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Technology Acceptance and User Experience: A Review of the Experiential Component in HCI

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Abstract

Understanding the mechanisms that shape the adoption and use of information technology is central to human-computer interaction. Two accounts are particularly vocal about these mechanisms, namely the technology acceptance model (TAM) and work on user experience (UX) models. In this study we review 37 papers in the overlap between TAM and UX models to explore the experiential component of human-computer interactions. The models provide rich insights about *what* constructs influence the experiential component of human-computer interactions and about *how* these constructs are related. For example, the effect of perceived enjoyment on attitude is stronger than those of perceived usefulness and perceived ease of use. It is less clear *why* the relations exist and *under which conditions* the models apply. We discuss four of the main theories used in reasoning about the experiential component and, for example, point to the near absence of psychological needs and negative emotions in the models. In addition, most of the reviewed studies are not tied to specific use episodes, thereby bypassing tasks as an explanatory variable and undermining the accurate measurement of experiences, which are susceptible to moment-to-moment changes. We end by summarizing the implications of our review for future research.

Introduction

It is a formidable challenge to understand the mechanisms that shape the uptake and use of information technology (IT). Any comprehensive account on the use of IT will need to cover detailed questions about how people operate a technology as well as broader ones such as the fit between culture and IT. It will need to account for brief encounters with IT as well as long-term use. It should span varieties of technologies, ideally both current and future ones. It should have something to say about how to design IT. And it should offer not just explanations of mechanisms but also allow predictions to be made about what IT users end up liking and adopting.

Research in information systems, human-computer interaction, and related areas has provided accounts on the uptake and use of IT. Two of those accounts are particularly vocal about the use of technology, namely the technology acceptance model (TAM; e.g., Davis 1989, Venkatesh et al. 2003) and recent work on user experience models (UX; e.g., Tractinsky et al. 2000, Hassenzahl 2004). TAM posits that the individual adoption and use of IT is determined by perceived usefulness and perceived ease of use. TAM has grown out of research in management information systems and has focused in particular on the prediction of adoption; its key constructs have been refined over three decades. Work on TAM has also catalogued a variety of moderators of the adoption and use of IT as well as a host of additional constructs to supplement perceived usefulness and perceived ease of use. One of these constructs is perceived enjoyment (e.g., Liao et al. 2008, van der Heijden 2003), which adds experiential and hedonic aspects to TAM.

Models of UX have described the experience of using interactive products, the consequences of those experiences, and the ways experiences and consequences are connected. UX models have primarily been developed in the literature on human-computer interaction as a reaction to the perceived limitations of usability models for consumer products; UX research has focused to a larger extent than TAM research on informing design. One prominent UX model (Hassenzahl, 2003) posits that interface quality encompasses both hedonic and pragmatic aspects, and in later developments that need fulfilment is related to hedonic quality both directly and mediated by positive affect (Hassenzahl et al. 2010). While work on UX seeks to understand the experiential and hedonic aspects of technology use, they are less refined in their treatment of the utilitarian aspects.

The overlap between work on TAM and work on UX models is limited: Most work on TAM does not cite UX models and most work on UX contains just one or two paragraphs on TAM. Moreover, reviews of TAM (e.g., Hess et al. 2014, Schepers & Wetzels 2007) rarely link to the experiential as understood in UX models, and reviews of user experience (e.g., Hornbæk & Bargas-Avila 2011) rarely mention TAM. Thus, the experiential component in human-computer interaction is seldom informed simultaneously by both strands of research.

The present paper focuses on the overlap between models of technology acceptance and those of user experience. The benefits of doing so are several. First, our understanding of empirical studies that include both TAM and UX models is limited; we are aware of no previous review of such studies. Nevertheless, they allow us to explore the experiential component in human-computer interactions. A better understanding of this component might advance both TAM and UX research. Second, TAM and UX models may appear to have different goals based on their development history. One emphasizes carefully crafted constructs and prediction, the other emphasizes impact on design and new constructs that account for the goodness of consumer products. However different these goals may seem, they are related: prediction should ideally inform design and new constructs should ideally solidify and support prediction. Comparing TAM and UX research may help make this happen and blend the two research traditions. Third, experiences interact with the utilitarian aspects of technology use and are increasingly recognized as important to performance and well-being. By focusing on the overlap between TAM and UX models we target these interactions while maintaining a primary interest in the users' emotions and experiences – the experiential component.

In this paper, we systematically search for papers in the overlap between TAM and UX models and review the papers found with respect to what constructs they consider, how the constructs are related, why these constructs and relations are proposed to shape use, and what the boundaries of the models are. Specifically, we contribute (a) an in-depth analysis of a sample of papers about both TAM and UX, (b) a discussion of how the experiential is treated in those papers, and (c) a set of implications for TAM and UX research.

Background on TAM and UX

We begin with a summary of key work on TAM and UX to provide a background of key constructs, relations, and propositions.

Technology Acceptance Model

TAM is one of the most widely used and researched models for predicting the adoption and use of information technology by individual persons. The impact of TAM is, for example, evident in the number of citations to its core publications, see Table 1. Studies of numerous technologies, user populations, and contexts of use have employed TAM and collectively show that it is a parsimonious and widely applicable model that tends to explain a fair amount of the variance in adoption and use (e.g., Venkatesh & Davis, 2000; Venkatesh, Morris, Davis, & Davis, 2003; Yousafzai, Foxall, & Pallister, 2007b).

Table 1. Ten selected TAM papers

Paper	Description	Citations [a]
Davis (1989)	Develops scales for measuring the core TAM constructs and tests their correlation with actual usage in two studies	34856
Davis, Bagozzi, and Warshaw (1989)	Proposes and tests the original TAM and compares it with the theory of reasoned action in a study with 107 users	18591
Taylor and Todd (1995)	Compares TAM with two variants of the theory of planned behavior through a study of 786 potential system users	7567
Karahanna, Straub, and Chervany (1999)	Investigates technology acceptance across time by comparing antecedents of initial adoption and continued use	3553
Venkatesh and Davis (2000)	Proposes and tests an extension of TAM, called TAM2, on the basis of four longitudinal studies	12604
Venkatesh et al. (2003)	Proposes and tests the unified theory of acceptance and use of technology (UTAUT) version of TAM, based on several studies	17575
Lee, Kozar, and Larsen (2003)	A systematic review of 101 TAM articles (published 1986-2003) and a survey of 32 researchers' views on TAM research	1851
King and He (2006)	A meta-analysis of 88 articles (published -2004), with particular focus on a moderator analysis of user types and usage types	1470
Yousafzai et al. (2007a; 2007b)	A narrative review of 145 TAM articles (published 1989-2004) and a meta-analysis of 95 of these studies	322+137
Williams, Rana, and Dwivedi (2015)	A systematic review of 174 articles (published 2004-2011) about the UTAUT version of TAM	44

Note: [a] According to Google Scholar, May 2017.

In its essence, TAM posits that individual adoption and use is determined by perceived usefulness and perceived ease of use. While perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance", perceived ease of use is "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). In TAM, a person's perception of the usefulness and ease of use of a system determines the person's attitude toward using the system, which in turn determines whether the person forms an intention to use the system and actually uses it, see Figure 1. The introduction of attitude as a mediator between the person's beliefs (i.e., perceived usefulness and perceived ease of use) and behavioral intention stems from the theoretical foundation of TAM. TAM is based on the theories of reasoned action (Fishbein & Ajzen, 1975) and planned behavior (Ajzen, 1991), which distinguish between beliefs, attitudes, and intentions and maintain that beliefs govern attitudes and attitudes govern intentions. The direct influence in TAM of perceived usefulness on behavioral intention to use discords with the theory of reasoned action but is justified by empirical evidence of direct belief-intention links (Davis et al., 1989). In addition to the effect of perceived ease of use on attitude toward using, TAM also posits that perceived ease of use influences perceived usefulness. That is, an easier-to-use system is perceived as more useful.

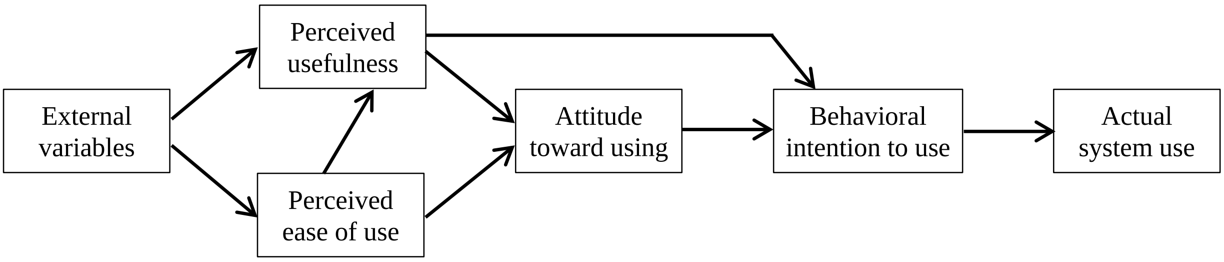

Figure 1. The original technology acceptance model, from Davis et al. (1989).

The key purpose of TAM has been “to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions” (Davis et al., 1989, p. 985). In pursuing this purpose, researchers have extended and modified TAM in four main ways. First, TAM asserts that any external variable may influence behavior only indirectly by influencing perceived usefulness or perceived ease of use. This assertion is somewhat surprising given the basis of TAM in the theory of reasoned action, which posits that behavioral intention is determined by attitude and subjective norm, not solely by attitude. Subjective norm concerns a person’s perception of the expectations of specific individuals or groups and the person’s motivation to comply with these expectations (Fishbein & Ajzen, 1975). Consequently, several later TAM studies recommend the incorporation of subjective norm (e.g., Taylor & Todd, 1995; Venkatesh & Bala, 2008; Venkatesh & Davis, 2000). In the unified theory of acceptance and use of technology (UTAUT) version of TAM, subjective norm is termed social influence and 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). Many studies of the UTAUT version of TAM find that social influence significantly affects behavioral intention to use (Williams et al., 2015). Perceived behavioral control, a key part of the theory of planned behavior, has also been included in some extensions to TAM (e.g., Koufaris, 2002).

Second, while the relationships between the TAM constructs have been confirmed in many, though not all studies (King & He, 2006; Schepers & Wetzels, 2007), the relative strength of the influences of the TAM constructs on each other varies with the context. This is unsurprising and has fostered studies aiming to identify moderators that capture aspects of the context important to technology acceptance. For example, Schepers and Wetzels (2007) find that subjective norm has a larger impact on intention to use in Western than non-Western settings but that the impact of subjective norm on actual use is smaller in Western than non-Western settings. This finding identifies culture as a moderator in TAM studies but it also shows that the relationship between intention to use and actual use may be more complex than assumed in the many TAM studies that employ intention to use as a proxy for actual use. Karahanna et al. (1999) investigate adoption over time and find that experience with a system is an important moderator in understanding use. For example, the shift from adoption to continued use makes the influence of subjective norm insignificant and the influence of perceived usefulness stronger (Karahanna et al., 1999).

Third, as can be seen from Figure 1 the original TAM did not elaborate the antecedents of perceived usefulness and perceived ease of use. Studies have subsequently proposed and tested a great many antecedents to reveal how these perceptions are formed and how they can be manipulated to foster actual use. In their review, Yousafzai et al. (2007a) list 79 external variables that have been proposed as antecedents of perceived usefulness or perceived ease of use. These antecedents include accessibility, awareness, computer anxiety, computer attitude, compatibility, end-user support, intrinsic motivation, management support, objective usability, perceived enjoyment, self-efficacy, social pressure, system quality, task characteristics, training, and voluntariness. Lee et al. (2003) include a subset of these antecedents in their review and find that they all exert a significant influence on perceived usefulness or perceived ease of use. However, the influence of many of the antecedents varies across studies, thereby yielding mixed results.

Fourth, it is generally acknowledged that TAM is mainly concerned with technology acceptance in utilitarian settings. This is, for example, evident in the explicit mention of job performance in the definition of perceived usefulness, in the frequency of systems the use of which is mandated, and in the typical backgrounds of the users in TAM studies. Of the 145 studies reviewed by Yousafzai et al. (2007a), the users in 73 studies were knowledge workers, engineers, managers, and other groups of staff (and the users in most of the remaining studies were students). However, some studies go beyond utilitarian settings by aiming to incorporate intrinsic motivation in TAM. Intrinsic motivation relates to perceptions of pleasure and satisfaction from performing a behavior. Constructs introduced to represent intrinsic motivation in TAM include perceived enjoyment and computer playfulness. For example, perceived enjoyment has been included in place of perceived ease of use (Serenko, Bontis, & Detlor, 2007), as a determinant of perceived ease of use (Sun & Zhang, 2006), and as a consequence of perceived ease of use (van der Heijden, 2004). The incorporation of intrinsic motivation in TAM provides a link to UX research.

User Experience Models

User Experience (UX) as a notion was established at the turn of the millennium; Hassenzahl and Tractinsky (2006) summarized early work and outlined some of the fundamental research questions for work on user experience. Whereas the notion of UX is widely used in practice and academia, there is not uniformly accepted model that drives research in the same manner as for TAM. Table 2 shows ten frequently-cited papers that contain UX models based on quantitative data; we use these papers to give a brief synopsis of UX models.

Table 2. Ten selected UX papers

Paper	Description	Citations [a]
Tractinsky et al. (2000)	Compares the influence of manipulations of aesthetics and usability on the use and perceptions of ATM layouts.	1178
Hassenzahl (2004)	Studies the relation among beauty, goodness, and product perceptions before and after using MP3 players.	848
Thüring and Mahlke (2007)	Develops a model of the relation among usability, aesthetics, and emotions.	215
Hartmann et al. (2008)	Presents a model of decision making in how people assess user interface quality and aesthetics.	180
Van Schaik and Ling (2008)	Compares modelling approaches in UX and includes objective measures of usability in models.	135
Karapanos et al. (2009)	Develops a model of phases from buying a phone to using it and shows different predictors of goodness and beauty between phases.	384
Hassenzahl and Monk (2010)	Samples across products to test how participants infer perceived usability from perceived beauty.	193
Hassenzahl, Diefenbach, and Göritz (2010)	Studies the role of need-fulfilment in the use of interactive technology and shows a link to hedonic quality perceptions.	350
O’Brien (2010)	Integrates hedonic/utilitarian motivations and a model of shopping experience.	171

Van Schaik and Ling (2011)	Combines UX and TAM models in an experiment with information retrieval.	45

Note: [a] According to Google Scholar, May 2017.

The models are in essence about the experience of interactive products, the consequences of those experiences, and the ways experiences and consequences are connected. The experience of interactive products has in particular been understood as the perceptions users form of products (such as whether a smartphone is classy or novel). Consequences of experiences have in particular been summary evaluations, emotional reactions (such as whether one feels positive affect in interaction), or changes in behavior. The summary evaluations are, typically, overall judgments of satisfaction, appeal, or the so-called "goodness" of an interface (Hassenzahl 2004).

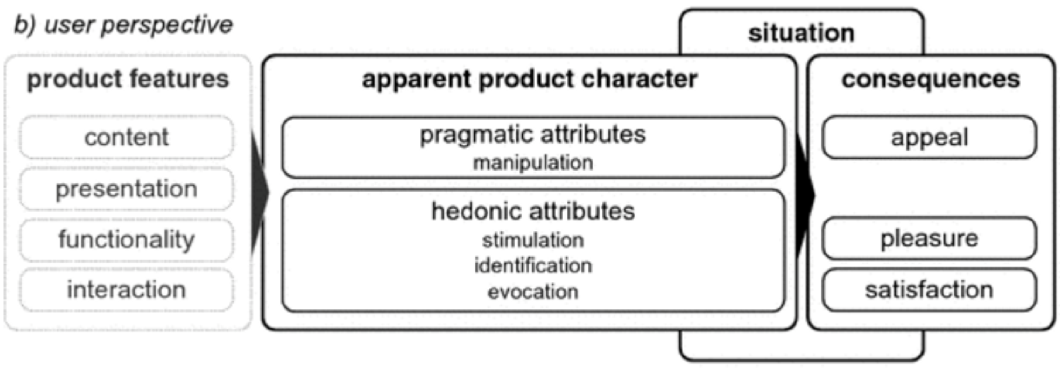

Figure 2: One representative model of user experience, showing the user's perspective on interaction (Hassenzahl 2003).

Figure 2 shows a representative example of a UX model, the original version of Hassenzahl's model (Hassenzahl 2003). It suggests that from a user's perspective, product features are experienced as an apparent product character formed by bundling features. The apparent product character is in part about pragmatic attributes, such as perceived usability, and in part about hedonic attributes, in particular those bringing stimulation or identification. These attributes are the bases for consequences, relative to a situation, including assessments of appeal, pleasure, and satisfaction. Whereas this model is not universal in the same manner as TAM, it and its later extensions (e.g., Hassenzahl et al. 2010) is probably the most widely applied UX model.

While the models in Table 2 and Figure 2 differ in many respects, they have several common characteristics. First, most models separate pragmatic from hedonic attributes of interactive technology (e.g., Hassenzahl et al. 2003; O'Brien 2010). Pragmatic attributes advance the user toward a goal and depend on whether the user sees a product as simple, predictable, and practical. Hedonic attributes are related to whether users see a product as providing identification or stimulation. Often hedonic and pragmatic attributes are assessed using the AttrakDiff questionnaire (Hassenzahl et al. 2003): This questionnaire separates hedonic qualities that are about identification with products (e.g., whether they are presentable) from whether a product is stimulating (e.g., exciting, innovative). Whereas pragmatic attributes often change as a result of use (in studies collecting pre- and post-use measures), hedonic attributes appear to be more stable over time. Pragmatic attributes are often found to exert a stronger influence on overall outcomes (e.g., goodness) than hedonic attributes.

Second, models of UX have in particular tried to account for the role of users' perception of interface aesthetics. Early studies showed that manipulations of aesthetics predicted usability. Tractinsky et al. (2000), for instance, showed that "what is beautiful is usable" (p. 127). Later studies have shown that the relation is probably more complex, depending on the specific context as well as on methodological variations (Hassenzahl & Monk 2010). Nevertheless, the perception of aesthetics as well as overall evaluations of beauty are key in UX models.

Third, current UX models show how perceptions of products change over time. Many studies compare measures of experience obtained after seeing but before using a product (say, of goodness) to measures obtained after use (e.g., Hassenzahl 2004). One finding from these studies is that some perceptions are relatively stable over time (e.g., beauty, Hassenzahl 2004) whereas others evolve as a technology is used (e.g., pragmatic quality, van Schaik & Ling 2011). Only a few models touch upon long-term use, most notably the one by Karapanos et al. (2009).

Fourth, emotions are central in some UX models (e.g., Thüring & Mahlke 2008; Hassenzahl et al. 2010). For instance, Hassenzahl et al. (2010) showed that need-fulfillment with interactive products was a source of positive affect. Thüring and Mahlke (2008) integrated emotions in their model of UX and argued that the perception of instrumental/non-instrumental qualities caused emotional reactions, which in turn affected the overall assessment of the system used.

Summary

Based on the outline of TAM and UX models above, it is clear that they differ substantially. Although both deal with the experiential component in human-computer interaction, they are rarely compared. In particular, we are interested in the studies that employ *both* types of models or employ constructs that cover both the TAM and UX views of the experiential. This will allow us to compare how their views of the experiential intersect and to attempt to move work on both types of model forward.

Review Method

The purpose of the review is to explore the overlap between TAM and UX models, by identifying and reviewing papers that contains both.

We focused on models as the key unit of analysis because a broader view on technology acceptance and user experience would lead to very general comparisons between, for instance, the theory of planned behavior (Ajzen, 1991) and need satisfaction theory (e.g., self-determination theory, Ryan & Deci, 2000 or the synthesis of needs by Sheldon, Elliot, Kim, & Kasser, 2001). Conversely, an exclusive focus on constructs as the unit of analysis might miss important differences in how explanations and predictions are made, and in the underlying assumptions about use and interaction. The first part of the review method – the selection of papers – followed systematic reviewing techniques (e.g., Cooper, 1982; Cooper, Hedges, & Valentine, 2009). Figure 3 gives an overview of the paper-selection process. We did a systematic review to get broad coverage of recent developments, rather than relying on earlier reviews of TAM (e.g., King & He, 2006) and UX models (e.g., Bargas-Avila & Hornbæk, 2011). The second part of the review method concerned the analysis and synthesis of the selected papers. Figure 4 gives an overview of the components involved in analysis and synthesis. The analysis and synthesis were informed by work on the structural components of theory (e.g., Dubin, 1969), in particular Whetten's framework on theoretical contributions (Whetten, 1989).

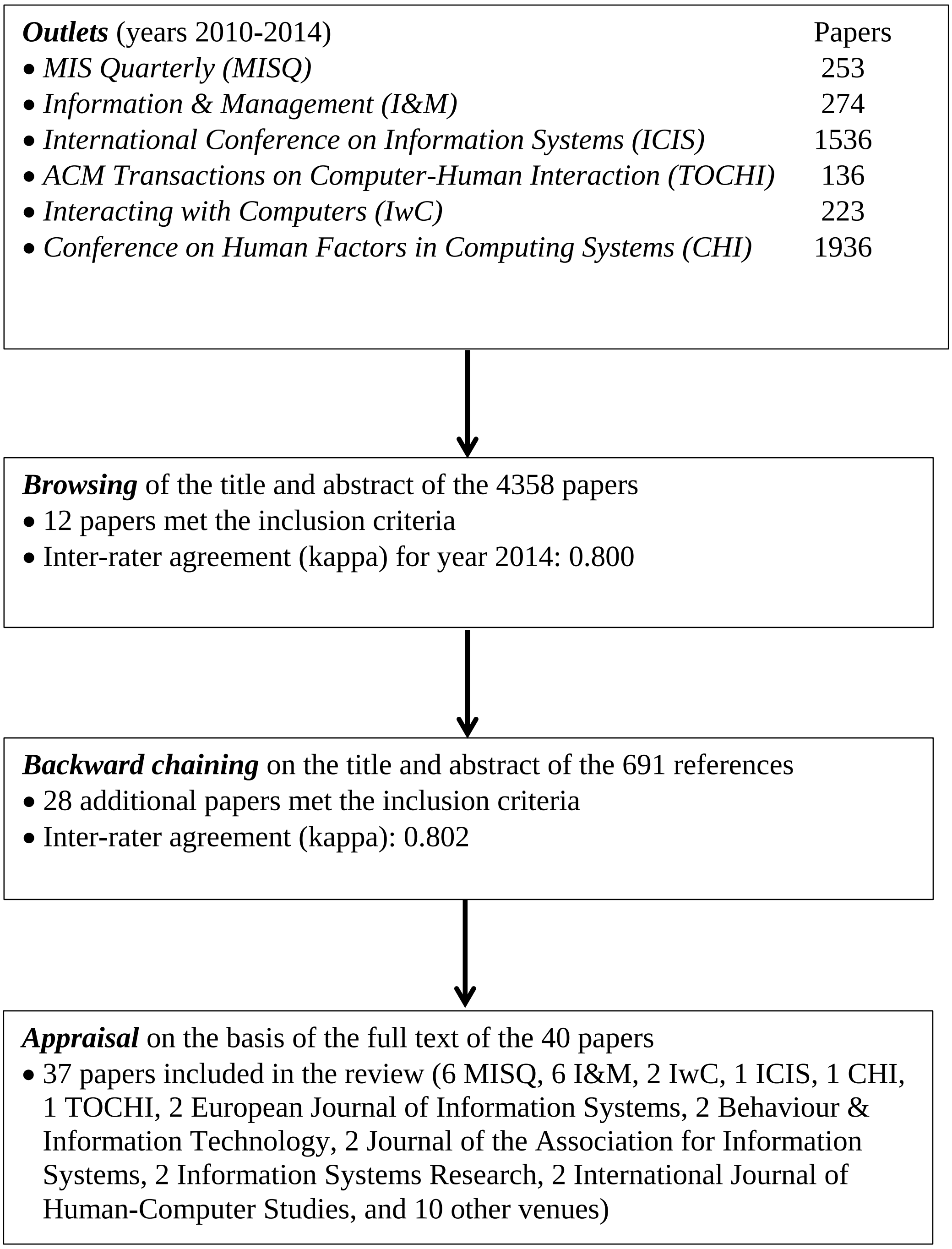

Figure 3. The paper-selection process.

What
Constructs

How
Path coefficients

Why
Theory use

Who/When/Where
Users
Technologies
Tasks
Organization

Figure 4. The components involved in analysis and synthesis (based on Whetten 1989).

Selection of Papers

We used a process of browsing, backward chaining, and final appraisal to identify papers about models of both technology acceptance and user experience. The rationale for starting with browsing was that it seemed an appropriate way to identify state-of-the-art papers when one area (TAM) had a much more refined terminology than the other (UX). With searching, we might miss UX work because the appropriate search terms would be unclear. Browsing was restricted to the five-year period 2010-2014 because recent papers were more likely to represent state-of-the-art than, for example, the classic papers summarized in the previous section. In addition, recent papers reference earlier papers. Thus, the earlier papers would be included through the subsequent backward chaining.

Browsing was done across three venues of TAM research and three venues of UX research. For TAM, we took *Management Information Systems Quarterly* (a top information systems journal and key outlet of TAM work), *Information & Management* (also a top journal and key outlet of TAM work), and *International Conference on Information Systems* (a top conference on information systems). For UX, we took *ACM Transactions on Computer-Human Interaction* (a top journal on human-computer interaction and an outlet of several UX models), *Interacting with Computers* (which have published several of the UX models discussed earlier in this paper), and *ACM Conference on Human Factors in Computing Systems* (a top conference on human-computer interaction). We included conferences in the set of venues to ensure the coverage also of recent advances, which are more likely to first appear at conferences.

In the 2010-2014 period, the six venues of TAM and UX research published 4358 papers. Based on the title and abstract of these papers we determined whether they met three inclusion criteria. First, the paper must *concern technology acceptance as well as user experience*. For TAM, a paper must contain one or more of ‘technology acceptance’, ‘Unified Theory of Acceptance and Use of Technology’, ‘perceived usefulness’, ‘perceived ease of use’, or grammatical variants of these terms in its title or abstract. We chose these terms because they captured the key components of TAM. For UX, a paper must contain one or more of ‘user experience’, ‘aesthetics’, ‘affect’, ‘appeal’, ‘emotion’, ‘engagement’, ‘enjoyment’, ‘flow’, ‘fun’, ‘hedonic’, or grammatical variants of these terms in its title or abstract. We chose the latter nine terms because an earlier review suggested them as central to user experience (Table 2 in Bargas-Avila & Hornbæk, 2011). It is important to note that papers are only included if they concern both TAM and UX. Second, the paper must *be about models*. Thus, a paper must describe model constructs and their relationships, and it must evaluate the model empirically or by reviewing empirical studies. For example, van Schaik and Ling (2011) described and empirically evaluated an integrated experience-acceptance model and Sabherwal et al. (2006) described a model and evaluated it through a meta-analysis of existing empirical studies. These papers were included. Conversely, Zhao and Srite (2013) was excluded because the authors did not evaluate their model. Third, the paper must *investigate the adoption and use of technology*. For example, we excluded the paper by Gorla and Somers (2014) because it modeled the acceptance and experience of outsourcing rather than information technology.

To be included a paper had to meet all three inclusion criteria. One full year of papers, totaling 997 papers, was coded by both authors with an interrater reliability of $\kappa = .800$, indicating substantial agreement (Landis & Koch, 1977). The rest of the 4358 papers were subsequently coded by either one or the other of the authors. This browsing process resulted in a sample of 12 papers.

To identify earlier work and include other outlets, we extended the browsing with backward chaining. That is, we examined the references of the 12 papers found through browsing to identify additional papers. Backward chaining is easier to report and reproduce than forward chaining, which is highly dependent on the time of chaining. We only considered references to journal articles, conference papers, and book chapters, in English. To be included these 691 references needed to meet the same inclusion criteria as during browsing. Based on the title and abstract of the references we identified 28 papers that met the three inclusion criteria and were not already among the papers selected through browsing. The backward chaining was performed by both authors with an interrater reliability of κ = .802, again indicating substantial agreement.

The 40 papers identified through browsing and backward chaining were downloaded and read in depth to assess their inclusion in the review. Three papers were excluded in this final appraisal. For example, we excluded Ayyagari (2006) because it turned out not to present a model of the adoption and use of technology. In total, our three-step process of paper identification resulted in the selection of 37 papers for review, all from well-reputed journals and conferences. In the reference list, the 37 reviewed papers are marked with an asterisk (*). In the discussion we return to some open questions left by this sampling strategy.

Analysis and Synthesis

As recommended in theory on meta-narrative reviews, we consider analysis and synthesis an activity that evolves over the course of the review process (Wong, Greenhalgh, Westhorp, Buckingham, & Pawson, 2013). Our analysis proceeded from a set of guiding questions taken from Whetten (1989) and resulted in an in-depth synthesis of the papers in the sample (see Figure 4). To the guiding questions, we added a number of ad-hoc sub-questions that were coded separately.

The guiding questions were adopted from Whetten's (1989) descriptive framework of the structural components of theories, inspired by the work of Dubin (1969). Whetten describes four questions that each capture essential elements of theory. The questions concern what (the constructs in a theory), how (the relations among constructs), why (the explanations of the relations), and who/where/when (the boundaries and contextual limitations of the explanations). The specific analysis steps were as follows:

- For <u>what</u>, we extracted all constructs from each paper (for a total of 283 constructs). We assumed that the constructs were included in modelling (e.g., shown in path models) or mentioned in the method description. Extraction was done independently by both authors and disagreements were settled by discussion. The constructs were also grouped into categories and categories into types in an open-ended thematic coding. This was done together in one session. Further, the constructs were coded independently by the authors on experiential/utilitarian/other, individual/social/other, and perceived/objective/other (average agreement ranged from 88% to 95%; all disagreements settled by discussions). We also coded whether participants were asked about constructs on multiple occasions or just once (complete agreement), and what period participants were asked about (a specific episode, a period of time, in general, other; agreement 95%).

- For how, we extracted all path coefficients from each paper (for a total of 346 coefficients). This enabled us to synthesize findings across papers by following the idea that beta coefficients can be used as estimates of effect sizes (Becker & Wu 2007, Bowman 2012, Peterson and Brown 2005). We use Bowman's recommendation on how to transform beta coefficients from structured equation modelling with latent variables (Bowman 2012, p. 377).
- For why, each author independently extracted references to the theories and explanatory frameworks used in the hypotheses and discussion section of each paper. We did not deem it feasible to attempt a formal coding for this step as the number of theories and frameworks can vary dramatically depending on definitions and granularity of coding; instead we opted for an informal approach that ensured that we captured the main trends. Thus, we aggregated the 418 references identified to find the most prominent theories and frameworks used in the sample.
- For who/where/when, the authors individually coded all papers on what we considered prominent aspects about users (user group, experience), organization (context, mandatory/voluntary use), tasks (content of task, prescribed/free), and technology used. Agreement was between 83% and 100%, disagreements were settled through discussion.

The synthesis of results proceeded using the categories from Whetten (1989), the coding mentioned above, and in-depth readings of the 37 papers. We next present the outcomes of that analysis, structured through Whetten's categories.

Results

The Constructs

The 37 studies investigated a total of 283 constructs, for an average of 7.65 constructs per study. We grouped the constructs into categories and the categories into types. Table 3 shows the twelve types of construct. Five types of construct matched the constructs of the original TAM model (Figure 1): perceived usefulness, perceived ease of use, attitude towards use, behavioral intention, and actual usage. In addition, social influence was one of the four predictors of technology acceptance in the later UTAUT version of TAM. Collectively, these six types accounted for 45% of the constructs. Four of the remaining types of construct accounted for the characteristics of the use situation as described in common models of usability (Hertzum, 2010; ISO 9241, 2010): user, system, task, and organization. These four types contained 24% of the constructs. The last type, apart from a small number of 'other' constructs, was experience of use, which contained UX-related constructs. With 29% of the constructs this type was the single largest type of construct.

Table 3. Types of construct, *N* = 283 constructs.

Construct type	Example constructs	*N*	%
Perceived usefulness	As in TAM	33	12
Perceived ease of use	As in TAM	29	10
Attitude towards use	As in TAM	10	4
Behavioral intention	Intention to use, continue to use	31	11
Actual usage	Types of use, task adaptations	16	6
Social influence	Social pressure, seeking support	9	3
User characteristics	Prior experience, gender, self-efficacy	37	13
System characteristics	System quality, simplicity	15	5
Task characteristics	Technology purpose, task type	7	2
Organizational context	Organizational use, volition of use	10	4
Experience of use	See Table 4	81	29
Other	Language, publication quality	5	2

The 81 constructs about experience of use included 30 instances of perceived enjoyment, see Table 4. Following Davis et al. (1992) perceived enjoyment was mostly defined as "the extent to which the activity of using the computer is perceived to be enjoyable in it's own right, apart from any performance consequences that may be anticipated" (Davis et al., 1992, p. 1113). This definition separates enjoyment from performance and, thereby, stands in contrast to flow, which links the positive experience of total involvement with skillful performance (according to Csikszentmihalyi, 1990, flow is the total involvement that occurs when the user's skills matches the challenges presented by the task). Flow was a construct in three studies (Agarwal & Karahanna, 2000; Ha et al., 2007; Sanchez-Franco, 2010) but only Ha et al. (2007) investigated how differences in user skills affected the flow experience, and none of the studies investigated how it was affected by differences in task challenges. Cognitive absorption, a concept related to flow, was defined by Agarwal and Karahanna (2000) who also identified its five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity. They defined cognitive absorption as “a state of deep involvement with software” (Agarwal & Karahanna, 2000, p. 673). While Wakefield and Whitten (2006) and Zhang et al. (2006) adopted the full construct of cognitive absorption, others have used parts of it (e.g., Koufaris, 2002) or defined very similar constructs: Turel et al. (2010), for instance, labelled their construct escapism.

Table 4. Experience of use constructs, *N* = 81 constructs.

Construct category	Example papers	*N*	%
Perceived enjoyment	Davis et al. 1992	30	37
Cognitive absorption	Agarwal & Karahanna 2000	7	9
Beauty	van Der Heijden 2003	6	7
Satisfaction	Igbaria et al. 1994	6	7
Flow	Agarwal & Karahanna 2000	3	4
Hedonic quality – identification	van Schaik & Ling 2011	5	6
Price value	Venkatesh et al. 2012	5	6
Perceived affective quality	Zhang et al. 2006	4	5
Hedonic quality – stimulation	van Schaik & Ling 2011	3	4
Perceived control	Agarwal & Karahanna 2000	3	4
Trust	Yu et al. 2005	3	4
Goodness	van Schaik & Ling 2011	2	2
Expectation confirmation	Thong et al. 2006	1	1
Anger	Beaudry & Pinsonneault 2010	1	1
Anxiety	Beaudry & Pinsonneault 2010	1	1
Distancing	Beaudry & Pinsonneault 2010	1	1

Satisfaction was defined differently in different studies but it was predominantly a broad construct. Igbaria et al. (1994, p. 351) made the broadness explicit by stating that satisfaction “in a given situation is the sum of one’s feelings or attitudes toward a variety of factors affecting that situation". They merely made the important restriction that for affective attitudes to count as satisfaction the person in the situation must interact with the system directly. Goodness was similarly inclusive in its scope: "a user's evaluation of the overall product quality" (van Schaik & Ling, 2011, p. 19). The other construct categories focused on specific aspects of the experience of use. For example, beauty concerned the user's aesthetic experience (e.g., Cyr et al., 2006), the stimulation dimension of hedonic quality concerned arousal and novelty (e.g., Liu et al., 2010), the identification dimension of hedonic quality concerned the user's social image (e.g., Lin & Bhattacherjee, 2010), and price value concerned the user's experience of the tradeoff between the value of using the product and the monetary cost of using it (e.g., Venkatesh et al., 2012). Notably, the constructs overwhelmingly described positive experiences and, thus, addressed how the presence or absence of positive experiences influenced technology acceptance and use. Only three constructs were negatively worded – anger, anxiety, and distancing – and they were all from the study by Beaudry and Pinsonneault (2010). Frustration, stress, and a host of other unpleasant experiences are not investigated in the reviewed studies but nevertheless important to the acceptance and use of technology.

While there were 16 categories of constructs about the experience of use (Table 4), the construct types from the original TAM model were much more uniform. Perceived usefulness, perceived ease of use, and attitude towards use were single-category construct types. On the one hand this suggest that construct development has proceeded to clarify conceptual and measurement issues with these constructs (see Tractinsky 2017). Thus, the absence of multiple categories of construct about these three construct types partly indicates their maturity, whereas the elements of the experience of use are to a large extent subject to investigation and debate. On the other hand, the absence of multiple categories of construct about perceived usefulness, perceived ease of use, and attitude towards use also means limited differentiation. No study investigated different ways in which a system could be useful, say by enhancing the user's job performance through either reducing variation in the quality of outputs or transforming the content of the job. Similarly, no study investigated different ways in which a system could be easy to use, say by requiring little cognitive effort, little motor effort, or little time to operate. Such differences could interact with the experience of use.

There were three categories of constructs about behavioral intention: behavioral intention to use (e.g., Lee et al., 2005), behavioral intention to continue to use (e.g., Li et al., 2005), and behavioral intention to positive word-of-mouth (Turel et al., 2010). Word-of-mouth introduced the social intention of recommending the system to others. In TAM, behavioral intention determines actual usage. With just 16 constructs about actual usage, this construct type was absent in the majority of the 37 studies. For example, Childers et al. (2001) studied the effect of perceived usefulness, perceived ease of use, and perceived enjoyment on attitude toward use, rather than on actual usage. Social influence consisted of a category about the influence of the norms and expectations of important others (e.g., Igbaria et al., 1996) and another category about seeking social support from others (Beaudry & Pinsonneault, 2010).

Four likely sources of the variance that the reviewed studies did not explore in much depth are user characteristics, system characteristics, task characteristics, and the organizational context. Each of these four construct types consisted of multiple construct categories, most of which were investigated in only one or two of the 37 reviewed studies. For example, the following user characteristics were only studied once or twice: animation predisposition, attachment motivation, computer anxiety, habit, learning goal orientation, personal innovativeness, relationship commitment, and seeking instrumental support. Thus, the effect of many user, system, task, and organizational variables on the experiential component of use has not been systematically studied. The five largest categories of constructs about user characteristics were prior experience, playfulness in interacting with computers, gender, age, and self-efficacy. Collectively, these five categories contained 73% of the 37 constructs about user characteristics. The only system characteristic studied more than twice was system quality. All studied system characteristics (e.g., convenience, objective usability, and system quality) were fairly coarse-grained and, therefore, unlikely to enable directed efforts at improving the design of the systems. Task characteristics were dominated by a category with four constructs that merely distinguished between hedonic and utilitarian tasks. The three remaining constructs about task characteristics were challenges (Koufaris, 2002), mode of use (goal mode or action mode; van Schaik & Ling, 2011), and task type (Hess et al., 2014). We find the small number and rudimentary content of these constructs noteworthy given the importance attached to tasks in human-computer interaction (e.g., ISO 9241, 2010; Whittaker et al., 2000). Finally, organizational context contained three constructs about facilitating conditions (from the UTAUT version of TAM; Venkatesh et al., 2003) and seven additional constructs, one of which was user participation in the design process (Sabherwal et al., 2006). User participation was the only construct that related the users' acceptance and use of a system to the preceding design process. The other 282 constructs assumed that any influence of the design process on the experiential component of use was fully mediated by the system resulting from the design process. Overall, these four sources of variance (viz., user characteristics, system characteristics, task characteristics, and the organizational context) seem a priori important. For instance, system characteristics inform design and user characteristics may explain individual differences and improve model fit. Yet, they appear to be superficially investigated in the reviewed studies.

We also classified the constructs with respect to three bipolar distinctions, see Table 5. The first distinction showed equally many experiential constructs (e.g., anxiety, design aesthetics, perceived enjoyment, social norms), utilitarian constructs (e.g., cost, perceived usefulness, self-efficacy, usability), and constructs unrelated to the experiential/utilitarian distinction. In terms of the main construct types, perceived usefulness and perceived ease of use were exclusively utilitarian while experience of use and social influence were predominantly experiential. User characteristics was the only construct type with a near equal mix of experiential (12), utilitarian (9), and other (16) constructs. The experiential/utilitarian distinction shows a literature in which interactions between the experiential and utilitarian aspects of technology use are investigated without a priori assigning primacy to either user experience or task performance.

The distinction between individual and social constructs revealed that 84% of the constructs were individual (e.g., attitude towards use, curiosity, perceived usefulness, skills) and only 11% social (e.g., perceived critical mass, social influence, top-management support, trust). Individual constructs dominated all twelve types of construct, except social influence and organizational context. For example, only nine of the 81 constructs about the experience of use were social. In three of these nine instances, the construct was trust (Benlian et al., 2010; Cyr et al., 2007; Yu et al., 2005). In addition, Hsu and Lu (2007) defined perceived enjoyment as “the extent to which the activity of participating in the online game community is perceived to be pleasure and satisfaction” (p. 1647). This social definition of perceived enjoyment showed that the same construct can be defined at different levels depending on the context. When perceived enjoyment was used in other studies, it was consistently defined at the individual level. The dominance of individual constructs is noteworthy given the importance of teamwork to task performance, the impact of social relations on well-being, and the adoption of social media by technology users.

The perceived/objective distinction showed that 88% of the constructs were perceived (e.g., excitement, intention to use, perception of external control, perceived ease of use) and only 5% objective (e.g., age, gender, mode of use, objective usability). For the most part, the reviewed papers investigated how users’ perceptions influenced their acceptance and use of technology. The objective constructs concerned only four construct types: user characteristics, task characteristics, system characteristics, and actual usage. However, only two of the 16 constructs about actual usage were objective (Brown et al., 2014; Yi & Hwang, 2003). That is, usage was mostly measured in the same way as the constructs predicting it, namely by asking survey respondents to self-assess their frequency of system usage. This common-method bias involves a risk of overestimating the correlation between predictors and usage.

Table 5. Classifications of construct content, *N* = 283 constructs.

Classification	Example constructs	*N*	%
Experiential vs utilitarian			
Experiential	Anxiety, design aesthetics	94	33
Utilitarian	Cost, perceived usefulness	92	33
Other	Actual usage, behavioral intention	97	34
Individual vs social			
Individual	Attitude towards use, curiosity	237	84
Social	Perceived critical mass, trust	32	11
Other	System quality, volitional nature	14	5
Perceived vs objective			
Perceived	Excitement, intention to use	248	88
Objective	Age, gender, mode of use	15	5
Other	Facilitating conditions, unplanned purchases	20	7

Relations among Constructs

The preceding section detailed what TAM and UX models are about; next we discuss *how* those constructs are related. Table 6 summarizes the effect sizes of relations among central variables in TAM and UX models. These effect sizes are expressed in terms of correlation coefficients, following Rosenthal (1991), and can be compared directly. The effect sizes are comparable to those in meta-analyses of TAM (e.g., King & He 2006; Schepers and Wetzels

2007). For instance, we found perceived ease of use to predict perceived usefulness (with an *r* of .52, and betas ranging from 0.02 to 0.79) as did King and He (average beta of 0.479, Table 4) and Schepers and Wetzels (beta of 0.48, Figure 2). The relation between perceived usefulness and behavioral intention to use was lower in our study (*r* = .31) compared to earlier work (King & He: 0.505; Yousafzai et al. 2007b, Table IV, *r* = .5). Note the large spread across all of these values: Although it suggests that considerable variation exists among studies, it is comparable to the variation found for instance by King and He (2006); their Figure 2 suggests a range of .06 to .81.

Table 6 also shows that enjoyment as a construct offers predictive value. Across studies, perceived enjoyment predicted perceived usefulness (r = .54) as strongly as did perceived ease of use (*r* = .52). For instance, Yi and Hwang (2003) studied a web-based class management system and found that perceived enjoyment (path coefficient 0.5) predicted perceived usefulness more strongly than perceived ease of use (path coefficient 0.02). Perceived enjoyment also explained more of attitude (*r* = .50) than did perceived ease of use (.20) and perceived usefulness (.35). The effect of perceived enjoyment on behavioral intention (.27) was comparable to the effects of perceived ease of use (.20) and perceived usefulness (.31).

The studies investigated different directions of the influence between perceived enjoyment and perceived ease of use: six studies used perceived enjoyment as a predictor, nine used perceived ease of use as a predictor. The identified effect sizes were similar; perceived enjoyment predicted perceived ease of use with *r* = .52, the opposite direction had *r* = .54. One study (Sun & Zhang 2006) explicitly tested the direction; we return to this study below.

In addition to the relations in Table 6, there are several other relations of interest. However, the relations between TAM constructs and other experience-of-use constructs (viz. those of Table 4) were explored infrequently in the sample, thereby preventing an in-depth analysis. The relation between cognitive absorption and TAM has just two data points for each of PU and PEOU (from Agarwal & Karahanna, 2000, and Zhang et al., 2006; *r*s = .47 for PU and .53 for PEOU) and two data points for behavioral intention (from Agarwal & Karahanna, 2000 and Koufaris et al. 2002; *r* = .19). The relation between hedonic quality and TAM constructs has also been investigated in only two studies (van Schaik & Ling, 2011, and Cyr et al., 2006; *r* = .46). Finally, specific predictions following from the model of Hassenzahl (2003, 2010) have only be investigated in one study (van Schaik & Ling, 2011).

Thus, the data do not allow us to say much about the relation among concepts from key UX models and the TAM constructs.

Table 6: The relations between predictor and predicted variables over the dataset.

Predictor[a]	*Predicted*[a]	*N*	*Weighted r*[b]	*Beta range*
PEOU	PE	9	.54	0.26 – 0.79
PEOU	PU	19	.52	0.02 – 0.79
PEOU	Attitude	8	.20	0.07 – 0.23
PEOU	BI	16	.20	-0.06 – 0.33
PU	PE	2	.46	0.21 – 0.48
PU	Attitude	7	.35	0.01 – 0.47
PU	BI	24	.31	-0.02 – 0.68
PU	Use	4	.27	0.13 – 0.28
Attitude	BI	9	.60	0.25 – 0.75
PE	PEOU	6	.52	0.24 – 0.75
PE	PU	7	.54	0.28 – 0.71
PE	Attitude	9	.50	0.23 – 0.58
PE	BI	18	.27	-0.09 – 0.71
PE	Use	4	.13	0.05 – 0.13

Notes: [a] PE = perceived enjoyment; PEOU = perceived ease of use; PU = perceived usefulness; BI = behavioral intention to continue to use. [b] weighted *r* obtained by transforming path coefficients or standardized regression coefficients into *r*s ($r = B + .05*\lambda$, where λ is 1 when B is non-negative and 0 when it is negative, Peterson and Brown, 2005), *z*-transforming the resulting *r*s (Rosenthal, 1991), calculating a weighted average of *z*-scores (Rosenthal, 1991), and transforming this average back to an *r*-value.

Context of Use

Studies of acceptance of and experience with technologies must account for circumstances surrounding use; in Whetten's (1988) terminology, this is about *who*, *when*, and *where* the models apply. Here we review how accounting for boundary conditions is done in the sample with respect to participants/users, technologies, tasks, and organizations. These factors are widely recognized as important in studying user interfaces and information systems, as discussed in the section on constructs.

Participants in the studies had varying experience with the technologies evaluated but the largest group (11 studies) was participants with extensive experience. For instance, in one of the studies in Venkatesh (2000), participants had three months of experience. In 7 studies participants had less experience, for instance having used the system for two hours per week (e.g., Sanchez-Franco 2010). In other studies, participants had no experience with the system (7) or nothing was described about participants (9).

The *technologies* studied included in particular the world-wide web (17 studies) and mobile technologies (10 studies). The application types spanned shopping, learning management systems, games, and communication software. It is noteworthy that 22% of the papers studied general categories of technology such as “micro-computers” (Igbaria et al. 1996) and “mobile internet technology” (Venkatesh et al. 2012). These papers did not differentiate the various motivations and activities involved in using these technologies. Only a couple of papers compared multiple systems. Thus, the individual studies made no real attempt to sample multiple technologies or to sample those technologies randomly within a particular type of system. Hassenzahl and Monk (2010) discussed extensively what this means for studies of UX and catalogued several concerns with these practices.

It varied how studies asked participants about their use experience and adoptionbehavior. Of the 37 studies, most asked about it in general terms (21; 57%). Those studies for instance asked “I have control over using the system” (Venkatesh 2000) or “Using MOD increases the quality of my life” (Liao et al. 2008, p. 48). Those questions subsume a variety of tasks and often long periods of time under a single question (three months in Venkatesh 2000; daily use over an unspecified period of time in Liao et al. 2008). Ten studies asked about a specific episode (27%). All these ten studies prescribed the tasks and their questions then clearly related to the period of use. Four studies asked participants across a specific period of time. Beaudry and Pinsonneault (2012), for instance, asked participants to “Indicate the extent to which you performed each of the behaviors below in the months following the introduction of [system name]” (p. A1).

The role of *tasks* varies quite a bit among studies. As mentioned above, many studies investigated general categories of technology and perhaps therefore 19 studies (51%) did not specify which tasks participants performed with the system and a further five studies (14%) mentioned a range of tasks that the system could support without asking participants specifically about particular tasks. None of these studies obtained information about users’ accuracy in solving the task or the effectiveness of the system.

Twelve studies used more specific tasks, such as “browsing an e-Services website for buying concert-tickets“ (Cyr et al. 2007, p. 48) or “participants performed a series of tasks to illustrate aspects of navigation as well as the availability of product information by searching the site for both toaster ovens and golf clubs by brand and within a specified price range” (Childers et al. 2001, pp. 519-520). Sometimes studies used several task variants (e.g., Childers et al. 2001), emphasizing their different impact on experience (e.g., “The participants were exposed to three additional sites that were selected to contain a range of experiences that reinforced the nature and capabilities of these electronic media”, Childers et al. 2001, p. 519). However, for instance in the case of Childers et al. (2001), those tasks and the variation associated with them were analyzed as one. Moreover, no study varied tasks and analyzed differences in task completion as part of the modelling. Note, that four studies introduced different tasks in other ways, for instance through the type of system or use (hedonic vs. pragmatic; see Hess et al. 2014; Wakefield & Whitten, 2006; Xu et al. 2012). In those cases, variation between hedonic and utilitarian systems was analyzed.

The studies were mostly conducted in a leisure context (16), followed by education (9), and work (6). The six remaining studies were conducted in lab (4) or mixed (2) settings.

Explanations of Relations among Constructs

Whetten (1988) discuss answering *why* constructs are related as “probably the most fruitful, but also the most difficult avenue of theory development” (p. 493). Across the sample, a variety of theories and models are used to propose hypotheses and to discuss empirical results. Those theories and models appear key to understanding the theory development in the overlap between TAM and UX, and to characterizing how researchers reason about how constructs relate. Below we discuss four of those theories and models: the theory of reasoned action/planned behavior; notions of the hedonic; motivation theory (in particular, self-determination theory); and affect theories.

In the sample, the theory of *reasoned action* and theory of *planned behavior* are often discussed (TRA/TPB; Fishbein & Ajzen 1975, Ajzen 1991). TPB is an extension of the TRA and aims to predict and explain human behavior. It is about attitudes toward a behavior, subjective norm, and perceived behavioral control as predictors of intention, which in turn predicts behavior. Both theories have been used in TAM research since Davis’s first papers (e.g., Davis 1989) and continue to be mentioned. In the current sample 62% of the papers refer to one or both of the theories.

Most of these papers mention TRA/TPB briefly as a precursor to TAM or as a general framework for understanding attitudes. For instance, van der Heijden (2003) wrote that "TAM adopts the well-established causal chain of beliefs->attitude->intention->behaviour that was put forward by social psychologists Fishbein and Ajzen" (p. 542). More specific uses of TRA/TPB include scale construction and the notions of subjective norm (e.g., Igbaria et al. 1996; Yu et al. 2005; Liao et al. 2008; Dickinger et al. 2008) and of perceived behavioral control (e.g., Liu et al. 2010; Venkatesh et al. 2012; Cyr et al. 2006).

TRA/TBP is rarely used to argue in depth about acceptance and experience, though three papers stand out on this (Agarwal & Karahanna 2000; Lin & Bhattacherjee 2010; van Schaik & Ling 2011). Agarwal and Karahanna speculated that cognitive absorption (CA) might work differently than the cognitive beliefs of TRA/TBP: "to the extent that CA represents an intrinsically motivating state, it is also plausible that it has a direct effect on intentions" (p. 676). This speculation was confirmed in that Agarwal and Karahanna found that CA directly impacts behavioral intention (indicated in their study by a significant path coefficient of .246). Supporting this finding, our Table 6 suggests a high direct effect of perceived enjoyment on behavioral intention (note that perceived enjoyment is related to but distinct from CA). Further, Lin and Bhattacherje (2010) discussed the role of attitudes in TAM research. They wrote that "Given the theoretical relevance of attitude as a key mediator in the TRA (Fishbein & Ajzen, 1975) and its established role as a predictor of attitude across a wide range of behaviours such as voting, work, and product and service purchase, we argue that it may be premature to drop attitude from IT usage models. Although cognitive considerations such as perceived usefulness may dominate one's motivation to use utilitarian IT, our findings suggest that affective considerations such as attitude may be more important for explaining usage of non-utilitarian systems such as [online video games]" (p. 176). Thus, in both cases experiential aspects of computer use seem to be at odds with the TRA/TBP basis of TAM. In addition, van Schaik and Ling (2011) argued that the principles of aggregation central to TRA/TBP might be at odds with specific experiences focal in UX research (p. 29):

> Models of interaction experience typically focus on the process of interaction within a session. However, models of technology acceptance, similar to their origins in models of rational behaviour, do not attempt to model individuals' actions on specific occasions, but instead focus on 'regularities in behaviour, consistent patterns of action, response tendencies' (Ajzen, 1988, p. 46). Therefore, the immediate experience of human–computer interaction in terms of Goodness and Beauty may not be predictive of

Intention to Use (over a longer time span), beyond the effect of beliefs such as Perceived Usefulness.

Thus, a potential difficulty with TAM models extended with experience components may be that these components are relevant mainly for briefer interactions whereas the time-scale considered with constructs originating in TAM are longer-term. We return to this point in the discussion.

The *hedonic* plays a prominent role as an explanation of how constructs relate. Most references are to van der Heijden's work (2004) but earlier work with theoretical frameworks on the hedonic is also cited (e.g., Hassenzahl, 2003; Hirshman & Holbrock 1982; Kempf 1999; Babin et al. 1999). Van der Heijden (2004) argued that hedonic information systems differ from productivity-oriented information systems in several ways. Hedonic systems provide non-instrumental value, are used more at home or during leisure, focus on fun, and encourage prolonged use. The empirical part of van der Heijden's paper confirmed the hypotheses that perceived enjoyment and perceived ease of use are stronger predictors of behavioral intention to use than usefulness. This was shown for a Dutch movie website, where "compared to perceived usefulness both perceived ease of use and perceived enjoyment have approximate twice as much predictive value to explain intention to use" (p. 699).

The notion of hedonic systems was central to van der Heijden (2004). Other studies in the sample use similar notions, for instance of interactive hedonic technologies (Lin & Bhattacherjee 2010), hedonic or functional devices (Wakefield & Whitten, 2006), hedonic elements (Cyr et al. 2007), and hedonic digital artifacts (Turel et al. 2010). Some extend the hedonic to concern motivations (Childers et al. 2001; Venkatesh et al. 2012), hedonic outcomes (Li et al. 2005; Lin & Bhattacherjee 2010), and values (Xu et al. 2012). Thus, exactly what the notion of the hedonic characterizes or applies to is somewhat unclear in the sample. Among the 22 studies that mention the hedonic, two manipulate it experimentally by contrasting it to the utilitarian or functional. Xu et al. (2012) compared smart-phone functions typically used with a hedonic aim (e.g., camera) to those typically used with a utilitarian aim (e.g., organizer). Wakefield and Whitten (2006) provided "functional or hedonic specifications" (p. 294) to participants looking at a picture of a PDA. Both studies show that the hedonic/utilitarian distinction affected key measures of experience and adoption. Interestingly, these studies manipulate orientation (hedonic or utilitarian) within the use of just one system, changing the features participants were asked about or the task framing. This suggests that systems cannot be assumed to be hedonic per se because the hedonic/utilitarian distinction can be easily affected. Instead, hedonic/utilitarian seems a continuum, shaped by tasks, systems, and users.

The key finding about the hedonic is clear. The two experimental studies mentioned above find that the role of perceived usefulness changes in a hedonic context, with “users of utilitarian mobile devices indicate significantly greater PU [perceived usefulness] compared to users of hedonic mobile devices” (Wakefield and Whitten, 2006, p. 295) and a different role for perceived ease of use (Xu et al. 2012). Other studies in the sample likewise find that perceived usefulness loses some of its predictive power in hedonic settings (e.g., van der Heijden 2004). Questionnaire items about perceived usefulness are not easy to construct (or answer) for hedonic systems and this might have impacted these findings. Thus, in some studies these questions were changed (e.g., van der Heijden 2004; Lin & Bhattacherjee 2010). For instance, van der Heijden noted that “The original TAM scale for perceived usefulness was problematic because it could not be tuned well to the hedonic nature of the information system under study”, (p. 698). He then adapted the questions for perceived usefulness (e.g., to contain items “I can decide more quickly and more easily which movie I want to go see than in the past” or “I am better informed about new movies”). However, Hess et al. (2014) showed that the reliability of perceived usefulness questions was lower in hedonic contexts. Thus, directly measuring and reasoning about usefulness for hedonic systems seems tricky. Hassenzahl (2004) made a related comment about satisfaction (which he claimed presupposes a task), disregarding this notion and using instead goodness.

Motivation theory is discussed in many papers, particularly in the form of self-determination theory (e.g., Deci 1975; Ryan and Deci 2000). References to Deci and Ryan’s work are found in 38% of the sample. The distinction from self-determination theory between intrinsic and extrinsic motivation has played a key role in the sample. Davis et al. (1992) used this distinction as did a recent meta-analysis by Hess et al. (2014). This distinction suggests that the reason *why* behavior is undertaken varies. In particular behavior can be intrinsically motivated (“doing something because it is inherently interesting or enjoyable”, Ryan & Deci, 2000, p. 55) or extrinsically motivated (“doing something because it leads to a separable outcome”, ibid.).

In the reviewed papers these two types of motivation are often linked to measured variables. For instance, Davis et al. (1992) wrote that “perceived usefulness is an example of extrinsic motivation, whereas enjoyment is an example of intrinsic motivation” (p. 1112). Other measured variables are likewise considered to reflect intrinsic motivation (e.g., playfulness; Venkatesh 2000) and extrinsic motivation (e.g., social pressure; Igbaria et al.

1996). Perceived ease of use is treated in different ways with respect to motivation. Sun and Zhang (2006) considered it related to intrinsic motivation: “PE and PEOU are conceptually close to each other. Both are conceived as intrinsic motivation variables” (p. 622). The specific items for perceived ease of use, however, include “I find it easy to get (the system’s name) to do what I want it to do” (p. 644), which seems more about achieving a separable outcome. Most other papers, though, treat perceived ease of use as an indicator of extrinsic motivation (e.g., Lee et al. 2005).

Some papers use the distinction between intrinsic and external motivation to develop hypotheses about relations among constructs. For instance, Xu et al. (2012) argued that (p. 7):

> Intrinsic motivation can result in increased time spent on tasks, and therefore, higher quality output and more productive work [Starbuck and Webster 1991], a concept tied to perceived usefulness. In addition, intrinsic motivation could increase the deliberation and thoroughness of cognitive processing, leading to enhanced perceptions of extrinsic motivation, such as perceived usefulness [Bagozzi et al. 1999; Batra and Ray 1986; Venkatesh et al. 2002].

This is used to argue for a link from pleasure in technology use to perceived usefulness. Others are less clear about the direction. Davis et al. (1992), for instance, expected “usefulness and enjoyment principally to combine additively in their effects on intentions in the present context. A positive interaction effect, where enjoyment has a greater effect on intentions if usefulness is high (and vice versa), is also consistent with the above theoretical considerations” (p. 1114).

Several papers also discuss the relation between perceived enjoyment and perceived ease of use (e.g., Venkatesh 2000; Sun & Zhang 2006). A key argument was made by Venkatesh (2000, footnote 3), who stated the following about the relation:

> It is possible to argue that perceived ease of use should influence intrinsic motivation (computer playfulness), rather than intrinsic motivation influencing perceived ease of use, as proposed. The causal flow from perceived ease of use to intrinsic motivation would be consistent with a motivational model where extrinsic and intrinsic motivation are the key predictors of intention/behavior, resulting in perceived ease of use being examined as a determinant of intrinsic motivation. However, given the focus on TAM, an outcome and process expectancy model, intrinsic motivation is expected to influence perceived ease of use.

However, the reviewed studies show similarly strong relations between perceived ease of use and perceived enjoyment when the former was assumed to influence the latter as when the influence was assumed to be in the opposite direction (see Table 6).

Also, extensive research in self-determination theory has catalogued the factors that undermine feelings of competence and autonomy (such as deadlines, evaluations, tangible rewards contingent on performance). For instance, Ryan and Deci (2000) described how competence can be improved through direct and positive feedback and through the absence of evaluations. Likewise, the need of autonomy can be satisfied when alternatives for action are provided and a choice provided. However, in the sample, Davis et al. (1992) is the only paper to discuss such factors and explicitly use Deci’s (1975) cognitive evaluation theory.

Affect plays a role in the reviewed papers, but less than one might think. In particular, classic affect theory such as the work by Russell (2003) is discussed infrequently; most of the discussion around affect is based on the work of Zhang and Li (2004) and Zhang et al. (2006). The latter papers build on Russell’s work by focusing on core affect and participants’ perception of an object’s ability to change their core affect (so-called perceived affective quality, PAQ). PAQ can be treated as a predictor variable and is the main operationalization of affect in the work of Zhang and colleagues. Even though the treatment of affect is limited, the explanations proposed by Zhang and colleagues merit a few comments. First, the understanding of affect used in most papers departs from the perception of affective quality; as mentioned, this is the most common conceptualization of affect. In Russell’s work PAQ is contrasted to prototypical emotional episodes, which is “what most people consider the clearest cases of emotions” (Russell & Barrett, 1999, p. 806). Intuitively, these appear to be much more closely related to the episodes that need to be dealt with in models of the adoption and use of technology. For instance, they are longer in time, rarer than core affect (which is always present), and associated with cognitive changes (including cognitive appraisal). It is neither clear what benefits the PAQ conceptualization brings, nor how an understanding of prototypical emotional episodes would help TAM and UX research.

Second, in the reviewed papers, affect is mainly treated as an antecedent rather than as a consequence. For instance, PAQ is exclusively used as a predictor. The thinking here appears to be that PAQ is temporally prior to the assessment of other constructs in the models. Sanchez-Franco (2010) explained this with a quote from Russell: “objects, events, and places (real, imagined, remembered, or anticipated) enter consciousness affectively interpreted. The PAQ of all the stimuli typically impinging at any one time (how pleasant, unpleasant, exciting, boring, upsetting, or soothing each is) then influences subsequent reactions to those stimuli" (Russell, 2003, p. 149). Here, "subsequent reactions" presumably involve perceived ease of use and perceived usefulness. However, data on PAQ and subsequent reactions are collected at the same point in time thus the direction of influence is unclear. In plenty of the settings investigated, affect is an important outcome of system use (and possibly, the most important outcome). Thus, we had expected to see more use of affect as an outcome variable.

Discussion

While the reviewed studies represent an extensive research effort, the experiential component in human-computer interactions is not yet well understood. The TAM and UX models provide rich insights about what constructs that influence the adoption and use of technology and about how these constructs are related. We see this as the basis for the appeal and influence of the models. It is less clear why the relations among the constructs exist and under which conditions the models apply. In the following we discuss the experiential as an object of theorizing, as a phenomenon tied to specific episodes, and with respect to the settings in which it is investigated. We end by summarizing some limitations of our work and the implications of our findings for future research.

Theorizing about the experiential

It is well-established that perceived usefulness, perceived ease of use, and perceived enjoyment influence the adoption and use of systems and that this influence is mediated by attitudes and behavioral intentions. These constructs and their relations have provided a parsimonious and stable basis for investigating how a substantial number of additional constructs influence adoption and use. The differences and similarities between experiential and utilitarian tasks, system uses, and constructs run deep through the reviewed studies. While there is widespread consensus about the definitions of perceived usefulness and perceived ease of use, perceived enjoyment is still one of multiple overlapping constructs used in modelling the experience of use (Table 4).

A variety of theories has been used in arguing about the constructs to include in TAM and UX models and about the relations between these constructs. We are however surprised about the modest role of these theories in explaining relations and driving model development. For example, self-determination theory (e.g., Deci, 1975; Ryan & Deci, 2000) has mainly been used to classify perceived enjoyment as an intrinsic motivator and thereby distinguish it from extrinsic motivators such as perceived usefulness. The basic psychological needs identified in self-determination theory (viz., autonomy, competence, relatedness) play little role in the hypotheses development and discussions in the papers. In self-determination theory, these needs are the innate reasons why certain activities lead to personal growth and psychological well-being. In particular, satisfaction of the needs of competence and autonomy are crucial for intrinsic motivation (Deci and Ryan, 1985). However, the concept of psychological needs is not used in the reviewed papers: neither those needs highlighted by self-determination theory, nor other need theories. In future work, it would be interesting to see needs enter the analysis as they provide a common way of understanding the motivations behind both experiential and utilitarian aims of use. It may be noted that recent work in UX (e.g., Hassenzahl et al. 2010; Tuch & Hornbæk 2015) makes extensive use of the ten needs identified by Sheldon et al. (2001). However, we find that neither this work nor self-determination needs play a role in the sampled studies.

In a recent book on TRA, Fishbein and Ajzen (2015) discussed data suggesting that attitude contains both instrumental and experiential aspects. The former often relate to cognitive aspects of attitudes that “involve such dimensions as wise-foolish and harmful-beneficial” (p. 82); the latter often “represented by adjective pairs as pleasant-unpleasant, enjoyable-unenjoyable” (p. 246). Fishbein and Ajzen noted that “factor analyses tend to confirm the idea that in many domains it is possible to distinguish two interrelated aspects of attitude” (p.84). This idea does not appear to have informed the reviewed studies, even though experiential and instrumental aspects of attitude appear highly relevant to studies of the experiential. For instance, some papers operationalize attitude as instrumental (e.g., Dickinger et al., 2011, gauged attitude by asking “Using PTT [push to talk technology] is:” follow by three semantic differentials, wise-foolish, good-bad, favorable-unfavorable; all appear instrumental when related to Fishbein and Ajzen’s examples), others include also experiential aspects (e.g., Lin and Bhattacherjee, 2010, used three items for attitude: “I have a favorable attitude towards [video game name]”, I am pleased to play [video game name].”, and “[video game name] is interesting”; the last two seem more experiential), and still others use only general formulations (e.g., van der Heijden, 2003, “I have a positive attitude towards this portal”). Based on this diversity in the operationalizations of attitude, it appears to us that a more precise understanding of attitude could provide an integrated way of dealing with the experiential and utilitarian aspects of adoption and use. Moreover, the predictive power of attitude might depend on how it is conceptualized, something which appears not to have been a topic in the reviewed papers.

Instead, attitude has been dropped in most refinements of TAM (e.g., Venkatesh & Davis, 2000; Venkatesh et al., 2003). The rationale has been that attitude does not add much explanatory power. However, dropping attitude from the models disconnects TAM from the theories of reasoned action and planned behavior in which attitude is a fundamental construct. In addition, the reviewed studies indicate that attitude is more important in explaining the experiential than utilitarian component of human-computer interactions. Across the reviewed studies perceived enjoyment had a strong effect on attitude, considerably stronger than the effects of perceived usefulness and perceived ease of use on attitude (Table 6). This result accords with Lin et al. (2001), who argued that "our findings suggest that affective considerations such as attitude may be more important for explaining usage of non-utilitarian systems" (p. 176). Thus, the removal of attitude from models seems to undermine the inclusion and understanding of experiential aspects.

The notion of the hedonic (Hirschman & Holbrock, 1982; van der Heijden, 2004) is the explanation most actively used in reasoning about why user-experience constructs relate to other TAM constructs in the way they do. This notion has been used in motivating new constructs, in distinguishing hedonic from utilitarian systems, in arguing that the role of perceived usefulness changes in hedonic contexts, in reasoning about the role of hedonics in utilitarian contexts, and in experimentally manipulating the absence or presence of hedonic qualities. It is however a definite limitation of the hedonic that it is mainly about positive emotions. Negative emotions and experiences are outside the scope of the hedonic, and they are virtually not investigated in the reviewed papers. Only three of the 81 experience-of-use constructs are about negative emotions and experiences. Many of the other constructs, though, originate from semantic differentials that have both a positive and a negative pole. But it is not immediately clear that these constructs are bipolar: this is, for instance, not the case for some views of affect (see Ekkekakis 2012), nor is it necessarily the case for satisfaction (see Tuch & Hornbæk 2015 for a discussion of two factor models of satisfaction). For instance, Cyr et al. (2007) asked about enjoyment using just positive anchors (interesting, entertaining, enjoyable, pleasant, p. 54) with a 7-point Likert scale. However, negative experiences such as frustration and stress are common with information technology. For example, Lazar et al. (2006) found that users wasted about 40% of their time on the computer due to frustrating experiences, thereby lowering workplace productivity and negatively affecting the users' mood. Relatedly, Eijckelhof et al. (2014) found that perceived stress increased with the duration of daily computer use. Future work should incorporate negative emotions and experiences in models of the adoption and use of technology.

In the reviewed studies, the models of Hassenzahl (e.g., Hassenzahl 2003; Hassenzahl et al. 2010) are seldom used to make predictions about the experiential and its overlap to TAM; only van Schaik and Ling (2011) attempted to use these models together with TAM assertions. In that way, theory building around the experiential is limited and for instance the propositions of Hassenzahl about the relation between positive affect and need fulfillment has not been brought to bear on the intersection between UX and TAM models.

A final observation is that the findings about perceived enjoyment are obtained using particular types of systems and instructions. Technologies that are studied as hedonic are often selected because they clearly focus on providing fun or enjoyment (e.g., Hsu & Lu 2007 studied games). Sometimes even the survey items about central TAM constructs are reformulated to fit a mostly hedonic context such as leisure (e.g., van der Heijden 2004). Our synthesis shows perceived enjoyment as a strong predictor of behavioral intention, stronger than perceived ease of use, but it is unclear to what extent this finding is a result of mainly studying enjoyment in settings that focus on enjoyment. Only six of the reviewed studies investigate the experiential aspects of use in work settings (e.g., Igbaria et al. 1996; Venkatesh 2000). Thus, the influence of the setting on the importance of perceived enjoyment is unclear in the reviewed studies. Untangling this influence seems an important next step.

Specific episodes or general prediction?

Some models of UX insist that we talk about “an experience”, highlighting the need to focus on specific episodes of use. Perhaps therefore, many studies of UX have focused on critical incidents rather than general prediction (e.g., Hassenzahl et al. 2008; Tuch et al. 2013). In contrast, the theory of planned behavior builds on the premise that it is necessary to aggregate over a variety of behaviors to achieve good prediction from intention (Fishbein and Ajzen 2015). The tension between these views is about how time factors into the experience of technology use. While it is trivial that use extends over time, it is less obvious whether perceived enjoyment, perceived usefulness, intention to use, and the other constructs are similarly conceived as extending over time, that is as continuously formed and reformed. In the models, constructs such as perceived enjoyment and perceived usefulness determine and, thereby, precede system use. At the same time, the perception of enjoyment and usefulness follows from external variables experienced when using the system during training or for real tasks. Thus, perceived enjoyment and perceived usefulness also follow from system use. This suggests that the intention to use a system is continuously formed and reformed on the basis of, among other things, how useful the system currently is to the user and how much enjoyment the user currently gets from it. If so, is perceived enjoyment a measure of the user’s momentary enjoyment of the system, general enjoyment of the system, or something in-between? This question is not answered by the definition of perceived enjoyment as the extent to which the activity of using the computer is perceived to be enjoyable in its own right (Davis et al., 1992).

The enjoyment of a system over a specified period of time is, presumably, an aggregate of the momentary enjoyments during that period of time (Kahneman et al., 1999). However, most of the reviewed studies are conducted at a single point in time (when the survey is issued) and the survey items tend not to be specific about the period of use. Under such circumstances it remains unknown how users set the period of time over which they aggregate their perceptions of enjoyment, usefulness and so forth. Following van Schaik and Ling (2011) we speculate that experiential constructs are more susceptible to moment-to-moment changes than, for instance, usefulness, thereby making experiential constructs more vulnerable to uncertainty about the period of time over which they are assessed. In discussing their measure of cognitive absorption Agarwal and Karahanna (2000) noted that while they measured the state of cognitive absorption retrospectively, “an ideal examination of this state would be during the activity that is its cause … or immediately following the activity” (p. 688). This note appears to acknowledge a need for examining experiences in the moment. Few of the reviewed studies do that; future studies will benefit from tying measures of experiences more specifically to episodes.

The settings in which systems are adopted and used

Factors about the users, systems, tasks, and organizational context of technology use are widely recognized as important but they are often missing in the papers. As many as 14 of the 37 reviewed papers include no constructs about the users, systems, tasks, and organizational context, thereby leaving considerations about the conditions under which the models apply to more informal analysis. Another 9 papers include constructs about the users but none about the system, tasks, and organizational context. That is, information about the conditions under which the models are studied is often confined to the method description or the wording of the survey items, and it often leaves seemingly important factors unspecified. For example, 51% of the papers do not specify which tasks users performed with the system, 24% of the papers provide no information about the users participating in the study, and 22% of the papers do not specify the system beyond a general category of technology (e.g., mobile internet technology). Without such information it is difficult to understand the models because "we understand what is going on by appreciating where and when it is happening" (Whetten, 1989, p. 492). It also becomes difficult to determine the boundaries of the models.

One might especially have expected more focus on what the systems are actually used for. A focus on actual use is a central tenet of research on human-computer interaction. This literature pays close attention to what users actually do with systems and emphasizes that tasks influence the performance with systems more than any other variable. In this understanding it would be difficult to imagine strong predictive power of models that do not account for task variability. As far as we can tell from the descriptions of tasks, most of the systems in the reviewed papers support a range of tasks. For instance, Agarwal and Karahanna (2000) studied the World Wide Web; Liao et al. (2008) investigated multimedia-on-demand. Experiences are likely to vary over the tasks that can be done with these systems. Furthermore, alternatives to the systems studied exist in 70% of the reviewed papers (because use was not mandatory in those papers). Here, participants may have performed some tasks with one system and other tasks with other systems or in other ways. When people can do the same thing with multiple systems, and use multiple systems for the same thing, general prediction appears to become harder and accounting for tasks seems to be crucial for valid modelling.

A few studies in the sample do manipulate tasks; they provide some insights into the variability and effects brought about by variations in tasks. Van Schaik and Ling (2011) manipulated mode of use, operationalized as finding answers to specific questions versus exploring a website. They found those manipulations to significantly influence the intention to use, but that this effect was mediated by beliefs about the system. Xu et al. (2012) asked participants about one of four smartphone functions, linked to particular tasks (e.g., the Phone for making and receiving calls, its MP3 player for playing music). The models created for each of those functions are markedly different: some have perceived ease of use as a significant factor whereas others do not; some have perceived pleasure as a significant factor whereas others do not. Taken together these findings suggest that tasks – what people do with systems – moderate the strength of many of the relations among the constructs in the models of TAM and UX.

Methodological Limitations and Open Questions

The method of the review has a number of limitations that leave open questions for future work. First, the review is based on the framework by Whetten (1989) and is explicitly concerned with theory development. Thus, our analysis of the overlap between TAM and UX models assumes that the aim of these models is theory development. This, however, may be contested on the grounds that the design of user experiences differs from theory in Whetten's sense. Rather than theory development, isn't UX models about supporting design? Whetten does not prescribe an analysis of design recommendations. That said, we contend that insights about design will be captured in the whys and hows that Whetten does prescribe. And would it not be hard to imagine support for design without any theory building? In any case, the specific role of design in the overlap between TAM and UX models seems to merit further study.

Second, the selection of papers for the review was governed by the inclusion criteria and selection process. In the course of doing the review, we have become aware of papers that include both TAM and UX models but fall outside of our sample (e.g., Aranyi and Van Schaik 2015, 2016). However, we have chosen to stick to our time-delimited set of high-quality conferences and journals; missing some papers seems inevitable.

Third, we have proceeded from a bottom-up coding of constructs. This has facilitated the identification of categories of construct but might have missed other forms of overlap between the constructs. For instance, perceived affective quality differs from hedonic quality in a number of ways. However, the concepts are also distinctly related, especially with respect to the mechanisms they propose for forming attitudes about technology. An open question for future work is to analyze such differences and similarities in much more depth.

Implications

In a critical review of TAM research, Lee et al. (2003) imagine that a manager will be unimpressed, and badly served, by the finding that to be adopted a technology must be useful and easy to use. While the simplicity of the model may attract researchers, it leaves out too many of the issues practitioners must understand to design good systems, select among competing systems, or have systems adopted by their staff. For example, systems are rarely varied in the models. Instead of modelling the adoption and use of multiple variants of a system, most of the studies model the adoption and use of a single system, thereby making it impossible to link the features of a system clearly to its adoption and use. Designers need such links to devise systems that will be adopted and used, and to revise systems that face non-adoption or partial use. Similarly, users or their management need such links to select among competing systems. Selecting among competing systems, that is, selecting on the basis of system features, is a common situation, probably more common than selecting between different classes of systems, such as between “mobile internet technology” (Venkatesh et al., 2012) and “an integrated suite of applications to support account managers” (Beaudry & Pinsonneault, 2010).

A specific challenge in drawing implications from the studies is conflicting findings about the direction of certain relations. For example, seven studies find that perceived enjoyment predicts perceived usefulness and two studies find a similarly strong relation in the opposite direction. The same is the case for perceived enjoyment and perceived ease of use, with six studies finding a relation in one direction and nine studies in the opposite direction (Table 6). Venkatesh (2000) argued on a conceptual basis that an effect of perceived enjoyment on perceived ease of use is more consistent with the focus of TAM. Sun and Zhang (2006) empirically tested the relation in both directions and found, on the basis of Cohen’s path analysis, that the dominating direction is that perceived enjoyment predicts perceived ease of use. Experiments that manipulate independent variables, as opposed to studies based on cross-sectional surveys, appear to provide a clear-cut, and much needed, way of teasing out the direction of the relations. Only five of the reviewed studies are experiments; 30 are surveys and two meta-analyses.

In summary, we catalogue ten implications of our review for future research on the understanding and modelling of the experiential component in human-computer interactions:

- Reaching consensus about the base construct, or constructs, in modelling enjoyment and experiences is key to working systematically toward understanding the experiential component.
- Bringing psychological needs into the analysis appears promising because they provide a common way of understanding the motivations behind experiential and utilitarian aims of use.
- Removing attitude from models seems, in particular, to undermine the inclusion and understanding of the experiential component of human-computer interactions. Cognitive and affective elements of attitude might usefully be distinguished.
- Incorporating negative emotions and experiences in models is important because these emotions and experiences are common in the practical adoption and use of technology.
- Untangling the influence of hedonic versus utilitarian settings on the relative importance of the experiential component is central to reaching an understanding of its role in adoption and use.

- Accounting for social aspects of use and incorporating them into modelling of experiences seems underdeveloped.
- Relating measures that aggregate across use to measures on episodes of use will help understand the experiential component of human-computer interactions and theorize about the relation between Kahneman's experiencing and the remembering self in such interactions.
- Accounting for what people concretely do with systems appears important because tasks probably mediate the strength of many of the relations among the constructs in the models.
- Varying the features of systems is necessary to link features to the adoption and use of a system and, thereby, guide the design of systems and the selection among competing systems.
- Manipulating independent variables, such as levels of ease of use, experimentally appears a much-needed way of investigating the adoption and use of technology in more detail.

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