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ACCEPTANCE AND ACCEPTABILITY CRITERIA: A LITERATURE REVIEW

Boris Alexandre^{1,*}, Emanuelle Reynaud¹, François Osiurak^{1,2}, and Jordan Navarro¹

¹ Laboratoire d'Etude des Mécanismes Cognitifs (EA 3082), Université de Lyon, France

² Institut Universitaire de France, Paris, France

* Corresponding author. Email: boris.alexandre@univ-lyon2.fr. Tel: 33 4 78 77 43 35

The full postal address is the same for all the authors

Laboratoire d'Etude des Mécanismes Cognitifs (EA 3082)

Institut de Psychologie

5, avenue Pierre Mendès-France, 69676 Bron Cedex, France.

RUNNING HEAD: ACCEPTANCE AND ACCEPTABILITY CRITERIA

ABSTRACT

One of the common issues related to tool use is to know why certain tools are chosen, accepted and used by users, while others are rejected. The aim of this paper is to find out if there are criteria related to the tool that can explain this decision. This manuscript proposes a literature review about acceptance and acceptability and presents the different historical approaches that have proposed an explanation to this issue (i.e. Ergonomics approach, Social approach, Productivity-oriented approach, Hedonic approach, User-experience approach), together with acceptance criteria listed in the field of psychology, ergonomics, or cognitive science. Subsequently, a synthetic view and an interpretation of the evolution of the issue of tool acceptance is proposed, along with a new classification of acceptance and acceptability criteria, which consists in grouping criteria present in the literature in four meta-criteria.

Keywords: Tool Use; Acceptance; Acceptability; Technology

ACCEPTANCE AND ACCEPTABILITY CRITERIA: A LITERATURE REVIEW

1. INTRODUCTION

Humans are unique in constantly modifying and improving tools and technologies¹ over generations. The corollary is that some tools are progressively replaced by others, raising the critical issue of the reasons why a tool is adopted or rejected by users. A broad definition of technology adoption is proposed by Rogers (1995), as a process starting from the discovery of an innovation and leading to the final adoption of a tool. Adoption is here defined as an individual (or collective) decision to accept and use a tool. More specifically, the process of adoption can be subdivided into two sub-processes based on the temporality of the interaction between the user and the technology (Barcenilla and Bastien 2009; Lee et al. 2003). Acceptability is an a priori phenomenon in the time scale of our confrontation with a tool, and it predicts intent to use (Barcenilla and Bastien 2009; Février 2011). It is defined as an explicit willingness to use a tool (Dillon and Morris 1996). In other words, acceptability is the more or less positive mental representation that a tool user has before using the tool (Tricot et al. 2003). Acceptance is defined as an a posteriori pragmatic evaluation, implying that a real activity is required from the user prior acceptance evaluation (Février 2011). In practice, when confronted to a new tool the user assesses acceptability at first, then after tool use tool acceptance is constructed (Bobillier-Chaumon and Dubois 2009). This distinction between actual use (i.e. acceptance) and a priori perceived use (i.e. acceptability) is essential, notably because the representation of a tool is not completely defined in advance but also generated during actual tool use (Tricot et al. 2003).

The issue of tool adoption has been addressed by several approaches, including ergonomics, sociology, cognitive science and psychology. In this context, a variety of concepts have emerged (e.g., usability,

¹ The terms 'tool' and 'technology' will be hereafter used interchangeably. 'Tool' refers to unattached object and handheld physical implement that is manipulated by the user to make a change in the environment (see Osiurak et al. 2010)

learnability, accessibility), sometimes generating confusion as to the definitions offered for these different concepts. The main objective of this review is to dispel this confusion by providing a thorough overview of the key criteria associated to acceptance/acceptability according to the following approaches: Ergonomics, Social Psychology, Productivity-oriented, Hedonic, User-experience, and Independent criteria. From this overview, we will propose a synthetic view based on key “meta-criteria”, which should help the reader understand the main similarities and discrepancies between the different approaches discussed.

2. APPROACHES TO ACCEPTANCE AND ACCEPTABILITY

2.1. ERGONOMICS

The first approach to acceptance has been developed by psycho-ergonomics. The main idea of this approach (also called tool-use centred approach) is that there are ergonomic criteria that will make a tool used and accepted. In this respect, they have identified two main criteria, namely, usability and accessibility.

Early definitions of usability explain this concept as an easy and effective use, the tool seen as a suitable support to complete a task (Bevan 2001; Shackel 1981). Nielsen (1994) stressed that usability is an evaluation criterion of a tool and is ipso facto acceptance criteria of the tool, and proposed to divide it into five dimensions: Efficiency, satisfaction, ease of learning, ease, and reliability (see also Dubois and Bobillier-Chaumon 2009). This proposal is relatively consistent with previous ones. For instance, Shackel (1981) decomposed usability criteria into four criteria with same weight: Effectiveness, learnability, flexibility and attitude (see also Harvey 2011). As summarized by Harvey et al. (2011), usability is defined as a concept involving usability (easy to manipulate), utilisability (achieve a goal at lower cost), operability (ability to keep a tool in a reliable functioning condition) and accessibility (make a tool usable for everyone) (Harvey et al. 2011). This concept of usability has been used for construction of ISO standards (Barcenilla and Bastien 2009; ISO/IEC 1998). According to ISO 9241-18, a product is usable when it allows the user to perform the task with "effectiveness, efficiency and satisfaction in a specified context of use".

Although the concept of accessibility is sometimes included in the definition of usability (e.g., Harvey 2011; see just above), it is thought as an independent criterion from usability (Bobillier-Chaumon and Dubois 2009). Accessibility means that a tool should be flexible, adapted to everyone (Bastien et al. 1998). As pointed

out by Brangier et al. (2010), access to technology is a precondition of usability. In this context, accessibility is naturally critical for disabled users.

The tool-use centred approach also proposes a methodological contribution, such as user tests to evaluate tool use performance. Nielsen (1994) created a famous usability evaluation, based on performance measures along with observational data and interviews with users (Nielsen 1994; Tricot et al. 2003). A number of authors have also contributed by listing many ergonomics recommendations (e.g. Bastien and Scapin 1992). However, a limitation to this approach is that its proponents have mainly focused on functional aspects linked to acceptability (before use), thereby neglecting acceptance (actual use).

2.2. SOCIAL PSYCHOLOGY

Within this approach, the user is considered as a social agent. Consequently, new issues have arisen: What are the social determinants of tool use (Fishbein and Ajzen 1975)? How our engagement in a tool influences the representation of its use (e.g. Bandura 1977)? What are the mechanisms of diffusion of innovation (e.g. Rogers 1995)? These issues will be detailed here in turn.

Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) are early theories from social psychology applied to acceptance. The TRA, developed by Fishbein and Ajzen in 1975, argues that behavioural intention determines real behaviour and acceptability (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975). In turn intention is determined by the following criteria: Performance, attitude and subjective norms (Li 2008). Ajzen (1991) describes performance as the task completion success, attitudes as the belief toward the tool and subjective norms as the social pressure to use a tool or not. TPB, an extension of TRA also developed by Fishbein and Ajzen (1975), adds three concepts to TRA. The first concept is effective use, implying that performance during tool use determines our intention to re-use it. The second concept is perceived behavioural control, which consists in an auto-evaluation of the user skills and resources in regard to tool use (Ajzen 1991; Février et al. 2008). The third additional concept is motivation defined as the engagement in tool use (Bobillier-Chaumon and Dubois 2009; Chau 1996; Chau and Hu 2002; Taylor and Todd 1995). These two theories are the theoretical basis of the Technology Acceptance Model (TAM) proposed by Davis (1989; see below).

Another major proponent of this approach is Bandura (1977; 1982; 1997), with the notions of agency and self-efficacy. Agency can be defined as the agent personal influence on his/her own functioning (Beillerot

2004). Self-efficacy, a concept that arises from agency and implied by it, is the overall personal judgment of being competent enough to implement a skill to use a technological system (Compeau and Higgins 1995; Février 2011). After all, the agent has no reason to act if not convinced to meet some success. Higher self-efficacy will lead to higher expectations of results with tool use, thus generating more engagement and less auto-depreciation. Tool use and acceptance are therefore linked to the criteria of motivation and belief in the fulfilment (Bandura 1997; Beillerot 2004). Bandura (1982) distinguished between vicarious experience (tool use compared to others individuals) and active experience (personal previous experience with a given tool) (see also Beillerot 2004). In connection with this theory, Luarn and Lin (2005) showed that self-efficacy directly impacts perceived intent to use as well as ease of use. Malhotra and Galletta (1999) also pointed out that subjective norm is a major contributor to self-efficacy.

Rogers (1995) and Tornatzky and Klein (1982) have championed the theory of diffusion of innovation. At the tool level, a technology must (a) have an advantage relatively to traditional strategies, (b) be compatible with users' values, experiences and needs of individuals and groups, (c) be easy to use, and (d) have quick and visible positive benefits. At the user level, the theory of diffusion of innovation assumes that, in a group, individuals have different characteristics and, as a result, different users' profiles (Hammes-Adelé 2011): A minority of innovative users (early adopters), then the early and late majorities of users (in two distinguished steps), and finally the laggards (a minority resistant to change). Therefore, a fundamental criterion of the tool acceptance would be the user profile. Each profile has distinctive features and is more or less inclined to tool use (Rogers 1995). Interestingly, inspired by the aforementioned attributes, Moore and Benbasat (1991; see Li 2008) proposed a revised version of TAM, with the following criteria: Relative advantage, complexity, image, visibility, and compatibility. In the same line, Tornatzky and Klein (1982) emphasized that compatibility, relative advantage and complexity impact the diffusion and acceptance of a technological system.

2.3. PRODUCTIVITY-ORIENTED APPROACH

Following both the ergonomic and social approaches, a user-centred and productivity oriented approach emerged from the 1980's. The most famous model is the Technology Acceptance Model (TAM) proposed by Davis (1989; Davis et al. 1992). The role of TAM is to predict the behaviour of the user (Legris et al. 2003) with intention of use (i.e. acceptability). The main criteria explaining the use in this model are Perceived Usefulness

(PU) and Perceived Ease Of Use (PEOU) (Davis 1989). Davis defines PU as “the degree to which a person believes that using a particular system would enhance his or her job performance” and PEOU as “the degree to which a person believes that using a particular system would be free of effort” (Davis 1989). PEOU and PU are defined as cognitive construct (or cognitive beliefs), and those must be differentiated from emotional construct that is attitude and behavioural constructs that are intention of use (Park 2009). PU and PEOU are two independent dimensions, and PU has the strongest link (50% more influential than PEOU) on use and intention of use, and PEOU is the second criterion (Davis 1989; Legris et al. 2003). The TAM was found accurate and reliable in a variety of contexts (Venkatesh and Davis 1996; Venkatesh and Davis 2000) and explains about 30% of the variance of actual use, and 40% of the variance of intention to use (Février 2011; Legris et al. 2003; Park 2009). Several TAM evolutions have added contributing criteria to PU and PEOU, such as the influence of the support, motivation, the responsiveness of the tool, visibility, experience of individual, etc. (Venkatesh and Davis 2000). Sun and Zhang (2006) underlines that evolutions of TAM can be on the individual dimension (e.g. improvement of the attitude), technological dimension (e.g. improvement of tool's variable: Complexity, purpose, learnability, etc.) or organizational dimension (e.g. motivation, place, etc.). TAM model has been used and amended by other authors, see Brosnan 1999; Erasmus et al. 2015; Ghazizadeh et al. 2012; Hsu and Lin 2008; Lee et al. 2005; Malhotra and Galletta 1999; Park 2009; Pituch and Lee 2006; Romdhane 2013; Vallerand 1997; Venkatesh and Davis 2000 for some examples. Venkatesh and Davis themselves offer a second version of their model called TAM 2, in which they added to PU and PEOU the social influence (defined as the subjective norm, image and voluntarism) and four instrumental processes: The pertinence of the task, the quality of the output, the demonstrability of results (i.e. the degree to which the results and benefits are apparent and tangible), the criterion of experience, user attitude, behavioural intention, actual use of the system and external variables (individuals or socials, link to the system or to the organizational context, see Koh et al. 2010; Venkatesh 2005; Venkatesh et al. 2003). As in the theory of reasoned action, subjective norm refers to social pressure to decide to use a technology (Ajzen 1991). This model demonstrates that the quality of output and demonstrability of results have a positive effect on the PU criterion (Li 2008). It may be noted that TAM2 explains 60% of variance of use, which is a considerable improvement over the first version (Park 2009). Over time, Davis will also separate ease of use criterion in three clusters: Physical effort, mental stress and learning difficulty; usefulness is also separated into three mains clusters: Job effectiveness, productivity and time saving, and importance of the

system to one's job (Davis et al. 1992). As underlined in an exhaustive literature review of Legris et al. (2003) on TAM, results are contradictory and inconsistent. If the original model is quite strong and achieves unanimity, researchers are unable to agree on the importance of each criterion. From one study to another, PU could be considered to have the greatest influence whereas PEOU could have none on the acceptance or on intention to use (Keil et al. 1995; Subramanian 1994) or the reverse (Chau, 1996; Igbaria et al. 1997; Jackson et al. 1997; Legris et al. 2003; Lucas and Spitler 1999). However, as said earlier and confirmed by King and He (2006) the TAM is valid and robust, and remains a gold standard. The variability and disparity of results, and sometimes the fact that there are too many variables is the main weakness of the TAM. Venkatesh et al. (2003) intended to unify knowledge on this topic, and created the Unified Theory of Acceptance and Use of Technology (UTAUT). This model is a synthesis of eight models and explains 70% of the variance of acceptability. There are four criteria: Performance expectancy, effort expectancy, social influence and facilitating conditions, with some moderators (gender, age, experience, voluntariness). Theoretically speaking, the UTAUT model includes constructs from eight models or theories: Theory of reasoned action, motivational model, theory of planned behaviour, model of PC utilization, innovation-diffusion theory, social cognition theory, a model combining the technology acceptance model and the theory of planned behaviour and TAM (Li 2008). This model was born from the observation that if PU is the best determinant of use (as reported in TAM 1), antecedents of PEOU and PU criteria should also be understood (Venkatesh and Davis 1996). From this model validation, the authors conclude that the following three criteria are the most important: Performance expectancy, social influence and efforts expectancy (Venkatesh et al. 2003).

Other models (Dillon and Morris 1996; Nielsen 1994; Triandis 1980) are based on a productivity-oriented approach. The model of Dillon and Morris (1996) opposed real usefulness to perceived usefulness. This model allows to differentiate perceptions and judgments from effective, practical and real facts; the use gives feedback that modifies our judgment (Dillon and Morris 1996). In another model, Nielsen made the theoretical choice of opposing social acceptability (context, social norms, personality, experiences) from practical acceptability (reliability, cost and usefulness, composed of utility and usability) (Février 2011; Nielsen 1994). Theory of interpersonal behaviour (TIB) of Triandis (1977) explains acceptance and acceptability with criteria of habits, context, affect and facilitating conditions (Triandis 1980). More exactly, Triandis distinguished cognitive components (beliefs about the tool) from affective component (feelings and attitudes) (Li 2008; Thompson et al.

1991). Finally, the theory of cost-benefit paradigm (Beach and Mitchell 1978; Johnson and Payne 1985; Payne et al. 1993) claims that the result of our interactions with tools and final judgment would be an evaluation of the cost compared to benefits: If the gain is greater than the effort our acceptance is more likely to be positive. The quality of the result and the effort (cognitive or physical cost) are two criteria that come into competition. The theories and models presented above show a determinist model, because the user is often seen as a rational decision maker. But other models put more emphasis on the subjective judgment and emotion, as we will see now.

2.4. HEDONIC APPROACH

In the literature, satisfaction is often mentioned as a determinant of usage. Bailey and Pearson (1983) and Cyert and March (1963), the precursors, implemented questionnaires to assess users' satisfaction. This approach is based on the idea that acceptance is reachable only if users are satisfied with the tool (Dahab 2001). Satisfaction is sometimes referred to as the "funology" or "joy of use" (Davis et al. 1992; Hassenzahl et al. 2000). For Romdhane (2013) satisfaction in literature is seen as a positive experience of interaction with a tool or device. Theoretically speaking, it is a real break with previous models. As Van Der Heijden (2004) stressed, we can now distinguish productivity-oriented approach (i.e. utilitarian) versus pleasure-oriented approach (i.e. hedonic). It is assumed that more pleasure means more productivity and larger use. In these models, the fundamental difference with the first models inspired by TAM is that perceived enjoyment and perceived ease of use are stronger determinants than perceived utility.

The information systems success model by DeLone and McLean (1992) defines satisfaction as being the potential result of use, because the most frequent users are the most satisfied. Originally proposed by Doll and Torkzadeh (1988), DeLone and McLean (1992) added the criteria of the system quality and information quality as determinants of satisfaction; they also emphasized the importance of the context. Note that in their updated model, they added quality service and net benefits (DeLone and McLean 2003).

In the expectation confirmation theory (or disconfirmation theory sometimes), Oliver (1980; 1981) argued that it is the confirmation of expectations on tool that determines our acceptance and continued tool use, i.e. the gap between the users' expectation and his actual experience. A small gap means that a priori goals have been achieved, so that the user is satisfied, and conversely a significant gap means dissatisfaction. Moreover, an

expectation confirmation leads to users' satisfaction and favour continuous use (Bhattacharjee 2001; Lankton and Harrison McKnight 2014).

Wixom and Todd (2005) mixed the model of user satisfaction, TAM and use criteria of information quality, composed by completeness, accuracy, format, and currency, system quality, composed by reliability, flexibility, integration, accessibility and timeliness, information satisfaction, system satisfaction, usefulness, ease of use, attitude and intention. The model explained 59% of variance of intent to use. The literature includes many studies and information on satisfaction models, see Lankton and Harrison McKnight 2014; Lindgaard and Dudek 2003; Rai et al. 2002; Seddon 1997; Van Der Heijden 2004.

Finally, another hedonic concept is *flow*, proposed by Csikszentmihalyi (1990), described as extreme concentration. Being in flow state means to be intensely involved in a task, this state is therefore connected to the general user satisfaction. Finneran and Zhang (2003) defines flow as an "experience itself composed of: Concentration, loss of self-consciousness, time distortion, and telepresence." Flow experience has a significant influence since it represents the degree of involvement in a task (Van Schaik and Ling 2012). According to Heutte and Fenouillet (2010) the state of flow has 4 dimensions: Cognitive absorption, altered perception of time, lack of concern about oneself, and well-being of the user. State of flow is a criterion for tool acceptance as positive experience and satisfying subjective state, which makes someone wishing to extend the action or the use in progress. Benefits of flow in tool use have been shown by many authors, see Finneran and Zhang 2003; Ghani 1991; Ghani and Deshpande 1994; Trevino and Webster 1992.

2.5. USER-EXPERIENCE APPROACH

Another dimension of the literature about acceptance and acceptability focuses on the importance of the use-related situation, context and experience as holistic unit, which determines our acceptance. This theoretical framework uses a mix of all the criteria exposed in precedent frameworks. Historically, two theoretical ruptures are being set. On the one hand, the idea that acceptance is gained in a given context (for example professional context, see Docq and Daele 2001), therefore tool use being part of situated action. A tool is always considered in a real context of use and implementation. Besides it is never acquired but rather challenged by each situation and varies among individuals (Bobillier-Chaumont and Dubois 2009). The importance of the context and the environment had already been studied in psychology and biology, in particular with the concept of affordance

(i.e. the idea that our cognition is contextualised in relation to the environment, with a set of action possibilities in an environment; see Gibson 1979) and the concept of enaction by Varela et al. (1993; i.e. the idea of "structural coupling" with the environment because our cognition is embodied, in interaction with self-environment, and the experience is a dynamic structure, inseparable from our environment). On the other hand, many authors now employ the term User Experience (UX), while others use the expression human-computer interaction (Brangier et al. 2009). The general idea of user experience is to consider the experience and the dynamics of interaction, with the idea that this dynamic in the user experience can influence the tool user socially (Brangier et al. 2010). Morville (2004) gives those criteria of UX: Useful, usable, valuable, desirable, findable, credible and accessible. Models of UX are based on the evaluative judgment of experience, with a global tool value and a holistic approach. In this approach, interaction and success of interaction are explained by a final evaluating opinion that includes a set of criteria, rather than an acceptance mechanism as previous models.

In Hassenzahl's UX model, there is a distinction between the designer's perspective and the user's perspective; UX is inseparable from these two actors. In addition to conventional criteria (efficiency, security, etc.), the criteria for acceptance are pragmatic qualities (productivity-oriented and associated with system manipulation) and hedonic qualities (associated to the resonance of the use in the subject, i.e. evocation, stimulation and identification; Hassenzahl et al. 2000) In addition, some criteria are associated with the tool: Content, presentation, functionality and interaction.

Another famous UX model is the CUE-model by Thüring and Mahlke (Mahlke 2008; Mahlke and Thüring 2007). In this model, there are three clusters of criteria: Perception of instrumental quality (pragmatic quality, usefulness of content), emotional reactions (positive affect and negative affect) and perception of non-instrumental qualities (hedonic quality, perceived enjoyment). As in Hassenzahl's model, there is a distinction between hedonic criteria (non-instrumental qualities) and production-oriented criteria (instrumental qualities). Those criteria will lead to user experience outcomes, composed by an overall evaluation (on beauty and goodness) and behavioural intention to use. In addition to those components of UX, the model takes into account some interaction characteristics, as user characteristics (intrinsic motivation, need for cognition), task/context characteristics (mode of use) and perceived artefact characteristics (perceived aesthetics, user interface design, disorientation, adequacy of information and accessibility).

Another concept in UX is symbiosis. Licklider (1960) isn't related to the UX concept, but he was the first to evoke the concept of symbiosis. The concept of symbiosis means a co-evolution. The symbiosis is "the hybridization between human and technology, also called symbiosis, neosymbiosis or technosymbiosis (Brangier and Hammes-Adelé 2011). For Brangier and Hammes-Adelé (2011), symbiosis between the tool and the user is defined by 1) a co-extension (an information transfer) 2) a co-evolution (an improvement of both parts, with a competition between both parts) 3) a co-action (i.e. continuous feedback) and 4) a co-dependency. The tool and the user must have those four criteria to be symbiotic. Brangier et al. (2009) give examples of ergonomic criteria involved in the symbiotic tool-user relationship. The main contribution of this approach is the fact that the preferred system is the one that increases the most our capacities (Licklider 1960), amplifies our cognition and improves human assistance (Brangier et al. 2010). To summarize, the more skillful a technology, the more it increases the chances of producing a symbiotic relationship, and therefore a good acceptance of technology.

Finally, we can note that the distinction between user experience models and classical acceptance model is not so clear, and differences are probably small, given the issues raised by the UX approach. For example, the importance of the environment, the dynamics of acceptance, the co-evolution of the tool and the individual, have been raised by researchers linked to models of acceptance. However, this does not mean that this approach is vain: While some researchers like Van Schaik and Ling (2012) use the term of experience of interaction, others like Barcenilla and Bastien (2009) describe the experience of a user as scattered experience, to signify all the difficulty to enter the experience of the user, which is multidimensional. Proulx (2002) evoked adoption trajectory and trajectory use. So beyond theoretical and partisan struggles, the important idea is that there is multidimensionality and complexity of the situation in tool adoption. User experience approach can measure what the tool gives to the user in terms of feelings and emotions, and integrates the experiential part on acceptance's issue.

2.6. INDEPENDENT CRITERIA

Other researchers made suggestions without necessarily creating a model or being part of a theoretical trend or another. We can mention: Aesthetics criteria (Bonnardel et al. 2011; Tractinsky 1997), importance of emotional design (Norman 2004), trust (or confidence) in tool, which predicts intend to continued use and acceptability (Biassoni et al. 2016; Kazi et al. 2007; Lankton and Harrison McKnight 2014; Sætren and Laumann 2015). User

profile (as age, level of education, gender, user characteristic, past use, cognitive skills, etc.) is also a frequently mentioned criterion that modifies tool use (Agarwal and Prasad 1999; Beier and Ackerman 2005; Compeau et al. 1999; Czaja et al. 2006; Freudenthal and Mook 2003; Gefen and Straub 1997; Johnson and Kent 2007; King and He 2006; Mathieu and Zajac 1990; Meyer and Allen 1984; Umemuro 2004; Venkatesh and Morris 2000). The attitude towards technology is also a criterion found in the literature (Al-Gahtani and King 1999; Blackwell et al. 2014; Czaja et al. 2006; Pommeranz et al. 2012; Selim 2007). Cognitive load is also a criterion mentioned by Debue et al. (2013), and finally quality of information (the content of information system and its complexity for the user) is a criterion in the literature (Biassoni et al. 2016; Swanson 1982).

The decision theory (or theory of decision making) from applied mathematics can also bring knowledge about tool acceptance, including user choice and strategies used to make a decision (Montmain et al. 2005), in our case to select a tool and adopt continuous use. Models of deductive reasoning in decision-making are based on the concept of maximum gain: People choose the least risky solution (Baratgin 2002). Bayesian theory of reasoning is a reference theory (Cozic 2005), assuming that decision is selected according to criterion of expected utility (Cozic 2005); decision-making is therefore based on the principle of probabilization of natural states. A certain probability is associated with every choice, and an individual will use the tool with the highest probability of maximizing his gain. Meanwhile, Espinasse (2009) emphasizes the need for studying the issue of the rationality of the decision maker. For example, transitivity which is conventionally a mathematical relationship accepted in Bayesian and expected-utility models is not necessarily valid for a given decision-making. For example, if an individual prefers A to B and B to C, the same individual will not necessarily prefer A to C (Tsoukias 2006; Tversky 1969). Individuals are not rational and logical subjects (Tversky 1969), and that increases the difficulty to understand and modelize their behaviour with a tool. Also, during the 60's, it was found that several decision criteria can be in competition (Tsoukias 2006), and that it is not only a unique gain function. Another point is the differences between collective and individual decisions. There are collective decisions that everyone takes, but also some individuals do not adhere to these collective choices and have a taste for autonomy. Montmain et al. (2005) highlighted the existence of individual differences in terms of heuristic, particularly due to the existence of cognitive biases that vary among individuals but also the personality of decision-makers. For example, some individuals may be more intuitive and others more rational. Several results on decision theory applied to a group, including the work of Rockenbach et al. (2007), show that

a group will be the most effective because a group can accumulate more gains expected at low risk levels. Finally, Baker et al. (2008) and Shupp and Williams (2008) have shown that groups are more aversive for low than high probabilities of gains.

3. THE NEED FOR A NEW READING GRID

3.1. GENERAL OVERVIEW

To summarize, we can propose this diagram of the historical evolution of the criteria of acceptability and acceptance (**Fig. 1**). Even if, as we have seen, there are many theories and approaches, five main approaches emerge: (a) The social psychological approach, like the TRA and TPB, with three criteria that stand out: Norms, attitude and beliefs, and (b) The ergonomics approach, with studies in ergonomics and the development of standards; this approach has mainly brought the criteria of accessibility, aesthetic and usability. These two approaches are the pillars of acceptance theories, and have greatly influenced the following theories and researches. Subsequently, two other models have been developed with the contributions of a multitude of researchers: (c) Productivity-oriented approach, with for example TAM and UTAUT, whose main criteria are utility and ease of use, and (d) Hedonic approach, with for example Expectation disconfirmation theory or the DeLone-McClean Model, which stresses the importance of criteria of satisfaction, fun enjoyment or motivation. Finally, shortly after and influenced by the latter two mentioned models, the user-experience approach (e) has emerged; one can mention in particular Hassenzahl's model and Mahlke's model, which retain as criteria a mix of all the previous criteria, but underline the importance of the subjects' emotional and subjective experience.

< INSERT FIGURE 1 ABOUT HERE >

3.2. META CRITERIA IDENTIFICATION

The purpose of this manuscript is not just to review the historical variance of criteria in the different approaches of acceptance and acceptability. This review on acceptance and this inventory of criteria can allow a proposition of a new reading grid, according to five clusters based on the literature review namely: Utility, ease of use, aesthetics, contextual & social differences and overall judgement. Following our literature review, 142 criteria of acceptance or acceptability have been identified, listed and sorted according to our five clusters. (33 in

utility, 37 in ease of Use, 4 in aesthetics, 44 in contextual and social differences and 24 in overall judgment). A hundred different concepts and criteria to talk about acceptance are too many, and the goal of this classification is to remove the unnecessary and show that a lot of criteria are similar and can be associated: Many approaches or theories use new words associated with old concepts, doing nothing more than make the problem more complicated. To give an example, Perceived Usefulness is a criterion mentioned in the TAM model. This criterion can be found in many other models and approaches, but under other names: For example, in the Hassenzahl's model under the name of Production-oriented Criteria, or under the name of instrumental quality in the CUE-model by Thüring and Mahlke. Moreover, the different researchers working on acceptance are not working in the same disciplines and do not have the same research interests (psychologists deal with cognition, engineers with tools, ergonomists with the use, economists with performances, anthropologists with the human), so researchers tend to describe the same phenomenon from a different perspective and with different words. In short, there are many concepts and criteria in literature because this is the same problem seen through different prisms, implying an unnecessary multiplication of concepts.

Regrouping those 142 criteria in five clusters, composed of four main meta-criteria (utility, ease of use, aesthetic and contextual and social differences) and an independent cluster (overall judgement), can be an effective way to better understand the phenomenon of acceptance and help to clarify the domain for future researches. The four meta-criteria are defined as follows: 1) *Utility* is focused on production. It expresses the purpose of the tool and its function. Utility is summed up by this question: What to do or produce with the tool? 2) *Ease of use*, which expresses the means of reaching the goal, the difficulty of use of the tool, associated cognitive and/or physical cost. In sum: How difficult is it to manipulate the tool? 3) *Aesthetic*, which is a judgment of the agreeability of the tool and refers to the aesthetics features. In sum: Is the tool pleasant and appealing to me? 4) *Contextual and social differences*. This meta-criterion contains all criteria for individual, social, psychological, cultural, contextual and organizational differences specific to each user or group in which the user is inserted. It considers the relationship between the tool and the user from the point of view of user perception and personal history, and addresses the issue of acceptance taking into account social and contextual variability. The literature review was made without any particular constraint, accepting any type of tool, with only the condition that it had to deal with the issue of acceptance or acceptability criteria. Once an article refers to a criterion within a particular model or approach, it was considered as a criterion to be handle. The assignment of the criteria to the meta-

criteria was done as follows: We identified the criteria in a literature review, and then we subjectively assigned them to a meta-criterion. Meta-criteria have also been identified intuitively: by trying to classify the criteria, five clusters naturally emerged. We assume the non-objectivity of the method, each criterion can be debated and this is clearly a limitation of our research approach, but we have tried to classify the criteria intuitively in one meta-criterion or another in the most just way possible. In case of doubt or hesitation between several meta-criteria, we assigned the criterion in the cluster Overall Judgment which groups the criteria that can belong to several criteria. Using this method, we were able to assign all of criteria in five clusters.

3.3. META CRITERIA PONDERATION

Including all criteria: Each of the 142 criteria has been weighted between 0 and 1. If a criterion corresponds to one of our four meta-criteria, it has the weight of 1 in a meta-criterion. For example, “perceived usefulness” is ranked in the meta-criterion "utility" with a weight of 1. Otherwise, if it divides between several meta-criteria, we divide its weight by the number of meta-criteria to which it belongs. For example, the criterion “user satisfaction” belongs to both the meta-criteria utility, ease of use, and aesthetics, so it is weighted to 0.333 in each of the three meta-criteria. In short, the weight of a criterion is equal to one divided by the number of meta-criteria concerned by this criterion. These four meta-criteria can account for all the criteria of the acceptance and acceptability present in the literature we found. 64.7% of the 142 criteria identified in the literature fit in utility, ease of use or aesthetics. More precisely, the meta-criterion of utility takes into consideration 27,1% of 142 criteria, ease of use 29,6% and aesthetics 8%. The 35.3% of the 142 criteria that do not fit into those first three meta-criteria fall in the fourth one: Contextual and individual differences, because related to individual users or groups of users differences. *Including the main criteria for each theory:* Each theory or model has a main criterion, i.e. its most influential criterion. Main criteria are used because this review does not describe how criteria are related (a criterion can be composed of sub-criteria, or accompanied by less important criteria in a model); using main criteria is therefore a way of highlighting some criteria. If only main criteria are kept, and less important criteria not considered anymore (those with lesser influence in the considered theory), only 52 criteria are left; those criteria are the main representative of each approach. 70,5% of those 52 criteria fit in the meta-criteria of utility, ease of use or aesthetics (28,3% of criteria found in literature

match with utility, 33,6% with ease of use, and 8,6 % with aesthetics). **Table 1** shows which criteria are in each meta-criterion, and main criteria are in bold. Criteria in the cluster overall judgement are criteria which fit the four meta-criteria utility, ease of use, aesthetics and contextual and social difference. Unlike the other four, this cluster is not a meta-criterion but a cluster created to classify criteria that are inseparable from the four meta-criteria.

< INSERT TABLE 1 ABOUT HERE >

3.4. *THEORY-BY-THEORY*

The theory-by-theory analysis is that each theory refers to the identified meta-criteria differently, paying particular attention to some and neglecting others (**Fig. 2**). Those results underline that each theoretical framework proposes a different view based on a particular equilibrium between the four meta-criteria.

< INSERT FIGURE 2 ABOUT HERE >

Ergonomics models mainly used ease of use criteria, because they are tool-centred, based on accessibility and manipulation of tool to explain acceptance. Obviously, contextual and social differences criteria are mainly developed by social cognition approach, because this approach focuses on variability between user, social attitude and norms linked to tool use. Productivity oriented approach is the first approach to insist on the importance of utility, but because this approach is historically influenced by social and ergonomics framework, it also includes social differences and ease of use criteria. Hedonic approach is also fairly balanced in its distribution between criteria, mainly because these models use satisfaction as a main criterion, which is a criterion that relates to utility, ease, and aesthetics simultaneously, because the user has to be satisfied according to several aspects related to the tool. Finally, UX models are balanced between three criteria linked with tool, namely utility, ease of use and aesthetics, because this framework uses all criteria of previous model, adding emotions as a global judgment on its three criteria.

4. CONCLUSION

In conclusion following the study of literature in the field of acceptance, acceptability and technology adoption, the following elements can be retained: The literature suggests a large number of criteria for acceptance, so it seems a priori difficult to propose a single explanatory criterion. However, some criteria are more cited than others, and a classification into four meta-criteria is offered here. Three meta-criteria directly linked to the tool (utility, ease of use and aesthetics) can explain the majority (65% of the 142 criteria, and 70% of 52 main criteria) of the phenomenon of acceptance according to the literature. A fourth meta-criterion, contextual, individual and social differences, explains the variability in the tools adoption experiences.

Moreover, acceptance and acceptability appear as subjective. With the importance of individual factors and importance of criteria which vary according to authors and studies, it seems difficult to propose a universal model, but the review done here in this manuscript can give some keys: First, the subject is a psychological socially situated actor, using the tool in a given context with a specific task, the influence of the environment and the internalization of experience (judgment, emotions, attitude, motivation etc.) by the user is important. Use and acceptance are temporary and dynamic, it maybe explains why there is a large variability of result in the literature. Relationship between user and tool is multidimensional. It means that a longitudinal study will be better than a one-time evaluation. Moreover, according to our results, future studies on acceptance have to limit criteria to the three main criteria in relation with tool: Utility, ease of use and aesthetics. Variability between subjects can be taken into account with a fourth meta-criteria of contextual and social differences.

Most of studies in the literature are based on a certain type of tool (digital tools like computers, websites or digital applications or softwares) with a forced or guided use for user, so future studies have to investigate different tools and different methodologies in order to be exhaustive. A next step in this work could be to validate this choice of criterion by presenting to subjects a task with tools varying according to these main criteria.

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Table 1. Criteria matching for each meta-criterion: Utility, ease of use, aesthetics, contextual and social differences, and overall judgement.

Meta-Criteria	Criteria
Utility	Effectiveness, expectations of results, extrinsic motivation, flexibility, gain , importance of the system to one's job, instrumental qualities (production oriented) , job effectiveness, job relevance, maximization of gain, needs of individuals and groups , perceived behavioral control, perceived usefulness , perceived utility, performance, performance expectancy, positive benefits, power (utility) , productivity, purpose, quality output, relative advantage , reliability, result, result demonstrability, self-efficacy , service quality, sharing knowledge, system quality, trialability, usability , user friendliness, utility
Ease Of Use	Accessibility , belief in the fulfilment, cognitive load, complexity, cost , ease of learning, ease of use, ease of use perceived by user, easy to remember, easy to learn, efficiency, efficient to use, effort expectancy, facilitating conditions , few errors, flexibility, information in the environment, information quality, learnability, learning difficulty, managerial action/support, maniability, mental stress, operability, organizational context , perceived behavioral control, perceived ease of use , difficulty to perform for user, physical effort, pragmatic qualities (manipulation) , responsiveness of tool, self-efficacy, support system , characteristics, time saving, usability , user friendliness
Aesthetics	Aesthetics , image, information in the environment , visibility
Contextual and Social Differences	Active experience , age, attitude, beliefs and desires , cognitive absorption, cognitive skills, collective intelligence, compatibility, computer, anxiety, concentration, context, education level, engagement experience, flow , gender, habit , intelligence, lack of concern, learner characteristics , level of education, managerial action/support, motivation, organization , organizational context, participation in training, past use, place, reliability, self-efficacy, social acceptability , social factors, social influence, subjective norm , subjective standards, technophobia, telepresence, time distortion, user profiles, values , vicarious experience, visibility, voluntariness of use, voluntarism
Overall Judgment	Affect/emotions, behavioral intention to use, beliefs , compatibility, emotional reactions , evaluations, funology, hedonic attributes , influence of the support, intention , intrinsic motivation, joy of use, non-instrumental qualities (hedonic), perceived enjoyment , pleasure, positive experience , quality perceived by user, satisfaction, subjectively pleasing, sympiosis, trust, user satisfaction , well-being

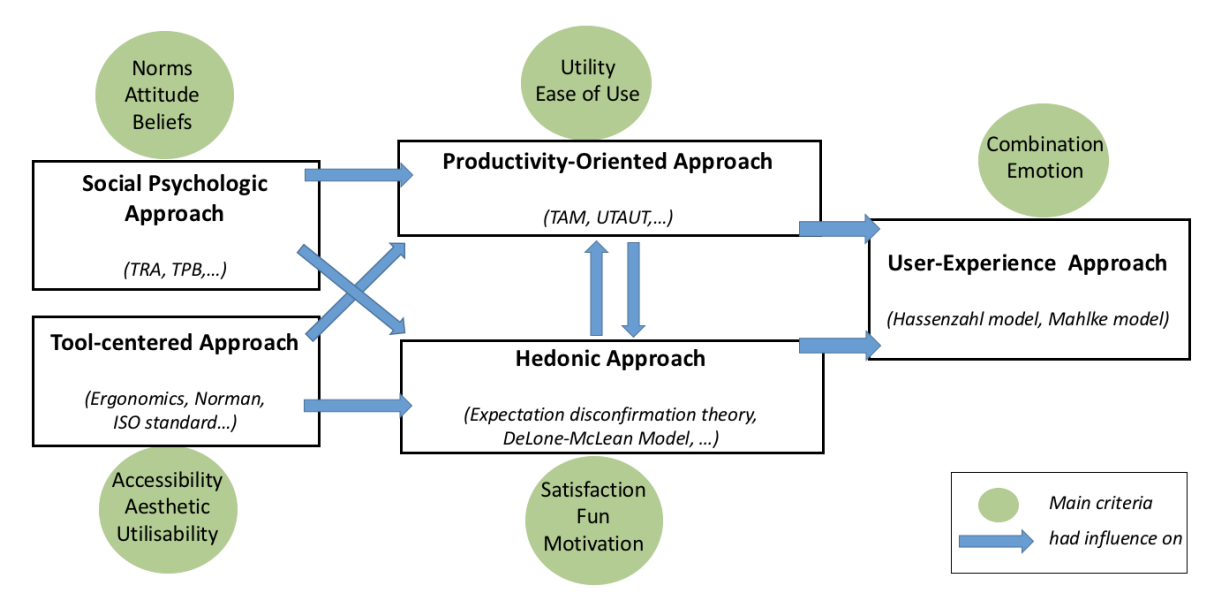


Fig.1. Different approaches to acceptance and acceptability

Acceptance and Acceptability Criteria

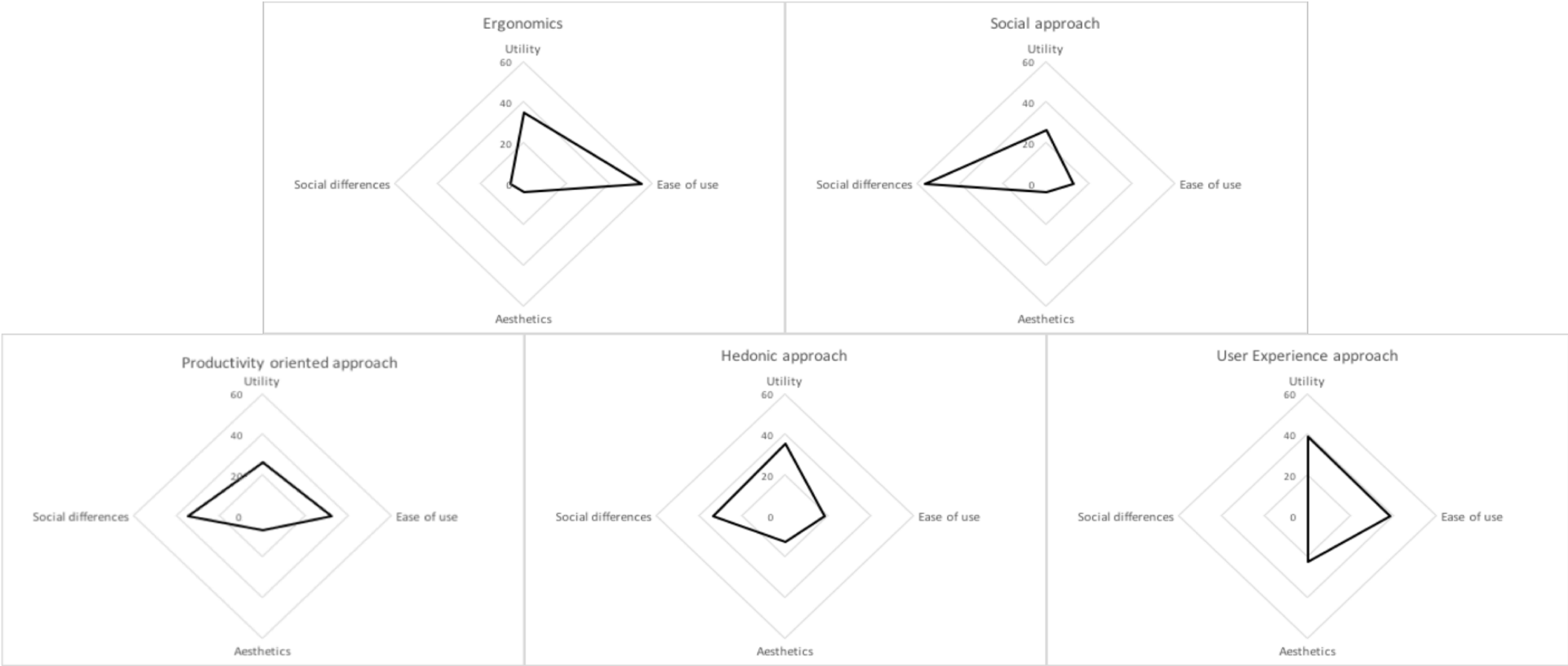


Fig. 2. Proportion of criteria for each approach. Each of the theoretical approaches is described as a radar diagram. Values represent ratio of criteria (in percentage) for each meta-criterion

Acceptance and Acceptability Criteria
