Understanding online collaboration technology adoption by researchers – a model and empirical study

Research-in-Progress

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Abstract

Collaboration in research continuously gains importance. Recent developments in online collaboration technology, namely social research network sites (SRNS), specifically aim to support research collaboration. SRNS allow researchers to present themselves, to network, to communicate, and to collaborate. Acceptance of this technology by researchers has received little academic attention, a void this research-in-progress addresses. Building on the Unified Theory of Acceptance and Use of Technology and its recent extension for collaboration technology we present a study design and a theory-based research model to investigate acceptance of online collaboration technology by researchers. As technology adoption research is still dominated by quantitative studies, our study design combines qualitative and quantitative elements and thus makes a methodological contribution. Analyzing qualitative results of 11 focus group sessions, we extend the theory-based model to integrate User Resistance. Additionally, three constructs are identified as antecedents of Performance Expectancy (communication benefits and noise) and Effort Expectancy (privacy concerns).

Keywords: collaboration, technology adoption, social networks, user resistance

Introduction

Corresponding to an estimated doubling of the global scientific output measured in journal papers every twenty years since 1907 (Larsen and von Ins 2010), the percentage of scientific publications co-authored by international collaborators increased from 10.1% in 1990 to 23.3% in 2005. In the same timeframe, the average number of co-authors per publication has increased from 1.87 to 3.30 (Leydesdorff and Wagner 2008).

Potential ICT support for this collaboration among researchers has long been studied in information systems (e.g. Kraut et al. 1987). One of the findings in literature is that so far ICT support has been primarily used for coordination among research groups instead of collaboration (Riemer et al. 2008). However, recent developments in online collaboration technology, namely *social research network sites* (SRNS), specifically aim to enable and support research collaboration. In parallel, recent academic studies (e.g. Fraser et al. 2006; Kalb et al. 2011; Majchrzak et al. 2008) point to the substantial value promise and productivity potential of online collaboration technology for researchers.

Using SRNS, researchers can collaborate more effectively and efficiently by *presenting themselves* with their academic profile beyond the boundaries of their institutions, by *networking* and *communicating*, by *staying updated* on current trends, and by *jointly working* on publication projects – from shared literature management to actual writing (Bullinger et al. 2010). Latest *usage statistics* of the two leading social research network sites *Mendeley* and *ResearchGate* indicate that researchers adopt and use this online collaboration technology specifically designed for their work context. By July 2011, one million researchers had subscribed to each of the two SRNS, representing a significant share of the target group of six million full-time researchers worldwide (OECD 2010, p. 18).

For social network sites, attempts to understand users' motives to accept and adopt online technologies have so far concentrated on hedonic technologies like Facebook (e.g. Church and Salam 2010; Krasnova et al. 2009; Theotokis and Doukidis 2009). Acceptance and adoption of the novel online collaboration technology by researchers have not yet received academic attention, a void this research-in-progress seeks to address. Building on the Unified Theory of Acceptance and Use of Technology, UTAUT (Venkatesh et al. 2003), and in particular its recent extension for collaboration technology by Brown et al. (2010), we present a study design and a theory-based research model to investigate acceptance of online collaboration technology, in particular SRNS, by researchers. UTAUT attempts to unify previously identified antecedents of technology acceptance. The model explains how *Performance Expectancy* and *Effort Expectancy* (behavioral beliefs), *Social Influence* (normative beliefs), and *Facilitating Conditions* (control beliefs) affect *Intention to Use*. Extending the methodological focus of current technology adoption research, which is on quantitative studies (Lee et al. 2003), our approach combines qualitative and quantitative elements. By analyzing the qualitative results from 11 focus group sessions with a total of 67 participants, we extend our theory-based model to integrate *user resistance* (Kim 2010). In addition, three constructs are added which have been stressed by interviewed researchers as antecedents of *performance expectancy* (communication benefits and noise) and *effort expectancy* (privacy concerns).

This research-in-progress (i) advances theoretical understanding of acceptance of online collaboration technology by combining technology acceptance and user resistance theories and (ii) adds to the methodological discussion by combining qualitative and quantitative research methods.

Related Work

Technology adoption is one of the most mature streams in information systems (IS) research. For our research, we build on studies exploring acceptance and use of collaboration technology (Brown et al. 2010) and attempts to apply UTAUT (Venkatesh et al. 2003) to online technologies like microblogging or social networking (e.g. Kalb et al. 2011; Schoendienst et al. 2010).

In the context of *collaboration technology*, Brown et al. (2010) identify a need for a measurement model given that "adoption of collaboration technologies is not progressing as fast or as broadly as expected" (Brown et al. 2010, p. 11). Combining UTAUT with theories from collaboration research, they find *performance expectancy* and *effort expectancy* to be mediated by *technology characteristics* as well as by *individual and group characteristics* (e.g. computer self-efficacy). Additionally, they integrate task

characteristics which moderate the relationship between technology characteristics and performance expectancy. The authors find that a set of situational variables, i.e. *influence of peers and superiors*, effect *social influence* while *facilitating conditions* are mediated by another set of situational variables (*influence of the environment*).

Concerning acceptance and adoption of *online technologies*, Niehaves and Plattfaut (2010) study the effect of *age* concerning acceptance and use of the internet and confirm constructs of UTAUT. Their study encompasses also the moderators *education* and *gender*. McElroy et al. (2007) study the influence of *personality* and *cognitive* style on the use of online technologies, finding strong evidence for *personality* to explain internet use variance. In the more focused area of (hedonic) online technologies, Facebook as the leader in the market of social network sites has been given significant attention (Church and Salam 2010). Koroleva et al. (2010) explore *information overload* on Facebook, Thambusamy et al. (2010) find that *enjoyment* is more important to Facebook users than *privacy concerns*, and Krasnova et al. (2010) examine *network constructing behavior*. Integrating UTAUT constructs, Theotokis and Doukidis (2009) develop and test a use-diffusion model for online technologies. From the results of their survey among Facebook users, they stress the importance of the *social aspect* for adoption and use. Building on TAM (Davis 1989), Church and Salam (2010), establish a research model of *satiation* and *variety-seeking behavior* in Facebook. They analyze feelings of *consumptional* and *relational satiation* as antecedents of an individual's intention to engage in a variety-seeking behavior.

In the particular field of *online collaboration technology for researchers*, to the best of our knowledge, only a small set of qualitative studies is available. Soeldner et al. (2009) use semi-structured interviews with members of virtual research teams to identify their requirements for an online collaboration technology. The *taxonomy of social research network sites* presented by Bullinger et al. (2010) is established on the basis of case studies and in-depth interviews. Building on TAM (Davis 1989), Kalb et al. (2011) investigate *knowledge sharing* by international researchers on a (hedonic) social network site. Richter (2011) differentiates the support of *Social Capital* for virtual teams in enterprise and academic context by reporting on two case studies.

Method

This research-in-progress addresses the missing model that integrates research strands of collaboration technology and technology acceptance by presenting a research model and empirical study design to investigate adoption and acceptance of online collaboration technology by researchers. The empirical study consists of four phases, which will allow triangulation of data. Table 1 outlines the study phases with their research methods and corresponding publications.

Table 1. Study Phases and Research Methods

Study Phase	**Research Methods**
Phase 1: Reviewing literature on collaboration, online technology and virtual research teams (Soeldner et al. 2010); and developing a theory-based model	Systematic literature review
Phase 2: Analyzing and comparing functionalities of online collaboration technology (Moeslein et al. 2009)	Multiple case study with 24 SRNS
Phase 3a: Interviewing providers of online collaboration tools on intention, target group and experiences (Bullinger et al. 2010) Phase 3b: Interviewing researchers on their adoption and use of online collaboration technology (Renken et al. 2011)	Phase 2a: 10 Semi-structured interviews (each 1 interviewee) Phase 2b: 11 Focus group interviews (each 4-7 interviewees)
Phase 4: Understanding acceptance and use of online collaboration technology by researchers via large scale sample	Empirical online survey study at a large university

Phases 1 to 3 have been concluded and we have established a subjective and interpretive understanding of the adoption and acceptance of online collaboration technology. Within our research, we examine one of the two leading social research network sites, *Mendeley*, founded in 2009. Mendeley's *core feature* is

collaborative online literature management which enables a more effective and more efficient shared publication process. By July 2011, Mendeley had more than 100 million published documents in its virtual library, uploaded by and available to its more than one million users. In addition, Mendeley also offers the *basic functionalities* of SRNS, e.g. an academic profile page or a list of other researchers with whom the individual user shares a connection and communicates (Bullinger et al. 2010).

Phase 3b has been performed to test our theory-based model. Data analysis has indicated four constructs not yet present in the model, but relevant to participants. Thus, they are of particular importance for the final research model. We proceed by presenting the research model as developed from theory. The remainder of the paper then presents qualitative data from the focus groups, the resulting final research model, next steps and expected contributions.

Theory-Based Model Development

Following UTAUT (Venkatesh et al. 2003), we use *Behavioral Intention* as the dependent variable in our model. Investigating the case of online collaboration technology, we specify it to the construct ***Intention to Use Online Collaboration Technology*** (INT). INT refers to the individual researcher's intention to use the online collaboration technology in their (collaborative) research process. This implies organizing their network and their literature using the online collaboration technology or sharing information about themselves and their research activities. On the other hand, INT also encompasses retrieving information from other researchers within the relevant field and keeping informed about new publications or trends. Figure 1 below gives a synopsis of the theory-based model and its variables.

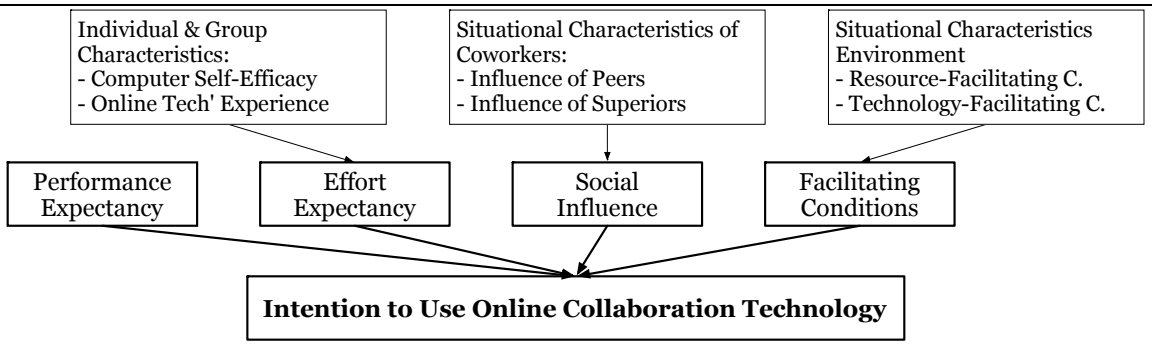

Figure 1. Theory-based research model

Venkatesh et al. (2003) define ***Performance Expectancy*** (PE) as the "degree to which an individual believes that using the system will help him or her to attain gains in job performance" (p. 447). Integrating similar concepts, e.g. *perceived usefulness* (Davis 1989) and *outcome expectations* (Compeau and Higgins 1995), this construct is the strongest predictor of intention in UTAUT. Important to our research, Venkatesh et al. (2003) have already shown that it is significant for both voluntary and mandatory settings. A set of studies, e.g. Schoendienst et al. (2011) and Theotokis and Doukidis (2009) have since tested voluntary settings and affirmed this strong prediction. We hypothesize that *Performance Expectancy* will have a positive influence on *Intention to Use* (H1).

Effort Expectancy (EE) is defined "as the degree of ease associated with the use of the system" (Venkatesh et al. 2003, p. 450). The construct is conceptually and empirically identical to the construct *perceived ease of use* from TAM (Davis 1989), with a high EE suggesting "high ease of use and not high effort" (Brown et al. 2010, p. 13). It has been found to be especially relevant in the field of personal technologies (Brown et al. 2010) and is significant in the early periods of technology adoption in both voluntary and mandatory settings (Venkatesh et al. 2003). Researchers with low effort expectancy, e.g. expecting the user interface to be counterintuitive and hard to understand, are thus expected to refrain from using the online collaboration technology. We hypothesize that *Effort Expectancy* will have a positive effect on *Intention to Use* (H2).

Computer Self-Efficacy (CSE) or an individual's assumption of being able to use a technology to fulfill a task is a major antecedent of EE (Brown et al. 2010; Compeau and Higgins 1995). Brown et al. (2010) find that individuals with greater computer self-efficacy perceive technologies to require less effort, counteracting Venkatesh et al. (2003) who had explicitly excluded an influence of CSE on INT. More specific to our research, extant studies in the field of online technologies have shown that the degree of experience with web-based tools or social software, i.e. *Online Technology Experience* (OTE), influences EE (Matzat 2009; Riemer et al. 2008, Thelwall and Price 2003, Walsh et al. 2000). Building on Brown et al. (2003), we define OTE as the researchers' previous experience with online technologies. Researchers with high OTE command a broad set of experiences with online collaboration technology, e.g. by having interacted with a conference management tool or by microblogging on conferences. They are supposed to perceive online collaboration technology as easy to use. Thus, we hypothesize that *Computer Self-Efficacy* (H3a) and *Online Technology Experience* will positively influence *Effort Expectancy* (H3b).

Social Influence (SI) is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al. 2003, p. 451). Findings by Theotokis and Doukidis (2009) show that *Social Influence* positively influences usage rates of (hedonic) online technologies like social networking. We therefore theorize that *Social Influence* has a positive effect on *Intention to Use* (H4).

Situational Characteristics in form of co-worker factors are relevant for the perception of *Social Influence* (Brown et al. 2010). The influence of persons relevant to the researcher, both *Peer Influence* (SIP) and *Superior Influence* (SIS) directly affect SI, which has an effect on the researcher's INT. In the academic relationship of dependency, e.g. the recommendation of an SRNS by a supervisor or the establishment of a university standard is expected to be a key determinant of *social influence*. Especially in collaborative research projects (Leydesdorff and Wagner 2008), the individual researcher faces a high number of system recommendations by peers, co-authors and colleagues. Thus, we hypothesize that both, *Influence of Peers* (H5a) and *Superiors* (H5b) will have a positive effect on the perception of *Social Influence*.

Facilitating Conditions (FC) refers to the extent to which various situational factors enable adoption and use of technology (Venkatesh et al. 2003, p. 453). The construct integrates similar concepts, e.g. *perceived behavioral control* (Ajzen 1991) and *compatibility* (Moore and Benbasat 1991). Brown et al. (2010) show that the construct influences *system use* of a collaboration technology. This is in line with Venkatesh et al. (2003) who state that if both PE and EE are present, FC becomes nonsignificant in predicting intention. Consequently, we theorize that *Facilitating Conditions* have a positive effect on *Intention to Use* (H6).

Brown et al. (2010) identify *Situational Characteristics*, i.e. the environment in which the online collaboration technology is implemented, as antecedent of FC. First, the technological infrastructure is important, i.e. *Technology-Facilitating Conditions* (FCT). A researcher evaluates to which extent the online collaboration technology is compatible with existing applications, e.g. whether collaboratively written publications can be easily synchronized between an individual desktop program and the shared space on the online collaboration technology. Second, *Resource-Facilitating Conditions* (FCR) influence the perception of FC. FCR cover e.g. the availability of budget to pay for the service – given scare infrastructure resource especially on public universities, this is expected to be an important determinant.

Given findings by Brown et al. (2010) that FC are mediated by FCT and FCR, we hypothesize that *Technology-Facilitating* (H7a) and *Resource-Facilitating Conditions* (H7b) have a positive effect on *Facilitating Conditions*.

Results from Qualitative Study

The theory-based research model has been discussed during phase 3b with 11 focus groups (45 to 90 minutes each). Using purposeful sampling, a total of 67 participants from five universities were recruited. Male and female participants represented different academic levels (assistant professors, postdoctoral researchers, graduate students and a group of master students for comparison), diverse disciplines (social sciences, business administration, economics, computer science), and both users and non-users of online collaboration technology following *maximum variation* (Patton 1987; Wu 2009). Transcripts from the interviews (333,679 characters) were independently coded by the co-authors in MAXQDA 10; inter-coder reliability constituted 0.930 (p-value <0.000). Coding started with a codebook *deducted* from technology

acceptance and online technology literature. To *inductively* explore attitudes of acceptance and user resistance, we also used grounded theory methodology. We chose this *abductive* approach because of the ability of grounded theory to analyze qualitative data systematically and to uncover underlying relationships. New aspects explaining attitudes and behavior were coded as concepts and by constant comparison (Glaser and Strauss 1967) iteratively condensed to a higher level of abstraction. For instance, the code "switching benefits" was defined as the benefit taken from switching to a new system when comparing its efficiency to the previously used system. Both authors coded the answer of one graduate student as a passage hinting to this category: "When I started as a student assistant my colleague introduced me to Mendeley. I had worked a bit with EndNote before. I preferred Mendeley because you can immediately edit the literature with it and can't do it with EndNote." The resulting *abductive* codebook holds 32 code categories derived either from the literature (19 categories) or from statements in the focus groups (13 categories).

The analysis of the focus group discussions has led to three results: First, we have found support for our theory-based research model. Second, discussions have strongly pointed to a missing construct: *User Resistance* (UR). Third, for PE and EE, three antecedents have been identified which will be included in our research model: *Communication Benefits, Noise,* and *Privacy Concerns*. For the four additive constructs, we have identified previous studies in the field of acceptance and user resistance by which we can extend our research model on adoption and acceptance of online collaboration technology by researchers. Below, table 2 gives a synopsis of the mentioning frequencies of the codes before the four additional constructs are presented.

Table 2. Overview Focus Group Results

Construct (novel constructs in *italics*)	**Frequency**	**Relative importance**	**Frequency** incl. **antecedents**	**Relative importance** incl. **antecedents**
PE – Performance Expectancy	97	19.2%	138	27.4%
CB	15	3.0%		
NO	26	5.2%		
EE – Effort Expectancy	30	6.0%	99	19.6%
CSE	17	3.4%		
OTE	28	5.5%		
PC	24	4.8%		
SI – Social Influence	13	2.6%	64	12.7%
SIS	13	2.6%		
SIP	38	7.5%		
FC – Facilitating Conditions	56	11.1%	83	16.5%
FCR	10	2.0%		
FCT	17	3.4%		
UR – User Resistance	27	5.3%	120	23.8%
SWB	39	7.7%		
SWC	54	10.7%		
Total	504	100%	504	100%

When an online collaboration technology is implemented, researchers may decide to *accept and adopt* it or *resist it* basing on their evaluation of change associated with the technology. User acceptance and user resistance are, however, not two sides of the same coin (Kim 2010). *User Acceptance* refers to an

individual's intention to use a technology (Venkatesh et al. 2003) in response to the characteristics of the system and its task outcomes (Davis 1989). Contrary, *User Resistance* has been defined as the opposition of an individual to changes associated with a novel technology, anteceding the intention to use a technology. It can occur before and during the deployment of the technology (Kim & Kankanhalli 2009). Accordingly, it is important to study technology acceptance jointly with user resistance, its possible antecedent.

User Resistance (UR) is conceptualized for our study in line with Kim and Kankanhalli (2009) as opposition of a researcher to change associated with a new online collaboration technology implementation. For instance, a researcher's resistance to exchange a working collaboration system to manage references for a new system will negatively influence his or her *Intention to Use Online Collaboration Technology*. Typical expressions by discussants are "I always say 'Never change a running system'" (social sciences) and "I am quite happy with the way I'm working. Existing alternatives don't interest me" (social sciences).

User Resistance has been shown to occur earlier than *Effort Expectancy*, as discussants with strong *User Resistance* denied to even evaluate the potential ease of use of a novel system. Researchers in our focus groups who were forced to switch to a novel technology, e.g. because of a boundary-spanning research project, have sometimes continued to harbor *User Resistance* by underutilization of the technology: "We have an online shared working space in our European project. I had to have an account but never log in because I still think email is easier" (social sciences). We consequently theorize that *User Resistance* will have a negative effect on *Intention to Use* (H8).

From our data and in analogy to user resistance literature, we conceptualize *User Resistance* as being influenced by *Switching Benefits* (SB) and *Switching Costs* (SC) (Kim 2010). Discussants often mentioned the possibility to have a shared writing environment as a potential *Switching Benefit* which would induce them to change their current research setup: "I switched from traditional word processor to a wiki technology as my main writing tool. This is much more effective for myself and I can just show it to anybody I like" (business administration). *Switching Benefits* are defined as utility associated with switching to a new alternative while *Switching Costs* refer to the disutility associated with this change (Chen and Hitt 2002). *Switching Costs* typically concern expected costs when migrating to a new system. Costs occur in terms of either money (e.g. proprietary software for data analysis instead to freeware), time or data loss. Explains one discussant: "If I consider changing to a new technology, required time to switch must be short and migration of existing data must be fast" (computer science). Extant literature points out that while negative change factors may lead to *User Resistance,* their absence does not necessarily lead to user acceptance (Kim 2010). We theorize that *Switching Benefits* and *Switching Cost* have a negative/ positive influence on *User Resistance* (H9a,b).

For the theory-based construct of *Performance Expectancy, Communication Benefits* and *Noise* have been identified in the focus groups as antecedents.

Communication Benefits (CB) describe the extent to which the online collaboration technology enables users to communicate quicker, easier and faster within the social research network. Our discussants stated that they adopt an online collaboration technology based on the ability to reach their communication partners. This is in line with Brown et al. (2010) who stress the importance of immediate communication in a collaboration technology. In addition, related categories (e.g. *ease of communication*, *awareness*) have been repeatedly mentioned in our focus groups sessions: "The good thing about this technology is that co-authors directly receive emails if there is any change. So if you work with five colleagues, you just add a comment and everybody has it in the inbox, no bothering with groups or email lists" (information systems). Discussants expected the online collaboration technology to increase their productivity and support task accomplishment, e.g. by facilitating updates on topical and methodological trends. Combining our empirical data with the findings of Schoendienst et al. (2011), who have found CB to be a significant determinant of PE, we hypothesize *Communication Benefits* to positively influence *Performance Expectancy* (H10a).

Concerning *Noise* (NO), researchers in the focus groups stated to have a significant set of software applications available to perform their activities (e.g. word processor, statistical tools, reference databases), a multitude of communication channels from emails to weblogs, and numerous possibilities for (online) networking on hedonic social network sites. Thus, participants expressed their fear that

another technology to support their (collaborative) research work would only add to this confusion: "But I have to say that I don't need the tenth platform to upload documents or another online calendar or some other stuff, forum or so. […] You can't keep up with all platforms; otherwise you won't do anything else the whole day" (social sciences). *Noise* is defined in analogy to Schoendienst et al. (2011) as the perception that using online collaboration technology leads to an increased information overflow. It is hypothesized that *Noise* has a negative influence on *Performance Expectancy* (H10b).

As an antecedent of theory-based *Effort Expectancy*, focus group data points to *Privacy Concerns*.

In analogy to Krasnova et al. (2009), data from our focus groups shows strong *Privacy Concerns* (PC), which are often related to EE. Online collaboration technologies enable researchers to exchange data on their work which needs to be well protected, e.g. to protect intellectual property. Discussants were particularly anxious on the effort it would take to find out how data is protected from abuse. "But honestly, I don't want anyone to crawl my documents. I would particularly mind if someone had access to my unpublished research projects" (business administration). Earlier technology adoption models did not include the aspect of privacy concerns whereas Krasnova et al. (2009) find evidence on its negative influence on EE in their research on adoption of online technologies. Thus, we hypothesize *Privacy Concerns* will have a negative effect on *Effort Expectancy* (H11).

Figure 2 gives a synopsis of our proposed research model as elaborated from the literature on technology acceptance and on online collaboration technology as well as data analysis from focus group discussions.

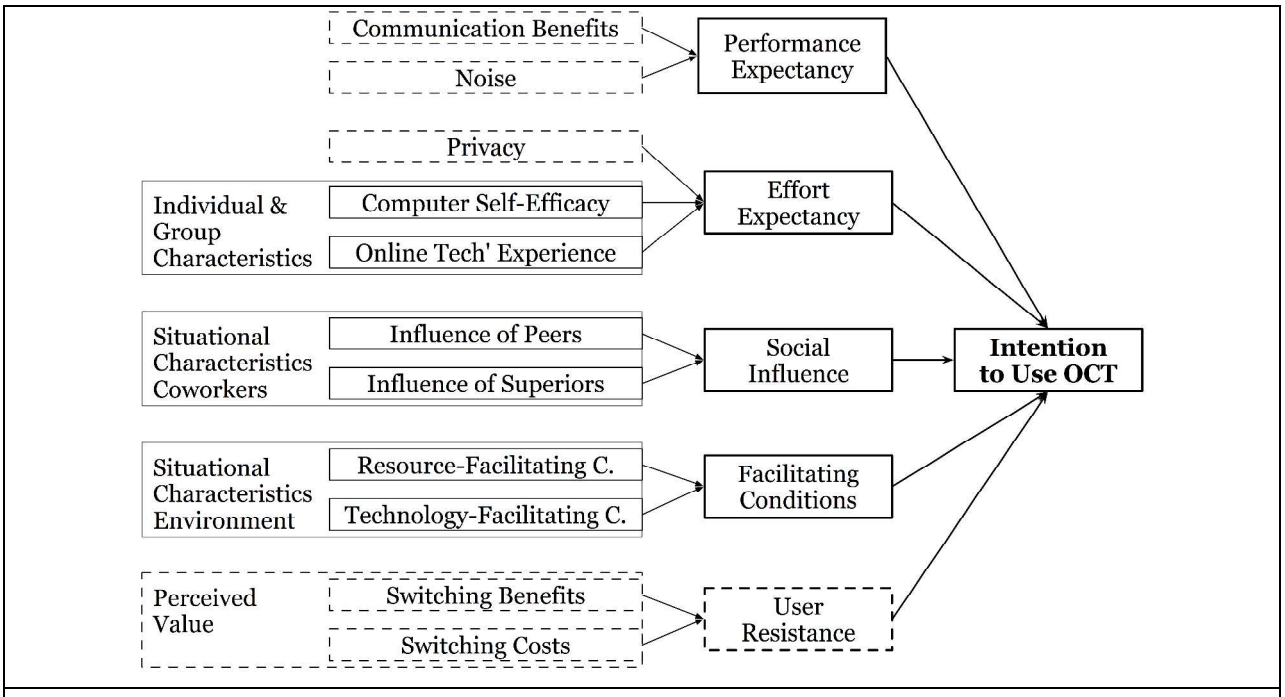

Figure 2. Proposed research model (novel constructs dashed)

Next Steps and Expected Contributions

In the upcoming study phase 4, we intend to validate the findings of the qualitative second and third study phases with a large-scale quantitative survey to reach generalizability.

To operationalize constructs of our empirical study, we rely to a majority on validated measurements. Partly, items have been modified to reflect the specific context of this research. All items are anchored on a 7-point Likert scale and all constructs are modeled as reflective. We have already run a first *pre-test* with 34 members of a university to further refine the measures of our proposed research model and are currently in the process of analysis. From the preliminary analysis, we find confirmation for the content validity of foreseen scales; some critical items have been reformulated and very few were removed. The

planned *data collection* involves a large-scale survey at a large European university with five schools, 300 full professors, 200 assistant professors and about 12,000 academic staff (including graduate students). Together with the university library, an email indicating the survey will be sent to this population. Given the variation in terms of discipline, academic experience, gender and age, it can be considered as appropriate for the proposed study.

The overall study is among the limited studies that attempt to explain user acceptance of collaboration technology from the theoretical perspective of technology acceptance and user resistance with empirical validation. Going beyond previous research, it is expected to provide three main contributions.

First, integrating *user resistance* in a model of technology adoption and use is expected to yield important theoretical advancement on the mediating role of this construct on *intention to use*. The construct as derived from focus groups and based in the literature on user resistance and adoption could explain why social research network sites are not yet fully adopted by researchers despite their value potential.

Second, the study combines qualitative data with a large-scale quantitative sample and thus contributes to the *advancement of methods* in research on technology adoption and acceptance. Using triangulation of study results and the qualitative results from earlier research phases, the study will add to the ongoing methodological discussion by presenting a tested multi-method approach.

Third, by validation of the theoretical model with *empirical data*, important differences and commonalities in researchers' intention to use an online collaboration technology will be identified. They will help to better explain and predict user resistance, acceptance and actual use in different disciplines, on various academic levels and in distributed institutions. This finding will be of particular importance to providers of online collaboration technologies for researchers and other knowledge workers. Along with Kalb et al. (2011), we believe that the target group of researchers is an example of early adopters in the knowledge economy and insights into their attitudes and behaviors will yield important implications for similar target groups.

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