USER ACCEPTANCE OF INFORMATION TECHNOLOGY:

THEORIES AND MODELS

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This item is not the definitive copy. Please use the following citation when referencing this material: Dillon, A. and Morris, M. (1996) User acceptance of new information technology - theories and models. In: M. Williams (ed.) Annual Review of Information Science and Technology, Vol. 31, Medford NJ: Information Today, 3-32.

OUTLINE

ABSTRACT

Understanding the factors that influence user acceptance of information technology is of interest both to researchers in a variety of fields as well as procurers of technology for large organizations. The present chapter reviews literature which demonstrates the nature of technological acceptance is mediated by distinct factor groups related to the psychology of the users, the design process of information technology, and the quality of the technology in user terms. It is concluded that current research offers insights that can support the derivation of reliable predictions of user acceptance. However, potentially overlapping theories seem to exist independently of each other and there exists scope for a unifying framework to extend innovation diffusion concepts and systems design models (particularly user-centered design) into a formal theory of user acceptance of information technology.

keywords: user acceptance; user-centered design; human-computer interaction; socio-technical systems; technology acceptance; innovation diffusion; usability; utility; acceptability; computers; models.

INTRODUCTION

While millions of dollars have been spent on information technology in the US over the last 30 years, there has been recent debate over the extent to which such expenditures have produced benefits to business and academia (LANDAUER). At least part of this debate revolves around the issue of whether information technology is actually accepted by its intended users. Without acceptance, discretionary users will seek alternatives, while even dedicated users will likely manifest dissatisfaction and perform in an inefficient manner, negating many, if not all, the presumed benefits of a new technology (EASON). In the present chapter, we will review the treatment of the issue of user acceptance and its corollary-resistance-as it applies to information technology design and implementation. In so doing, we will draw on literature in the distinct areas of innovation diffusion, technology design and implementation, human-computer interaction (HCI) and information systems (IS) where the concept of acceptance has been explicitly tackled.

While much published material addresses issues of design and evaluation of systems to enhance usability, this is not our primary focus, and no attempt is made in the present chapter to produce design guidelines or review user interface evaluation studies. (SHNEIDERMAN offers an excellent introduction.) Instead, the review will concentrate on the determinants of user acceptance and resistance as these concepts have been addressed theoretically and empirically in the scientific literature on information technology design and use. Specifically, the present review will emphasize literature that seeks to indicate how researchers and developers may predict the level of acceptance any information technology will attain.

THE CONCEPT OF ACCEPTANCE

For present purposes, user acceptance is defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. Thus, the concept is not being applied to situations in which users claim they will employ it without providing evidence of use, or to the use of a technology for purposes unintended by the designers or procurers (e.g., using an Internet connection for personal entertainment in a work situation). Obviously there is a degree of fuzziness here since actual usage is always likely to deviate slightly from idealized, planned usage, but the essence of acceptance theory is that such deviations are not significant; that is, the process of user acceptance of any information technology for intended purposes can be modeled and predicted.

Lack of user acceptance is a significant impediment to the success of new information systems (GOULD ET AL; NICKERSON). In fact, users are often unwilling to use information systems which, if used, would result in impressive performance gains (e.g., ALAVI & HENDERSON; SWANSON, 1988). Therefore, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project (DAVIS, 1993).

Both practitioners and researchers have a strong interest in understanding why people accept information technology so that better methods for designing, evaluating, and predicting how users will respond to new technology can be developed. Although practically intertwined, design and evaluation are logically independent issues, as noted by DILLON, and it remains an open question in many instances how to translate usability evaluation results to specific interface design improvements. Acceptance theory seeks to extend the traditional model of user-centered design espoused in usability engineering approaches (e.g., NIELSEN) from questions of interface improvement towards predictions of likely usage.

Historically, developers and procurers of new technology may have been able to rely on authority to ensure that technology was used, at least in industrial/organizational contexts, though even the much maligned scientific management of TAYLOR appealed to the motivational power of financial reward in encouraging workers to use the tools designed for them in the way in which they were told. However, current working practices, as well as the leisure and educational applications of information technology, render the search for predictive measures of acceptance more acute. As technological use spreads across society and organizations become more dependent on information technologies, the concern with designing information systems that will be used appropriately grows.

Researchers have studied a range of issues related to this topic, from individual user characteristics such as cognitive style (HUBER) to internal beliefs and their impact on usage behavior (e.g., DESANCTIS; FUERST & CHENEY; GINZBERG; IVES ET AL; SRINIVASAN; SWANSON, 1987). Acceptance has been viewed as a function of user involvement in systems development (BARKI & HARTWICK; FRANZ & ROBEY; HARTWICK & BARKI) or as a measure of the political climate in an organization (MARKUS). The type of system development process used (e.g., ALAVI) and the process by which technology is implemented and diffused (e.g., BRANCHEAU & WETHERBE; FICHMAN; MOORE & BENBASAT) have also been explored. None of these variables can account for sufficient variance in acceptance to enable a researcher, procurer, or designer to predict user acceptance reliably.

The search for a single-variable answer is unlikely to yield an explanation of the level of acceptance any information technology will receive among its intended users. However, there are distinct trends in the literature that suggest the issue is not intractable, and several clusters of determining variables have been proposed. This literature is diverse and emerging from distinct disciplines. Though THOMPSON covered tangentially related work under the heading of "technology utilization" in Vol. 10, this is the first ARIST chapter on information technology acceptance. Thus it is appropriate to tackle this topic in a manner that affords the reader some insight into the range of perspectives that converge on this problem as well as the precise empirical findings to date.

At the highest level, acceptance has been subsumed under the theoretical analysis of innovation diffusion, and it is appropriate to start coverage of the topic here. However, precise analysis of user acceptance has now become a central concern of disciplines studying information technology in particular rather than general technological innovations. This work concentrates more directly on the determinants and importance of user acceptance, rather than the broad issues of social diffusion, and is the major focus of the present chapter. More than one theoretical approach is necessary for our complete understanding of the issues involved, and, for clarity, approaches are treated independently at the outset.

INNOVATION DIFFUSION THEORY AND INFORMATION TECHNOLOGY

Perhaps the principal theoretical perspective on technology acceptance is innovation diffusion theory, which has been applied at both individual (e.g., ROGERS) and organizational (e.g., ZALTMAN ET AL.,) levels of analysis. Its primary intention is to provide an account of the manner in which any technological innovation moves from the stage of invention to widespread use (or not). Though not concerned with information technology exclusively, diffusion theory offers a conceptual framework for discussing acceptance at a global level.

Diffusion theory posits five characteristics of innovations that affect their diffusion: relative advantage (the extent to which a technology offers improvements over currently available tools), compatibility (its consistency with social practices and norms among its users), complexity (its ease of use or learning), trialability (the opportunity to try an innovation before committing to use it), and observability (the extent to which the technology's outputs and its gains are clear to see). Each of these characteristics on its own is insufficient to predict either the extent or the rate of diffusion, but diffusion studies have demonstrated that innovations affording advantages, compatibility with existing practices and beliefs, low complexity, potential trialability, and observability, will be more extensively and rapidly diffused than an innovation with the cluster of opposite characteristics (ROGERS). An early meta-analysis of the innovation diffusion literature found that three of these characteristics had the greatest influence on adoption: compatibility and relative advantage were positively related to innovation adoption ($p < .05$), while complexity was negatively related to adoption at marginally significant ($p < .062$) levels (TORNATZKY & KLEIN). However, the authors criticized the then current conceptualizations of these constructs. Relative advantage, in particular, was cited as especially ambiguous because the criteria used to judge what is "advantageous" is often not defined (e.g., an innovation could be advantageous because it costs less or is less complex).

In examining and extending these characteristics in a context specific to information technology (IT), MOORE & BENBASAT report an extensive effort to develop an instrument which can be used to evaluate user perceptions of IT innovations. Their results suggest that the most important perceived characteristics of an IT innovation which affect decisions regarding use are: voluntariness of use, image ("the degree to which use of an innovation is perceived to enhance one's image or status in one's social system," p. 195), relative advantage, compatibility, ease of use, trialability, result demonstrability, and visibility. These results lend at least partial support to ROGERS' factors, but add an important emphasis on variables related to discretion and ease of use.

Innovation diffusion theory suggests that factors at the level of the individual user are also important. ROGERS divides technology or innovation adopters into five categories depending on their speed of uptake: innovators, early adopters, early majority, late majority, and laggards. Such distinctions could be seen as somewhat fuzzy, not least because any distribution over time could be so divided. However, Rogers plots these categories over a normal distribution where each major category (innovators and early adopters are combined into one for this purpose) represents a standard deviation of dispersion. Accordingly, the division between early and late majority is the mean, with laggards and late adopters constituting 50% of the population. On this basis, Rogers estimates that early adopters and innovators jointly make up only 16% of the total population. Early adopters have disproportionate influence over the adoption of any technology, and profiling studies of these categories have revealed a number of personality (e.g., risk-taking, adventure seeking) and socioeconomic (e.g., wealth, education) variables that supposedly distinguish their members.

This approach seems to have direct relevance to studies of IT acceptance in organizations. BRANCHEAU & WETHERBE showed that the cumulative adoption distribution of spreadsheet use closely follows a sigmoidal, S-shaped curve, as predicted by innovation diffusion theory. Thus, organizations evaluating technology for use in the organization must be cognizant of the user base for which the tool is both designed and purchased. For a tool that will be used throughout the organization, it is reasonable to expect that a protracted period of time may be required before all users are "up to speed" on how to use the tool effectively. Understanding users who are likely to be "laggards" is important; intervention strategies (i.e., extended training) can be designed with those users in mind.

Recent research has attempted to extend diffusion theory to more complex adoption scenarios. For example, managerial influence in the organization can encourage (or discourage) acceptance explicitly through expressed preferences and/or mandates (LEONARD-BARTON & DESCHAMPS; MOORE & BENBASAT) and through reward systems and incentives (LEONARD-BARTON). Thus, studies that examine acceptance at the level of the organization need to account for the potential importance of managerial influence.

The innovation diffusion approach seems to have been useful in the area of end-user computing (EUC) within the IS literature, as many of the theoretically strong EUC studies (e.g., BRANCHEAU & WETHERBE; MOORE & BENBASAT at the individual level; BROWN & BOSTROM at the organizational level) are based on theories of innovation diffusion. In fact, in their review and analysis of the EUC literature, BRANCHEAU & BROWN suggest innovation diffusion as a promising basis for future EUC research.

While diffusion theory provides a context in which one may examine the uptake and impact of information technology over time, it provides little explicit treatment of user acceptance. Its most direct link would appear to be in the area of innovation characteristics that may drive individual adoption decisions (i.e., the perceived complexity, compatibility, etc. of a particular IT) and innovation positioning (the planned marketing of a technology to a specific group or organization)(ROGERS). As researchers seek to identify the factors that determine user acceptance of any information technology and, in particular, factors that can be influenced by design, the question of acceptance has come to be tackled more directly by researchers working outside (or at least on the outskirts of) the classical innovation diffusion tradition. Most noticeably, researchers in the fields of human-computer interaction and management information systems (MIS) have drawn heavily on theoretical work in social and cognitive psychology, as well as sociology, in studying user acceptance. For purposes of clarity, a distinction is drawn here between those theoretical approaches seeking to understand the social and psychological determinants of user acceptance at an individual level and those seeking to understand user acceptance in terms of the design and implementation process of new technology.

THEORETICAL APPROACHES TO UNDERSTANDING THE PSYCHOLOGY OF USER ACCEPTANCE

Acceptance has been conceptualized as an outcome variable in a psychological process that users go through in making decisions about technology. In this literature, there is little or no emphasis placed on the design of usable interfaces; to researchers in this area, the system design (including the user interface and the tasks supported) are, for practical purposes, fixed. Instead, this research seeks to understand the dynamics of human decision making in the context of accepting or resisting technology. Much of this work comes from the field of Management Information Systems (MIS), where research seeks to predict how users in an organization will react to new technologies. Drawing on the work of social psychologists concerned with human action, this research offers an explicit treatment of the acceptance issue utilizing constructs and theoretical approaches that are not typically cited in the innovation diffusion literature.

The Theory of Reasoned Action and Its Derivatives in User Acceptance

FISHBEIN & AJZEN'S Theory of Reasoned Action (TRA) in the social psychology literature (see Figure 1) defines relationships between beliefs, attitudes, norms, intentions, and behavior. According to this theory, an individual's behavior (e.g., use or rejection of technology) is determined by one's intention to perform the behavior, and this intention is influenced jointly by the individual's attitude and subjective norm, defined as "the person's perception that most people who are important to him (*sic*) think he should or should not perform the behavior in question" (Fishbein & Ajzen, p. 302, italicized comment added).

According to TRA, attitude toward a behavior is determined by beliefs about the consequences of the behavior and the affective evaluation of those consequences. Beliefs are defined as the individual's subjective probability that performing a given behavior will result in a given consequence. Affective evaluation is "an implicit evaluative response" (FISHBEIN & AJZEN, p. 29) to the consequence; thus the attitude construct in TRA is general in nature and is not anchored to any given belief set . This approach represents an information processing view of attitude formation and change which states that external stimuli influence attitudes only through changes in the person's belief structure (AJZEN & FISHBEIN).

Figure 1. Theory of Reasoned Action (FISHBEIN & AJZEN)

However, attitude alone does not solely determine behavioral intentions. Intentions are determined also by subjective norms, which, in turn, are determined by an individual's normative beliefs and motivation to comply with perceived norms. The end result is a generalized model for understanding the determinants of human behavior in situations where people may exert their choices. The model has been used to make accurate predictions of human choice in situations as diverse as voting in elections (BOWMAN & FISHBEIN) and consumption of alcoholic beverages (SCHLEGEL ET AL.,). In their meta-analysis examining the application of TRA, SHEPPARD ET AL. found that the theory performed extremely well in the prediction of choice among alternatives. They concluded that the theory was exceptionally robust and offered strong predictive utility, even when used to investigate situations and activities falling outside the original boundary conditions of the theory (such as predicting nonvoluntary behavior, or when intentions were assessed even before subjects had all the information necessary to form a completely confident intention).

The Technology Acceptance Model (TAM)

While TRA is a general model applicable to many areas, a number of MIS specific models have been derived from TRA. Of these models, the most widely cited is DAVIS' (1989) Technology Acceptance Model (TAM) (see Figure 2). The goal of TAM is to predict information system acceptance and diagnose design problems before users have experience with a system. TAM predicts user acceptance of any technology is determined by two factors: perceived usefulness and perceived ease of use.

Within TAM, perceived usefulness (U) is defined as the degree to which a user believes that using the system will enhance his or her performance. Perceived ease of use (EOU) is defined as the degree to which the user believes that using the system will be free from effort. Both U and EOU are specific perceptions and are anchored to specific beliefs users hold about the system. According to TAM, U and EOU have a significant impact on a user's attitude toward using the system (A), defined as feelings of favorableness or unfavorableness toward the system. (Thus, attitude is a general construct not tied to any specific beliefs about the technology.) Behavioral intentions to use the system (BI) are modeled as a function of A and U. BI then determines actual use. Research has consistently shown that BI is the strongest predictor of actual use (DAVIS ET AL., TAYLOR & TODD).

Figure 2. Technology Acceptance Model (DAVIS ET AL)

There are several interesting differences between TAM and TRA. First, DAVIS ET AL explicitly drop subjective norms from the model, arguing that the subjective norm construct is context-driven. They explain that, while subjective norms may be important in some settings, in the empirical work validating TAM, it was not found to be an important predictor of intentions. Davis et al explain that, because the technology studied was of a personal and individual nature (i.e., use of the technology was not dependent on others' use of the same technology), system usage was not likely driven by social influences.

Another important difference is that TAM proposes a direct path from perceived usefulness to intention, violating TRA which shows attitude completely mediating the relationship between beliefs and intention. According to DAVIS ET AL, in the work environment, intentions to use IT may be based on its anticipated impact on job performance, regardless of the individual's overall attitude toward that system. In other words, even though an employee may dislike a system, that employee may still use the system if it is perceived to increase job performance (thus, it has high perceived usefulness).

A final note of interest regarding TAM's divergence from TRA is the direct effect of EOU on U. In other words, when faced with two systems offering identical functionality, a user should find the easier one to be more useful. DAVIS states that if a user becomes more productive via ease-of-use enhancements, then he or she should become more productive overall. The converse (that U influences EOU) does not hold, however.

Thus, from a theoretical perspective, perceived ease of use influences perceived usefulness, but not vice versa.

In their work validating TAM, DAVIS ET AL. found a stronger relationship between perceived usefulness (U) and intentions to use than perceived ease of use (EOU) and intentions. The relationship between EOU and intentions was largely mediated by U. In comparing TAM and TRA, DAVIS (1989) found that TAM was a better predictor (based on the amount of variance explained, R2) of intentions to use a particular software package, reporting an R2 of .47 for Time 1 (immediately after the introduction of the software) and an R2 of .51 for Time 2 (14 weeks later). These figures were compared with .32 and .26 for TRA at Time 1 and Time 2, respectively. DAVIS (1993) reports similar results in looking at different technology and removing behavioral intentions from the model. TAM has been found to be extremely robust and has been replicated using different tasks (ADAMS ET AL., MATHIESON). In a comparison of several models, Mathieson found that TAM predicted intention to use a spreadsheet package better than alternative models. In another comparison of theoretical models, TAYLOR & TODD found that TAM provided a good fit to data on the use of a computing resource center, accounting for 34% of the variance in behavior, 52% of the variance in intention, and 73% of the variance in attitude.

In another study examining the efficacy of TAM, ADAMS ET AL. suggested that both U and EOU may change over time and that perceptions of EOU may develop only through prolonged usage. STRAUB ET AL. further supported the validity of the perceived usefulness and perceived ease of use constructs, finding that the TAM measures explained 48.7% of the variance in self-reported system usage. However, for computer-generated (objective) measures of use, the TAM variables explained only about 7% of the variance, suggesting that other factors may be significant predictors of system usage.

While STRAUB ET AL. did not suggest any specific factors that may be important, some (e.g., Adams et al.,TOPI) have suggested a user's experience with the system may be one factor having substantial influence, while others have suggested self-efficacy (e.g., HILL ET AL., WOOD & BANDURA) as an important antecedent of individual behavior. However, this area remains relatively unexplored.

Theory of Planned Behavior

While the Theory of Reasoned Action (TRA) has been the most widely used theory for examining user acceptance, other theoretical perspectives have also been used. The Theory of Planned Behavior (TPB) (AJZEN, 1985, 1991) is a descendant of TRA and adds a third antecedent of intention, perceived behavioral control, to the TRA model. Perceived behavioral control is determined by the availability of skills, resources, and opportunities, as well as the perceived importance of those skills, resources, and opportunities to achieve outcomes. Perceived behavioral control has been viewed to be close to BANDURA's (1982) self-efficacy belief concept (Ajzen, 1991).

TPB holds that attitudes, subjective norms, and perceived behavioral control are direct determinants of intentions, which in turn influence behavior. TPB is illustrated in Figure 3.

Figure 3. Theory of Planned Behavior (AJZEN, 1991)

In attempting to apply TPB (which, like TRA, is a generalized model), a Decomposed Theory of Planned Behavior (TAYLOR & TODD) has also been examined in the IS literature which attempts to identify and model the specific antecedents to attitude, subjective norm, and perceived behavioral control relevant to IT use. Taylor & Todd suggest perceived usefulness, perceived ease of use, and compatibility as antecedents of attitude (largely consistent with TAM). In addition, they suggest that peer influence and superiors' influence are antecedents of subjective norm. Finally, they model self-efficacy, resource-facilitating conditions, and technology facilitating conditions as determinants of perceived behavioral control.

While not as extensively studied as TAM, the literature provides several tests of TPB. However, the results have been somewhat mixed. MATHIESON tested both TAM and TPB and found that, while TPB was predictive of user intention, it did not provide as complete an explanation of intention as TAM. In addition, Mathieson noted that TAM was easier to apply.

TAYLOR & TODD tested the decomposed version of TPB discussed above and found that TAM was a (slightly) better predictor of usage, but that the decomposed TPB model provided a more complete (albeit slight) understanding of the determinants of intention (R2 = .57 for TPB and .52 for TAM). The authors note that, in choosing between TAM and the decomposed TPB, the trade-off of moderate increases in explanatory power for intentions versus added complexity is a difficult one. The decomposed TPB adds seven more variables to increase the predictive power of behavior 2% over TAM. However, the decomposed TPB also helps researchers better understand the roles of subjective norms and perceived behavioral control, which are absent from TAM. Taylor & Todd conclude that if the goal is to predict IT usage, TAM may be better; however, if the goal is to better understand specific determinants of intention, the decomposed TPB may offer additional explanatory power.

Thus, the Theory of Reasoned Action and its derivatives (specifically, the Technology Acceptance Model and the Theory of Planned Behavior) provide a useful and robust composite perspective on the issue of technology acceptance. These theoretical approaches have provided an important contribution to this MIS research stream, and additional studies have been attempting to build on the existing body of knowledge in this area. (VENKATESH & DAVIS).

Related work

Other theorists have proposed psychological variables that influence acceptance independently of the TAM or TRB frameworks. For example, IGBERIA demonstrates the importance of experience on acceptance of IT, while TORKZADEH & DWYER suggest, on the basis of their data, that user training influences acceptance by impacting satisfaction and user confidence. Clearly, there is a vast range of variables that could correlate with acceptance, and theoretical guidance is required both to make sense of the most important ones and to indicate how their influence operates. In their meta-analysis on systems implementation research, ALAVI & JOACHIMSTHALER develop a framework suggesting that the individual user factors most relevant to the issue of acceptance are cognitive style, personality, demographics, and user-situational variables.

Cognitive Style. Cognitive style has historically proven a controversial variable in both theoretical and applied literatures in psychology, HCI, and IS research. In general, cognitive style refers to the characteristic ways in which individuals process and use information (GOLDSTEIN & BLACKMAN) and can be seen in human information processing terms as a stable pattern of handling incoming stimuli and formulating responses. Cognitive style theorists posit dimensions upon which individuals can be placed according to their characteristic pattern of information processing. To date, more than one hundred different dimensions can be found in the literature, although a core cluster accounts for the majority of the work on this topic. For example, the Myers-Briggs Type Indicator (MBTI) (MYERS), based on Jungian constructs, consists of four scales designed to measure extraversion-introversion, judging-perceiving, sensing-intuition, and thinking-feeling dimensions. Despite interest among researchers in the potential explanatory power of the variables, serious doubts about the efficacy of the MBTI have been suggested and, through empirical testing, have been shown to be justified (ALAVI & JOACHIMSTHALER, HUBER).

Personality. Personality refers to the cognitive and affective structures maintained by individuals to facilitate adjustment to events, people, and situations (GINGRAS, GOUGH). Personality traits that have been suggested to impact IT acceptance include need for achievement, degree of defensiveness, locus of control, dogmatism, and risk-taking propensity (GINGRAS; ZMUD). Many of the personality constructs currently found in the literature closely resemble cognitive style dimensions, suggesting a general blurring of the distinctions between these terms in some literatures.

Demographics. A number of demographic variables including age and education have also been studied and shown (in some contexts) to influence system use (BENBASAT & DEXTER; MOCK ET AL., TAYLOR). Certainly, there is little surprise that age or education influences use of technology within broad parameters, but the relationship is not strong enough to account for all (or even most) of the variance in user responses.

ALAVI & JOACHIMSTHALER include a class of variables they term "user-situational variables" that include training, experience, and user involvement, which correlate well with acceptance of new technology. In their meta-analysis, they found that the broad group of user-situational factors were more important than individual difference variables.

These results are supported by GUIMARAES ET AL., who found that "characteristics of the decision maker" (including organizational level and experience with the technology) explained the most variance in measures of overall satisfaction, decision-making satisfaction, and perceived benefits of the technology. They also found that "characteristics of the implementation process" (including user involvement, training, and top management support), which are similar to the "user-situational factors" of ALAVI & JOACHIMSTHALER, explained a significant amount of variance in each measure taken (overall satisfaction, decision-making satisfaction, and perceived benefits of the technology).

RAMAMURTHY ET AL. have examined a class of variables which they term "user specific characteristics" and their link to user effectiveness with technology. In their model, personal/demographic variables suggested to affect user performance with technology include domain expertise (operationalized as education) (LUCAS, LUSK), domain experience (TAYLOR, 1975; WHITE, 1984), system experience (FUERST & CHENEY, SANDERS & COURTNEY), gender (DAMBROT ET AL., PARASURAMAN & IGBARIA), and intelligence (e.g., CHERVANY & DICKSON). Ramamurthy et al. also include cognitive style and personality as important predictors of technology performance, consistent with ALAVI & JOACHIMSTHALER discussed earlier.

In their study, RAMAMURTHY et al. found that domain expertise, system experience, intelligence, and gender had important influences among one or more dimensions of technology effectiveness (measured as performance, efficiency with the tool, and user satisfaction). Interestingly, among the cognitive style dimensions, sensing and thinking types outperformed intuitive and feeling types. Finally, among personality dimensions, introverts performed better than extroverts on the efficiency dimension, but there were no differences in performance or satisfaction.

Thus, there is a clear stream of research which has examined the influence of individual psychological variables on user performance or acceptance of technology and which lends support to the idea that user situational variables are the most important determinants. There is a parallel here with the innovation diffusion literature which has examined characteristics inherent in the tool (or innovation) and their role in technology acceptance. Clearly, both individual and tool-specific characteristics are important; however, there is a dearth of theoretical models that link both perspectives in understanding the nature of technology acceptance.

THEORETICAL APPROACHES TO THE DESIGN OF ACCEPTABLE TECHNOLOGY

While the findings on user acceptance as a psychological construct both shed light on the forces that determine individual behavior and enable researchers to predict with some accuracy how users will respond to a given application, there is a need to address acceptance at the outset of technology development, prior to investing in development costs. Furthermore, even if individual user acceptance could be assessed, it is clear that implementation and use issues at the organizational level are more than just the composite of individual utility and ease of use ratings (EASON). In the present section, we review literature that explores these issues and that can inform the design and development process of information technology to ensure or at least increase the acceptance of any resulting artifact.

Socio-Technical Systems Theory of Acceptance

The socio-technical systems perspective has become influential in the analysis of the organizational impact of technology. Originating in work carried out by the Tavistock Institute in London (e.g., TRIST ET AL.,) on the introduction of mining technology in Britain, socio-technical systems theory views any organization as an open system of interdependent sub-units, transforming inputs to desired outputs. As the theory has moved on from its original psychodynamic model of human behavior, the term "socio-technical" has become synonymous with almost any analysis of a configuration of technology and users (CHERNS), though its use in the present chapter is linked more closely to the researchers and theoreticians who have developed the concept.

A fundamental tenet of socio-technical systems thinking is that a technology on its own (in the form of its technical capability) has little meaning for purposes of organizational analysis, being truly comprehensible only in terms of the context in which it is embedded and, by extension, the organizational goals or transformations that it serves or enables (PASMORE & SHERWOOD,). Moving beyond a concern with one user and an interface, socio-technical systems theory argues that a network of social relationships surround all working practices (e.g., cooperation among workers over the course of a task, supervisory relationships, and general social interaction) (ARGYLE). The gainful employment of any technology hinges on the ability and willingness of users to employ it for worthwhile tasks (i.e., those deemed central to the organization's goals). Accordingly, any technology cannot be analyzed or understood in isolation of the goal-oriented organization it is intended to support. In order to jointly optimize both the social and technical attributes of any organization, allowance must be taken at the engineering level of the social dynamics of any organization or sub-unit within it (CHERNS).

Socio-technical systems theory has given birth to a framework for technology design that emphasizes holistic job satisfaction (rather than just task performance) and user participation throughout the development process (MUMFORD). Thus, socio-technical theorists recommend the analysis of all stakeholders, not just the direct users of a technology, the formation of planning groups to oversee the design, the performance of prototyping exercises, and the analysis of likely impact the technology will have on the organization (EASON). The intention of such a design process is to avoid unpleasant side effects in working practices and to ensure as much a social solution as a technical solution to the computing needs of an organization.

Though historically influential in Europe, Asia, and North America, the socio-technical approach has been criticized by some researchers as more management-oriented than truly user-centered (EHN). Concerns that participant users may become victims of groupthink over time, that power in making design decisions resides with the same management groups, and that the theory takes an overly simplistic view of job satisfaction have been aired in recent critiques (e.g., PAIN ET AL.; RAMSAY). However, socio-technical systems approaches have been pivotal in shifting technology design away from just financial and technical concerns manifest in traditional software development models such as the "waterfall" model (BOEHM) towards a more user-centered perspective.

In studying technology acceptance, socio-technical theorists such as EASON (1988) conceptualize acceptance in terms of two competing forces: control and enhancement. Control factors are those that impose rules or structures upon the users, thereby removing autonomy (control over their own actions) from them. According to socio-technical thinkers, working group autonomy is to be encouraged since it is considered to increase satisfaction and long-term performance. Among the control issues raised with respect to technology design are: access, reliability, confidentiality, monitoring, pacing, stress, social contact. Low or high presence of certain factors (e.g., low reliability, high pacing) with the introduction of a new technology is likely to reduce the users' perception of control and thus increase the risk of resistance.

Enhancement factors include sense of mastery, growth of knowledge, discretion, ability to act informally, requirement for certain skills, and enabling worker cooperation. These factors should all be maximized as appropriate for the context (though skill requirements are not to be inherent for certain situations). A technology that is designed to support such factors is likely to increase user acceptance in an organization.

Supporting evidence for the specific effects of control and enhancement variables on acceptance of information technology is scarce, though these factors propose a specific path for research. Socio-technical thinkers tend to emphasize these as part of the holistic view of organizational impact of information technology that must be managed throughout the design process. In proposing autonomy, growth, and job satisfaction as important values, emphasis is placed on user participation in the design process through task analysis, usability evaluation, and planned introduction. Case studies of designs and their introduction mark the typical socio-technical analysis of information technology (e.g., KLEIN & EASON; MARKUS), rendering specific and individual weighting of control and enhancement factors problematic. Recently, HARTWICK & BARKI reviewed the research on user participation and concluded that there is a low correlation between participation and use (mean r=0.12). They proposed the concept of psychological involvement as an intervening variable in this relationship, suggesting further avenues for research.

Related theories of acceptance

While the socio-technical perspective has gained most currency in the literature, there are several related approaches to design that warrant mention. Though many of them share much of the basic socio-technical emphasis on organizational fit and stakeholder influence on acceptance, they are frequently presented as distinct approaches in the literature.

Collective resources approach. Perceived shortcomings in the treatment of power relationships in socio technical theory have led to the emergence of what has been termed the Scandinavian (BAECKER ET AL) or Collective Resources Approach (EHN). This theoretical perspective is closely related, and indeed emerged partly from, developments in socio-technical theory when it was applied in Sweden and Norway by practitioners. It is distinguishable in its strong political perspective that seeks to actively engage trade unions as equal partners in the planning of work and the technology that will support it. Well documented accounts of the collective resources approach can be found in Ehn and in GREENBAUM & KYNG.

Soft-Systems Methodology. Soft-Systems Methodology (SSM) emerged, like socio-technical systems thinking, as a response to the supposedly "harder" technical perspective that seemed to be driving systems engineering in the 1960s and early 1970s (CHECKLAND). Emphasizing the need for multiple perspectives on the value and utility of any technical system, depending on it being viewed by users, managers of users, or technical developers for example, SSM seeks to encourage the development of a technology that is most suitable for any given context. It has been described somewhat disparagingly as a "manager's methodology" that fails to adequately address the political power relationships in the design and implementation of new technology (PAIN ET AL.) but it has been influential as a specific framework for conceptualizing systems analysis (CHECKLAND & SCHOLES).

Activity theory. Activity theory is an approach to understanding human work and technology which emphasizes the long-term well-being of workers or users (HACKER). Eschewing "one best way" task design for user-determined task procedures, action theorists seek to design work practices that are enriching and that lead to development of skills and knowledge (GRIEF). Assuming internal regulatory processes on the part of the user and needs for flexibility, self-control, and self improvement, activity theorists argue that acceptance of technology is contingent on the extent to which it meets these goals in the context of the user's own work. In so saying, activity theory largely aligns itself with the broad humanistic aims and the methods of the socio-technical approach. It is at least partially distinguishable by its emphasis on praxis, the shared sense of how activities are to be performed (BANNON & BODKER), rather than an emphasis on the product of the organizational process which characterizes socio-technical systems thinking.

Human-centered design. Human-centered systems design is a more recent approach to design that emerged in the UK. in the early 1980s (COOLEY). Sharing many of the basic assumptions of all the above-mentioned approaches, it goes further in explicitly denying the possibility of a scientific approach to systems design and encourages immersion on the part of the design team in the praxis and lives of the organization members any tool is designed to support (PAIN ET AL). As yet, the fruits of this approach have not been assessed outside of the work of its chief protagonists.

Human-Computer Interaction and the Usability Engineering Approach to Acceptance

Addressing more traditional human factors concerns of workstation and interface design, the field of human-computer interaction (HCI) has long sought to influence the development of more user-centered technology. In so doing, HCI research has moved from its original concern with hardware ergonomics and screen design to the point where the complete range of user issues are of interest. Current textbooks on HCI (e.g., PREECE ET AL; BAECKER ET AL.) cover the gamut of issues from basic user psychology to design guidelines, from models of the design process to models of skill acquisition, from cost-benefit analyses of user-centered design to analyses of the social impact of new technology.

HCI research has concentrated heavily on the concept of usability, both in terms of its definition and its measurement (DILLON, NIELSEN). Though not equivalent to the concept of acceptance, most HCI researchers assume that the more usable a technology is made, the greater its chances of proving acceptable to users. To this end, many HCI researchers emphasize employing techniques very similar to those of socio-technical theorists (e.g., user participation, rapid prototyping of interfaces, use of focus groups) in trying to design more usable systems (e.g., GOULD), thus blurring distinctions between many of the social science and engineering research traditions that have an interest in developing more humanly acceptable systems.

The concept of usability has evolved through several stages of definition. Though one may trace its use back to DE QUINCEY, its modern application to information technology initially equated it with the idea of designing for ease of use (HANSEN). Hence one may find definitions of usability both in terms of equivalent semantic expressions ("user friendly" STEVENS, "easy-to-use" DU BOULAY ET AL.) and in relationship to the presence or absence of certain interface features (e.g., windows, icons, menus, and pointers) (SHNEIDERMAN). Neither approach has proved sufficiently satisfactory, given findings on industrial practice (DILLON ET AL.) and the contextual dependencies of usability (WHITESIDE ET AL.).

Recently, probably because of the field's close links with engineering and manufacturing industries, operational definitions have replaced semantic and feature-based definitions, and a draft international standard for usability has been proposed. According to ISO 9241 pt. 11, the usability of an application refers to the effectiveness, efficiency, and satisfaction with which specific users, performing specific tasks in specific environments, can use an application. Such a definition is seen as providing a target to be set for designers to meet in any given context and shifts the focus from interface creation to evaluation in seeking to understand usability. Consequently, researchers have developed tools and measurement techniques in response to this definition that supposedly enable the usability engineering approach to be put into practice throughout the product development cycle (e.g., BEVAN & MACLEOD; NIELSEN).

One of the few researchers to make explicit the link between usability and acceptability is SHACKEL. According to his formulation, an acceptable system is one that appropriately satisfies the requirements of its users for utility, usability, and cost. Utility refers to the range of functions provided by the technology, the activities it will enable users to perform. Note that utility so construed is not the same as DAVIS' construct of perceived usefulness outlined earlier in this chapter. Users may rate utility high for their intended use, but these ratings may not equate with more objective measures of utility derived from formal task analysis (e.g., DRURY ET AL.), although in some contexts there would almost certainly be close correspondence. Usability refers to the extent to which users can employ these functions in an effective, efficient, and satisfactory manner, while cost is self-explanatory. For any one user, or organization, trade-offs between these variables may be made; some users might be willing to sacrifice cost savings for greater usability, while others might consider usability of lesser importance compared to financial outlay and utility.

Such a conceptualization poses potential problems for evaluation in organizational terms, since end users are frequently not the purchasers. As a result, perceptions of cost, and their impact on the acceptability equation, are likely to be drawn from people who are not providing the measure of usability or perhaps even of utility. Reconciling these differences may prove problematic and theoretically there exists a strong point of contact between usability engineering and more socio-technical approaches to design.

Furthermore, such differentiation in data sources suggests potential incommensurability between usability engineering and MIS approaches to acceptance.

However, operational definitions of usability, framed within an acceptability equation of the kind advocated by SHACKEL, offer a pragmatic approach to tackling acceptability. By performing task analysis and agreeing on the utility that needs to be provided within a system, then testing people's use of it through effectiveness, efficiency, and satisfaction measures, the HCI approach can provide a means of measuring and predicting acceptability explicitly. Within mainstream usability engineering, such pragmatic concerns tend to drive the research base. This can be seen in recent attempts to understand the relative value of user based tests over expert evaluations (NIELSEN), the cost-benefits of usability evaluations in terms of product development costs (BIAS & MAYHEW), and, most recently, the debate over the number of users that one needs reliably to identify problems with a system (LEWIS, VIRZI). LANDAUER makes a case for extending this type of research, arguing that it offers the best hope for advancing the field of technology design to yield more acceptable systems.

Usability engineering specialists, like socio-technical theorists, seek to influence the complete process of design, but the approaches are somewhat distinct in terms of the relative emphasis they place on the physical and conceptual design of the interface. Although the usability literature makes reference to organizational level issues (GOULD), it is not a major focus of this research, and recommendations for design tend to concentrate on methods and techniques for developing the user interface. This relationship is inverted in the socio-technical literature where interface issues tend to be relegated to a side-issue, hence the attempts by theorists such as EASON and SHACKEL to reconcile the two.

Related work

It should not be concluded that only social scientists and HCI researchers are concerned with user acceptance or that user-centered design stands in opposition to traditional information technology design practice. In many ways, design methods form a continuum from the more technology centered to the more user-centered, with few designers or methodologists existing at the extremes.

BOEHM has proposed a spiral model of software design that stands in sharp relief to the waterfall model and places strong emphasis on prototyping and re-design, two major characteristics of usability engineering methods. Furthermore, structured design methods such as Structured Systems Analysis and Design Methodology (SSADM) (CUTTS) or Jackson Systems Design (JSD) (JACKSON), supposedly rigorous methods for ensuring a logical design, are being modified to incorporate more user-centered techniques (DAMODARAN, in the case of SSADM; LIM ET AL., in the case of JSD) so that user acceptance might be more directly tackled, although the success of such approaches remains to be seen.

CONCLUSION

The question of user acceptance is of concern to all researchers and procurers who wish to predict which candidate technologies will prove most suitable for an organization or how a given design is likely to be received by users. As such, the issue draws on multiple theoretical perspectives and on research topics as diverse as change management in organizations, human attitude formation, systems analysis, user interface design, and technology diffusion.

Innovation diffusion theory provides a general framework within which the social impact of a technology can be modeled and, in so doing, it seeks to provide insights into the characteristics of those groups who will adopt a technology at different phases, or into characteristics inherent in the technology that may influence specific groups to adopt it. However, predicting how any one group or user will receive a new technology is not the province of diffusion theory, and this question is better tackled within the specific decision-making framework provided by TAM.

In seeking to influence the design of technologies to maximize their acceptance, organizational analysis approaches, such as socio-technical systems theory, enable the planning of work activities around technology in a manner that minimizes resistance and ideally maximizes the potential for user satisfaction and development. Of the many theories in this domain, there appears to be much overlap, and the term "socio technical systems thinking" is a generically applicable title for this commonality.

Finally, usability engineering affords the means of factoring acceptance into the design of the interfaces between users and the technology. By articulating the concept in an (at least partially) operationalized form, usability engineering work in the field of HCI offers pragmatic techniques for maximizing the chances of the acceptability at the interface between the system and the individual user.

Clearly, each approach offers something to our understanding of the issue of user acceptance. At this time, there appears to be little hope for an overarching theory that will encompass both the explanation and the prediction of user acceptance, as well as providing the tools for ensuring that any design process leads to an acceptable product. However, the terrain is mapped, and further research can yield the type of answers that are still sought.

In particular, a direct mapping between TAM and the operational definitions of usability and utility manifest in the HCI literature would be useful, as it is not clear whether the

HCI definition of usability is just a more decomposed version of TAM's ease of use. Clearly, TAM offers a tight theoretical linkage of constructs that have been shown to play an important role in user acceptance. However, the degree to which this theoretical outline can play an important role in actually guiding system design has not been evaluated. On the other hand, HCI conceptualizations of product acceptability and usability are grounded in practice, and it appears that theoretical relationships between usability elements (e.g., effectiveness, efficiency, and satisfaction) have not been resolved. In part, this requires a detailed examination of the extent to which the three components of the ISO definition are equally important. Certainly, these issues deserve direct empirical examination, but there appears to be little evidence that anyone has tackled them yet. This is certainly a fruitful area for further research.

At the other extreme, research into the negotiation of criteria of acceptability among participants in an organizational design context, where power structures and technical competencies are mixed, would also be insightful and go some way to bridge socio-technical, usability engineering, and acceptance predictability paradigms. Ideally, theory should inform practice and vice versa; thus, understanding both the practical as well as theoretical problems associated with technology acceptance should remain important for all research in this domain.