of the method.

In section 7.2, I pointed out that the users view a UIS (taking the trustee role in a trust relationship) as a tool that supports them in achieving a certain goal (Muir 1994; Lee/See 2004). Thus, the users expect the UIS to support them based on their current need. Consequently, the first aim of the first development activity is to precisely define which user goal shall be supported by the UIS. This user goal will thereafter guide the subsequent steps of the method.

After defining the user goal that shall be supported when using the UIS, situations in the interaction process between the users and the UIS in which trust support is necessary need to be identified. Following trust theory, trust is important in situations characterized by uncertainty (Luhmann 1979). As a result, trust support is necessary in the situations of the interaction process in which the users perceive some kind of uncertainty. Literature on requirements engineering as well as human-computer interaction mentions a plethora of different techniques that can be used – sometimes with a small shift in focus – to determine uncertainties in a systematic manner (Sommerville 2007). A technique widely used for identifying requirements is *interviews* with future users, which can be easily adapted to also identify uncertainties the users might have. Real-world *scenario descriptions* can be used to gain insights from interviews, even if only abstract system descriptions are available (Sutcliffe 1998). *Viewpoint-oriented approaches* take different perspectives of system usage into account and help to discover conflicts that can result in uncertainties (Kotonya/Sommerville 1996). Even *ethnographical methods* can be used, in which the use of a system is observed from the outside in order to understand uncertainties.

After the identification of the uncertainties the users have to face during their interaction with the UIS, the uncertainties need to be prioritized. We need to keep in mind that most system development projects need to comply with certain time constraints and a budget. Consequently, in most cases, not all of the identified uncertainties can be addressed. Thus, to ensure that the trust support will have the desired effect, the most crucial uncertainties should be addressed first. In this context, crucial needs to be understood in terms of impact on an uncertainty to hinder the users to achieve their desired goal. Thinking of a navigation service, e.g., the users' uncertainty regarding the quality of the recommended route would be much more crucial than an uncertainty regarding the correctness of the calculated gas consumption.

Development products of the first development activity are a description of the interaction process between the user and the UIS that allows comprehending in which points of the interaction process the user has to face which uncertainty, and a prioritized list of the identified uncertainties. Furthermore, existing time constraints and the budget should be reviewed in order to define how many of the prioritized uncertainties shall be addressed in the ensuing steps of the method.

8.2.2 Identifying Suitable Trust Dimensions

In the second development activity of the method, the prioritized list of uncertainties will be used to identify dimensions of trust that are suitable to address the uncertainties. This step is necessary, since trust has proven to be multifarious and multidimensional (Mayer/Davis/Schoorman 1995; Abdul-Rahman/Hailes 2000; Lee/See 2004). As argued in section 2.4.7, trust support is supposed to be most effective when the TSCs are derived based on the single antecedents of the trust dimensions. Consequently, in this activity of the method, the suitable trust dimensions to address the single uncertainties will be identified before the third development activity focuses on the specific antecedents of the dimensions.

We need to keep in mind that trust is studied in different context in various fields (Ebert 2009) when aiming to identify suitable trust dimensions. As shown in section 2.4, the plethora of trust research resulted in different kinds of trust relationships that have been studied. Consequently, possibly suitable trust dimensions need to be identified based on the prevalent trust relationship. Assuming that a trust relationship between two humans that is mediated by a UIS is studied, the dimension defined by Mayer, Davis and Schoorman (1995) or alternatives – see Ebert (2009) for an overview – should be checked regarding their suitability. In my example in the next section, I focus on a trust relationship between a human being and a UIS. Consequently, the dimensions porposed by Lee and See (2004) should be checked regarding their suitability to address the uncertainties identified in the previous development activity.

After identifying the set of suitable trust dimensions, these dimensions need to be matched with the prioritized uncertainties. Using the example of the navigation service again, the uncertainty regarding the quality of the recommended route should be addressed using the process dimension by Lee and See (2004). Assuming the user wonders about a specific recommendation – e.g., because he drove this route several

times on his own and usually takes a different route – it is important to help the user understand why a specific route has been recommended. This idea is covered by the process dimension of trust.

The development product of the second development activity of the method is a list of prioritized uncertainties that is enhanced by trust dimensions that appear to be suitable to address the uncertainties.

8.2.3 Identifying Suitable Trust Antecedents

In the third development activity of the method, the prioritized list of uncertainties supplemented with trust dimensions is used to identify antecedents of trust that appear to be suitable to address the uncertainties. This step is necessary, because trust is a multidimensional construct with different antecedents forming each dimension (Mayer/Davis/Schoorman 1995; Jarvis/Mackenzie/Podsakoff 2003). Following the trust support logic presented in section 2.4.7, the identification of specific antecedents of each suitable dimension will empower designers to derive more precise TSCs which address each prioritized uncertainty.

Collections of possible antecedents could be found in the works by Mayer, Davis and Schoorman (1995) – when focusing on an interpersonal trust relationship – and in the works by Lee and See (2004) and Muir (1994) – when focusing on a trust relationship between a human being and an IT artifact such as a UIS.

Using the example of a navigation service again, I argued that the process dimension is most suitable to address the uncertainty regarding the quality of the recommended route. In section 7, I showed that this dimension is formed by five antecedents: *user authenticity*, *understandability*, *predictability*, *confidentiality* and *data integrity*. Of these five antecedents, understandability seems most suitable to address the uncertainty. As described above, the user has driven the route several times, and now wonders why is provided a different recommendation. Consequently, the navigation service should help him to comprehend why a different route is recommended, e.g., by providing additional information concerning the recommendation itself.

It is necessary to state that it is possible for multiple antecedents of a dimension to appear suitable to address a single uncertainty. Even though it is possible to address one uncertainty using multiple antecedents, this should only be done if the uncertainty is very crucial and one antecedent seems insufficient to address it. The reason for this

recommendation is that every antecedent will be used to derive one or more functional requirements in the next development activity, and every functional requirement that needs to be considered costs design and implementation effort. Based on my experience in several applications of the method, I recommend choosing the antecedent that seems to be most suitable to address the uncertainty from a theoretical point of view.

The development product of the third development activity of the method is a list of prioritized uncertainties that is enriched with trust dimensions and antecedents that seem suitable to address the uncertainties.

8.2.4 Deriving Trust-related Functional Requirements

In the fourth development activity of the method, the prioritized list of uncertainties enhanced with trust dimensions and antecedents is used to derive trust-related functional requirements that can be integrated in any system development process, when developing a new UIS. As identified in the literature review in section 4, current trust literature can hardly guide my method beyond the third development activity, since the vast majority of papers do not derive any specific design elements based on their behavioral results. Nevertheless, more technical-oriented insights from requirements engineering can be used for this development activity.

Requirements engineering distinguishes between *functional* and *nonfunctional* requirements. *Functional requirements* define functionalities that need to be provided by a system and are the foundation for the next steps in the systems development process (Pohl 2008). *Nonfunctional requirements* are not directly related to specific functionalities. They define characteristics of the system like availability, reliability or security (Sommerville 2007). The antecedents of trust as identified in the previous development activity are so-called *underspecified functional requirements* (Pohl 2008). These requirements allow a wide range of interpretations of what exactly they mean concerning the future system's characteristics. Hence, they need to be refined into functional requirements (Pohl 2008). To eliminate any ambiguity during system design, a number of methods found in the requirements engineering literature can be applied (Chung et al. 2000; Gross/Yu 2001; Cleland-Huang et al. 2005).

When deducting functional requirements, it is also necessary to consider the situational context, e.g., the usage situation in which the antecedent is supposed to counter the

uncertainty, since the functionality defined here is used in the same context. A compilation of a reusable set of antecedent-to-requirement translations – analogous to software requirement patterns (Withall 2007) or patterns of interaction (Martin/Rouncefield/Sommerville 2006) – helps to both reduce the effort needed in this step of the process and, at the same time, improve the quality of the functional requirements derived. It is important to note that antecedents can also be influenced by trust supporting measures that cannot be defined as functional requirements and, thus, do not result in software design elements. An excellent example for this is expertise – the user's opinion whether the developers have the means to create a high quality application – which is strongly influenced by prior own experiences, media coverage and gossip (Lee/See 2004).

I will continue to use the navigation service for exemplary illustration. Further, I will rely on Pohl's (2008) concretization as the method of choice for deriving trust-related functional requirements. In the third development activity I identified that the uncertainty regarding the quality of the recommended route should be countered using the antecedent understandability. The user has to face this uncertainty when the service recommends the route to the user. Consequently, to counter this uncertainty, I can derive the following functional requirement:

> R0: When the recommended route is presented, the user should be able to access additional information which helps him to understand why this route was recommended. Possible additional information include traffic jams, road works, gas consumption and expected travel time for the recommended and alternative routes.

The development product of the fourth development activity is a list of trust-related functional requirements for the UIS in development. The concretization will result in at least one functional requirement for each antecedent. The trust-related functional requirements ensure that functionalities are implemented in the UIS that support the underlying trust antecedents and thus counter the respective uncertainties.

8.2.5 Deriving Trust Supporting Components

The fifth and final development activity of my method is the design of TSCs based on the trust-related functional requirements gathered in the previous step. Following the accepted basics of system design, different possible design solutions for the trust-related functional requirements will be developed and discussed (Sommerville 2007).

In the course of this process, functionalities of the UIS are derived based on the trust-related functional requirements, and implemented using components (Berkovich et al. 2011). These components are the so-called trust supporting components, since they address requirements which aim to enhance the users' trust in the UIS. As with all design activities in the system development process, deriving TSCs is a creative process, and can only be supported methodologically to a limited extent (Sommerville 2007). This development activity is arguably the vaguest in the overall method, like in every system development process. Thus, prior experience in system design is helpful when deriving effective TSCs that address the trust-related functional requirements.

In the context of the navigation service, the exemplary trust-related functional requirement stated that the additional information helping to understand why this specific route was recommended should be accessible. A suitable TSC to address this requirement is, e.g., to offer a new button in the lower left corner of the screen which enables the user to access such additional information after the route has been recommended to him.

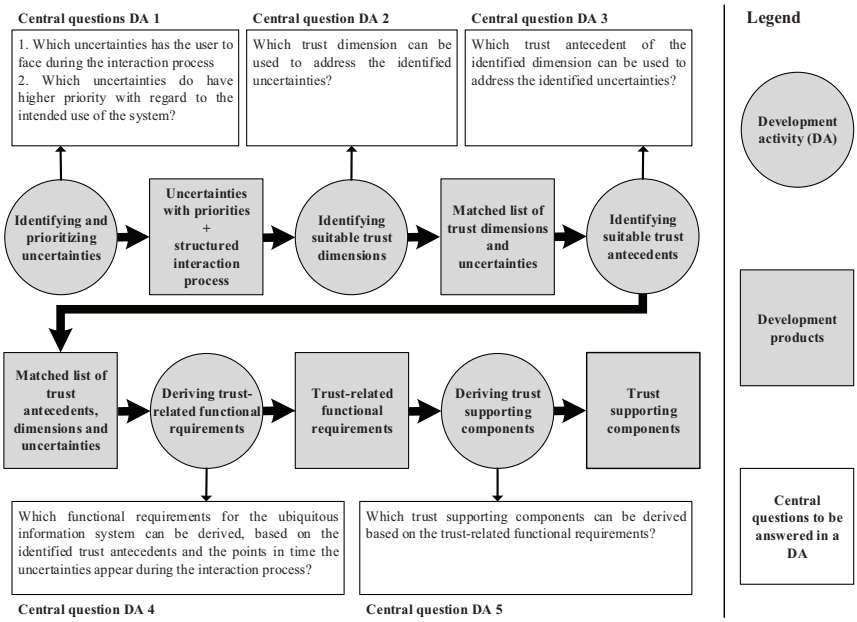


Figure 41: Method for deriving TSCs for UIS
Source: Adapted from Söllner et al. (2012b)

The end products of the method for deriving TSCs for UIS are specific TSCs that counter the uncertainties the users have to face when using the UIS. These uncertainties were previously identified in the first development activity of the method. Figure 41 provides an illustration of the method, including the different development activities and products, as well as central questions that need to be answered in each development activity.

8.3 Application of the Method – The Case of DinnerNow

To evaluate the applicability and the quality of the results derived using the method, I will now present details on one application of the method, namely for the derivation of TSCs for the UIS prototype *DinnerNow*, a restaurant recommendation service for smartphones (in particular the iPhone, see Figure 42 for screenshots of two main screens of DinnerNow).

The application's main goal is to support the decision-making process when two or more people spontaneously decide to have lunch or dinner together in an unfamiliar environment. DinnerNow allows the user to freely select the filter criteria for the recommender system. In the initial version of the prototype – i.e. without TSCs – the user may choose whether to use personal preferences, like the ethnicity of the cuisine, the restaurant's ambiance, and previous personal experiences. He may also want to include ratings from internet-based rating portals like qype.com or google.com. Additionally, DinnerNow automatically takes the users current location into account when generating the recommendation. Since both past interaction (in form of the user's or company's previous experiences) and profile attribute information (like preferred type of cuisine) are taken into account, DinnerNow combines collaborative filtering (historical interaction) and content-based filtering (profile attributes) (Melville/Sindhwani 2010).

After selecting the input criteria and requesting a recommendation, the user is presented a screen which shows him the best option based on the input for the current location. Included into this screen are some details about the restaurant, as well as functions to call the restaurant (e.g. for a reservation), to open a navigation window to the restaurant, and the option to see the next best choice found by the recommender system. Should the user be dissatisfied with the recommendations, he can return to the start screen again, change the settings and generate a new set of recommendations. Figure 42 shows the layout for the screen for changing the search options and the result screen which provides a recommendation.

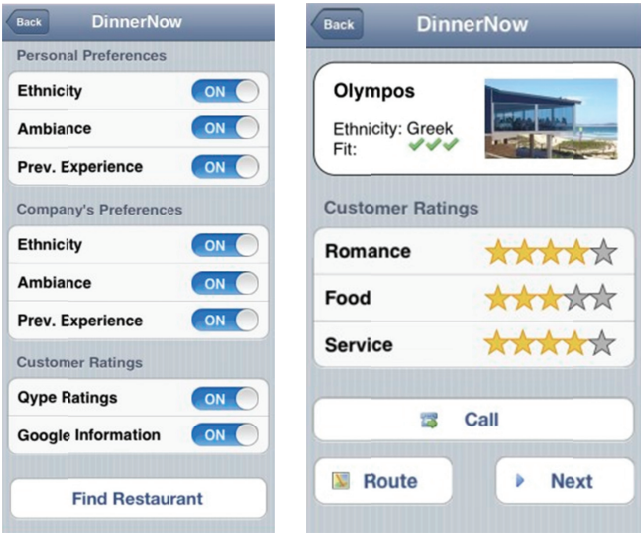


Figure 42: **DinnerNow search options (left, stretched) and results screen without TSCs (right)**
Source: Hoffmann and Söllner (2014)

8.3.1 Identifying and Prioritizing Uncertainties

Following the description in section 8.2.1, in the first development activity, the main goal of DinnerNow is used to identify uncertainties the user has to face when interacting with DinnerNow. Afterwards, the uncertainties need to be prioritized and it is important to decide how many uncertainties shall be countered.

When identifying the uncertainties the user has to face, I relied on the Think Aloud method (Lewis/Rieman 1993; Nielsen 1993). In particular, three potential users of DinnerNow used the initial version of the prototype to express their thoughts and concerns when interacting with DinnerNow. All three had extensive knowledge of mobile, pervasive, ubiquitous technology and have a technical background. The results were used to create a description of the interaction process between the users and DinnerNow, including nine uncertainties that arose at different points during the process.

Two uncertainties arose when the users had to select the input for the recommendation generation process. My three test users were uncertain whether DinnerNow really has

access to the information in the users' profiles on social networking sites, and if the selection of preferences really has an influence on the algorithmic determination of a recommendation.

Another two uncertainties are directly associated with the system's core feature, the recommendation. Firstly, the users were not certain if DinnerNow finds a recommendation based solely on the selected search options or if other factors play a role too. For example, they were suspicious that the application provider could manipulate the recommendation due to kickbacks received from certain restaurant owners. Hence, they were unsure about the recommendation's quality. Another concern was whether the opinion of a broad group of internet users rating restaurants will reflect the user's taste, especially when using the application in a foreign country means being immersed in a different culture.

Five more uncertainties were associated with the way the recommendations are presented. If a user is not happy with a recommendation, he has the option to receive the next best suggestion by selecting "Next," or he can completely start over using different search options. The three test users reported that this was very annoying, since they felt that they should be able to influence the interaction process more directly instead of only choosing "Next" when they were not satisfied with the first two recommendations. If the user has found a recommendation he is happy with, he has the option to open a navigation window and see an estimate for the time needed to get to the restaurant. Uncertainties in this context are whether his position has been determined correctly, whether the calculated itinerary is the best available, and if the estimates for the distance and time needed to get to the restaurant are accurate. Finally, the users mentioned that DinnerNow is only useful in a limited number of situations. Thus, it was emphasized that the system needs to be available whenever it is needed.

Summing up, using the Think Aloud method, nine different uncertainties were successfully identified: The uncertainties regarding …

- … the accessibility of the necessary information in social networks,
- … the impact of the selected options on the recommendation generation process,
- … the quality of the recommendation,

- … the reliability of the user ratings,
- … not being able to influence the recommendation generation process without restarting DinnerNow,
- … the accuracy of one's own location,
- … the accuracy of the best route to the restaurant,
- … the accuracy of the estimates for distance and time,
- … the availability of DinnerNow whenever it is needed.

After having identified those nine uncertainties, their relative importance for the users was determined in a moderated discussion (Kotonya/Sommerville 1998), using an outranking-based approach (Herrmann/Daneva 2008). As a result, the uncertainty regarding the quality of the recommendation was ranked to be the most important uncertainty. This result is consistent with the trust literature, because the recommendations are the core feature of DinnerNow. Since DinnerNow is only used as a tool to achieve the users' goal (Muir 1994; Muir/Moray 1996) to find the best restaurant in their current situation, any uncertainty regarding the core feature would make the users stop using DinnerNow.

The uncertainty regarding the reason for not being able to influence the recommendation generation process without restarting DinnerNow came in second place. This high ranking is consistent with the finding that users do not want to be patronized by any technology. They want to have the option to take control if they perceive the need to do so (Beier/Spiekermann/Rothensee 2006; Spiekermann 2007).

The users ranked the uncertainty regarding the reliability of the user ratings third. They argued that this feature is in general helpful, but in such a very taste-dependent domain like restaurants, they wondered how reliable the ratings of unknown Internet users are. This is somewhat contradictory to current literature, which suggests that Internet users have a high trust in anonymous recommendations made by other users (Forrester Research 2009; Nielsen 2009).

The uncertainty regarding the impact of the selected options on the recommendation generation process was ranked fourth by the users. This can be connected to Lee and

See's (2004) and Luhmann's (1979) argumentation that increasing automation of technology will lead to a decreasing ability to understand how a system works. Since the users do not want to be patronized by technology, such uncertainties are ranked higher than others (Beier/Spiekermann/Rothensee 2006; Spiekermann 2007).

The users ranked the uncertainty regarding the accessibility of the necessary information in social networks fifth. Here, it is important to point out that connecting different applications to Facebook and thus allowing to access different kinds of information was not yet as popular as it is now by the time I began writing my dissertation. Thus, I did not expect this low ranking at that time. Nevertheless, even at that time, trends like the growing popularity of Facebook and the existence of websites such as qype.com showed that information useful for DinnerNow is available on the Internet. Thus, I think the users could easily imagine that an innovative system could access and use such information.

The four uncertainties regarding the correctness of the own location, the correctness of the best route to the restaurant, the correctness of the estimates for distance and time, and the availability of DinnerNow when it is needed were ranked lowest by the users without a more detailed or differentiated ranking of the four uncertainties. Reasons for these low rankings were the high quality of available navigation services for cars or smartphones, and the relatively good availability of mobile Internet access in almost every location, as well as the high availability of services in general in Germany.

Due to the schedule of my project, only the three highest ranked uncertainties were chosen to be alleviated; the complete ranked list of uncertainties is shown in Table 23.

Rank	**Uncertainty regarding …**
1	… the quality of the recommendation.
2	… not being able to influence the recommendation generation process without restarting DinnerNow.
3	… the reliability of the user ratings.
4	… the impact of the selected options on the recommendation generation process.
5	… the accessibility of the necessary information in social networks.
Lowest rank	… the accuracy of one's own location.
	… the accuracy of the best route to the restaurant.
	… the accuracy of the estimates for distance and time.
	… the availability of DinnerNow whenever it is needed.

Table 23: **Ranking of uncertainties for DinnerNow**
Source: Adapted from Söllner et al. (2012b)

The creation of the ranked list of uncertainties and the definition which of them shall be countered by TSCs resembles the end of the first development activity, since all desired development products, according to section 8.2.1, were created.

8.3.2 Identifying Suitable Trust Dimensions

After having identified the uncertainties that shall be countered by TSCs, suitable trust dimensions to address the uncertainties will be identified in the second development activity.

The highest ranked uncertainty shows similarities with the example I used in the sections in which I developed the method. In both cases, the uncertainty is related to the core features of the system, namely recommending the best restaurant and finding the best route. Consequently, I argue that the uncertainty regarding the quality of the recommendation should be addressed using the process dimension.

For the second ranked uncertainty regarding not being able to influence the recommendation generation process without restarting DinnerNow, I argue that the performance dimension seems to be the most suitable. In fact, the users call for an additional functionality which allows them to influence the process. In general, issues regarding functionality belong to the performance dimension.

Rank	Uncertainty regarding …	Dimension
1	… the quality of the recommendation.	Process
2	… not being able to influence the recommendation generation process without restarting DinnerNow.	Performance
3	… the reliability of the user ratings.	Performance
4	… the impact of the selected options on the recommendation generation process.	
5	… the accessibility of the necessary information in social networks.	
Lowest rank	… the accuracy of one's own location.	
	… the accuracy of the best route to the restaurant.	
	… the accuracy of the estimates for distance and time.	
	… the availability of DinnerNow whenever it is needed.	

Table 24: **Ranking of uncertainties matched with suitable trust dimensions**
Source: Adapted from Söllner et al. (2012b)

In the case of the uncertainty regarding the reliability of user ratings, I argue that the performance dimension again seems to be the most suitable to address this uncertainty. This uncertainty questions whether relying on user ratings provides any contribution at

all to support the user in achieving his or her goal. This is again a question regarding its particular functionality. Thus, it is related to the performance dimension.

I identified a suitable dimension to address each of the three uncertainties. An illustration of the development product of the second development activity is shown in Table 24.

8.3.3 Identifying Suitable Trust Antecedents

As described in section 8.2.3, in aim of the third development activity is to identify suitable antecedents of each dimension in order to enable the derivation of more precise trust-related functional requirements in the subsequent development activity.

I identified the process dimension as the most suitable to deal with the uncertainty that regards the quality of the recommendation. Going back to section 7, five antecedents of this dimension were identified. Due to the parallels with my previous example, I also argue that understandability is the most suitable antecedent of the process dimension to address this uncertainty. This idea resembles the user's need to be able to understand what the system does, even if only to a certain degree, and how the results are created to assess their quality. A UIS that addresses this need and provides functionalities which allow the user to better understand what it does, and how the results are generated should, thus, be perceived being more trustworthy.

I identified the performance dimension as the most suitable to address the uncertainty regarding not being able to influence the recommendation generation process without restarting DinnerNow. Obviously, the test users are missing a functionality they regarded as being important. In section 7, three different antecedents of this dimension were identified. I argue that the antecedent responsibility is the most suitable to address this dimension, since this antecedent covers the functional entirety of a UIS.

I again identified the performance dimension as the most suitable to deal with the uncertainty regarding the reliability of user ratings. It seems that the test users did not have the amount of trust in user ratings as recent customer surveys suggested (Forrester Research 2009; Nielsen 2009), and did not regard the user ratings as an accurate information source upon which to rely when making a decision. Out of the three antecedents of the performance dimension, I argue that the antecedent information accuracy is the most suitable to address this uncertainty, since it refers to those exact aspects.

For this reason, I identified a suitable antecedent of each dimension to address each of the three uncertainties. An illustration of the development product of the third development activity is shown in Table 25.

Rank	Uncertainty regarding …	Dimension	Antecedent
1	… the quality of the recommendation.	Process	Understandability
2	… not being able to influence the recommendation generation process without restarting DinnerNow.	Performance	Responsibility
3	… the reliability of the user ratings.	Performance	Information accuracy
4	… the impact of the selected options on the recommendation generation process.		
5	… the accessibility of the necessary information in social networks.		
Lowest rank	… the accuracy of one's own location.		
	… the accuracy of the best route to the restaurant.		
	… the accuracy of the estimates for distance and time.		
	… the availability of DinnerNow whenever it is needed.		

Table 25: Ranking of uncertainties matched with suitable trust dimensions and antecedents
Source: Adapted from Söllner et al. (2012b)

8.3.4 Deriving Trust-related Functional Requirements

According to section 8.2.4, the trust antecedents now need to be concretized into trust-related functional requirements that can be used in any system development process.

Based on my argumentation in the previous section, I identified the antecedent *understandability* as suitable for addressing the uncertainty regarding the quality of the recommendation. Thus, it can be used to increase the user's trust in DinnerNow. According to the results found in section 8.3.1, the respective uncertainty arises when the recommendation is generated and presented to the user. Consequently, I need to help the user to better understand why this recommendation is of high quality. With the aid of this knowledge, I can derive the trust-related functional requirement that should enable the user to access additional information which will help him to assess the quality of the recommendation, right after the recommendation has been presented to him.

The uncertainty regarding not being able to influence the recommendation generation process without restarting DinnerNow, will be addressed using the antecedent *responsibility*. According to the interaction process, this uncertainty arises when the user is not satisfied with the recommendation and wonders why he only can request

another automatic recommendation or restart the whole service. In section 8.3.1, I argued that this seems to be related to a finding in the literature which shows that users do not want to be patronized by technology. They wish to have the possibility to actively influence the process if necessary. As a result, I can derive the trust-related functional requirement which gives the user the possibility to access a list of all available restaurants, and several search and sorting options for the identification of the most suitable restaurant on his own.

I identified the antecedent *information accuracy* to be the most suitable to address the uncertainty regarding the reliability of the user ratings. In section 8.3.1, I identified that this uncertainty arises when the user ratings for a specific recommendation are displayed. According to survey results, Internet users have a higher trust in the opinions of their friends than in those of anonymous Internet users (Forrester Research 2009; Nielsen 2009). Thus, relying on ratings of friends should increase the perceived accuracy of this information, and, thus, increase trust. As a result, I can derive two trust-related functional requirements. First, the user should be able to choose whether anonymous user ratings and/or ratings made by friends should be used in the recommendation generation process. Second, if desired by the user and if available, the ratings from the friends of the user or his company should be displayed instead of anonymous user ratings.

Summing up, in this development activity I was able to derive the following, four distinct trust-related functional requirements for DinnerNow:

> R0: The user should be able to access additional information which helps him to assess the quality of the recommendation directly after the recommendation has been presented to him.
>
> R1: The user should have the possibility to access a list of all available restaurants, and several search and sorting options to identify the most suitable restaurant on his own.
>
> R2: The user should be able to choose whether anonymous user ratings and/or friend ratings should be used in the recommendation generation process.
>
> R3: If desired by the user and if available, the ratings from the friends of the user or his company should be displayed instead of anonymous user ratings.

8.3.5 Deriving Trust Supporting Components

Goal of the fifth and final development activity of the method is to derive specific TSCs for DinnerNow based on the trust-related functional requirements.

To fulfill R0, a new button (*Fit*) was added. It allows the user to access information regarding how well the recommendation fits every preference of the user used in the recommendation generation process. The button is available right after the recommendation is presented, and is located right below the restaurant details (see TSC1 on the right screen in Figure 43). The decision to use a button that needs to be pressed instead of showing a pop-up window with identical information is based on the idea that some users might not need this information at all, or only when they start using DinnerNow. Thus, a button that needs to be pressed seemed less invasive and more appropriate.

R1 was fulfilled by implementing another new button (*Browse List*), allowing the user to choose a restaurant from the list of restaurants suggestions. The button is available right after the recommendation is presented and it is located below the *Next*-button which provides the next most suitable restaurants according to the results of the recommendation generation process (see TSC2 on the right screen in Figure 43). Thus, it is below the *Fit*-button, since this button will only be used if the user does not like the recommendation. This is a conclusion to which the user usually comes after he wanted to check the fit of the recommendation and his preferences.

To fulfill R2, the possible input selections were altered. Instead of being able to choose between different sources of user ratings, the user has now the option to include anonymous user ratings, in general, and ratings of his friends, in particular, in the recommendation generation process (see TSC3 on the left screen in Figure 43).

R3 was fulfilled by displaying only the ratings of friends after the recommendation is presented. This is only done if such ratings are available and desired by the user (see TSC4 on the right screen in Figure 43). If available and desired, the headline will change from ‘user ratings’ to ‘friends’ ratings’.

Since TSCs for all trust-related functional requirements have been derived, the desired development product of the fifth and final development activity has been created. As a result, a new prototype of DinnerNow, including four TSCs has been developed.

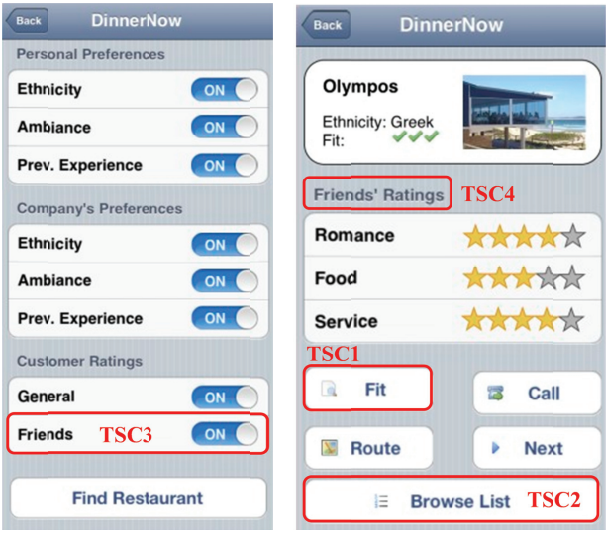


Figure 43: **DinnerNow search options (left) and results screen with TSCs (right)**
Source: Hoffmann and Söllner (2014)

8.4 Evaluation

In section 8.3, I applied my method and showed that it is, in general, suitable for deriving TSCs for UIS. However, the question, whether the TSCs derived using my method will really lead to a higher perceived trustworthiness and usage of the UIS cannot be answered without a respective evaluation. Consequently, I will describe the empirical evaluation of the product of my method in this section. According to Gregor (2006) assessing the quality of the outcome of a method is a suitable approach for evaluating the same. Thus, I used a laboratory experiment which compares the initial version of the DinnerNow prototype without TSCs (Low Trust) and the prototype including the TSCs (High Trust). I investigate whether the addressed antecedents of trust could be increased, whether this led to an increase in trust in DinnerNow, and whether this also resulted in a higher intention to use DinnerNow. This serves as a proxy for actual usage, since the prototype is not yet available. Additionally, I will report the mean value of the importance of each TSC as rated by the participants. This approach allows conclusions to be drawn throughout the whole process, beginning with the importance of each single TSC, its effect on the desired antecedent, on trust itself and, finally, on the intention to use.

In order to evaluate both versions of DinnerNow, I recruited 166 undergraduate students and randomly sorted them into two groups. All participants listened to a 15 minute introduction on DinnerNow, which included the goal of the prototype and how to interact with DinnerNow. Afterwards, I handed out iPod touch devices to every single student, and they were asked to complete three pre-defined tasks using DinnerNow, so as to ensure that they saw all functionalities of each version. Finally, the participants had to complete a questionnaire consisting of different statements about DinnerNow (details on the measurement instrument can be found in the appendix). I used a 7-point Likert response format to record the data (1 = totally disagree / totally unimportant, 4 = neutral, 7 = totally agree / totally important). 143 of the 166 questionnaires could be used for the evaluation. 85 of the 143 questionnaires were completed by female participants and 58 by male participants. 75 participants evaluated the Low Trust prototype, and 68 participants evaluated the High Trust prototype.

Trust and intention to use were measured using different reflective indicators. Both, the antecedents and the importance of each TSC were measured directly. The goal of this evaluation differs from those carried out in sections 6 and 7, and due to the fact that the structural relationship between the antecedents, dimensions and trust have already been shown in the previous section, I will not present detailed results concerning the measurement models and structural relationships. To make it short, all measurement models fulfill the desired quality criteria. The following presentation of the results will focus on the mean values of the importance of each TSC and the changes in the mean values of the antecedents and constructs. Also the impact of each antecedent on trust and the impact of trust on the intention to use will be of interest.

8.4.1 Results of the Laboratory Experiment

Effect on trust	**β-value**	**t-value**	**p-value (Higher → Higher)**
Understandability	0.134	1.830	< 0.05
Responsibility	0.247	3.145	< 0.01
Information accuracy	0.382	4.886	< 0.001
Effect on intention to use			
Trust	0.793	15.315	< 0.001
Thresholds for the significances when using a one-sided t-test: $p < 0.1$: $t \geq 1.289$; $p < 0.05$: $t \geq 1.658$; $p < 0.01$: $t \geq 2.358$; $p < 0.001$: $t \geq 3.160$			

Table 26: **Results of the regression analysis of section 8**
Source: Adapted from Söllner et al. (2012b)

First, I will investigate whether the structural relationships that serve as a basis for the derivation of the TSCs holds true in the case of DinnerNow. Thus, Table 26 shows the impact of the three antecedents on trust and the impact of trust on the intention to use.

The results presented in Table 26 show that all assumed structural relationships are affirmed ($p < 0.05$). Therefore, they are suitable to serve as a basis to derive the TSCs for DinnerNow.

Statement (Low Trust)	**Mean**	**t-value**	**p-value (higher than "neutral")**
It would be important to have the possibility to access additional information which shows the fit between my preferences and the respective characteristics of the recommendation.	5.88	13.873	< 0.001
It would be important to have the possibility to select a restaurant from a list of available restaurants on my own, when I am not satisfied with the recommendation, instead of only being able to request entirely new recommendations.	5.71	12.376	< 0.001
It would be important to have the possibility to rely on ratings of my friends instead of only those made by anonymous Internet users.	5.41	7.801	< 0.001
Statement (High Trust)			
It was important to have the possibility to access additional information which shows the fit between my preferences and the respective characteristics of the recommendation.	5.62	11.506	< 0.001
It was important to have the possibility to select a restaurant from a list of available restaurants on my own when I was not satisfied with the recommendation.	5.59	10.020	< 0.001
It was important to have the possibility to rely on ratings of my friends, instead of only those made by anonymous Internet users.	6.01	14.257	< 0.001

Table 27: Perceived importance of the derived TSCs
Source: Own illustration

Next, I will present the results regarding the importance of each TSC as rated by the participants. Here, I need to mention two specific facts. First, TSC3 and TSC4 were rated together. From a system development point of view, these are two different TSCs based on two different trust-related functional requirements. However, from a user point of view, rating both TSCs separately would cause confusion, e.g., since being able to choose ratings of friends as an input only makes sense if these ratings also appear later in the process. Second, even the participants using the Low Trust prototype answered statements regarding the importance of each TSC. However,

instead of asking how important each TSC was for them, I asked how important such features would be in their opinion (see Table 27).

The results presented in Table 27 show that all TSCs were rated as important by the participants. Thus, I can conclude that my method allows developers to derive TSCs that are considered to be significant by potential users of a UIS.

In the end, I will present the results regarding the changes of the mean values of the antecedents of trust, trust itself and the intention to use (Table 28).

Antecedent / Variable	**Mean Low Trust**	**Mean High Trust**	**t-value**	**p-value (High > Low)**
Understandability	4.76	5.24	1.954	< 0.05
Responsibility	4.49	4.96	2.028	< 0.05
Information accuracy	4.49	5.06	2.655	< 0.01
Trust	4.8137	5.1194	1.466	< 0.1
Intention to use	4.8800	5.3897	2.022	< 0.05

Table 28: Comparison of the mean values for trust observed for the low and high trust versions of DinnerNow
Source: Adapted from Söllner et al. (2012b)

The results show that all mean values could be significantly increased ($p < 0.1$). Thus, it is evident that the four TSCs led to significant increases in all their related antecedents, meaning all TSCs achieved the desired effect. The increase in trust itself is the lowest compared to the antecedents and the intention to use. However, the increase was still significant at 0.1. Finally, it is possible to verify that the mean value of the intention to use was successfully increased significantly. As a result, the desired outcome was also achieved here. The TSCs lead to an increase in their desired antecedents, trust itself and the intention to use.

Lastly, I want to point out that the evaluation shows that my method allows an intensive evaluation, not only of the final development products (the TSCs), but also of the theoretical foundations used to derive the TSCs. Since my method relies on breaking down the broad concept of trust into its single antecedents, I can retrace and evaluate the single theoretical relationships used to derive each single TSC.

In total, I can conclude that the method is suitable to derive TSCs for a UIS that will increase users' trust and intention to use this UIS.

8.4.2 Limitations

I already mentioned some limitations of the evaluation throughout the previous sections. However, in this section I want to provide an overview of the different limitations of the evaluation, revealing what the evaluation can and cannot uncover.

Using a laboratory experiment comes with advantages and disadvantages. Let us focus on the disadvantages first. It remains questionable, whether the participants of the experiment really behave like they would behave in a natural setting outside the laboratory. Furthermore, all participants were undergraduate students. Consequently, the generalization of the results is limited to this group. Nevertheless, the participants show a quite good fit with the intended users of such a UIS, since they are comparably young and possess considerable knowledge of technology.

However, a laboratory experiment also has its advantages. Due to the very controlled environment, it is possible to isolate changes in the behavior to specific treatments. Furthermore, the high control in the laboratory setting allows more accurate testing prototypes of systems that still lack some functionality. I could, e.g., design the tasks in a way that the users could see all functionalities of DinnerNow, and, at the same time, reduce the probability that they experience major problems while using the UIS. Additionally, I could wipe out the impact of different devices, since all participants were given the exact same devices with the same operating system and the same versions of the prototype.

Lastly, it is crucial to point out that the presented results do not allow the complete logic of my method to be evaluated, since I investigated the impact of the antecedents on trust directly without considering the dimensions. I chose to do so, since the aim of this section was to assess whether my method is suitable to derive valuable TSCs for UIS. Furthermore, I presented extensive empirical evidence of the relationships between the different constructs in sections 6 and 7. Therefore, I wanted to limit this part of the evaluation to a minimum in this section, and focus more explicitly on the quality of the TSCs and their effects. However, this makes the evaluation of the relationships less rigorous than in the previous sections 6 and 7.

8.5 Conclusion

The aim of this section was to answer the fifth and final research question of my dissertation:

> "How can the behavioral insights on the formation of trust in UIS be used to develop UIS which will be more readily adopted by their intended users?"

The results presented in this section reveal that the behavioral insights into the formation of trust in UIS can be used to derive detailed TSCs for a specific UIS, if multiple insights from different disciplines are combined. I relied on insights from trust theory, theory-driven design requirements engineering to develop my method. In the first development activity, trust theory guided my thoughts and I argued that countering uncertainties the user has to face is the key for a successful development of trust. In development activities two and three, I followed the ideas of the theory-driven design approach and derived trust dimensions and antecedents that are suitable to counter the identified uncertainties. In the fourth development activity I employ knowledge take from requirements engineering to analyze the fact that the antecedents can be interpreted as underspecified functional requirements, and that they need to be concretized into what I call, trust-related functional requirements that can be included in any system development process. Finally, I derived TSCs based on the trust-related functional requirements in the fifth development activity.

The application of my method to derive TSCs for DinnerNow and the subsequent evaluation show that the method is suitable for deriving TSCs for a UIS that are considered important by potential users. These TSCs lead to an increase in the addressed antecedents, trust itself and the intention to use. Furthermore, the evaluation shows that the method not only allows an assessment of the quality of the development products, namely the TSCs, but also an evaluation of the theoretical foundations used to derive every single TSC.

In accordance with the taxonomy by Gregor (2006), my method adheres to the theory of design and action. Using this method, the gap between behavioral and design research, as described, e.g., by Spann (2010) can be closed, and more trustworthy and ready-to-use UIS can be developed using trust theory. My method is also a practical contribution, since it can be used by UIS designers and developers to derive TSCs for their UIS. Furthermore, I derived 4 TSCs that can be used by designers and developers if they have to face a comparable challenge.

Nevertheless, future research should continue to apply, evaluate and refine my method. My method should be used to derive TSCs for other UIS, and the results should be evaluated using different research methods, such as field experiments, or studies to

investigate whether the results observed in my laboratory experiment also apply in a more natural environment. Furthermore, a more thorough evaluation of the method itself, not only the development products, should be conducted, e.g., by building two comparable teams of designers that use different methods for deriving TSCs for a specific UIS. Afterwards, whether the team using my method could derive better TSCs or similar TSCs in less time should be compared. Additionally, any problems concerning the application of the method should be collected and analyzed. I consider myself a trust expert, but is it unrealistic to assume that every developer or designer will possess the same amount of knowledge of trust theory. It would also be useful to evaluate different TSCs from a productivity point of view. In my evaluation, I focused on the impact of the development products and did not consider the input necessary to develop the product. However, it might, e.g., be possible that a specific TSC may only show half of the impact of another TSC, but can be implemented in 10% of the time.

9 Summary of Contributions and Areas for Future Research

In the previous sections, the discussion subsections already provided parts of the contributions of my dissertation. The aim of this section is to provide a coherent overview of the single contributions to theory and practice of my contribution, and to provide an outlook for future research areas that are not covered by my dissertation. Furthermore, it resembles options for next steps that could be taken based on my dissertation.

9.1 Theoretical Contributions of the Dissertation

9.1.1 Assessing the Readiness of Information Systems Research on Trust for Supporting the Development of More Trustworthy Ubiquitous Information Systems

The first RQ I aimed to answer in my dissertation was:

> "How ready is IS trust research for empowering developers of UIS to account for the increasing importance of trust during UIS development, in terms of the conceptualizations used, antecedents identified and types measurement models employed, as well as guiding designers to design more trustworthy UIS?"

In section 4, I showed that IS trust literature has created a respectable knowledge base, but I also identified several gaps in the literature that should be addressed to further strengthen the knowledge base in terms of empowering researchers and practitioners to design trustworthy UIS.

I identified that 14 of the 16 papers that focused on a trust relationship in which an IT artifact takes the trustee role, relied on interpersonal trust theory, and that none used a theoretical foundation which is explicitly designed for such trust relationships. This resembles a first gap in the literature which I addressed in sections 6 and 7 of my dissertation. Furthermore, I found hardly any insights in the importance of different foci of trust in the context of IT artifact adoption in general and UIS adoption in particular. I addressed this gap in the literature in section 6 of my dissertation. Next, I identified that IS trust research has identified a plethora of different antecedents of trust, but many studies suffer from measurement model specification issues which might lead to Type I errors. The main problem is the use of formative indicators for a reflective measurement of trust. I addressed this issue in section 5 of my dissertation.

Regarding the use of theoretical insights on trust for IT artifact design, I found hardly any paper that explicitly relied on theoretical insights to design a particular IT artifact. Furthermore, none of the papers provided an approach empowering researchers and practitioners to design trustworthy IT artifacts. I addressed this gap in section 8 of my dissertation.

9.1.2 Assessing the Value of Using a Formative Measurement Approach for Trust for IT Artifact Design

The second RQ I aimed to answer in my dissertation was:

> "What is the value of using a formative measurement approach for trust when aiming to design trustworthy UIS?"

In section 5, I first showed how existing knowledge of interpersonal trust can be used to develop a formative measurement model of trust. This contribution addresses the problems of measurement model mis-specification in IS trust research, as identified in section 4.

I was able to show that existing measurement models of trust that use reflective indicators related to the different dimensions of trust can easily be re-specified, meaning they are then correctly specified formative measurement models.

In my empirical evaluation of both types of measurement models, I was able to show that the choice of measurement model has hardly any impact on the structural relationships in the model. Thus, researchers can use formatively specified measurement models without any fear that this selection might impact their structural results. Furthermore, I was able to show that using a formative measurement model of trust enables the creation of more detailed insights regarding the impact of the different dimensions on trust. Consequently, when aiming to derive TSCs for a specific IT artifact, in my case a UIS, a formative approach is more useful, since it offers more details on factors which influence trust than a reflective measurement approach does. I decided to develop a formative first-order, formative second-order measurement model in my dissertation, in order to acquire detailed information about the formation of trust in UIS.

9.1.3 Identification of Different Foci of Trust and Evaluation of their Impact in the Context of Ubiquitous Information Systems Adoption

The third RQ I aimed to answer in my dissertation was:

> "Do users perceive different foci of trust in the context of UIS adoption, and if yes, do the different foci influence each other and do they have distinct effects on other constructs important for UIS adoption?"

In section 6, I adhered to recent trust research in the management discipline and employed a multifoci approach to investigate trust in the context of UIS adoption. By means of this approach, I was able to identify four different foci of trust: trust in the UIS itself, trust in the providers of the UIS, trust in the Internet and trust in the community of Internet users.

I was able to show certain relationships between the different foci of trust in my empirical evaluation. Trust in the Internet showed a high impact on trust in the community of Internet users. Furthermore, I observed a high impact of trust in the Internet on trust in the provider of a UIS. The latter focus of trust displayed a high influence on the trust in the UIS itself. Additionally, I identified two foci of trust that are especially important in the context of UIS adoption. One focus, namely trust in the UIS itself, was found to be the most important of all, in terms of its impact on the core consequences of trust according to the Trust-TAM (PU and ItU). Additionally, I identified that a second focus, namely trust in the providers of the UIS, is also an important focus in regards of his impact on trust in the UIS itself, the PEOU and PU. This focus has hardly been investigated by previous IS trust research. Since this construct appears to be of definite importance, not only in the context of UIS adoption, but also in the context of IT artifact adoption in general, other researchers should investigate the importance of a comparable construct in the area of interest. According to Gregor (2006), this is a theoretical contribution of the type 'explanation and prediction'. When aiming to derive TSCs for UIS, these results imply that these two foci should be further investigated to better understand how they form and how they can be influenced. In my dissertation, I focused on trust in the UIS itself, since it proved to have the highest impact on core Trust-TAM constructs in the context of UIS adoption.

9.1.4 Development and Evaluation of a Theory of the Formation of Trust in a Ubiquitous Information System

The fourth RQ I aimed to answer in my dissertation was:

> "Which factors form and what impact do they have on the users' trust in a UIS?"

In section 7, I developed and evaluated a formative first-order, formative second-order measurement model for trust in a UIS, since this focus of trust was shown to have the highest impact in the context of UIS adoption. I developed this model by adapting insights from the HCI theory on trust in automation and theory on security and privacy to the needs of studying trust in a UIS.

In the empirical evaluation of my model I was able to show that the developed model, which includes three dimensions (performance, process and purpose) and eleven antecedents is suitable for assessing the formation of trust in a UIS comprehensively, since the model fulfills the desired quality criteria. Furthermore, I observed that the purpose dimension had the highest impact on trust, followed by the process dimension. Of all three, the performance dimension had the weakest impact. This is interesting and contradicts existing insights which say that the performance dimension should have the highest impact, because an IT artifact is used as a tool to achieve a certain goal. Similar results were found regarding the impact of single antecedents. The antecedents related to privacy and security literature showed the highest impact on their respective dimensions. An explanation could be the increasing automation of IT artifacts, such as UIS. The users seem to focus more on aspects such as security and privacy when deciding whether a UIS is trustworthy compared to other systems. According to Gregor (2006), this is a theoretical contribution of the type explanation and prediction. Regarding the design of UIS, the insights are valuable, for they provide possible sources for the derivation of TSCs.

9.1.5 Development, Application and Evaluation of a Method for Deriving Trust Supporting Components for Ubiquitous Information Systems

The fifth RQ I aimed to answer in my dissertation was:

> "How can the behavioral insights on the formation of trust in UIS be used to develop UIS which will be more readily adopted by their intended users?"

In section 8, I developed, applied and evaluated a method for deriving TSCs for UIS. Hereby, I employed insights from trust theory, theory-driven design and requirements engineering. The method consists of five development activities, starting with the identification of uncertainties the user has to face when using a specific UIS. These uncertainties and the moments in the interaction process in which they arise serve as the starting points for the derivation of TSCs. First, dimensions of trust that seem suitable to counter the single uncertainties are identified. Next, the according

antecedents of these dimensions that seem suitable to counter the single uncertainties are identified. In the fourth development activity, the antecedents, and the points on the interaction process are used to specify trust-related functional requirements that can be integrated into any system development approach. These trust-related functional requirements serve as a basis for the derivation of TSCs for a UIS in the fifth and final development activity of my method.

The application and evaluation of my method shows that it is suitable to derive valuable TSCs for UIS. In a laboratory experiment which compares the prototype including the four derived TSCs to the initial version of the prototype, I was able to verify that the derived TSCs are considered important by the users. Additionally, I was able of confirming the effectiveness of the TSCs, since all addressed antecedents of trust could be significantly increased. Consequently, the TSCs should have increased the users' trust in the UIS. This could be confirmed by the significantly higher value for trust observed for the prototype which included the TSCs. Also, because the users' intention to use the UIS was successfully increased and that significantly, it can be concluded that the developed method is suitable to derive effective TSCs for UIS. In a broader context, this successful evaluation of the developed method also shows that the gap between behavioral and design-focused IS research can be closed, and that the vast amount of behavioral knowledge can enhance the IT artifact design process. According to Gregor (2006), this is a theoretical contribution of the type design and action.

9.2 Practical Contributions of the Dissertation

9.2.1 Measurement Instruments

Methodologically, I argued that formative measurement models provide more valuable insights for the design of IT artifacts than reflective ones. Following this argumentation, I developed and evaluated formative measurement instruments based on trust theory in sections 5, 6 and 7.

In section 5, I developed a formative measurement model based on interpersonal trust theory. The empirical evaluation showed that this measurement model is valuable for measuring trust in the context of interpersonal trust. Thus, this measurement model can be used when focusing on interpersonal trust relationships, such as those between users and providers of a UIS. In section 6, I developed the formative measurement

models for the four foci of trust I identified in the context of UIS adoption. The empirical evaluation showed that these models are indeed suitable for such measurements. Consequently, these measurement models can be used when one or more of these four foci are prevalent. In section 7, I explicitly develop a more detailed formative first-order, formative second-order measurement model for trust in a UIS. The empirical evaluation of this measurement model also showed that it is suitable to capture trust in a UIS. When aiming to gather detailed insights regarding the formation of trust in a specific UIS, this measurement model can be used to create the desired information.

The developed and evaluated measurement instruments are ready-to-use, and can be included in any suitable study by practitioners or other researchers.

9.2.2 Identification of the Importance of Trust in the Providers of Ubiquitous Information Systems in the Context of their Adoption

In section 6 of my dissertation, I investigated the impact of four different foci of trust in the context of UIS adoption. I identified that two foci of trust are especially important in this context: trust in the UIS itself, and trust in the provider of the UIS. Prior research also focused on trust in the UIS itself, the importance of trust in the providers, however, has not been highlighted before. My results suggest that this focus should also be considered when aiming to develop UIS that the potential users will regard as trustworthy and intend to use. Consequently, providers should not solely focus on making their UIS more trustworthy, but also focus on being perceived as trustworthy by potential users.

The results provided in section 6, showed that the dimensions benevolence and integrity were more important than the dimension ability. Consequently, providers should try to address the first two dimensions, e.g., by actively communicating how they use personal data of customers, and by making sure that they are perceived as honest business partners, whose actions match their statements. Another source for potential starting points for enhancing the users' trust in the providers is the collection of antecedents presented in section 4. Practitioners can review these antecedents, and judge whether they match their respective context. Furthermore, they can derive TSCs which address the trust they receive as providers.

9.2.3 Antecedents of Trust in the Context of Ubiquitous Information Systems Adoption

In three sections of my dissertation, I investigate antecedents of trust in the context of UIS adoption. I already mentioned in the previous subsection that I found in section 6 that benevolence and integrity were found to have a higher impact on trust in the providers of a UIS than the dimension ability, and that these results and the collection of antecedents in section 4 can be used by the practitioners to derive TSCs addressing the trust in them as providers.

The third section dealt with antecedents of trust is section 7. Here, I investigated the dimensions and antecedents of the most important focus of trust in the context of UIS adoption: trust in the UIS itself. Regarding this focus, I found that all dimensions have a significant impact on trust. Purpose ranked highest, and was closely followed by process and purpose. Furthermore, I found that all antecedents do have a significant impact on their respective dimensions. Among all antecedents, the antecedents related to security and privacy issues were found to have the highest effect on their respective antecedents. As with trust in the provider, the collection of antecedents of trust in section 4, offer further antecedents that can be reviewed according to their suitability.

9.2.4 Method for Deriving Trust Supporting Components for Ubiquitous Information Systems

One core goal of my dissertation was to help practitioners face the increasing importance trust is assumed to have in the advent of ubiquitous computing. Until now, IS trust research lacks detailed descriptions how the vast amount of behavioral information can be used to design new IT artifacts, such as UIS. Consequently, I focused on developing a method for deriving TSCs for UIS. These TSCs are meant to aid practitioners in overcoming the challenge of the increasing importance of trust which technology will generate. The method consists of five development activities, starting with the identification of uncertainties and ending with detailed TSCs for specific UIS derived using trust theory.

The application and empirical evaluation of my method showed that it can be used to derive TSCs for UIS. Furthermore, I was able to prove that TSCs have the desired effects, and, ultimately, lead to a higher trust of potential users in the UIS. This, in turn, leads to an increased intention to use the UIS. This resembles, yet again, a possibility for practitioners to heighten users' trust in their UIS and increase the

chance of the UIS being adopted. I need to mention that employing my method requires the willingness to look into trust theory. This resembles a hurdle for many practitioners. However, based on my evaluation, I can say that this hurdle should be taken as the benefits should outweigh the actual effort. It could be easier for practitioners to just derive TSCs based on antecedents found in the literature, however, I believe that the effect of this approach will be smaller than if they were to employ my method.

9.2.5 Trust Supporting Components for Ubiquitous Information Systems

I did not only provide a method for deriving TSCs in UIS, I also developed four TSCs for DinnerNow that are ready to be reused in other UIS. The empirical evaluation of the TSCs showed that they were regarded important by potential users, and that they had a significant impact on their respective antecedent. Moreover, the TSCs were proven to be effective, enabling practitioners to review whether the developed and evaluated TSCs are suitable for implementation in their UIS. However, practitioners should keep in mind that the evaluation of the TSCs is based on a laboratory experiment and that some parts of DinnerNow were simulated. Thus, they should also assess whether the TSCs seem helpful for their UIS in a comparable context or setting the UIS shall be used in.

9.3 Areas for Future Research

9.3.1 Understanding the Formation of Trust in the Provider of Ubiquitous Information Systems

In section 6, I showed that two foci of trust are especially important in the context of UIS adoption: trust in the UIS itself and trust in the provider of the UIS. As pointed out earlier, I focused on the formation of the most important focus of trust (trust in the UIS) and how it can be influenced. However, the results in section 6 show that trust in the provider of the UIS has a high impact on trust in the UIS itself, as well as on the PU and PEOU. Thus, investigating how this construct is formed and how these insights can be used to design even more trustworthy UIS appears to be a promising area for future research.

9.3.2 Understanding the Interplay between Trust in an IT Artifact and Trust in the Provider of the IT Artifact

As I pointed out, the study presented in section 6 was – to the best of my knowledge – the first IS trust study to explicitly view trust as a multifoci construct and investigated

the interplay between different foci and their impact on other constructs. However, a single study cannot provide valid and reliable results for a whole discipline. Consequently, future studies should also use a multifoci approach.

Furthermore, I think the relationships between trust in a UIS and trust in the provider of the system in particular, and between trust in an IT artifact and trust in the provider in general is especially interesting. I am aware of the fact that the IT artifact and the provider are different entities. Thus, using different foci to address them is the right approach. However, I wonder if it is sufficient to study one of these constructs without considering the other one. Regarding trust in the providers, I could imagine that a researcher is just interested in the overall trust in the provider without any focus on a particular IT artifact he provides. Considering trust in the IT artifact itself, I do not think that this construct should be studied without also investigating trust in the provider of the artifact, because we will always relate an IT artifact we are using to its provider. If we think that a specific IT artifact is great, we will also associate this positive impression with the providers. In the same way, we will blame the providers for shortcomings of an IT artifact. Considering, e.g., Apple and its different devices, I use an iPhone and am pretty satisfied with it. Since the iPhone is provided by Apple, I automatically correlate this satisfaction with the job Apple did developing the iPhone. This positive perception of Apple then shapes my perception of any new IT artifact they release. Consequently, if I would restart my dissertation, I would not just focus on trust in a UIS itself, but also investigate the trust in the provider of the UIS, as well as the interplay between both constructs.

9.3.3 Refining the Theory on the Formation of Trust in Ubiquitous Information Systems

I adapted the HCI theory on trust in automation to fit the needs of the IS discipline in terms of studying trust in UIS, and I was able to show that this theory is useful for deriving TSCs in UIS. However, during my time as a visiting researcher at the IS department at Temple University in Philadelphia, Pennsylvania, USA, and when I presented one of my papers at the International Conference on Information Systems 2012 (Söllner et al. 2012c), some researchers raised concerns about details in the model which I myself shared.

A major point whether *trust* is the right term for this construct, remains questionable, since trust is pretty precisely defined, e.g., in management literature, and the suitability

of some dimensions of trust in automation should be reinvestigated. The process dimension, e.g., posits that understanding of inner processes of a UIS will foster trust (Lee/See 2004). I think this position is applicable and correct. However, it remains questionable whether such a construct should be interpreted as a dimension of trust, or as a distinct construct which has an impact on trust. Considering the definition of trust by Mayer, Davis and Schoorman (1995) and their three definitions ability, benevolence and integrity, it seems that process should more likely be interpreted as a distinct construct, since process hardly matches any of the three original dimensions. Additionally, the suitablility of the purpose dimension should also be reinvestigated. Recalling my argumentation in the previous section, I think that trust in an IT artifact and trust in its provider are distinct constructs. According to the definition of the purpose dimension by Lee and See (2004), this dimension also relates to the designers of the UIS. Thus, this dimension could be redundant if applied to the concept of trust in the providers of the UIS or a dimension of this construct.

Valuable input concerning this refinement is provided in a recent publication by McKnight et al. (2011). The authors develop dimensions for a construct they call trust in technology, which is comparable to trust in a UIS. I think it could be possible to integrate these two constructs to refine the theory on the formation of trust in UIS.

9.3.4 Refining the Method for Deriving Trust Supporting Components for Ubiquitous Information Systems

In section 8, I developed my method for deriving TSCs for UIS. Despite the fact that I was able to show that the application of my method leads to TSCs that significantly increase potential users' trust in the UIS and their intention to use it, I think the method could provide even stronger results with some refinements.

The strength of the method is the rigorous derivation of trust-related functional requirements from trust theory in the development activities two to four. In some publications, my collaborators and I relied on a method consisting of four development activities (Söllner et al. 2012a; Hoffmann/Söllner 2014). In this version of the method, we merged the development activities two and three, and directly derived trust antecedents to counter the identified uncertainties. I think this is also a suitable approach, however, I argue that it is more systematic to include a specific development activity to match the uncertainties and the trust dimensions and to then match the trust antecedents in the next step. This makes the process more comprehensible.

Whereas my method is very rigorous in development activities two to four, it lacks some rigor in development activities one and five. This is related to the fact that both activities rely on qualitative or creative approaches. In the first activity, a number of potential users describe their experiences when using the UIS. This description then serves as a basis for the identification of the different uncertainties they have to face during their interaction with the UIS. Here, I can imagine that NeuroIS (Dimoka et al. 2012) could help to strengthen the rigor of this activity. Dimoka (2010) showed that it is possible to measure trust and distrust in general as well as their degrees using fMRI. Furthermore a vast amount of different concepts, including uncertainty, can be visualized using NeuroIS tools (Dimoka/Pavlou/Davis 2011). Consequently, it could be fruitful to capture the brain activities of potential users when they interact with a UIS, in order to enrich their descriptions of the interaction with objective data of their brain activities. This may make it possible to identify further points in the interaction process in which uncertainties or other negative perceptions seem to arise. Regarding the fifth development activity, it could be valuable to further integrate additional design patterns provided by HCI literature. This could help to better justify the exact design of a specific TSC.

9.3.5 Developing Trust-related Requirement and Design Patterns

From a practitioners' point of view, applying my method to derive TSCs for UIS comes with the requirement of being willing to deal with trust theory. This could create resistance in practitioners, and reduce the practical impact of my dissertation. Helpful tools to overcome such resistance and strengthen the practical impact are patterns. Patterns can be derived using different development products of varying activities of my method. Requirement patterns can be used to identify recurring trust-related functional requirements, and prepare them in a way that practitioners just need to check the applicability of available trust-related requirement patterns when developing a new UIS (Hoffmann et al. 2012a). A first step towards deriving requirement patterns based on the application of my method in the course of the VENUS project resulted in twenty trust-related requirement patterns (Hoffmann et al. 2012b). Table 29 presents an example of a trust-related requirement pattern that is ready for use in any UIS development approach.

Trust-related requirement patterns aim at supporting practitioners in deriving suitable trust-related functional requirements for their UIS, whereas trust-related design pattern aim at helping practitioners to translate trust-related functional requirements into

effective TSCs. At present, I am not aware of any initiatives which aim to develop trust-related design patterns of such specificity, but such patterns would complement the trust-related requirement patterns and further support practitioners in deriving TSCs for UIS. This would help to foster the trust of potential users, and would increase their intention to adopt the UIS.

Understandability			
RE Activity: *Elicitation, Specification*		*Pattern Type:* *Product*	*Stakeholders:* *Users*
Goal (Problem)	Satisfy the user need to easily understand the system.		
Forces	The user wants to know how outcomes, such as recommendations, are generated. There is a tradeoff between securing the mechanisms against competitors and the curiousness of the users.		
Template (Solution)	The system shall provide information how a specific output was created.		
Application and Examples The system shall provide the used data for computing the recommendation.			*Known Uses* DinnerNow

Table 29: Example of a trust-related requirement pattern
Source: Adapted from Hoffmann et al. (2012a)

9.3.6 Investigating the Adaptability of the Developed Method to other Classes of Systems, other Types of Trust Relationships and other Psychological Constructs

The method I developed in section 8 of my dissertation focuses on deriving TSCs for UIS. However, the method should easily be applicable to derive TSCs for IS in general, since hardly anything in the method is UIS-specific.

The only thing that needs to be kept in mind, when applying the method to derive TSCs for other IS, is that the trust relationship might change. Consequently, it should be thoroughly investigated which trust relationship is prevalent, since the theoretical foundation used to derive the trust-related functional requirements depends upon the type of trust relationship.

Furthermore, my method should also be applicable to derive design elements related to other theoretical concepts besides trust. In fact, development activities two to five can easily be used to derive design elements based on theoretical insights from most psychological constructs. The only trust-specific activity of my method is development activity one. Here, uncertainties are identified, since trust is only important in situations of uncertainty. For other psychological constructs, equivalents comparable

to uncertainties in the context of trust need to be identified for finding an according starting point for the theory-based derivation in the subsequent steps of the method.

9.3.7 Understanding the Process of Trust Building

As pointed out in the theoretical background in section 2.4.1, trust is not a stable concept. Trust needs to be built and maintained over time. However, empirical studies usually rely on data collected at a specific point in this trust building and maintaining process. Since I explicitly focused on initial trust, this also holds true for the three studies described in sections 5, 6, 7. Such data enables conclusions to be drawn about the relationships between different constructs, such as foci of trust. Nevertheless, it does not allow conclusions to be made about how trust develops over time. The trust may have simply been high or low in that exact moment of data collection.

To overcome this static investigation of a construct like trust, it would be interesting to research how trust develops as the trust relationship between trustor and trustee matures. First contributions focused on identifying different stages in the trust building process (Singh/Sirdeshmukh 2000), but I am not aware of models which focus on the variations in impact of different antecedents in different stages. Such insights would help us to better understand the nature of trust, which is a core construct of IS research.

9.3.8 Understanding the Importance of Trust in Other Phases of the Innovation-Decision Process

Keeping in mind that trust is not a stable concept, but has to be built and maintained, and recalling the innovation-decision process as described in section 2.3.3, another possible area for future research is the importance of trust in different phases of this process. Due to my focus on initial trust, my dissertation only addresses the importance of trust in the beginning of the decision phase of the innovation-decision process. However, trust should also be important in other phases of the process.

In management literature, some researchers, e.g., focus on trust repair (see Tomlinson and Mayer (2009) for an overview). This stream of literature focuses on the consequences of a breach of trust, and how trust can be rebuilt after such an incident. Comparable research in the context of UIS adoption and use in particular, or IT artifact adoption and use in general, is very sparse. Nevertheless, this area is also important in this context, since problems in the interaction process can lead to a loss of trust in a specific IT artifact. Considering the release of Apple's map app, many users

experienced major problems using this app. This, in turn, affected their trust in the app and in Apple, since the company was known for providing only high quality products and services.

Furthermore, trust should also play an important role in the phase preceding the decision, namely in the persuasion phase. Nowadays, the users are usually faced with a plethora of different IS supporting them in achieving the same goal. There are, e.g., numerous different navigation services available. Consequently, another important question for practitioners is how to design the presentation of their IS in a way that the user decides to give this IS a try, instead of an IS of the competition. This is important, since the TSCs that can be derived using my method can only impact the users' perception if they actually decide to give the UIS a try.

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Appendix

Measurement Instruments

Measurement Instrument Used in the Study Presented in Section 5

Indicator	Statement	Source	Mean value	Standard deviation
Perceived Ease of Use (reflective)				
PEOU1	Learning to use ____ would be easy for me.	Adapted from Kamis, Koufaris and Stern (2008).	5.39	1.64
PEOU2	It would be easy for me to become skillful at using ____.		5.48	1.50
PEOU3	____ is easy to use.		5.26	1.63
Perceived Usefulness (reflective)				
PU1	Using ____ improves my performance in deciding which location to visit.	Adapted from Kamis, Koufaris and Stern (2008).	4.18	1.52
PU2	Using ____ improves my effectiveness in deciding which location to visit.		4.17	1.52
PU3	____ is a useful tool to support me in deciding which location to visit.		4.07	1.51
Trust (reflective and formative)				
Ability	____ is like a real expert in recommending suitable locations.	Adapted from Wang and Benbasat (2007).	4.10	1.59
Benevolence	____ puts my interests first.		3.44	1.64
Integrity	____ provides unbiased location recommendations.		3.78	1.70
Intention to Use (reflective)				
ItU1	Assuming I had access to ____, I intend to use it.	Adapted fromWang and Benbasat (2009) and Bhattacherjee and Sanford (2006).	4.03	1.73
ItU2	Assuming I had access to ____, I would plan to use it in the near future.		3.97	1.70
ItU3	Assuming it had access to ____, I would plan to use it.		3.95	1.66

Measurement Instrument Used in the Study Presented in Section 6

Indicator	Statement	Source	Mean value	Standard deviation
Trust in the Provider (formative)				
Provability	The provider does a good job.	Developed using theoretical foundations provided by Mayer, Davis and Schoorman (1995).	7.51	1.56
Prov-benevolence	It is important for the provider that ____ supports me in achieving my goals.		7.10	1.70
Provintegrity	I can count on the statements		5.79	2.00

	of the provider.			
Trust in the Internet (formative)				
Sitnormality	I feel good about how things go when doing activities on the Internet.	Developed using theoretical foundations provided by McKnight,Choudhury and Kacmar (2002a).	3.37	2.13
Struct-assurance	I feel assured that legal and technological structures adequately protect me from problems on the Internet.		3.70	1.92
Trust in the UIS (formative)				
Performance	____ performs well.	Developed using theoretical foundations provided by Lee and See (2004).	6.39	1.82
Process	I understand the inner processes ____ uses to support me.		4.81	2.24
Purpose	I understand why ____ was developed.		7.31	1.63
Trust in the Community of Internet Users (formative)				
Userability	Information provided by other users of the Internet is valuable.	Developed using theoretical foundations provided by Mayer, Davis and Schoorman (1995).	5.74	1.84
User-benevolence	Other users of the Internet offer me help when I have questions.		3.66	1.90
Userintegrity	In general, I can count on the information provided by other internet users.		3.97	1.93
Perceived Ease of Use (reflective)				
PEOU1	Learning to use ____ would be easy for me.	Adapted from Kamis, Koufaris and Stern (2008).	7.15	1.69
PEOU2	It would be easy for me to become skillful at using ____.		6.92	1.71
PEOU3	____ is easy to use.		6.34	2.16
Perceived Usefulness (reflective)				
PU1	Using ____ improves my performance in organizing and managing events.	Adapted from Kamis, Koufaris and Stern (2008).	5.20	2.18
PU2	Using ____ improves my effectiveness in organizing and managing events.		5.47	2.18
PU3	____ is a useful tool to support me in organizing and managing events.		6.18	1.90
Intention to Use (reflective)				
ItU1	Assuming I had access to ____, I intend to use it.	Adapted fromWang and Benbasat (2009) and Bhattacherjee and Sanford (2006).	5.53	2.18
ItU2	Assuming I had access to ____, I plan to use it.		5.59	2.22
ItU3	Assuming it had access to ____, I would use it to organize and manage my next event.		5.48	2.26

Measurement Instrument Used in the Study Presented in Section 7

Indicator	Statement	Source	Mean value	Standard deviation
Performance (formative)				
Responsibility	_____ has all functionalities needed to fulfill its goal.	Adapted from Muir and Moray (1996).	6.35	1.75
Information accuracy	I can count on the information provided by _____ to be accurate.	Developed based on the definition presented in section 7.2.	6.74	1.58
Reliability	I can rely on _____ to work.	Developed based on the definition presented in section 7.2.	6.32	1.81
Process (formative)				
User authenticity	I think that no one can pretend to be me within the _____ environment.	Developed based on the definition presented in section 7.2.	4.49	2.39
Understand-ability	I understand how _____ works.	Developed based on the definition presented in section 7.2.	6.69	1.97
Predictability	During usage, I can anticipate what _____ will probably do next.	Adapted from Muir and Moray (1996).	5.35	1.93
Confidentiality	I can control which user can access which of my data.	Developed based on the definition presented in section 7.2.	5.54	2.10
Data integrity	I think that no one can change my data unauthorized without being noticed.	Developed based on the definition presented in section 7.2.	5.53	2.35
Purpose (formative)				
Authorized data usage	I think that my data is used for delivering the services _____ offers.	Developed based on the definition presented in section 7.2.7.2	5.69	2.17
Designer benevolence	I think that the designers of _____ want to help me in achieving my goal.	Developed based on the definition presented in section 7.2.7.2	7.23	1.69
Faith	I think _____ will be an useful tool for planning and managing events in the future.	Adapted from Muir and Moray (1996).	6.75	1.73
Trust (reflective)				
Trust1	_____ is trustworthy.	Adapted from Gefen (2002).	5.77	1.91
Trust2	I have a good feeling when relying on _____.	Adapted from Komiak and Benbasat (2006).	5.29	2.06
Trust3	I can trust the information presented by _____.	Adapted from Cyr et al. (2009).	5.85	1.87

Measurement Instrument Used in the Study Presented in Section 8[22]

Indicator	Statement	Source	Mean value	Standard deviation
Antecedents of Trust				
Understand-ability	I understand how _____ works.	Developed based on the definition presented in section 7.2.	4.99	1.48
Responsibility	_____ has all functionalities needed to fulfill its goal.	Adapted from Muir and Moray (1996).	4.71	1.39
Information accuracy	I can count on the information provided by _____ to be accurate.	Developed based on the definition presented in section 7.2.7.2	4.76	1.30
Trust (reflective)				
Trust1	_____ is trustworthy.	Adapted from Gefen (2002).	5.11	1.55
Trust2	I have a good feeling when relying on _____.	Adapted from Komiak and Benbasat (2006).	4.92	1.55
Trust3	I can trust the information presented by _____.	Adapted from Cyr et al. (2009).	4.67	1.70
Intention to Use (reflective)				
ItU1	Assuming I had access to ____, I intend to use it.	Adapted from Bhattacherjee and Sanford (2006).	5.23	1.62
ItU2	Assuming I had access to ____, I would plan to use it in the near future.		5.13	1.67
ItU3	Assuming it had access to ____, I would plan to use it.		5.35	1.48

[22] The statement regarding the importance of the different TSCs were already provided in section 8.4 and thus are not reported here.

Ubiquitous information systems (UIS) are proposed to represent a fundamental paradigm shift in information systems research. Despite the advantages of such systems, they also come with disadvantages, such as their increasing automation and opaqueness. When aiming to develop UIS that are readily adopted and used by their intended users, those disadvantages need to be addressed. A promising approach to overcome this challenge is fostering the users' trust in UIS.

Matthias Söllner presents a method for deriving trust supporting components for UIS, based on existing insights from literature as well as a new theoretical approach on the formation of trust in UIS. The empirical evaluation of the method shows that the trust supporting components increase the users' trust as well as their intention to adopt a UIS.

The book targets researchers, lecturers and students in information systems, business administration and human computer interaction. It also provides insights for practitioners who develop UIS.

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