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Abstract

Information services delivered via wireless, portable communication devices continue to pervade our work and leisure spaces. While people are continuously bombarded with promises of newer and better ways to maintain contact with others and to have constant access to information, however, there remain a number of open issues that inhibit the potential for an open information society. The bidirectional influence between such wireless technologies and applications and their potential end-users, contributes to the development of both the technologies and applications and the social setting in which they are embedded. In this paper, we extend current studies of Information and Communications Technology (ICT) uptake by integrating interpretations of "ubiquitous computing" and its pervasion of everyday life. We draw upon findings from a range of IS research to structure our future studies of adoption issues in relation to a variety of wireless application cases. We show that, while some "traditional" IS/IT dimensions of uptake still hold, there are now a variety of other "non-utilitarian (hedonic)" factors that developers and designers need to take into account. We conclude by proposing a research model – expanded from model of user acceptability and product uptake, a descriptive framework based on the "Price of Convenience"(Ng-Kruelle, Swatman, Rebne and Hampe 2002).

Keywords

Pervasive computing, wireless devices, user adoption, innovation, privacy.

INTRODUCTION

Araya (1995) described the new generation of computing devices as forming "most explicit attempt yet to move computing technology beyond the confines of tool usage towards a pervasive penetration of everyday life" (p1). Today, much of the promise of cheap, easy-to-use devices supporting ubiquitous connectivity/ nomadic computing have been, or are on the verge of being, realised. The range of what originally appeared to be independent development paths – sensors, actuators, wireless networks and ubiquitous devices powered by intelligent computation – have been integrated and this synthesis has begun to blend with our professional and personal personal lives. This might be expected to lead, perhaps, as (Meyer and Rakotonirainy 2003) suggest, to a seamless integration of people, devices and computing. This outcome is also known as *pervasive computing* – computing at any time, anywhere (Economist 1998), or as *sentient computing* (Economist 2003). Additional buzz words are being created by research institutes and the industrial bodies, each aiming to stake a claim in the ubiquitous computing territory: "ambient intelligence", "aware computing" and the "intelligent home" (Economist 2003). With the spreading mobile and wireless networks, and the establishment of communication infrastructure that ensure ubiquitous communication capabilities with "always-on" connectivity, the IT industry is central in the active diffusion of a variety of ubiquitous computing devices with varying degree of capabilities out into the market. This variety of buzzwords and labels attached indicates that we are looking at a situation in dynamic flux: both technologically and usage. Technologically because the product, the mediating tool for execution of various activities, is itself still evolving due to continuous development of and convergence of multiple standards, and supporting architecture. Usage, either social or professional in nature, because digital

converge is continuously breaking down boundaries between personal and business lives, and thus blurring user roles or creating new ones.

The social and professional context for this diffusion is clearly undergoing fundamental change – we really do not yet know the extent or the character of the eventual impact. In earlier work (Ng-Kruelle, Rebne, Swatman and Hampe 2003), we have argued that the bidirectional influence between context-aware pervasive ICT innovations wireless technologies and applications and their potential end-users, contributes to the development of both the technologies and applications and the social setting in which they are embedded.

Studies of ICT innovation diffusion need to be set within an explicit and dynamically evolving social *context.* In 2001, a report was published by Context-Based Research Group[1] on wireless device usage among people in nine cities (Blinkoff 2001): Beijing, Hong Kong, Tokyo, Stockholm, Paris, London, New York, Los Angeles and San Francisco. The anthropologists that conducted this study noted several cultural differences: In Stockholm, wireless phone devices are considered an extension of users' personalities, becoming "totems". In Paris, users are more concerned on the aesthetic aspects of the phone looks than the underlying technology and the functionalities. In London, shy users are adopting Short Message Service (SMS) and e-mail to overcome their shyness and reach out to others. Likewise, in Japan wireless usage helps citizens hurdle social barriers. In the U.S., there's fear about information overload created by being available 24 hours a day for 7 days a week (Blinkoff 2001; Méndez-Wilson 2001). This study reveals one interesting point: that the same product will have multiple usage identity, not only across communities, but also within communities where user behaviour is distinguished by a general attitude to innovation (see also reference (Rebne, Ng-Kruelle, Swatman and Hampe 2002)for further discussion of this).

Within the IS research community, there is an immense collection of meta-analyses and models attempting to understanding general factors influencing uptake of information and communication technology (ICT). Rather inadequate, however, is a consolidated/systematic analytic framework (or model) useful to guide studies of ICT diffusion within the domain of ubiquitous computing – where the dynamics surrounding the ICT is taken into account. In our research for related literature, we found that, during the last few years, research which aims to expand traditional findings of ICT uptake to that of "wireless applications" adoption have begun to emerge – especially in relation to mobile phones, for example (Sieber and Sabatier 2003; Van der Heijden and Sangstad Sørensen 2003),. This paper collects and reviews the existing literature and extends this by integrating:

- The concept of "ubiquitous computing", its pervasive penetration of everyday life and its implications; with
- End-user perspectives on the uptake of ICT

The structure of the paper is as follows:

- An introduction to the domain of study – context-aware and location-based (ICT mediated) services;
- A review of the diffusion of innovation and innovation adoption and usage literature within this domain;
- The integration of this literature into the Price of Convenience (PoC) framework which guides our ongoing research in this area;

and a conclusion and description of future work in the PoC programme.

CONTEXT AWARE APPLICATIONS: LOCATION-BASED SERVICES

Context is defined as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves" (Korkea-aho 2000). Context-awareness on the other hand refers to the usage of this information. For example, a system is considered to be context-aware if it can "extract, interpret and use context information and adapt its functionality to the current context of use" (Korkea-aho 2000). It is no difference than the above mentioned techniques of ubiquitous computing, where special intelligent tools such as sensors and programs are required in the execution.

For researchers working in the field of pervasive/ubiquitous computing, context is considered the "key in their efforts to disperse and enmesh computation" into daily lives (Moran and Dourish 2001). Context-aware computing are often applied to mobile devices that adapt to environmental sensor information (Barkhuus and Dey 2003). The main objective of context-aware computing is to therefore, to obtain, then use the information

[1]Context Based Research Group: http://www.contextresearch.com/context/index.cfm Accessed on October 15, 2003.

about the context of the devices in the delivery of services – according to the user, time, place or event (Moran and Dourish 2001). The context-aware application which seems most pushed by the industry is that of location-based services (LBS), where location information is used as *the* context for the delivery of services. As mobile telephony becomes increasingly common as a handheld computing platform, location-tracking of mobile phones enables location-based services to spread outside closed environments – thus becoming ubiquitous, pervading daily lives.

In LBS, personalisation and delivery of service is based on the knowledge of the location of an object or individual. With LBS, two factors are important in the service delivery stage - *position* and *location*. "Position", which consists of latitude, longitude and elevation data, is considered the most basic descriptor of LBS. "Location" on the other hand contains a broader definition, referring to adjoining sets of position coordinates which are labelled by "identifiers" such as the name of city or street (PricewaterhouseCoopers 2001). Geo-coding then converts the labels into a standard latitude/longitude position format. In wireless applications, location is an element of a user's (both human and machine) context. Closely related to location and position information is *temporal information*, which plays an essential accompanying role in LBS[2]. A close category of services is concerned with finding, tracking, formatting, and provisioning nothing but navigation data and current position coordinates using various location-detection and positioning technologies. This category is called location services (LS), not LBS. LBS get their geospatial data by invoking LS, then adding other functions to that data (PricewaterhouseCoopers 2001).

Location-based services (LBS) can be categorised according to the ways an application respond to and make use of location information. In this sense, the applications can be divided into location aware applications and location sensitive applications, described as the following:

- **Location Aware**[3]: Application that responds to queries about where a user is (example when arriving in an unknown place), where an object is in relation to the user, or specific interests available nearby (such as hotels for people looking for a place to stay). This feature also includes the "ability to obtain, interpret, and use location and position information" while making deductive accompanying relationships, making them explicit, and then using them to make relevant suggestions to users (Biswas, Horhammer, Han and Murray 2001). In a wireless context, the location information can either be "automatically" obtained by the network or be provided be the users.
- **Location Sensitive (location precise)**: Applications that transmit data to users at a particular location. For example, YellowMap[4] provides "KomfortRouting" and "CityGuides" services to mobile phones with multimedia capabilities, smartphones and organisers. Another example is the sending of advertising data to subscribers within the specific vicinity. A user who steps out of the area would not receive the message.

In order to support these applications, many techniques exists to provide information-based "pulled services"; either by using real-time or static data. A subscriber who activated "Where is the nearest XYZ?" information request, may be supported by data provided by mobile data device which local storage rather than real-time data generated from a server. Based on the location of the mobile device, and the user's preference, the mobile network conducts a search in its information resource database, finds a match, and answers the request. This is however the simplest form of LBS. When it is extended to include data mining techniques, implemented on the servers, the service providers are able to value add to the information request. For example, by observing the wireless subscriber's movements, the application can include additional information such as the current traffic conditions and other details. As the applications mature, more LBS would emerge that combines various sources of real-time data to the location information.

Another type of services are "pushed services", involving advertising for enhancing customer loyalty (when implemented "appropriately") or adopting an mobile buddy lists such as the AIM (AOL Instant Messaging). Push services such as *permission marketing* based on subscriber's location is a controversial issue with potential privacy threat. In order to "legally" obtain consent from subscribers, some mobile operators introduce benefits such as reduced call rates for users willing to accept these services. The permission is thus based on the "opt-in" approach, and that subscribers would not receive advertisement unless prior consent is given.

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[2] Some mobile computing applications require information on the order of occurrence of events (temporal information) and the location of the occurrence (spatial information).

[3] Location awareness is a part of the "context awareness" application. It uses context information (e.g. identity, spatial, temporal, environmental, social, resource and Physiological information) to be used to adapt the application to the current environment. Levijoki, S. (2000). Privacy vs Location Awareness, Department of Computer Science, Helsinki University of Technology. **2002**.

[4] See http://www.yellowmap.de

It is without doubt that wireless privacy will always be is an issue. Because of the increased of wireless devices – e.g. commercial wireless networks, cell phones, smart phones, laptops, PDAs, pagers, GPS, radio frequency identity (RFID), and even smart tags in clothing, personal data will continue to grow exponentially. An example of the pervasiveness of this issue and technology, is the move by Europe's three largest retailers: Metro, Tesco and Carrefour (together with Intel) to implement Electronic Product Code (EPC) Network. It's a move from the "traditional" UPC- und EAN-Barcodes (Universal Product Code, European Article Numbering System) to the usage of RFID for better information flow and a more efficient supply chains management (heise.de 2004).

END-USER ICT ADOPTION FROM IS/IT PERSPECTIVES

The term "adoption" is often used interchangeably with uptake, acquisition, acceptance, implementation, assimilation, routinisation and usage (Turner and Turner 2002). The different terms used often denote applications to "specific stages". Generally, the rate of adoption of any innovation has been found to vary across classes of users (Hahn and Yu 1999; Harrisburg, Hasan and Ditsa 1999; Baptista 2000; Littrell and Miller 2001; Veiga, Floyd and Dechant 2001), or (Rogers 1995) be due to:

- cultural values/beliefs (which affect the user perception of the product),
- role of similar or earlier installed product (thus, affecting the experience/ inexperience of the adopting unit of the product); and
- something more complex, more intrinsically embedded within the potential adopter, which varies according to the context (Ng-Kruelle, Swatman, Rebne and Hampe 2002);
- and the social system.

Many researchers have addressed this phenomenon attempting to derive models and theories to help explain or predict users adoption of a new innovation and its diffusion over a particular social system (Mahajan, Muller and Bass 1990). (Prescott and Conger 1995) in their meta review of 70 IT related DOI papers published over the last decade has found "traditional DOI" theory to be most applicable to ITs with intra-organisational locus of impact. Inter-organizational locus of impact IT innovations, appear to be more affected by contextual and environmental variables, and their differences may be better explained by economic influence or critical mass theories. The critical mass theory, is found to be an influential explanatory model that attempt to predict that the utility of communication medium to its users will rise with the number of people using the system, especially when the users play an important role to each other within the system (Markus 1987). The key classical adoption of innovation characteristics were listed in (Tornatzky and Klein 1982) literature of 75 innovation adoption papers. Three key innovation characteristics were identified as:

- compatibility with existing practise,
- relative advantage over existing practise, and
- complexity.

Later, (Rogers 1995) expanded by adding a number of other dimensions including

- trialability, and
- observability.

These general models of innovation adoption were then applied by IS researchers to ICT contexts, resulting in the identification of further factors that influence uptake (Turner and Turner 2002). (Davis 1989)'s Technology Acceptance Model, introduced user perceptions of usefulness and ease of use as important factors for user acceptance and use. Further works have since attempted to extend the classical works of (Tornatzky and Klein 1982; Davis 1989; Rogers 1995). For example (Agarwal and Prasad 1997) adopted the dimensions of perceptions of relative advantage, ease of use and compatibility with existing values and practice while added two additional dimensions: the innovativeness of users and the media through which potential users become aware of the technology and its features. And more recently, (Venkatesh, Morris, Davis and Davis 2003) reviewed user acceptance literature and compared eight[5] prominent models – both original and extended versions, resulting in the Unified Theory of Acceptance and Use of Technology (UTAUT) that integrates elements across the eight models.

Although there is a huge amount of primary academic literature relating to "adoption of ICT", there is very little which deals with the adoption of wireless ICT and which is non-technical in perspective. There is however, a rich seam of writing in non-academic, professional literature, workshops and conference proceedings which we have identified initially through searches in online databases such as ProQuest, ScienceDirect, ABI/Inform, and

[5] The eight models reviewed are the theory of reasoned action, the technology acceptance model, a motivational model, the theory of planned behavior, a model combining the technology acceptance model and the theory of planned behavior, a model of PC utilization, innovation diffusion theory, and social cognitive theory.

the ACM Digitial Library and through follow up research (eg citation searches). We have summarised the literature we found and, in the table below, analysed it within the structure of a generalised set of dimensions of ICT adoption which we derived from the primary DoI literature

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Relative Advantage: end user perceptions of advantage over the current ways of working, also differential advantages between different groups. Often this is measurable in economic terms such as cost, and in non-economic terms such as social prestige, convenience and satisfaction.

Mobile/Wireless case summary
Nomadic computing/ Wireless workplace: Promises of wireless, portable communication devices of newer and better ways of being constantly available and in touch with information an with other people. Drivers include both technological and changes in work and society. (Churchill and Munro 2001)
Wireless Internet: Ubiquitous Internet access to necessitate conveniences brought about by emerging applications such as mobile information access, real-time multimedia communications, networked games, immersion worlds, cooperative work, etc. (Garcia-Macias, Rousseau, Berger-Sabbatel, Toumi and Duda 2003)
Mobile Phones / Mobile Commerce / Mobile Internet : Advantages over fixed network include: Mobility, Zeitverzuglosigkeit, Personalisation, Localisation, Multi-media capability, Location independent, Constant Reachability, Comfort, Speed, Security, Convenience, Instant Connectivity, Dialogue oriented Mobility, Ubiquity, Context specific, Remote control, Entertainment (Gerpott 2001; Kollmann 2001; Müller-Veerse 2001), (Wohlfahrt 2001), (Zobel 2001)
Wireless Applications: End-user unconscious trading of the conveniences of mobility against the price of individual privacy. (Ng-Kruelle, Swatman et al. 2002)

Ease of use: as perceived by end-users, also perceived complexity. Including usability issues.

Mobile/Wireless case summary
Mobile interactive systems: Designers should consider providing users with "mobile awareness", i.e. an awareness of the affect that the mobile communications environment might have on the user's interaction with the system (or with other users via the system). (Cheverst, Davies, Mitchell and Friday 2001)
Handheld CSCW: identification of complementing user interface paradigms for handheld CSCW will enhance mobile computing and the CSCW field in general.(Kristoffersen and Ljungberg 1999)
Nomadic computing: Changing of user profiles from fixed to mobile users, from reliable high bandwidth and reliable network connectivity to mobile devices with limited processing power and capabilities. Resulted in importance place on network and application performance for ensuring comfortable acceptance degree compromise between capabilities and portability. (LaPorta, Sabnani and Gitlin 1996)
Nomadic computing: Studies indicated that users apply distinct feature assessment model – assessment of nomadic benefits vs. the nomadic demand (i.e. nomadic trade-off in terms of software and hardware), where reliability rate is required more when being mobile than when fixed. (Sacher and Loudon 2002)
Mobile communication and services usage: usability inputs methods for one and two hand usage, tactile feedback such as key clicks and vibra-alert, good screens and audio for multimedia services, and connectivity with other devices. (Väänänen-Vainio-Mattila 2002)
Mobile phones and communicators: the importance of design and user interface at NOKIA that crosses a variety of physical, cultural and language settings. Even more so as different forms of and practices changes as more personally adaptable systems become available for consumers. (Väänänen-Vainio-Mattila 2002)

Critical mass and the role of consumers in diffusion

Mobile/Wireless case summary
Mobile communication technologies: Consumer behaviorism is understood and pursued differently by researchers in the industry and academia (particularly social sciences). Bringing together the understanding from both, reiterate that diffusion and consumption of mobile telephony and computing must be understood through investigation of the contexts and processes of their use in everyday life. (Green, Harper, Murtagh and Cooper 2001)
Wireless Applications: End-user unconscious trading of the conveniences of mobility against the price of individual privacy. (Ng-Kruelle, Swatman et al. 2002)
Wireless interactions: human approach unfamiliar, interactive technologies based on what they know from interaction with others, where the rules of human interactions are defined in the shared values, belief and protocols – in a culture. (Sacher and Loudon 2002)

Mobile phones: Social norms around mobile telephony are in flux with dramatic changes in user attitudes and usage pattern through experience with the device, services and with other users. (Salzman, Palen and Harper 2001)

Compatibility: the degree of "fit" between the new (wireless world) and old system (wired world) in terms of working practice, values and needs.

Mobile/Wireless case summary
iMode: The modern Japanese culture – especially the youth, is well known for its enthusiasm for electronic devices. In additional, it fits into the nature of the Japanese mobile users who spend a lot of time outdoors and use public transportation, as well as putting more emphasis on reach than depth of content. (Barnes 2001)
Mobile phones: study of 19 new mobile phone users who are tracked for the first six weeks after service acquisition, show novices rapidly modify perceptions of social appropriateness around mobile phone use – i.e. actual nature of use contradicts from prediction. Mobile phones are discovered to occupy multiple social spaces in parallel, even with conflicting norms (physical space of user vs. virtual space of comversation). (Finland) (Palen, Salzman and Youngs 2001)
Wireless interactions: human approach unfamiliar, interactive technologies based on what they know from interaction with others. Culture-based design is the key to discovering appropriate rules and designs for applications and products with little or no defined conventions. (Sacher and Loudon 2002)
Youth and mobile phones: Ethnographic study of teenagers and their use of mobile phones showed that "everyday, practical activities are influenced by established social practices" – that of gift-giving practices. This can assist to inform design and in conceptualizing future emerging technologies and services. (UK) (Taylor and Harper 2002)

Innovativeness of users

Mobile/Wireless case summary
3rd Generation mobile phones: An ethnographically oriented field studies of teenage mobile phone users, specifically their participation in gift-giving practices, to guide design in user interface and form of a concept of mobile phone.(Berg, Taylor and Harper 2003)
Mobile communication technologies: The identity of communication technologies is very much in movement and is constantly being redrawn, according to the communicative niches occupied by, on the one hand, innovations and proposals for new services and, on the other, the creativity of users. (Italy, UK, France, Germany and Spain) (Fortunati 2001)
Mobile devices: the blurring of "personal" and "work" life, however not necessary coexisting in harmony. Need for applications to support users in management of communication across groups. (Sacher and Loudon 2002)
Mobile telephony and technology: Study on how young people with different level of knowledge in technology, are developing new and innovative ways of interaction. (Spain) (Sieber and Sabatier 2003)

Perception: including perceived usefulness and perceptions generated by 3rd party (media, etc.)

Mobile/Wireless case summary
Mobile commerce: Empirical study of four constructs are found to be significant in affecting decision by subscribers in changing to new mobile service providers: the amount and the perceived usefulness of general advertisements, the perceived usefulness and privacy issues of personalized advertisements. (Hong Kong) (Ho and Kwok 2003)
Mobile parking service: Study on non-utilitarian influences on adoption of functionally oriented mobile services. TAM is extended with the motivational influence of self-expressiveness. (Norway) (Pedersen and Nysveen 2003)

Mandated, championed or discretionary use

Mobile/Wireless case summary
Mobile Internet: Consumer acceptance of gadgets and devices in the case study are financed by their employers. (Denmark) (Fogelgren-Pedersen, Andersen and Jelbo 2003)
Teleworking: A study of nine companies have found that slow adoption and diffusion of telework is mainly attributed by the lack of appropriate telework adoption guidelines and misunderstandings by middle management. Often there is a fear or a wait-and-see attitude for successful cases before diffusion occurs. (Japan) (Higa and Shin 2003)

Dynamics – continuous change of social and private communication behaviour and the inter- disciplinary implications of mobility (sociological, psychological, design of public spaces, etc.)

Mobile/Wireless case summary
Mobile telecommunication technologies : Mobile users utilise technology strategically, for a number of different but integrated professional and personal purposes, in a number of different social environments and relationships. Consumers' usage also changes according to context, i.e. taking on different identities, both depicted in cultural representations of ICTs. (Green, Harper et al. 2001)
Mobile communication: Mobile communications crossing the traditional borders of HCI, human factors, sociology and technology in ways that necessitate a rethinking *of how the* various social, psychological, and cultural factors affect the adoption, design, and usability of mobile communications products and services. (International workshop) (Salzman, Palen et al. 2001)

Context – the set of facts or circumstances that surround a situation or event

Mobile/Wireless case summary
Mobile phones: Further studies need to be conducted to reveal persistent social practices, how these are routinely accomplished, how new technologies may impact, contribute or detract from social practices – all these which could be used as input to inform design. (UK) (Berg, Taylor et al. 2003)
Mobile lifestyle: An ethnographic study on how people in 7 cities (Beijing, New York City, San Francisco, Rome, Stockholm, Rio de Janiero and Sydney) and cultures evolve and advance in their adoption of new mobile lifestyles. (Blinkoff 2001)
Mobile telephony: adoption by teenagers indicate interest to be accessible to others and the symbolic value of certain artifacts – ways in which social maturation and emancipation proceed along various trajectories conditioned by one's social status, gender, life situation, etc. (Norway) (Ling 2001)
Mobile applications: to address the desire of mobile users to include the situation of "human interface" needs into "human+context interface", an input and interaction mechanism that is able to capture the user within her unique situation. (Sacher and Loudon 2002)
Mobile telephony: Factors of adoption need to be placed in context where social norms around mobile telephony are in flux with dramatic changes in user attitudes and usage pattern through experience with the device, services and other users. (Salzman, Palen et al. 2001)

Acceptability issues

Mobile/Wireless case summary
Mobile Commerce: Finding that TAM constructs such as perceived usefulness and perceived ease of use are multidimensional in themselves, authors conducted study from a *perceived value-based view* on adoption decisions to identify key benefits and barriers - the *give* and *get* value components. (Finland) (Anckar, Carlsson and Walden 2003)
Mobile computing: The success is hampered by many debilitating factors, mainly technical that prohibited full acceptance: poor Graphical User Interfaces, slow networks, wasteful protocols, disconnections, weak terminals, immature IP access to networks, poorly optimized Operating Systems for mobile applications, content conversions from wired to wireless network, etc. (Agrawal and Famolari 1999)
Mobile agent technology: Full-scale adoption in untrustworthy network environments has been delayed by security complexities such as integrity attacks, availability refusal, confidentiality attacks and authentication risks. (Bierman and Cloete 2002)
Mobile applications: In additional to addressing technical issues for setting up mobile computing environment, social and privacy issues related to personal information (in addition to spatial- , and temporal- information) need to be addressed. (Hawick and James 2003)
Personalised services in mobile commerce: Study found privacy to be a concern, but not as important as the usefulness of the personalized services. (Hong Kong) (Ho and Kwok 2003)
Pervasive Retail (MyGrocer): Studies on in-store and on-the-move scenarios found consumers placing values on perceptions that MyGrocer is a faster, easier and giving better value for money. However, they want to remain in control of the system and do not trust service providers in protecting their privacy. (Roussos, Koukara, Kourouthanasis, Touminen, Sappala and Frissaer 2002)
Mobile services: right pricing structure, security (of the data and physical security of using device in public space) and trust in various partners in the value chain. One of the criteria for acceptance is related to social adoption of the experience: how people are connected emotionally. (Väänänen-Vainio-Mattila 2002)

THE RESEARCH MODEL: PRICE OF CONVENIENCE - USER ACCEPTABILITY AND PRODUCT UPTAKE BEHAVIOUR

We identified, from the information gathered above, various external issues, both utilitarian and non-utilitarian issues to be deeply entwined in the relationship between three entities: the end-user, the product and the system of which adoption/uptake occurs. With an understanding of the dynamics within wireless environment and its

implications on end-user (and vice-versa) provided by empirical data and existing theories of innovation, the PoC analytic framework is developed to underpin future research into user acceptability of an evolving innovation, to balance Price (cost of privacy loss) and Convenience (mobility, flexibility, etc.). When an individual adopts an innovation, s/he reacts through knowledge and experience to the situation, and as s/he interacts with others in the system, s/he again creates, use and share this knowledge. In order to understand how this occur, it is therefore necessary to understand the context – how it emerges and transforms. It is these issues, in respect of wireless applications, and its pervasiveness in the society, its implications on privacy loss which form the core concern of our research programme, and the development of the *Price of Convenience: User Acceptability and Product Uptake Model (PoC).* First introduced in (Ng-Kruelle, Swatman et al. 2002), the model is now extended to incorporate dimensions relevant, as identified in the literature review presented in the previous section, in end-user adoption of pervasive wireless applications. This PoC model focuses on three components:

- The **Subject**: End user adoption behaviour and acceptability attitude on the formulation of the individual's price of convenience. It includes the end-user characteristics such as lifestyle, motivation, knowledge, innovativeness, involvement, demographics, experience, trust, values and attitudes.
- The **System**: How context emerges and transforms end user behaviour and attitude, which is influenced by the environment. The context is a tapestry of influences from different "system actors" that shapes culture, the subjective norms and provide exposures. The emergence of context becomes input for transformation of the **Subject** behavior and attitude.
- The **Object/Product**: The characteristics and the pervasiveness of wireless applications including perceived usefulness/convenience against loss of privacy and security.

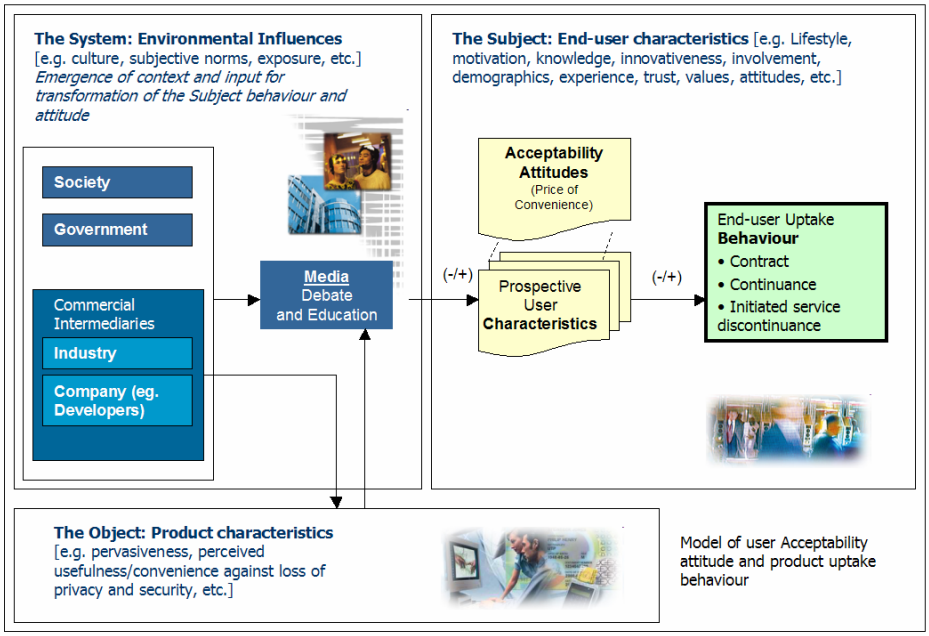

Figure 1: Consolidated literature findings as basis for Model of User Acceptability and Product Uptake

CONCLUSIONS AND FURTHER WORK

Modelling PoC systems will assist us in process identification (interfaces, interactions), measurement (system dynamics, interruptions, disturbances) and possibly control (client over the system, vice versa).

The research model provides a methodology for developing and implementing a "product" in a structured manner. It attempts to apply and extend the conventional *enterprise system process modelling* design to the new virtual business models driven by the digital economy. By modelling PoC system through a series of modules provides a method for process identification (interfaces and interactions), measurement (of dynamics and level of satisfaction) and control (of end-user over the system, vice-verse).

Further work will require identification and validation through anecdotal and empirical research factors influencing the design and operation of such a system. For this purpose, we will perform longitudinal analysis of textual data - mapping and mining the evolution of concepts over time in both small and large text collections. We plan to make use of Leximancer (Refer to website: http://www.leximancer.com/), a Bayesian-

based content analysis software system to provide some support in this process. To this end, we are currently developing a mechanism to enhance the visualisation of the evolution of concepts/concept relationships.
The scope of our initial study is socially pervasive ICT systems and artefacts, for use by private end-users (i.e. business-to-consumer services or government-to-consumer services, consumer-to-consumer). The study will be divided into two phases. The first phase will be a pilot study using Leximancer for empirical operation and validation of the model. Data collected here will be limited to a sample of reports published within the practitioner and public media over the period of 1999-2002. This limits, fairly effectively, the readership demographic to professionals within a single geographic/linguistic market to ensure a controlled cultural context. The second phase, an extensive historical public media content analysis will be undertaken. The objectives of this second phase are (a) to compare the explanatory power of Activity Theory and Interactive Learning; and (b) to evaluate the "probabilistic predictive" power of the PoC Model by comparing the feedback at a point in time against contemporaneous published market predictions made by market intelligence sources (such as EITO, Gartner and PriceWaterhouse Coopers).
In subsequent work, we intend to consider the explanatory power of alternative theories of attitude formation; extend the domain of study from the private to the business use of pervasive ICT services and innovations (and to investigate cross-contamination of attitude and behaviour across private and business use); and to conduct empirical cross-cultural studies.
In conclusion, we expect this work to significantly contribute to our knowledge of socially pervasive computing. While theoretically founded, we hope the results to be widely applicable in practice.

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