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Towards a Validated Construct for Information Systems Pervasiveness: An Exploratory Assessment

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Abstract

The proliferation of pervasive information systems' research has motivated a gradual technological shift away from the desktop computing paradigm towards more ubiquitous forms of information systems presence and use. This progression towards pervasive IS is accompanied by an implication that there exist clear and unambiguous boundaries between pervasive and non-pervasive information systems. This study poses that this implied dichotomy is not an accurate reflection of reality and proposes a more accurate conceptualization of pervasiveness through developing its construct. In particular, it adopts the methodological approach of construct development and reports the results from two of the three phases, i.e. definition of construct's domain and instrument development. A preliminary instrument was developed through literature analysis and then was assessed for its content validity through a survey of experts (N=33). Experts recognized ubiquity and context awareness as the two determinant characteristics of pervasiveness while diffusion was perceived as the ultimate goal of a pervasive IS and not as a technology characteristic. The final pervasiveness instrument can be exploited by information systems researchers aiming to enrich their own theoretical propositions by taking into account how pervasiveness influences things like technology acceptance and usability evaluation.

Keywords: Pervasive Information Systems, Pervasiveness, Construct Development

1 Introduction

Research on pervasive information systems has steadily proliferated over the past years, reflecting a parallel gradual technological shift away from the desktop computing paradigm towards more ubiquitous forms of information systems presence and use. Issues that have grasped the attention of pervasive IS researchers include, amongst others, how pervasive technologies transform the information systems discipline (Birnbaum 1997), issues surrounding the design of pervasive IS (Kourouthanassis and Giaglis 2007), real-life case studies and applications (Hansen *et al.* 2006), factors influencing the usability and user acceptance of pervasive information systems (Neely *et al.* 2008), and others.

Underlying this research, is a commonly held understanding that pervasive information systems differ from their older counterparts in that they provide computation capabilities across their surrounding environment (Abowd *et al.* 2002) and in that they are used by nomadic and perhaps opportunistic users who interact with the information system naturally and unobtrusively, free from significant time or place restrictions (Junglas 2006). However, the majority of this research also seems to imply that there exist clear and unambiguous boundaries between pervasive and non-pervasive information systems or, in other words, that any given information system can be classified as either pervasive or not (and, moreover, that all people asked would agree on such classification). This implied dichotomy is certainly not an accurate reflection of reality: we can more accurately conceptualize *pervasiveness* (i.e. the degree to which any information system encompasses properties of the pervasive class) along a continuum with purely desktop and purely pervasive IS being at the extreme ends (Figure 1).

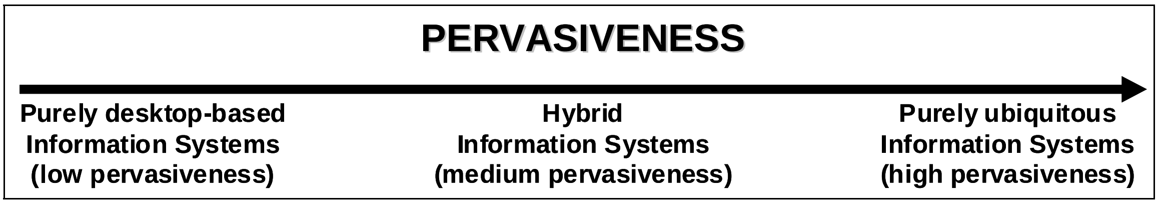

Figure 1 A Continuum of Information Systems Pervasiveness

If different information systems, even different *pervasive* ones, do not share the same degree of pervasiveness, it is natural to hypothesize that any theorization which is directed to pervasive information systems but treats them all equally will be of limited explanatory power. For example, models trying to predict factors that affect one's intention to adopt a pervasive information system will be necessarily incomplete if they do not take into account the possible moderating role of the degree of a system's pervasiveness on such adoption factors. In other words, if we assume that the factors influencing the adoption of desktop-based information systems are different from those of pervasive ones (as implied in numerous efforts trying to extend TAM, UTAUT or similar adoption models in the realm of pervasive information systems), then the relative weight of any factor may be influenced by the degree of pervasiveness of the information system under question – an effect hardly investigated at any such study to date.

It is indeed somewhat surprising that research in delineating pervasiveness is so scarce (Junglas 2006; Kourouthanassis *et al.* 2008; Lyytinen and Yoo 2002). In this paper, we lay the ground for such research by reporting the results of the first stages of a systematic attempt to develop a validated psychographic construct that can be used to assess the pervasiveness of an information system as perceived by its users, as well as an associated measurement instrument in the form of Likert-based questionnaire items. We propose the development of a psychometric construct because pervasiveness is a latent phenomenon that cannot be objectively quantified using objective measures.

Furthermore, research that could benefit from this construct is predominantly anchored on psychometrics (for example, theories of planned behaviour and reasoned action as precedents to IS technology models). Our results can used by information systems researchers aiming to enrich their own theoretical propositions by taking into account how pervasiveness influences things like, for example, technology acceptance and usability evaluation.

2 Method of Construct Development

The development of a psychometric instrument is formally known as *construct development* or *scale development*. According to DeVellis (2003, page 9) construct development is used to "*develop scales when we want to measure phenomena that we believe to exist because of our theoretical understanding of the world, but we cannot assess directly*". For example, age does not require a multi-item scale (and hence a construct) as it stands on a concrete and unambiguous event (one's date of birth). On the other hand, phenomena like information systems usefulness are rather abstract and cannot be observed or assessed directly. Such phenomena need a carefully constructed and validated scale. Pervasiveness is certainly one such phenomenon as it relates more to how respondents *perceive* it within a given information system rather than to how technological elements have been assembled to supposedly support it.

To develop our construct of *(perceived) pervasiveness* we have relied on principles proposed by Churchill (1979), as refined later by DeVellis (2003) and Lewis et al. (2005). These are considered seminal works regarding construct development and have been repeated employed in various disciplines, including information systems (Lewis *et al.* 1995; Smith and Milberg 1996) and business management (Govindarajan and Kopalle 2006; Moss *et al.* 2003). According to these principles, construct development is divided into three sequential phases: (a) *construct domain specification*, (b) *instrument construction*, and (c) *data collection and measurement purification* (Figure 2). Each of these phases is methodologically discussed in this section. We then proceed to report the results we have obtained through the first two phases of our research (in sections 3 and 4), while our design for phase three, which is currently under way, is then discussed as future research in section 5.

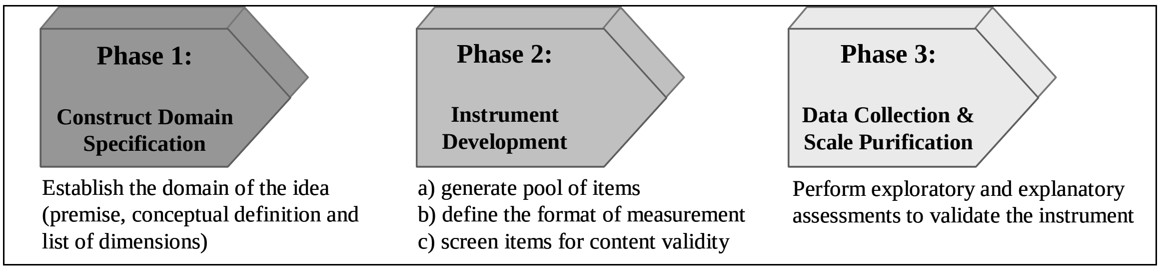

Figure 2 Phases in Construct Development (Lewis et al. 2005)

2.1 Phase 1: Construct Domain Specification

The first phase aims at establishing the domain of the new construct. According to Lewis et al. (2005), this phase produces three items of information: the *premise*, which specifies the purpose of the construct, the *conceptual definition*, which describes the construct in general or theoretical terms, and a *list of dimensions,* which represent the elements of the construct.

Literature review and analysis is the predominant method for the specification of the construct domain.

2.2 Phase 2: Instrument Construction

The instrument construction phase aims at producing a draft instrument of the new construct. This involves three tasks:

- Generating a pool of items. Items are generated from and for all the statements that tap each dimension of the construct (Lewis et al. 2005). As construct development is a refinement process, it is imperative for each dimension to be represented by multiple items (because some items will be rejected in following stages). For that reason, the initial pool of items is characterized by redundancy and items with slight different shades of meaning (Churchill 1979; DeVellis 2003; Lewis et al. 2005).
- Defining the format of item measurement. After generating the pool of items, the researcher must define the format of measurement to be used, which in turn dictates the wording and presentation style of the item pool.
- Having the pool of items screened for content validity. During this step, the instrument produced must be reviewed for content validity, in other words whether the instrument measures the content of a given construct (Straub et al. 2004).

2.3 Phase 3: Data Collection and Measurement Purification

The third phase of construct development results in the production of the final instrument measuring the new construct. Data collection through multiple administrations of the instrument is required in order for the measurement properties of the instrument to be assessed and optimized with each administration. Both exploratory and confirmatory techniques are applied sequentially to the different samples in order to achieve the best results. Exploratory analysis inquires instrument's construct validity and reliability while confirmatory analysis provides in addition nomological validity and generalizability.

In the following sections, we discuss how phases one and two have been carried out in our research and propose further research for the execution of phase three.

3 Phase 1: Construct Domain Specification

Following the relevant literature, we specified the domain of perceived pervasiveness through literature analysis. More specifically, we performed a systematic literature review, which had two goals: first, to collect and codify the extant knowledge concerning pervasive information systems and, second, to use the collected pool of studies for the specification of the construct domain.

Literature review is arguably sensitive to data collection and source credibility. We have therefore limited the collection of literature to studies that have undergone peer review and have appeared in journals, refereed conference proceedings or refereed edited volumes. We covered the period from 1991 (the year that Weiser’s seminal paper on pervasive information systems was published) to mid-2008. The literature collection process was iterative, as the analysis of initially identified publications naturally led to the identification of new knowledge sources. This process was followed to maturity, when no more relevant studies or new knowledge could be identified.

3.1 The Premise

The purpose of the construct is to capture and measure the properties that define the degree of pervasiveness of a given information system as perceived by its users. The construct is intended to extend and enrich either causal theories in pursuit of predicting a dependent variable, for example technology acceptance models, or evaluative theories seeking to assess quality requirements, such as usability testing or design evaluation.

3.2 Conceptual Definition

We define pervasiveness as the *"extend to which an IS consists of interconnected technological artifacts, diffused in their surrounding environment, working together to ubiquitously support user tasks and objectives in a context-aware manner"*. The three dimensions that we recognize as determinants of pervasiveness are ubiquity, diffusion and context awareness and are discussed in the following sections.

3.3 List of Dimensions

Ubiquity

In their quest to support humans in their everyday life, pervasive IS are challenged regarding their ability to provide anytime and anywhere access to information, communication, and services (Birnbaum 1997). The concept of ubiquity captures the endeavor of pervasive IS to overcome spatial and temporal boundaries. Ubiquity, as a consequence, should be represented by a suitably equipped physical space or a computer activated world, according to Weiser (1991), that allows casual access to computing (Brumitt et al. 2000). Moreover, ubiquity takes on the lens of the environment to provide the functionality for a user to move. In other words, mobile, handheld or even wearable computing devices enable the user to visit different places, while still enjoying continuous access to computational services (Junglas 2006; Lyytinen and Yoo 2002). Except from physical mobility, which is related to equipment and users, logical mobility, refers to the application ability to move from one device to another while data access is maintained (da Costa et al. 2008), is also an option in a ubiquitous world. Drawing on the above, we define ubiquity and provide the characteristics that synthesize its conceptual scope in Table 1.

Table 1 Definition of Ubiquity and its Statements

Ubiquity	
Definition	**Statements**
the system's capability to provide users with continuous access to information resources irrespective of their location within the system's boundaries	• anytime and anywhere service accessibility • anytime and anywhere service availability • user mobility throughout the system boundaries • device mobility/portability throughout system boundaries • application mobility/migration across contexts and devices

Context Awareness

As pervasive IS exceed organizational boundaries and aim at supporting users in their everyday lives, they must be capable to support their users over various and different contexts (Kourouthanassis and Giaglis 2007). Therefore, in addition to spatiality and temporality, the contextuality in which the action occurs is of prime importance and must be taken under consideration. For this purpose, pervasive IS employ context awareness to collect contextual data and use them to provide relevant services to their users (Dey 2001). In other words, context awareness operates as a relevancy filter to the ubiquitous nature of pervasive IS. The collection of contextual data and their utilization, through context aware mechanisms, makes pervasive IS knowledgeable about the context into which they support their users and adapt to its specificity. Consequently, context awareness enables pervasive IS to automatically execute a service, that is, to trigger a command or reconfigure the system on behalf of the user according to contextual information (Dey et al. 2001). The latter implies that pervasive IS can react according to context states and changes by adapting its behavior and even by offering its services proactively. Table 2 provides the definition of context awareness and its set of statements.

Table 2 Definition of Context Awareness and its Statements

Context Awareness	
Definition	**Statements**
the system's capability of perceiving contextual information regarding the user, the system, and the environment to dynamically and proactively adapt its functionality	• Offer users context-relevant information and services • Propose appropriate selections of actions to users • Automatically or proactively execute a service regarding context state • Adapt or reconfigure the system accordingly to the context state

Diffusion

Pervasive IS requires the physical integration of technological infrastructure in order to ubiquitously support their users (Scholtz et al. 2002). Nevertheless, as computing devices become diffused in the environment, interaction with the system may become distractive. Indeed, attention is an important issue in pervasive IS, because humans will be likely to perform other physical and mental activities while also interacting with pervasive devices (Scholtz and Consolvo 2004). For that reason, computational resources of pervasive IS should be diffused in the physical surrounding in a way that promotes the effective and unobtrusive use of services or as Weiser defined it, invisible in use (1991). Invisibility in use is enhanced when computational devices manifest themselves in a way that users can utilize the knowledge and skills they have obtained from their daily lives to interact with them – in other words, through natural interaction (Yue et al. 2007). Moreover, diffusion of pervasive IS in the physical environment suggests that architecture of places will be challenged. Aesthetics and pleasing design is an important requirement especially for pervasive IS, since they pervade user lives (Mankoff *et al.* 2003). Drawing on the above we define ubiquity and provide the characteristics that synthesize its conceptual scope in Table 1.

Table 3 Definition of Diffusion and its Statements

Diffusion	
Definition	**Statements**
the extent to which the system do not challenge the aesthetics of the physical architecture and promotes interaction modalities that are invisible in use	• Distraction free usage of services • Low cognitive load when using services • Aesthetical interference in the physical surrounding • Effective placement of computation in the physical layout

4 Phase 2: Instrument Construction

4.1 Item Pool Generation

Following the delineation of the construct dimensions and statements, the pool of items for pervasiveness was generated. In particular, where items that have been used to predict system acceptance could be found in the literature, they were adopted. Additionally, newly created items were produced for each statement of each dimension where literature-derived items could not be used. Table 4 depicts the pool of items that was generated.

Table 4 The Pool of Items for the Pervasiveness construct

Dimension	Items	
Ubiquity	U1.	The SYSTEM* is available to use wherever I need it
	U2.	The SYSTEM* is available to use whenever I need it
	U3.	I am able to use the SYSTEM* anytime
	U4.	The SYSTEM* is accessible everywhere in the APPLICATION SPACE**
	U5.	The SYSTEM* is always available to me
	U6.	The SYSTEM* allows me to be mobile while using it
	U7.	The SYSTEM* is easily accessible
	U8.	The SYSTEM* can be accessed through portable devices
	U9.	I can still use the SYSTEM* when I switch to another device
	U10.	I am able to use the SYSTEM* through different devices
	U11.	Using the SYSTEM* is independent of place
	U12.	I am able to move around while using the SYSTEM*
Diffusion	D1.	My attention does not need to be focused on the SYSTEM* the whole time
	D2.	Using the SYSTEM* requires little attention
	D3.	I don’t have to concentrate fully on the SYSTEM* when using it
	D4.	I don’t need to be intensely absorbed when using the SYSTEM*
	D5.	The usage of the SYSTEM* does not disrupt me from other activities
	D6.	Using the SYSTEM* is not physically demanding (e.g. typing, clicking, scrolling etc.)
	D7.	I don’t need to be deeply involved when using the SYSTEM*
	D8.	I interact with SYSTEM* components that are hidden
	D9.	The SYSTEM* does not distract me too often
	D10.	The SYSTEM* does not require continuous attention
	D11.	Using the SYSTEM* is not mentally demanding (e.g., thinking, deciding, remembering, searching, etc.)
	D12.	The SYSTEM* components are embedded in the surrounding architecture
	D13.	The SYSTEM* components are not easily distinguishable from the environment
Context Awareness	CA1.	The SYSTEM* is able to adapt to changing conditions
	CA2.	The SYSTEM* is capable of automatically adjusting to the circumstances
	CA3.	The SYSTEM* can act according to the current circumstances
	CA4.	The actions of the SYSTEM* are in line with the situation
	CA5.	The SYSTEM* automatically adapts to the situation at hand
	CA6.	The SYSTEM* can automatically trigger actions relevant to the situation
	CA7.	The SYSTEM* understands my needs and responds accordingly
	CA8.	The SYSTEM* can act without my explicit input
	CA9.	The SYSTEM* provides me with information relevant to what I expect
	CA10.	Sometimes the SYSTEM* initiates interactions with me
	CA11.	The SYSTEM* comprehends what information I need

* SYSTEM refers to any Pervasive IS ** APPLICATION SPACE refers to the physical boundaries of the SYSTEM

4.2 Measurement Format Definition

As discussed earlier, our construct is a psychometric one, in the sense that it measures how users perceive the degree of pervasiveness in an information system. Therefore, all our items were phrased as declarative sentences measuring attitude in terms of agreement/disagreement levels to support Likert-scale measurements, which are the typical measurement format in psychometric instruments.

4.3 Item Screening

Item screening is the last step of instrument construction phase and it has the purpose of evaluating the content validity of pervasiveness items and to provide a first set of items ready to be applied on real subjects. As discussed earlier, the most commonly employed evaluation item content validity is judgmental and subjective. However, to increase the robustness of our results, we decided to perform an empirical assessment of content validity in our study. More specifically, we have executed an expert survey with a judgement sample of experts and used the CVR (Content Validity Ratio) Relaxed, initially proposed by Lawshe (1975) and then modified by Aziz and Macredie (2005), Lewis et al. (1995) and Straub et al. (2004), as a score of content validity for our items. An expert survey is a judgment sample of experts who are called to offer their expertise on the construct under development (Churchill 1979).

In order to compute $CVR_{Relaxed}$, experts are asked to rate how relevant they think that each item is to the construct that is intended to be measured using the scale "1=Not relevant, 2=Important (but not essential), and 3=Essential" (Lawshe 1975). $CVR_{Relaxed}$ is computed for each item using formula (1):

$$CVR_{Relaxed} = \frac{N_e + N_i/2 - N/2}{N/2} \quad (1)$$

where N_e is the number of experts indicating "essential" for the item, N_i is the number of experts indicating "important" for the item, and N is the total number of experts. Items that have a CVR score above a threshold, which depends on the number of experts rating each item, are considered valid.

In parallel with experts' responses on item relevancy, during the expert survey experts were also asked to evaluate the clarity and conciseness of items, thus contributing to item reliability.

Defining the Judgment Sample

The sample of the expert survey was a set of researchers that are considered experts in the domain of pervasive computing and pervasive information systems. In our case, we employed a quality criterion to reduce the population of all possible researchers of the area to an expert sample. In particular, we queried three pervasive systems journals (*Personal and Ubiquitous Computing*, *IEEE Pervasive Computing*, and *Pervasive and Mobile Computing*), and one conference (the *IEEE International Conference on Pervasive Computing and Communications*), which are considered the primary publication outlets in the area. We queried each source through the search engine of the EBSCO database to collect the volume of the publications for all authors having published in any of these sources. We then counted the number of papers published in these sources per author. We selected authors having three or more publications in all sources to be our sample, thus resulting to a sample of 119 researchers. Moreover, we conducted an impact analysis for 30 authors of our sample – randomly selected – to validate the power of the quality measure selected for defining the sample. Using a software tool called "Publish or Perish" (Harzing 2008a) we defined the *h-index* for each of these researchers. The results showed high impact of these researchers in the area, with h-indexes ranging from 10 to 34 (for a definition and analysis on the h-index score refer to (Harzing 2008b)).

Expert Survey Design

The expert survey's goal is to provide experts with the ability to judge item content validity and reliability. Content validity is evaluated using the quantitative criterion of CVR, while item reliability is evaluated through phrasing corrections that enhance items' clarity and conciseness. We built a website to host the expert survey in order to achieve the functionality required, especially in terms of accessibility (our sample included researchers from around the world) and ease of use (item reliability evaluation is labour intensive due to writing and commenting). Furthermore, as authorized and eponymous access is crucial for an expert survey, we requested from the experts to enter the survey using a unique identifier, which we provided them with through an invitation email. Experts were also given the ability to comment on the domain specification of the construct (as discussed in section 3) and propose alternative dimensions if they wished.

The survey was carried out between May and June 2008. Experts were approached via a personal invitation email where there were asked to participate in the survey and provided with their unique identifier and link to access the survey's website. From the 119 experts approached, 39 responded (a satisfactory response rate of 32%). Thirty-three answers were ultimately usable after removing incomplete questionnaires.

4.4 Expert Survey Results

We computed the $CVR_{Relaxed}$ score for each item, along with the *CVI (Content Validity Index)* for each dimension, which is simply the average of $CVR_{Relaxed}$ values for the retained items. For an expert survey of 33 experts, an item must have $CVR_{Relaxed}$ score above or equal to 0.31 (CVR_{thres}=0.31) (Lawshe 1975, page 568). Table 3 illustrates the judgments provided per item, along with estimated $CVR_{Relaxed}$ per item and CVI per dimension.

Table 5 Frequencies of Judgments and $CVR_{Relaxed}$ per Item

Dimension	Item	Irrelevant	Important	Essential	$CVR_{relaxed}$ (N=33, CVR_{thres}=0.31)	
Ubiquity **CVI_U = 0.476**	U1	3	7	23	0,606	
	U2	3	9	21	0,545	
	U3	3	9	21	0,545	
	U4	3	10	20	0,515	
	U5	4	12	17	0,393	
	U6	6	9	18	0,393	
	U7	6	10	17	0,333	
	U8	4	15	14	0,303	reject
	U9	3	18	12	0,272	reject
	U10	2	20	11	0,272	reject
	U11	7	11	15	0,242	reject
	U12	7	11	15	0,242	reject
Diffusion **CVI not applicable**	D1	8	7	18	0,303	reject
	D2	4	18	11	0,212	reject
	D3	8	13	12	0,121	reject
	D4	5	19	9	0,121	reject
	D5	4	21	8	0,121	reject
	D6	6	18	9	0,090	reject
	D7	8	14	11	0,090	reject
	D8	9	14	10	0,030	reject
	D9	9	17	7	-0,060	reject
	D10	13	10	10	-0,090	reject
	D11	12	14	7	-0,150	reject
	D12	14	13	6	-0,240	reject
	D13	16	11	6	-0,300	reject
Context Awareness **CVI_{CA}=0.550**	CA1	0	9	24	0,73	
	CA2	0	13	20	0,61	
	CA3	1	13	19	0,55	
	CA4	2	13	18	0,48	
	CA5	0	17	16	0,48	
	CA6	2	14	17	0,45	
	CA7	4	17	12	0,24	reject
	CA8	8	9	16	0,24	reject
	CA9	4	21	8	0,12	reject
	CA10	10	12	11	0,03	reject
	CA11	7	21	5	-0,06	reject

As Table 5 shows, all items from the dimension of diffusion were rejected by the experts, as none of the items scored a $CVR_{Relaxed}$ above the threshold value. Seven items from the dimension of ubiquity were retained, along with six items of context awareness. Therefore, the instrument to be administered in phase three includes 13 items (U1-U7 and CA1-CA6) from two dimensions, context awareness and ubiquity.

In an attempt to qualitatively evaluate the outcome of the expert survey, we observe a strong belief from the experts that pervasive IS should be characterized by ubiquity. This is justified by the fact that all items representing time and place flexibility were valued as essential by the experts, except from U11 which was rejected due to its wording as experts commented. Furthermore, aspects of mobility and accessibility were also found important, contributing two items to the dimension of ubiquity (U6 and U7).

Regarding context awareness, experts recognize this technology characteristic as even more essential for a pervasive IS compared to ubiquity ($CVI_{CA} > CVI_{U}$). However, it is interesting to note that all items rejected (CA7-CA11), relate to the user adaptability perspective, imposing that experts perceive context awareness just as the ability of the system to adapt to environmental circumstances.

Finally, diffusion was not considered important by the experts and was excluded from the final pervasiveness measurement instrument. Experts agree mostly with the distraction-free element for pervasive IS (items D1-D5) and less so with the effortless usage (D6-D7). At the same time, they do not find infrastructure invisibility to be a necessity for a pervasive system (D8, D12-D13). An argumentation for this result might be the fact that diffusion is more or less an outcome from the orchestration of several "pervasive dimensions". In other words, diffusion is the ultimate goal of a pervasive IS and not a technology characteristic that would enable this goal.

5 Phase 3: Data Collection and Measurement Purification

As discussed earlier, phase three is currently under way aiming to validate the instrument that was constructed in phase 2 through applying it to users (as opposed to experts). This phase involves two steps: an exploratory and a confirmatory assessment of the instrument.

For the exploratory assessment, individuals will be exposed to a simulated experience of using three different pervasive information systems through a scenario walkthrough method. The participants in the survey will be asked to follow a usage scenario for each pervasive system and then will be administered a questionnaire including the pervasiveness instrument from phase 2.

The empirical data gathered from this effort will be analysed for reliability (reliability analysis) and factor forming (exploratory factor analysis). This exploratory assessment will aim at establishing factorial, convergent and discriminant validity, along with reliability, for the pervasiveness construct. The outcome of this step will be an improved instrument with further item exclusions possible, depending on factor loadings obtained.

The confirmatory assessment will then be performed with the purpose to assess the efficacy of the instrument's items and the consistency of a pre-specified model with hypothesizations over causal effects. In other words, the instrument that will result from the exploratory analysis will be complemented with additional factors and all factors will be tested together in real conditions. We have selected technology acceptance to be the theoretical setting of this test: the pervasiveness instrument will be incorporated to a technology acceptance model and be tested within a wider study aiming at identifying the antecedent or moderating effects of pervasiveness in information systems adoption. Our selection was based both on methodological issues and research opportunities. The basic methodological restriction for our instrument is a context that uses psychometric instruments for its investigations and technology acceptance is thus a natural choice. The second reason is that technology acceptance provides a fertile ground for research in pervasive IS on its own right and hence our results might have a wider impact than simply providing further substantiation to the pervasiveness construct.

The confirmatory assessment will evaluate the nomological validity of the model in addition to the validation achieved during the exploratory assessment (factorial, convergent, discriminant validity and reliability). Furthermore, while the initial forming of factors from the exploratory assessment will be used as a starting point, the factor model will be re-evaluated with data from the second sample. The outcome of the confirmatory assessment will be the validated pervasiveness construct and measurement instrument.

6 Conclusion

Framed within the context of Pervasive Information Systems the purpose of this study was to report the results of the first stages of a systematic attempt to develop a validated psychographic construct that can be used to assess the pervasiveness of an information system as perceived by its users. Following the dominant methodological approach, construct development, we defined *pervasiveness* and recognized its dimensions. To this end, evidence from an expert survey fed the refinement and validation of the initially constructed instrument. Results showed that ubiquity and context awareness were found to be important determinants of pervasiveness contrary to diffusion. The items retained from the two dimensions comprise the temporary instrument of pervasiveness, which needs to be purified and validated through multiple administrations to adequate samples (the next step of this study).

The instrument of pervasiveness, in its final form, can used by information systems researchers aiming to enrich their own theoretical propositions by taking into account how *pervasiveness* influences things like, for example, technology acceptance and usability evaluation. Technology acceptance is perhaps the research area that could benefit most from an instrument measuring IS pervasiveness. Early theorizations in this area have sought to predict IS user acceptance in general by investigating cognitive, affective and behavioural factors (Davis 1985; Venkatesh *et al.* 2003), while more recent research has tackled the most specific question of *pervasive IS* user acceptance (Connelly 2007; Garfield 2005). Such research will be arguably better informed if it takes pervasiveness into account as noted above since pervasiveness can provide additional explanatory power over the moderating effects of technology on user perceptions (Sun and Zhang 2006).

Furthermore, usability evaluation is another field where a metric of pervasiveness could improve the validity and comparability of research results. The field of pervasive IS lacks standard evaluation methods and criteria for usability evaluation, thus resulting in non systematic treatments (Neely *et al.* 2008; Scholtz *et al.* 2002). Lacking proven evaluation methods, researchers are approaching usability evaluation subjectively and impromptu, for example, using system specific methods that lack generalization power. A metric of pervasiveness will be a significant step towards systematic usability evaluation of pervasive information systems.

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