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Perceptive Users with Attitudes - Some Hueristics on Theorizing

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Abstract

Many existing theories of user perceptions and attitudes towards technology suffer from "over investigation" of users' attitudes and "under investigation" of the technologies that cause them. This can be the result of a pursuit of generalisability at the expense of accuracy and salience to practice. In this paper, we offer some heuristics for addressing this issue. We propose that salient features of technologies can be identified using affordance theory. The functional affordances of technologies form the basis for users' descriptive beliefs (perceptions). These in turn form the basis for more generalized beliefs that lead to attitudes. We further suggest that multi-indicator structural models (MISMs), from contemporary psychometrics are highly suitable for modeling this theory area. We offer a brief illustration of how our heuristics could be used to develop a theory.

Keywords: Individuals, attitudes, perceptions, theory building, modeling, technology affordances, multi-indicator structural models

Introduction

There has been ongoing dialogue within the IS community about the degree to which IS researchers should aim for generalisability of theory, and the tension between accuracy, simplicity and generalisability (Seddon and Lyytinen, 2008). In a recent discussion (Seddon et al. 2008), the panellists noted that many studies are not as representative as they claim to be, because the technologies and users that are studied vary considerably. For example, not all email or ERP systems are the same, and the characteristics and perceptions of individual users may vary within and between different contexts of use. Overall, there is a trade-off between generalisability, accuracy and simplicity (Figure 1). Within that, generalisability and simplicity are often privileged at the expense of accuracy.

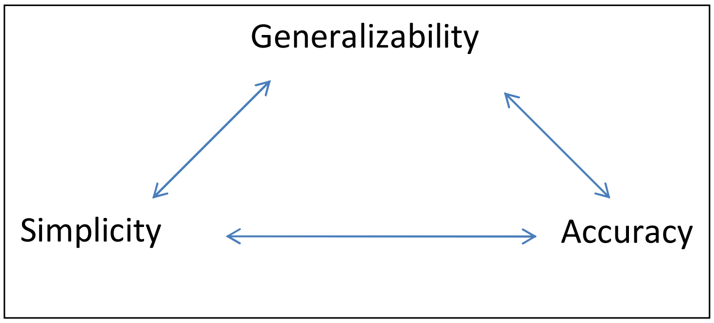

Figure 1: the trade-off between generalisability, accuracy and simplicity in theory

This tension is not unique to IS, but is an ongoing issue within social science research (Blalock, 1982). The diversity of social phenomena tends to lead to issues with theory generalisability and parsimony (simplicity). The quest for parsimoniousness is often the cause of a gap between models and the complexities of the real world. *"[Although social scientists] strive for theories that are simultaneously parsimonious, highly general, and therefore applicable to a wide range of phenomena, yet precise enough to imply rejectable hypotheses, it does not appear possible…to achieve simultaneously all three of these ideal characteristics…my own position is that of the three, parsimony is the most expendable*" pp28, (Blalock 1982).

One reason why generalisability is valued in theory development is that it is assumed to be evidence of the development of a cumulative research tradition. Generalisable models may be created by expanding the scope (boundaries) of existing models or by combining two or more models with a more limited scope (Dubin 1978).

In the IS research community, issues have been raised about the state of research into user attitudes and perceptions towards technology in a special issue of the Journal of the Association of Information Systems (Benbasat et al. 2007; Hirschheim 2007). Benbasat and Barki (2007) suggested that the popularity of the TAM has diverted researchers away from its antecedents, in particular, the design of the IT artifact and the characteristics that make it useful. They further suggest that the addition of various constructs (other models with a different scope) such as trust and self-efficacy to TAM has created the "illusion of cumulative tradition", but has not in fact extended the boundaries of the theory (Benbasat and Barki, 2007, p. 213)

The proposed solution is to carry out more specific and accurate research; to be more explicit about the boundaries and scope of the generalisability of our research; and not to make excessive, and unsubstantiated claims of representativeness and generalisability (Seddon et al. 2008). In this paper, we suggest some responses to these challenges. We examine discussions of IS theory to determine the proper role and scope of IS theories. We then use affordance theory to explain how salient aspects of technology may be derived. We turn to social psychology for insights into the process by which users form attitudes towards technologies, based on their initial perceptions. We then review contemporary psychometrics for guidelines as to how to test these models empirically. We finish with a short illustration, and a discussion of implications.

It is important to note that each of the theories we use in our argument has a large literature in its own right. In the interests of simplicity, relevance and flow of exposition, we select examples from each discipline that are most relevant to this discussion.

The IS Discipline

The IS discipline has been involved in soul-searching as to the purpose and scope of the academic study of information systems (Benbasat et al. 1996; Benbasat et al. 2003; Lyytinen et al. 2004; Robey 2003; Weber 2003). Various viewpoints have been proposed. At opposite ends of the continuum are Benbasat and Zmud's (2003) argument for the centrality of the IT artefact, and Lyttinen and King's (2004) view of the field as a "marketplace of ideas".

An IT artifact can be conceptualized as the application of IT to enable or support some tasks embedded within a structure(s) that itself is embedded within a context(s). Benbasat and Zmud (2003) argue that the IT artifact and its nomological net constitute the IS discipline. They posit that IS research should be involved with questions of 1) how IT artifacts are conceived, constructed, and implemented; 2) how IT artifacts are used, supported, and evolved; 3) how IT artifacts impact the context in which they are embedded. Anything outside this nomological net is not IS research. Benbasat and Zmud (2003) argue for the centrality of the IS artefact in defining IS research; "*We are concerned that the IS research community is making the discipline's central identity ambiguous by, all too frequently, under-investigating phenomena intimately associated with IT-based systems and over-investigating phenomena distantly associated with IT-based systems*".

Lyytinen and King (2004) offer an alternative conceptualization of the IS discipline without a theoretic core. Instead, they propose three factors that account for disciplinary legitimacy. First, fields that appear to be dealing with socially salient issues are more likely to be legitimized: The salience in the IS field is about achieving pragmatic, praxis-based legitimacy. Second, fields need to derive strong results: The IS field can achieve this through high-quality research and instruction on, for example, decision support tools, system development methods, and ERP systems. Finally, the field's centre needs to be "plastic" to adapt to the shifting salience of the issues that might concern it. This preserves the capability of IS to produce strong results, and with strong results, legitimacy follows.

In our view, widely cited theories of user attitudes and perceptions towards technologies, such as the Technology Acceptance Model (TAM) (Davis et al. 1989), or the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003), would be excluded by both sets of criteria. The TAM can be applied equally to almost any artifact, from a lawn mower to a mobile phone. According to Benbasat and Zmud's criteria, although it does include a technology artifact in its nomological net, it "over-investigates" the user's attitudes at too great a distance from the specific technology they are responding to. We are not "*extending the model backward towards IT, implementation and design factors*" pp213 (Benbasat et al. 2007)

According to Lyytinen and King's conceptualization, popular theories of user attitudes towards technologies are also limited. That IT artifacts should be usable and easy to use appears to be obvious; but this knowledge is not salient, and does not provide strong results for practice. In 1998, Robey and Marcus lamented that IS theory is not "*well positioned to recommend actions for improving the intervention [of a new technology]*" pp10 (Robey et al. 1998). Ten years later, theories of user attitudes and perceptions towards technology are still "*leading to research that is unable to provide actionable advice*" (Benbasat and Barki, 2007, p. 213). It does not inform those involved in the production and management of IT artifacts as to what processes or characteristics will create perceptions of usefulness and ease of use in their users and customers, or how this process will take place.

In conclusion, we argue that the pursuit of generalisability and parsimony in theory has led to a lack of precision in conceptualizing the constructs that contribute to the formation of user perceptions and attitudes. We have over-investigated the measurement of user affect (since it is more easily generalisable), and under-investigated the *specific* causes of that affect. This has likely led to claims of generalisability which may exceed what can be supported by the research sample and context, if this were modelled in a more specific theory. For example, while it may be the case that perceived ease of use of a technology is generally antecedent to intention to use the technology; the antecedents of "ease of use" of a virtual instrument for micro-surgery are unlikely to be the same as the antecedents for "ease of use" of a mobile game. In effect, at a practically relevant level of abstraction, they are different theories. To address these issues, we propose the following heuristics for extending the role and scope of IS theories of user attitudes and perceptions towards technology to include IT artifacts.

Heuristics from discussion of the IS discipline

H1. The role of IS theory of user attitude towards technologies is to explain the process of the formation of attitudes and perceptions (affect) towards technology artifacts *in sufficient detail to be salient to practice*.

H2a. The proper scope of IS theory of attitudes and perceptions towards technology should explain the process by which the perceptions and attitudes of individual users, and classes of users are formed in response to interactions with *specific* technologies in *specific* contexts. The degree of specificity should be driven by usefulness, accuracy, and salience to practice rather than the pursuit of theoretical parsimony and generalisability.

H2b. Salient and accurate IS theory of user attitudes and perceptions towards technology needs to include both 1) the relevant *interactions* between salient characteristics of the technology and characteristics of the user and 2) the structural relationship between those interactions and attitudes and affects towards technology.

Current IS theories of user attitudes and perceptions fall short according to two influential conceptualizations of the field. How, then, should we develop better theories?

Affordance Theory

There is a wide range of phenomena that could potentially be investigated when considering an IT artefact in context. To identify features that are salient in forming user perceptions and attitudes, we need to select those features of interest from the wide range of factors that are available for investigation.

There are two sets of considerations involved here: what features the IT artefact actually has, and what features the user perceives it to have. The first is a product of the design and build process, while the second is a product of the interaction between the user and the technology. These obviously have a relationship to one another, but it is not necessarily a simple relationship. For example, many users are not aware of all the functionality that an online service offers, and may only use a subset of it. Moreover, people do not always use software for the purpose for which it is designed. For example, people may use Amazon.com as a research database, since the list of titles it supports is so extensive, while the software was designed as a virtual shop-front for book-selling. Finally, users may believe a system to be capable of some functionality it does not actually support.

We examine two possible theoretical foundations for identifying the features of a technology that are salient to forming user perceptions and attitudes; representation theory (which can be used to model what an information system actually does) and affordance theory (which can be used to identify a user's perception of what an information system does).

Representation theory proposes an ontology for specifying and describing the core constructs of information systems that applies to both the external view of the systems inputs and outputs (a "black box" model) and the internal structure of the system (a "white box" model) (Wand et al. 1990). This ontology contains rigorous definitions of the components of information systems, their interactions and states, and the process of decomposing high-level views of a system into more detailed views. Representation theory is popular with theorists of conceptual modelling because of its potential to provide an accurate view, both internal and external, of an information system as it is designed and built.

Affordance theory allows us to identify aspects of an IT artefact *as perceived by the user* that are antecedent to the formation of user attitudes and perceptions, remembering that these perceptions may be different to the system as designed and built. In design theory, affordances involve the interaction between an actor and the properties of her environment. Human activities are shaped by the material environment they occur in (Gaver 1991; Gibson 1977; Gibson 1979; Norman 1999). An affordance is what is allowed or "afforded" by an object in an environment. For example, something we might normally recognize as a chair (for sitting on) might also afford standing on, or in rare circumstances, being used as a weapon. It would not afford use for a fine motor function such as sewing or tooth cleaning.

Affordance theory can be usefully applied to IT artifacts and human agents. Hartson identifies four types of affordance: real or physical, cognitive, perceptual, and functional (Hartson 2003). A physical affordance is defined as a design feature that enables a physical activity. Adequate size and an easy-to-access location on the screen could be physical affordance features of an interface button (Hartson 2003). A cognitive affordance is a design feature that enables thinking and/or knowing about something. For example, clear and precise words in a button label enable users to understand the meaning of the button (Hartson 2003). A perceptual affordance is a design feature that enables the user in perception (e.g., seeing, hearing, feeling, sensing). Cognitive and physical affordances are key concepts in interface and interaction design. Perceptual affordances support physical and cognitive affordance – what can be done with the software. Users must be able to perceive cognitive affordances and physical affordances in order for them to aid the user's cognitive and physical actions (Hartson 2003). A functional affordance is a higher-level enablement (than simply a button-click), i.e. an affordance that allows the user to do something useful in the work domain. This takes the discussion of affordances beyond user interfaces to the larger context of overall system design, and the use of IT for purposeful actions (McGrenere et al. 2000).

Representation theory could be used to develop a model that described the set of affordances (of all four types) of the system as designed. However, it will not describe the users' perceptions of the functional affordances of the system: the functions the system is used for may not be the functions it was designed for. Further, systems with different internal features may provide equivalent functional affordances. For this reason, we believe that the set of functional affordances of the system as perceived by the user is the best starting point for identifying features about which the user may develop relevant beliefs and perceptions.

We suggest that if IS theory is to meet the criteria proposed by either Benbasat and Zmud (2003), or Lyytinen and King (2004), then, whenever the characteristics and hence the affordances of the IT artefact change, theories about it must also change. No one would deny that the functional affordances of IT artitfacts change over time. Current industry trends such as integrated portals, or the integration of SMS (short message system) functionality with online services, can be regarded as supporting new functional affordances – they support functions such as push notifications that were not previously available.

To summarize, the perceived functional affordances of technology artifacts define the set of salient external technology features that form the basis for theories of user attitudes and perceptions towards technology. These affordances change over time, with the introduction of new technologies and with changes in existing technologies. IS theory is therefore likely to change over time, with changes in the functional affordances of underlying technologies.

Heuristics from affordance theory

H3a. The functional affordances of technology artifacts should be used to identify salient external features of a technology for theory building. These change over time. Therefore, the range of users' beliefs about them will also change over time.

H3b. Consequently, accurate and salient IS theory is generalisable only to the extent that technologies share the same functional affordances. Therefore, IS theory must change over time with changes in the functional affordances of underlying technologies.

Social Psychology

Information systems theory draws heavily on theories of attitudes and behaviour from social psychology. For example, TAM (Davis et al. 1989) and its successor UTAUT (Venkatesh et al. 2003) both cite the theory of reasoned action (TRA) (Fishbein et al. 1975) and its successor, the theory of planned behaviour (TPB) (Ajzen 1991) as an important part of their provenance. Although the core theories are widely known, the detailed discussion that lies behind these theories is not.

Fishbein & Ajzen (F&A) (Fishbein et al. 1975) distinguish between affect, cognition and conation. Affect is a person's feeling towards and evaluation of some object (person, issue, event); cognition is his or her knowledge, opinions, beliefs and thoughts about the object; and conation refers to his or her behavioural intentions. F&A use "attitude" to denote affect, "belief" to denote cognition, and "intention" to denote conation (Figure 2). Beliefs link an object to some attribute, which may be any trait, property, characteristic, affordance or outcome associated with that object.

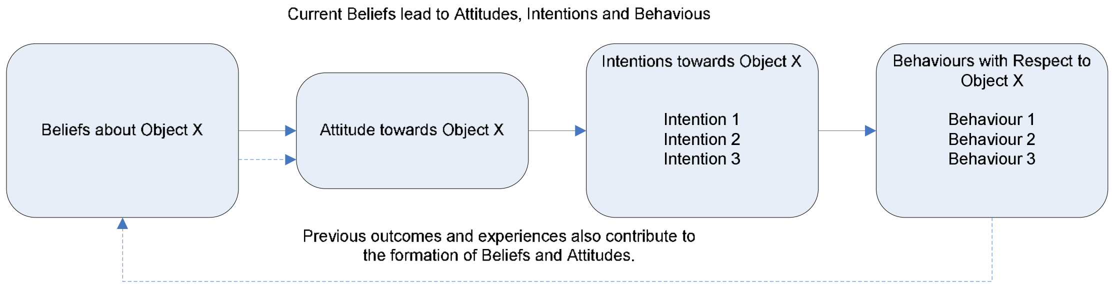

Figure 2: The formation of beliefs and attitudes towards technology

Belief Formation

F&A assert that the belief concept is central to understanding attitudes, intentions and behaviours. Beliefs about an object form the basis for the formation of attitudes towards that object. Belief formation involves the establishment of a link between two aspects of an individual's world. One is direct observation via the senses of a [technology] object (for example that a website offers a certain information item or button to push). This gives rise to descriptive beliefs about the object. Since people rarely doubt the validity of their own senses, descriptive beliefs are usually held with maximum certainty. Beliefs that go beyond directly observable events are inferential beliefs. These are formed from descriptive beliefs – for example, the presence of certain information may be used to infer usefulness. Inferential beliefs may be based in the first instance on previous inferences, but F&A claim that most inferential beliefs can eventually be traced back to descriptive beliefs. However, the distinction between descriptive and inferential beliefs is a continuum, rather than a dichotomy: "*At the descriptive end of the continuum, a person's beliefs are directly tied to the stimulus situation, and at the inferential end, beliefs are formed on the basis of these stimuli as well as the residues of the person's past experiences; the continuum may be seen as involving [a range from] maximal to minimal use of such past experiential residues*" pp 133 (Fishbein et al. 1975).

IS theories of perceptions and attitudes towards technology have often failed to adequately distinguish between descriptive and inferential beliefs. The terms "perception" or "user's perception" or "customer's perception" are often used in the IS and consumer behaviour literature as catch-all terms that encompass both descriptive and inferential beliefs. For example, the perceptions of website users of the navigability of a site are likely to be more descriptive than inferential: They are reasonably precise and likely to be well correlated to objective features such as the number of clicks required to achieve a goal. There may be some variation based on the individual, but the responses are likely to be reasonably similar between individuals, with a substantial portion of the differences in score explained by objective qualities of the site.

However, the belief whether a site is easy to use is a more inferential than descriptive belief. There are two issues with inferential beliefs that place them at a remove from salient features of the technology. The first is that they are much more generalized than descriptive beliefs, which greatly reduces their salience in any specific context. The question "Is it easy to use?" is a question one could reasonably ask about a diversity of technologies, from lawn mowers to surgical instruments. However, if we do not include the antecedent descriptive beliefs, which are based on the affordances of the technology; then this question, although it may have the same wording, is effectively a different question when used in different contexts. The characteristics and features that contribute to respondents rating a lawnmower as "easy to use" may include how easy it is to start, its weight and maneuverability and so on; and will be different to those that contribute to the evaluation of electronic surgical instruments (for example accuracy, visual quality and response latency). Measuring the inferential beliefs alone does not provide any clues to inform the design of either technology.

The other issue with inferential beliefs and the subsequent formation of attitudes towards a technology is that they tend to accumulate over time and with experience. For example, consider two users who are asked to provide their perceptions of the trustworthiness of an e-commerce website, and then to indicate their attitudes and intentions towards conducting e-commerce transactions on that site. One user has previously experienced credit card fraud on the Internet (but not on that site) and one has not. They will likely have similar descriptive beliefs as to whether the site offers specific features shown to be antecedent to trust in electronic commerce such as privacy and security (Pittayachawan et al. 2008). Furthermore, those beliefs will likely correspond reasonably well to the actual affordances of the site. However, the user that has previously experienced credit card fraud may hold a lower degree of trust (an inferential belief), and a more negative attitude to transactions on that website, and to e-commerce in general, because they have an experiential residue from their previous fraud experience. These unmeasured causes make the measurement of inferential beliefs and attitudes less reliable.

In summary, we have shown that measuring inferential beliefs and attitudes alone does not provide useful insights about technology design, and social psychology provides guidelines that allow us to bridge the gap between technology affordances and user attitudes towards them. This entails clearly separating user perceptions (descriptive beliefs) from inferential beliefs and attitudes in our theories. We use the term "user perceptions" as synonymous with F&A's term "descriptive beliefs".

Heuristics from social psychology

H4. Relevant user perceptions (descriptive beliefs) should be derived from the functional affordances of the technology artefact and used to develop the descriptive beliefs in the theory.

H5. User perceptions (descriptive beliefs) about technologies are separate from, and antecedents to, affects (attitudes) towards technologies.

H6. User perceptions (descriptive beliefs) are usually held with maximum certainty (Fishbein et al. 1975)

H7a. User perceptions (descriptive beliefs) change with the affordances of the technology artefact (Fishbein et al. 1975). (from **H3a**)

H7b. Therefore, user perceptions (descriptive beliefs) can be very reliably measured (from **H6**) but can never be highly generalisable beyond artifacts of a similar type with similar qualities and affordances (from **H7a**).

H8a. User perceptions (descriptive beliefs) ultimately contribute to attitude or towards a technology, but are mediated by inferential beliefs based on those descriptive beliefs but also on prior knowledge and experience (Fishbein et al. 1975).

H8b. Therefore, user perceptions cause attitudes, not vice versa.

H9. Attitude (affect) is a more generalisable concept than perception and may be meaningfully applied to classes of things (e.g. e-commerce websites), which reduces its salience for any specific technology unless linked to it by the antecedent inferential and descriptive beliefs.

H10 Measurements of attitude will include more unmeasured causes from past experiential residue than measures of inferential beliefs, and measurements of inferential beliefs will include more unmeasured causes than descriptive beliefs (Fishbein et al. 1975).

H10a. Therefore, measurement of attitudes is less reliable and salient than measurement of inferential beliefs, and measurement of inferential beliefs is less reliable and salient than measurement of descriptive beliefs.

Psychometrics

Recent statistical modeling approaches from contemporary psychometrics, in particular, multi-indicator structural models, as advocated by Les Hayduk (Hayduk 1996; Hayduk et al. 2000a; Hayduk et al. 2000b) as an alternative to factor-based models, are well suited to the implementation of the models we proposed in the previous section.

What is a multiple indicator structural model? Approaches to structural equation modeling are the subject of an extensive technical literature, which cannot be fully summarized here, so only some key concepts are reviewed. In simple terms, Hayduk posits that **all** arrows in a SEM model indicate relationships that need to be supported by theory; and there are no important theoretical differences between measurement and structural relationships. This requires that researchers give the same level of theoretical consideration to relationships between latent variables and their indicators (traditionally described as the measurement model) as they do to the relationships between latent variables (traditionally described as the structural model). This applies equally to reflective latent variables (where the causal relationship is hypothesized to be from latent to indicator) as it does to formative latent variables (where causal relationship is hypothesized to be from indicator to latent variable). Hayduk (Hayduk 1996) argues that the loading of an indicator on a latent variable (the λ value) is a truth claim or hypothesis that needs to be supported by theory. For example, consider two studies which examined a latent construct "perceived website content quality", with indicators accuracy, believability, timeliness and relevance. The first study was conducted on a site that provided public access to historic census data, and had loadings of 0.87, 0.83, 0.67, and 0.55 respectively. The second was conducted on a site that provided breaking news from the parliamentary press gallery and had loadings of 0.56, 0.62, 0.89, and 0.71. Hayduk would suggest that the meaning of perceived website content quality was different from one study to another – the second was best represented by timeliness, while the first was best represented by accuracy and believability. Since the indicators have not changed, the only alternative is to admit that the changes arise because the identity of the concept (and hence it's meaning) has changed. Similarly, changes in the variance of a concept reflect changes the meaning of the concept, because the correlation between the concept and indicator is again altered, and the meaning of the data, e.g. the wording of the questionnaire items, is unchanged pp 32 (Hayduk 1996).

Hayduk notes that survey design and modeling methods texts, based on factor analysis, frequently advise is that every latent construct in the model should have three or four indicators and no constraints be placed on exogenous or error covariances (Hayduck 1996). While this ensures that the model is identified and can be estimated, freeing all covariances lacks theoretical rigour, and specifying the expected effects among the constructs, instead of permitting all free estimation, will prevent many model identification issues while also increasing theoretical rigor, as the researcher is required to theorize about the size of those parameters. This in turn obviates the need for multiple indicators. Instead, the single best (most immediate, direct) indicator suffices (Hayduck 1996).

Hayduk suggests the following four steps for developing multiple indicator structural models. These steps ensure that the meaning of a latent concept remains unchanged by tying it to its single best indicator:

1. Chose the indicator you believe is the best single available indicator of the concept in question.
2. Fix the path coefficient for that indicator.
3. Fix the error variance for that indicator at a specific value.
4. If desired, use further indicators with free path coefficients and error variances.

Step 1 selects that part of the shared external world (the measured indicator variables) that is most similar to the hypothesized concept. For example, for the user's perception of the timeliness of website information an indicator such as "The information on this website is timely" will be very similar to the hypothesized concept. Step 2 sets the scale for that concept to correspond to the scale for the observed indicator. Step 3 quantifies the assessment of how similar or dissimilar the concept is to its best indicator. Since we have created a very close correspondence between the descriptive belief (e.g. about website information timeliness) and the indicator, it is reasonable to assume the error variance will be low. People report their own perceptions accurately if they are genuine in their attempts to do so. Step 4 is only possible of there are two or more indicators of a concept, and it provides a test for the conceptualization that are asserted in steps 1 to 3 (Hayduck 1996).

In summary, we suggest that MISMs (Hayduk 1996; Hayduk et al. 2000a; Hayduk et al. 2000b) are particularly suited to the development and testing of theories and models of user attitudes and perceptions towards technology, because they support detailed and accurate modeling of user perceptions of technologies, and the process by which user attitudes towards technologies are formed. The more specific a belief about a technology, the more difficult the task of finding equivalent indicators becomes. Hence, we would expect many of the most specific beliefs to have only a single indicator. On the other hand, it is easier to identify sets of equivalent indicators for more general attitudes or intentions. This leads us to suggest the following two heuristics.

Heuristics from psychometrics

H11. MISMs can be used effectively to develop and test models with a more latent variables representing hypothesised constructs than traditional factor models. This permits finer conceptual distinctions that allow for the inclusion of descriptive beliefs (perceptions) towards technology.

H12. Descriptive beliefs (direct perceptions) can be modelled as latent variables with fewer, but more direct indicators (or only one) and relatively small, fixed error terms.

Synthesis

Drawing on the arguments of the previous sections, we concur with Benbasat and Zmud (2007) that much IS theory of user perceptions and attitudes towards technology pursues the illusion of generalisability at the expense of accuracy and real-world salience. This can be addressed by extending the theory to include the IS artefact. Since there are many external and internal features of the IS artefact that could be included, affordance theory allows us to identify the functional affordances, i.e. those salient features of the technology that can be used for purposeful action by users (Figure 3).

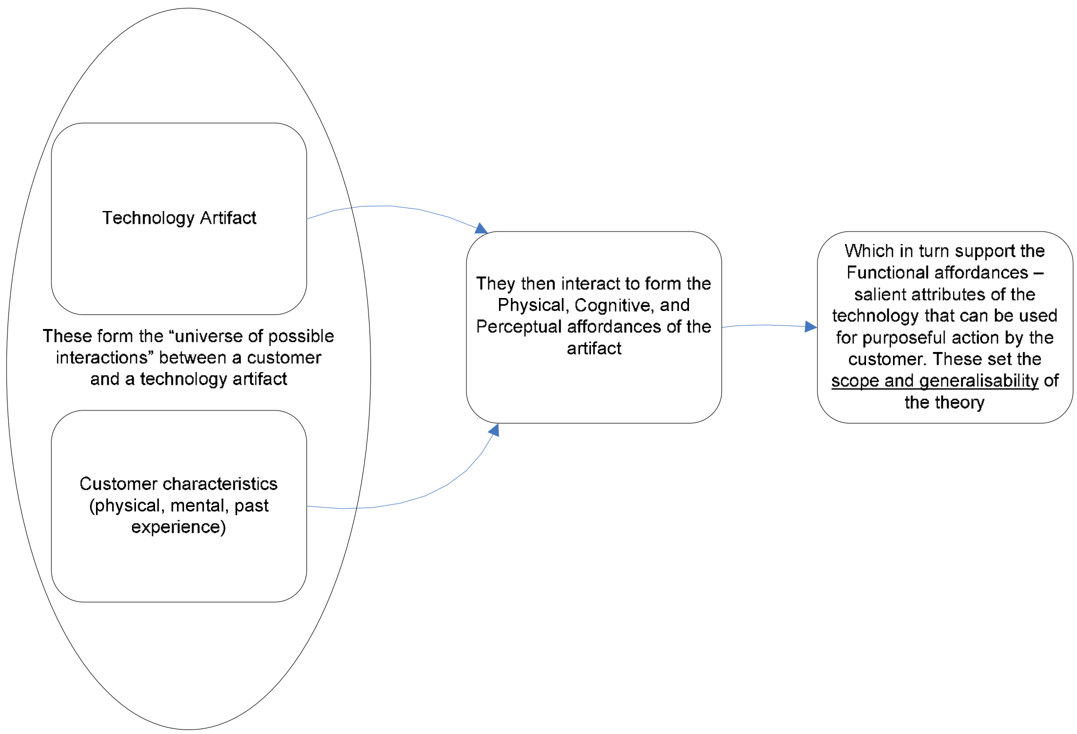

Figure 3: Affordance theory allows us to identify the salient features of technologies for inclusion in theory

In order to address the challenge posed by Benbasat and Zmud (2007), we need to be able to extend existing theories of user beliefs and perceptions towards technology to include the antecedent technology artifact. Once we have identified the salient external features of the artifact for inclusion (Figure 3) we can model the process by which those features form beliefs and attitudes.

Social psychology informs our understanding of how affordances form descriptive beliefs, which lead to inferential beliefs and ultimately to attitudes towards technologies, as shown in Figure 4. We can now extend our theory of user beliefs and attitudes "backwards" and link those user beliefs to technology and design characteristics that can provide actionable advice.

Further, we find that multi-indicator structural models offer a practical way of modelling and testing these theories (Figure 4), because they are particularly suitable for modelling descriptive beliefs and the structural relationships between beliefs and attitudes.

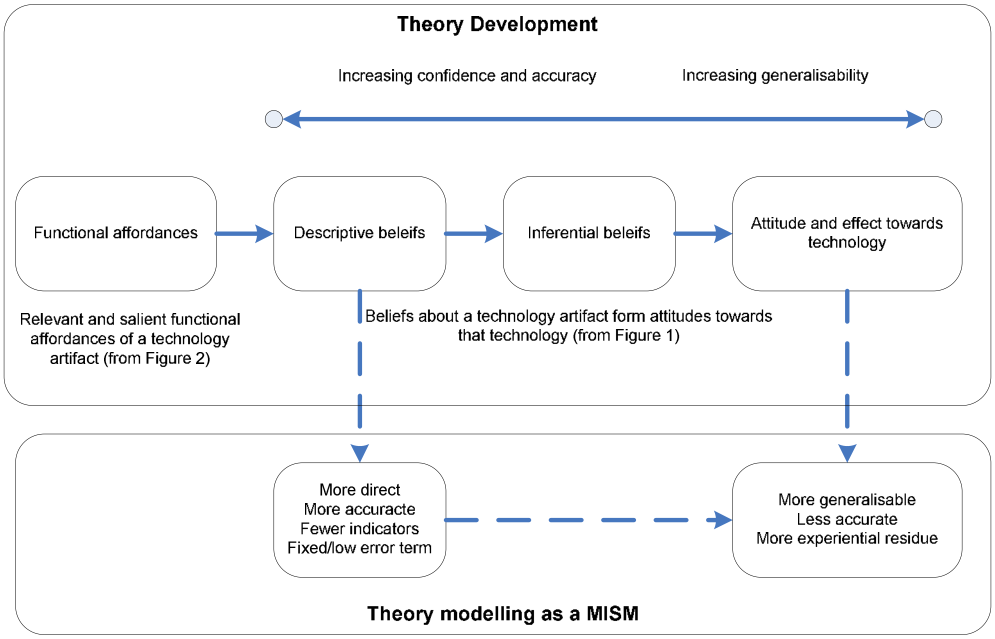

Figure 4: Theory Development and Modelling

Illustration of Theory Development

The illustration of theory development has been kept simple, and is not intended as a complete theory, but as an illustration of the process by which the heuristics advocated in this paper can be applied. In Figure 5 we see the general process illustrated above in Figure 4 instantiated for this example.

The technology artefact we wish to study is a website. We determine from stakeholders that the most useful and salient feature of this website is that it is designed for information retrieval (although it may have other functional affordances as well). We further determine, perhaps from taxonomies of website types and purposes, that this is a common purpose for websites, and our theory may therefore have some potential for generalisability to other information provisioning websites. This is the scope and context of the theory and the extent of its generalisability.

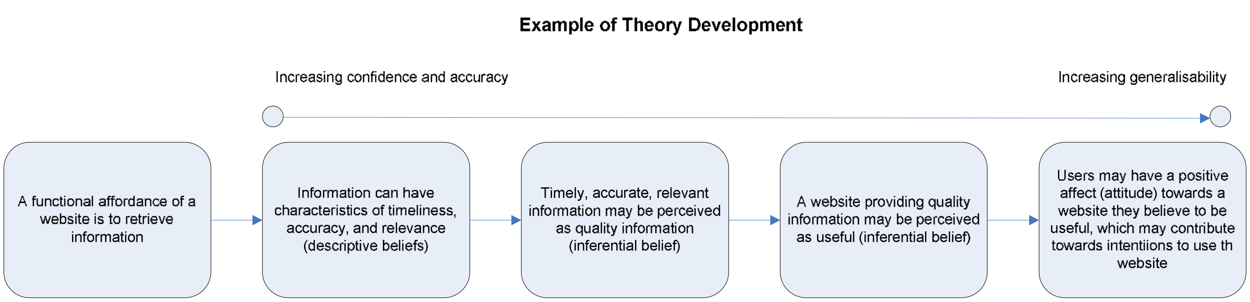

Figure 5: Developing a Theory

We might then determine that the most salient characteristics of information, if it is to be useful for purposeful action, are accuracy, timeliness, and relevance. This insight might come from previous studies of website information quality, general studies of information quality, or from stakeholder discussions. These are the characteristic about which website users may hold descriptive beliefs (perceptions). It is possible for information to be timely but not accurate, etc., so that these qualities, and hence the descriptive beliefs about them, may vary independently. These descriptive beliefs may form more generalisable inferential beliefs about the overall quality of the information. It is possible that there are some important aspects of information that we have failed to include in our theory, so that the inferential belief may be less reliable than the descriptive beliefs it is based on.

If the information is generally considered to be of good quality, this may contribute to the user's belief that the website is useful. This is a further level of inference. Finally, their beliefs about usefulness will contribute towards an overall attitude towards the website. As we increase the scope of what we are measuring, we have decreased the reliability of the measure – other, unmeasured factors, such as the customer's general attitude towards technology, their past experiences with other websites and information channels, etc., may contribute to their attitude.

Next, we illustrate the principles from psychometrics by developing a multi-indicator structural model (MISM). This statistical model is only an illustration, and does not necessarily demonstrate all the qualities required of a robust, empirically testable MISM. According to our theoretical model, accuracy, timeliness and relevance are descriptive beliefs that are antecedent to an overall perception of information quality. Each of these is modelled with a single indicator, e.g. "I believe that this website provides accurate information". Since this is a maximally valid and immediate measure of the construct, we do not need multiple indicators. In fact, trying to construct other indicators would likely lead to changes in the construct's meaning, as other items will be less immediate and therefore likely be related, if every so slightly, to other constructs. Using the most direct measures available makes it unnecessary to employ complex statistical means to assess reliability and validity. Validity is obvious from the wording of the indicator and the closeness to the concept while reliability is given by the specified measurement error. Insistence on complicating the issue for no purpose other than to comply with inappropriate recommendations for multiple indicators brings no benefit when the reasons for using multiple indicators are not applicable. As Figure 6 shows, more generalized and abstract beliefs, such as "Perceived Usefulness" may well require multiple indicators to ensure their validity and reliability. For the indicators of descriptive beliefs we constrain the error variance to a small value, e.g. 10% to 20% of the variable's variance, since they are direct measures, self-reported by the customer, and therefore likely to be held with high certainty. Hayduk (1996) suggests performing sensitivity analyses on the error variances for additional control.

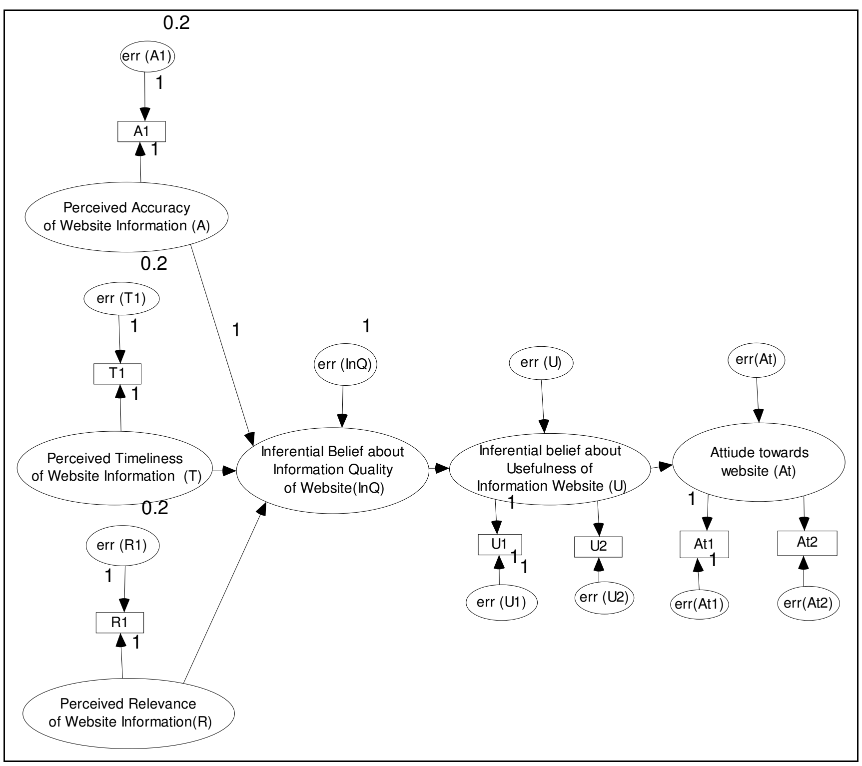

Figure 6: Example of a MISM

These descriptive beliefs cause an inferential belief about the information quality of the website. We free the error term on this construct, as it is possible that there are unknown other descriptive beliefs that contribute to overall beliefs about information quality. Next, we hypothesise that beliefs about information quality contributes to a belief about usefulness, which contributes to an overall positive attitude towards the site. It is likely that this will explain only a portion of the variance of attitude towards the information website, as there are likely to be other, un-modelled constructs that also contribute.

The meaning, scope and likely generalisability of the theory are made clear in this example. We have eschewed a generic label such as "perceived usefulness" and made explicit exactly what we mean by perceived usefulness in this theory net. We have modelled what we believe are important antecedents to perceived usefulness and overall attitude that have salience *in this context*. We have allowed different characteristics of information to vary independently, which provides the model with high diagnostic power. It is possible that the contribution of the various qualities of information might vary from one information provisioning site to another. For example, timeliness might make greater contribution to the perceived information quality of a traffic report website than to an advanced mathematics homework revision site, where accuracy and relevance to the syllabus might be more highly valued. Such variations can be easily tested for by applying the *fully estimated* model from one context to another context and examining fit.

This suggests that a theory is more than the union of constructs and statistically significant causal relations. It also contains the measurements (which are often viewed outside of the theoretical realm, but need to be justified in the same terms as "structural" hypotheses. Moreover, and most important, and most frequently neglected in the IS context, the theory also includes the *strength* of the causal relationships. This suggests that a theory of usability of a traffic report website is different than the theory of usability of a math homework site, even though the constructs, measures, and significance of relationships are identical. Imagine two theories of relativity, the first to suggest that $E=mc^2$ and the second to suggest that $E=3.1415 \times mc^2$. Surely, we would argue that these are two different theories, despite the fact that both relate Energy and Mass in the same structural way. Yet, this fact is frequently overlooked in IS theorising where the focus appears to be on the presence or absence, rather than the strength of relationships.

Implications and Conclusion

We identified a number of issues that have impeded the development of usable IS theories of user perceptions and attitudes towards technology. Over the last two decades, we have made claims of the generalisability of theories such as the TAM (Benbasat and Barki. 2007). The TAM has been "extended" with the addition of other belief constructs such as trust and self-efficacy (Benbasat and Barki. 2007).

More recently, the general pursuit of theory generalisability at the expense of accuracy (Seddon and Lyytinen 2008); the claims on a cumulative tradition of research into user perceptions and attitudes towards technology (Benbasat and Barki 2007); and the appropriateness of the scope of these theories have all been called into question. Theories of user attitudes and beliefs such as the TAM suffer from an excessive focus on user beliefs at the expense of the technology artifacts that cause them. This has resulted in a lack of focus, over the last 10 years, towards advancing our understanding of the technology antecedents of beliefs, since so much energy has been expended on the TAM and its extensions. These extensions to the TAM have not greatly enhanced our understanding of this phenomenon, since beliefs have been explained in terms of other beliefs, rather than expanding the boundaries of the system (Benbasat and Barki, 2007).

The contribution of this paper is to offer some guidelines for addressing these problems. We offer a new approach for developing theories of perceptions and attitudes towards technology that is well grounded in theory and highly practical. We show how the relevant aspects of the technology artefact can be included in a theory net by identifying its functional affordances as antecedents to user perceptions and attitudes. These affordances constitute the scope and boundary of the theory (the extent to which it can be generalised), so we can avoid excessive claims of generalisation. We provide guidelines from social psychology for modelling the formation of attitudes based on descriptive beliefs (perceptions). We separate descriptive beliefs from inferential beliefs and overall attitude. When descriptive beliefs are closely modelled on affordances, which are based on external design features, the model can describe the impact of a specific design feature on the user's affect towards a technology. This provides a theory that responds to the challenge of Benbasat and Barki (2007): It allows those involved in the management and design of technologies to evaluate the impact of specific changes and interventions. Finally, we draw on contemporary psychometrics to show that it is possible to develop highly practical, testable models that are well grounded in psychometric theory, using these principles.

Our discussion suggests some opportunities for future research. We have offered guidelines for extending theories of user attitudes and perceptions “backwards” to include perceived technology affordances. Future research could extend further, and investigate the interactions between the actual technical features and functionality of technology artifacts (which could be analysed using representation theory) and the user’s perception of the functional affordances.

A potential issue with our heuristics is that our approach will likely change the assumption of the possibility of a cumulative research tradition in this area of information systems theory. By constraining the scope and generalisability of theories of user attitudes and perceptions towards technology to the *relevant* function affordances of a technology artefact (or a class of artifacts sharing the same affordances), we place clear bounds around the generalisability unless the context is similar, which means that theories cannot be arbitrarily extended.

Even when the scope has been clearly defined, the functional affordances differ between technology artifacts, and the functional affordances of a class of technology artifacts (for example, websites) may change over time. In fact, “intellectual” technologies such as computer-based systems are more flexible and dynamic than other technology artifacts (Curley et al. 1982). This means that as a field, we may be constrained in our ability to build a cumulative tradition which is also salient to practitioners in specific contexts. If the antecedents of user perceptions and attitudes become outdated, then the theory itself will become outdated and require revision.

In conclusion, the heuristics we offer here have the potential for developing highly nuanced, granular, and accurate description of the process of formation of user attitudes and perceptions towards technologies. We make some sacrifices in generalisability, but it is likely that the previous levels of generalisability of this area of theory have been over-claimed anyway.

In combining insights from multiple fields, we have developed and illustrated what we suggest are highly practical heuristics for developing theories of user attitudes and perceptions towards technology, which allow this area IS theory to reclaim its proper identity, and the study of user attitudes and perceptions towards technology to progress.

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