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User-driven innovation? Challenges of user involvement in future technology analysis

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The shift from the traditional push towards more user-driven innovation strategies in the information and communications technologies domain has urged companies to place the user at the core of their innovation process in a more systematic way. In this paper we reflect on the implications of this new innovation context for traditional product development processes. Given these implications, two challenges are discussed that are crucial to true user-driven innovation, i.e. the challenge of continuously involving the user and the need for tools to facilitate the integration of knowledge into the increasingly interdisciplinary development process. Drawing on our own experiences in the interdisciplinary Research On Mobile Applications and Services (ROMAS) project, which focused on future mobile applications in a living lab setting, we illustrate how the two challenges can be tackled.

THE INDUSTRY THAT DEVELOPS information and communication technologies (ICT) has been challenged in various ways over the last few decades. Due to extensive convergence in the domains of communication, consumer electronics, computing and content on the one hand (Yovanof and Hazapis, 2008) and hyper-competition and increased market liberalization on the other, companies that aim to occupy or sustain a leading market position in the ICT industry have increasingly been forced into accelerated product development and into skipping important research stages. As a result, there has been an explosion of non-disruptive innovations that are not always clearly different from other products on the market (De Marez and Verleye, 2004; Yovanof and Hazapis, 2008). In this changed context, many new products fail to 'cross the chasm' between the adoption segments that include innovators and some early adopters on the one hand and the mass market on the other (Moore, 2002; De Marez and Verleye, 2004).

Furthermore, traditional product development strategies are said to have crucial shortcomings since they are no longer able to guarantee the successful adoption and diffusion of new ICT. Although innovation is traditionally considered to be a rather linear, research- and price-driven process, this focus seems to have shifted over the years (Rosted, 2006), influenced by the altered role of the technology user as an important stakeholder. Confronted with almost unlimited choices, users' demands have become more sophisticated. Today's users increasingly seek out those products and experiences that fit their personal and situational needs. Consequently, a clear insight into users' needs and experiences has become indispensable (De Marez and Verleye, 2004; Veryzer and Borja de Mozota, 2005).

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Indeed, although 'the consumer' has always been important, the rationale of involving the user has drastically changed. The new context has urged companies to put user needs at the core of their innovation strategies in a more systematic and structured way. Many authors have explored this shift from traditional push- to more pull- and user-driven approaches. Whereas the former are characterized by technology-centred strategies and limited user involvement, the latter acknowledge the crucial role of users in the innovation process (Rickards, 2003; Trott, 2003; Von Hippel, 1986; 2005). In this context we can also refer to policy action that supports user-driven innovation, such as the rise of living labs, which are user-driven innovation environments, and the launch of the European Network of Living Labs (ENoLL) in 2006. Although many other policy initiatives are embedded in this new innovation context, it remains difficult to create a meaningful synergy between users and technology in the field of ICT development.

This paper therefore aims to discuss the integration challenges still to be found in this user-centred context. It is organized as follows: first, we expand on a number of theoretical perspectives on technology and society and the notion of user-driven innovation. We then explore the implications for traditional innovation and development processes. Given these implications, we then identify two important challenges for scholars and practitioners from a user-driven innovation perspective. As a complement to the literature, we draw on our own experiences in the ROMAS project, to illustrate how the two challenges can be tackled. Finally, we summarize our findings and identify some opportunities for further research in this field.

Theoretical perspectives

Interplay between technological and societal forces

The relationship between technology and society has already been studied from various perspectives. The idea of 'technological determinism', which considers technology as the prime mover in transformation, and which propagates the industry's 'push' perspective, has dominated the theoretical debate for several decades. It largely ascribes changes in society to technological advances, which are thus assumed to have important social consequences (Haddon *et al.*, 2005). This theory of 'technological determinism' fits into the 'diffusion of innovations' framework (Rogers, 1995), which is dedicated to the adoption and diffusion of new technologies in society. Technology adoption is assumed to follow a predictable path and is considered to be influenced by 'change agents' (e.g. private firms, influential individuals etc.). In the theory of diffusionism, the first group of people who adopt the new technology (innovators and early adopters) are seen as catalysts for the successive waves of adoption. The final aim is to reach the rest of the market, to the point where the adoption rate has become so high that the innovation can be considered successful (this is referred to as the 'critical mass') (Rogers, 1995). A common criticism of the diffusion theory has to do with its pro-innovation bias and the assumed linearity of the innovation and adoption process.

However, from the 1960s on this industry-push perspective was challenged by more human-centred paradigms that largely reject this notion of technological determinism and which point to the deviation of adoption curves from Rogers' theory. One of them is the social shaping of technology framework, which focuses on the daily use of technology and stresses the power of human actors and societal forces (Williams and Edge, 1996; Lievrouw, 2006). This social constructivist vision aims to make technology development more user- and human-centred. Closely related to the social shaping perspective is the social construction of technology (SCOT) approach (Bijker and Law, 1992), in which the concept of 'interpretative flexibility' is used to refer to the differences between individuals and social groups when it comes to giving meaning to technological development (Haddon *et al.*, 2005; Lievrouw, 2006). In the SCOT perspective, it is assumed that negotiation between certain social groups influences the construction and emergence of new technologies (Bijker and Law, 1992; Haddon *et al.*, 2005).

Although both approaches emphasize the interaction between technological and societal forces, they have been criticized for their rather linear social determinism. Other theories have a less linear view: e.g. the actor-network theory (Latour, 1993), which states that technology and people are part of socio-technical networks, which influence the shaping, forms and uses of (new) technologies. This and other approaches try to focus on technological development from a mutual shaping or interactionism point of view (Lievrouw, 2006). They provide us with a theoretical basis for uniting the technology-centred with the user- or human-centred vision, since the successful adoption and diffusion of technology is ascribed to the continuous interaction between technological and societal forces (Rickards, 2003; Trott, 2003; Boczkowski, 2004).

User-driven innovation

In this new context, the notion of user-led or user-driven innovation has assumed a prominent role. In current definitions, 'user-driven innovation' refers to the process of collecting a particular type of information about the user: it deals with insights both at an observable and a more latent level that are quite difficult to grasp (Rosted, 2006). As a result, user-driven innovation requires an interdisciplinary approach.

Several approaches have been put forward for the collection of this type of knowledge. Hansson (2006) distinguishes two types of user-driven innovation methods: voice of the customer methods and lead-user methods. Eric Von Hippel's work on 'lead users' (1986) can undoubtedly be regarded as pioneering in this respect. Furthermore, the traditional

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user-research tools (including methods such as focus groups, surveys etc.) have been supplemented by alternative analytical methods (e.g. archetype research, personas, scenarios, proxy technology assessment etc.) from various disciplines (e.g. design, foresight, fault tree analysis, anthropology etc.) in order to support user-driven innovation. Whereas the so-called traditional methods usually focus on what people say and think, methods from other disciplines are now used to dig deeper into what people do or want (e.g. ethnographic research, observations, user toolkits etc.), and feel or dream (e.g. generative methods) (Sleeswijk Visser *et al.*, 2007).

Følstad (2008) situates the rise of living labs in this context of user-driven innovation. Living labs are innovation environments that provide full-scale test-bed possibilities for inventing, prototyping, interactive testing and marketing of (new) mobile technology applications (Schumacher and Niitamo, 2008; Følstad, 2008). They can be seen as human-centric systemic innovation instruments, encouraging the interaction between all stakeholders in the innovation process and facilitating the involvement of users as co-creators (Ballon *et al.* 2007). As discussed by Warnke and Heimeriks (2008: 74), systemic innovation instruments are intended:

> …to provide platforms for learning and experimenting, facilitate the management of interfaces, foster new alignment of elements and stimulate demand articulation, strategy and vision building.

Contrary to other test platforms, living labs provide a more natural testing environment and strongly encourage continuous and meaningful interaction between developers/suppliers and users.

However, this shift towards user-driven innovation also brings problems and challenges, such as the issue of the continuous involvement of users and the discrepancy between theory and practice in this respect. Although the user-driven innovation paradigm advocates an open perspective and stimulates the involvement of users from the early development stages onwards, this still contrasts sharply with the narrow and technology-centric scope of many projects. Furthermore, there is a lack of integration of best practices and available methodologies, methods and tools into interdisciplinary user-driven innovation research (e.g. in the living lab setting) (Feurstein *et al.*, 2008; Følstad, 2008). For example, in the early development stages it is often difficult to transcend users' limited powers of imagination:

> …without having a fully developed ICT device at their disposal, users do not have a clear-cut idea of what they require, want or need. (Limonard and de Koning, 2005: 176)

This challenge requires a consolidation of knowledge and tools from various disciplines (e.g. foresight, design, social sciences) and reinforces the role of policy-makers in the establishment of innovative experimentation and co-creation platforms. Another recurring integration challenge arises from the interdisciplinary process itself and refers to the integration of knowledge. The following section discusses two of these challenges, which were underlying the objectives of the ROMAS project.

Integration challenges

Challenge 1: Continuous and adequate interaction with the user

The first challenge concerns the *need for the continuous and adequate involvement of the user*. Several scholars have focused on the fact that there are still only a few companies that effectively involve the customer or user in the innovation process (Alam, 2002; Krisensson *et al.*, 2004). Kristensson *et al.* (2004: 4–5) attribute this discrepancy between theory and practice mainly to the lack of empirical evidence on the benefits of user-involvement and user-oriented strategies compared to traditional research and development. Although research has indicated that if new product development fails, it usually goes wrong from the beginning (Khurana and Rosenthal, 1998), user involvement is too often limited to just one or only the final stage (e.g. usability testing, evaluation etc.) (Haddon *et al.*, 2005). However, the benefits of involving users continuously have already been investigated: users can for example generate unique and valuable ideas for future products (Kristensson *et al.*, 2004). User-driven innovation should thus go beyond merely asking users for feedback after the piloting phase or launch. Instead, users should be involved from the idea stage right up to the post-launch evaluation stage. Furthermore, as user-driven innovation deals with those user insights (needs, expectations etc.) that users cannot always easily articulate, development teams are now forced to explore new and interdisciplinary methodological tools.

Challenge 2: Integration of knowledge: creating a synergy between users and technology

The second challenge concerns the problem of *integrating the knowledge* being gathered by multidisciplinary teams, using either user- or technology-centred methodologies. Although it is crucial that the user insights generated find their way into the development process, the adequate translation and transformation of user insights and requirements into more technical requirements (and vice versa), is still a challenge. The notion of translators is also used in this context (Veryzer and Borja De Mozota, 2005). In this respect it is relevant to mention the gap between QoE and QoS, two important concepts in the field of ICT development. Whereas the latter, which refers to '*general application service performance*' (Soldani, 2006: 1), received a lot of attention in the past, it seems that QoE has now taken over, driven by the abovementioned shift from push to pull. Experiences are seen as *a new source of value* (Pine and Gilmore, 1999: 2) and the nature of users' experiences with new products can determine their success or failure (Crisler *et al.*, 2004; Jain, 2004) In this changed context, Corrie *et al.* (2003: 2) emphasize the importance of users' expectations and experiences:

> QoE is how the user feels about how an application or service was delivered, relative to their expectations and requirements.

De Marez and De Moor (2007) looked into QoE at a conceptual level and identified five main dimensions and over 70 subdimensions. Given this diversity of factors influencing users' QoE, its adequate measurement and translation remains a challenge: insights into users' experiences and expectations (e.g. in a particular context or for a certain application) are often not shared in an interdisciplinary development team. In this respect, the blueprint of a new interdisciplinary approach for correlating QoE to QoS parameters in a living lab environment is expanded upon in this paper.

The next section illustrates how both challenges were tackled in the interdisciplinary ROMAS project. The results are structured into three main research stages.

Case study: The ROMAS project

Project description and research setting

ROMAS was funded by a consortium of industry partners (i.e. Microsoft, Concentra and i-City) and the IBBT, founded by the Flemish Government in 2004 to stimulate innovation in the ICT domain. A user-oriented assessment of (future) wireless applications in cities was conducted. Six IBBT research groups collaborated on this project and i-City's large-scale living lab was the main research location. Although it is now part of iLab (an IBBT research platform offering three complementary infrastructures for elaborate testing in both controlled and living lab settings), i-City was located in Hasselt (Belgium) at the time. Using technologies such as Wi-Fi, Bluetooth, general pocket radio service (GPRS) and universal mobile telecommunications system (UMTS), it covered a wireless environment offering various applications to a large panel of test users via different platforms (e.g. personal digital assistant (PDA), laptop etc.).

The main objective of ROMAS was to generate a set of cross-application research findings that can optimize the integrated development process for new digital products and services. In view of this, an interdisciplinary framework was set up to pretest and co-develop new and innovative applications. This framework enables developers and companies to gain an insight into the main drivers and constraints in service innovation and into the conditions for meeting social and user requirements (Lievens and Pierson, 2006).

Methodological framework

The common methodological framework covered three main research stages in the innovation-development process (Lievens and Pierson, 2006). In the first stage (opportunity identification), possible (future) applications and trends in consumer behaviour were explored. Next, the socio-economic feasibility of these possible services and applications was investigated by the i-City test panel. At the time of the research, the panel had 450 members. Although the test users were more than averagely interested in mobile technologies, the explorative nature of this project and the open access to the panel justified the choice of this research setting. In the second stage (concept development and evaluation), a selection of mobile applications was studied by interdisciplinary research teams in a horizontal layer, investigating market-oriented, sociological, usability, legal, technological and social networking issues. Finally, the third stage (test market and piloting) consisted of an evaluation of the results from the second stage on an individual application level and included an assessment of possible strategies for service innovation. In this paper, we only focus on user- and market-oriented research conducted by the Research Group for Media and ICT and Wireless and Cable Research Group, both affiliated to IBBT and Ghent University.

In order to illustrate how the abovementioned integration challenges were tackled in ROMAS, we zoom in on distinct moments of user involvement during the three stages (see Figure 1), discussing each concrete methodological approach. In addition, we illustrate how a living lab setting can be successfully complemented by other research methods.

Results of stage 1: Opportunity identification

The first stage, i.e. the identification of mobile opportunities, started with a wide scan of mobile applications that are possibly of interest for a wireless city environment. The purpose of this scan was to generate relevant input and knowledge in order to identify current and future mobile applications that might not only make a significant difference to consumers' everyday lives, but might also generate revenues for technology suppliers. One of the major challenges at this stage was not only to successfully involve users in this early part of the process, but also to overcome users' limited capacity to imagine future technological opportunities.

First, extensive desk research was conducted in order to list existing mobile applications and new concepts developed by the mobile industry. This inventory was used as background information to familiarize the researchers with the possibilities of mobile technologies. Secondly, in order to generate some new (and even wild) ideas for future mobile city services, users were involved in two focus groups. The first consisted of members of the i-City panel, all familiar with advanced mobile applications and their use in a city environment. The second group consisted of regular consumers, only familiar with the basic applications of traditional mobile phones.

In this context, a frequently recurring issue in user research is the limited ability of common users to break loose from the existing frame of reference and to imagine future needs and applications. Users often keep referring to familiar technologies such as multimedia messaging services, phone calls etc., and find it difficult to empathize with other users' lifestyles; e.g. a 25-year-old reflects only on his daily

<table>
<tr><th colspan="8">Innovation-development process</th></tr>
<tr><td colspan="6">Prior-to-launch</td><td colspan="2">Post-launch</td></tr>
<tr><td rowspan="2">Opportunity identification</td><td colspan="3">R&D</td><td rowspan="2">Test market and piloting</td><td rowspan="2">Launch</td><td rowspan="2">Adoption diffusion</td><td rowspan="2">User diffusion, evaluation</td></tr>
<tr><td>Concept design</td><td>Concept development and evaluation</td><td>Innovation development and production</td></tr>
</table>

Figure 1. Schematic overview of the three research phases

Table 1. Archetype Patricia and some of her daily activities

Time use	Specific activity
Housekeeping activities	
Cleaning	Contact the cleaning lady
Food	Buy groceries
Children's education	Help the children with their homework
Work	
Full-time job	Keep up with email
	Contact employer when child is ill
	Book a ticket for a conference
	Meet a business associate in a restaurant
Transportation	
Journey from home to work	Avoid traffic jams
	Buy petrol
	Take the children to school
Travel abroad	Book airline tickets
Leisure travel	Go on holiday

activities and finds it difficult to identify with the life of an elderly person.

To eliminate these shortcomings, time-use frameworks were used in the focus groups. Eight categories of daily time-use were identified: *social participation, household activities, study, work, transportation, leisure, health* and *sleeping and resting/relaxing.* To complement the traditional social science method of focus groups, three user-archetypes were developed to help the participants empathize with other lifestyles. Working with archetypes is an alternative way of conducting user research and was inspired by design practices. An example of one of the archetypes is Patricia (see Table 1). Patricia is 40 years old, a manager in a major international firm, mother of two children and therefore always trying to balance work and family life. For each archetype, we listed a series of daily activities within the time-use framework.

Participants in the focus groups were asked to describe their daily activities at different times using questions like '*what do you normally do on a work day between 7 and 9 am?*' requiring simple answers like '*Take the kids to school, have breakfast, drive to work, take the bus to the university etc.*' They then reflected on how mobile technologies could facilitate these activities. The archetypes were used to reflect on the activities of people with other lifestyles. During the brainstorming session, which took place at the end of 2006, participants imagined they were in the year 2010 and were therefore not restricted by current legislation and technological limitations. 47 'wild ideas' were generated in these sessions, all original and very useful for subsequent stages of the research project. By combining the wild user ideas with the results from the desk research, a list of 80 mobile applications was created. The list was preliminarily divided into eight categories based on the time-use research. Although the full list of 80 applications (Table 2) is too long to be discussed in detail in this paper, it served as input for the compilation of attractive and successful application clusters (stage 2).

Given the results that were yielded in this first instance of user involvement, the next logical step was a feedback session with the supply-side, i.e. the content and service providers who can also be considered as professional users of the mobile applications and can therefore provide valuable input for technological developments. Potential service providers were contacted and sounded out for their interest in

Table 2. Final list of 80 (future) mobile applications

Finding people with same interests	Note taking	Reader
Mobile payment	Traffic jam alerts	Mobile auction
Practical and admin. Information for students	MapQuest find me	Prescriptions
Indication of parking spaces and availability	i-nanny	Health monitoring
Mobile information services	Mobile flirt	E-care
Sports events on mobile	Mobile chat	Finding lost elderly person
Tourist portal	Mail/diary on mobile	Video surveillance
Keeping up hiking and cycling routes	Mobile domotics	Shared agenda
Mobile news	Mobile banking	Business card exchange
Find shops	Parking ticket on mobile	Meal help
Movie choice	E-ticket	Mobile administration
Download presentations or other info	Shopper	School diary and report
Checking available places in cinema	eQuick recipes	Mobile academy
Smart domotics	E-meal	Study mentor
Smart machines on mobile	Study choice guide	Restaurant order and payment
Medication prescriptions and schedules	Mobile learning	CV on mobile
Public transport schedules	Mobile terminal	Accident reporting
Carpooling system	I-map	Manual download
Mobile dating	Automated tolling	Shop alert
Smart mobile messenger	Mobile blog	Receipt download
'Independent living' support	Mobile feed reader	Monitoring organization aid
Free mobile surfing	Restaurant finder	Identity and medical info on mobile
Location-based advertising	Photo service	Heartbeat information
Making appetizers	Scanning information	Dentist appointment
Mobile video calling	Webcam	Blind aid
Spare time suggestions	Museum tour	Cot death alarm
Mobile search	Event information	

the use of mobile applications to support their existing products and services. By combining all input sources (desk research, user research and consultation of industry partners), three types of applications were identified:

- User-generated applications that were not being developed by the industry at the time of the research.
- Applications that were mentioned by the users and that were already being implemented by the industry.
- Applications that were not mentioned by the users in the study, but that already were already commercialized or being developed by the industry (push-driven).

Table 3. 13 clusters and corresponding Cronbach's alpha values

Application cluster	Cronbach's alpha
Food and shopping help	0.871
Tourist information	0.775
Mobile social contact and friends	0.789
Doing 'usual, daily tasks' more efficiently by mobile	0.812
More effective healthcare	0.812
Mobile high-tech	0.790
Mobile help for study and work	0.764
Doing unusual tasks more effectively by mobile	0.776
Payment and Money affairs	0.763
Help with serious health issues	0.721
Multimedia	0.654
Administration	0.760
Mobile news and information	0.679

Results of stage 2: Concept evaluation

Next, all the applications considered in the first phase were transformed into workable paper concepts and presented to a large audience in order to evaluate their adoption potential and identify appropriate market segments. For this concept evaluation phase, we conducted a major survey among the i-City panel (n = 420). The advantage of such an evaluation is the panel's familiarity with mobile city concepts and experience with actual working applications. In total, 312 panel members completed the survey.

First, we examined the 80 applications and/or ideas and tried to group the long list into some clearly distinguishable application clusters. The criteria for this clustering are the correlations and similarities in interest patterns for certain subsets of applications. The difference in the interest shown in each of these application clusters can be considered as a first exploration of their potential. Secondly, the clusters were ranked to identify the most promising application(s)/cluster(s).

A factor analysis (using the principal component analysis technique) of the interest shown by the 312 respondents in the 80 mobile city application(s) showed that this interest can be summarized in 21 factors, still explaining 67.5% of the total variance ($R^2 = 0.674$). The internal consistency and reliability of each factor was assessed using Cronbach's alpha (alpha values exceeding 0.65 are considered to be internally consistent). Using this approach, 13 clusters were discovered (Table 3).

Since each cluster represents a set of applications with strong correlations in the interest (or disinterest) shown by the 312 respondents, they can also be considered as a potential added value domain for mobile city applications for a certain part of the market.

16 applications could not be clustered and were therefore analysed separately. Clusters and single applications were ranked on the basis of the respondents' interest level (Table 4). The overall average interest ranking for all the clusters showed that the most important innovations in these mobile applications are not the most high-tech ones, but rather those applications that enable people to save time and that contribute to a better quality of life. Despite the popularity of the virtual social contacts on the web, the mobile social contacts and friends cluster certainly does not appeal to the majority of the sample population (2.94/5). Despite the high ranking of news in the most-wanted content rankings, the mobile news cluster only received an average interest of 3.11/5. There does not seem to be great enthusiasm for sports on mobile (2.74/5) either. A possible explanation for this may be found in the somewhat abstract description of the application ideas, which is typical for this stage of the process.

Further and deeper analysis is certainly necessary in order to reach definite conclusions about the appeal of each of these applications. The correlation of interests in the different kinds of application was also used to cluster participants. Although this clustering is not discussed in detail in this paper, the analysis yielded valuable insights into the appeal of certain types of application to certain user clusters, by means of profound analysis of interest, perceived added value and willingness-to-pay for some applications.

Results of stage 3: Test market

For the third user involvement session, we take a look at the test market phase. One application, i.e. *mobile news*, was selected from the list by the industry partners for further development despite its limited appeal to the panel members (Table 4). As the industry partners aimed to test the application and assess the adoption potential of the mobile news application on the basis of a working prototype, the mobile news application was developed by Concentra. The i-City panel was able to test it and the adoption potential of the application was assessed by means of a large-scale survey (Berte *et al.*, 2008). Since the results from earlier user research were

Table 4. Ranking of application clusters and separate applications based on respondents' interest level

Application (cluster)	Average interest (1: not interesting at all – 5: very interesting)	Application (cluster)	Average interest (1: not interesting at all – 5: very interesting)	Application (cluster)	Average interest (1: not interesting at all – 5: very interesting)
Very appealing		**Moderately appealing**		**Not appealing**	
Indication of parking spaces and availability	4.23/5	Mobile search	3.78/5	Food and shopping help (*FoodShop* cluster)	3.23/5
Practical and administrative information for students	4.20/5	Doing 'usual, daily tasks' more effectively by mobile (*Effective I* cluster)	3.73/5	Mobile news and information (*MobNews* cluster)	3.11/5
Public transport schedules	4.11/5	Checking available places in cinema	3.72/5	Spare time suggestions	3.10/5
Payments and financial affairs (*Money* cluster)	4.01/5	More effective health care (*Health I* cluster)	3.68/5	Mobile social contacts and friends (*Social* cluster)	2.94/5
Traffic jam alerts	4.01/5	Doing 'unusual tasks' more effectively by mobile (*Effective II* cluster)	3.68/5	Carpooling system	2.93/5
Help with serious health issues (*Health II* cluster)	3.99/5	Download presentations or other information	3.65/5	Location-based advertising	2.78/5
Independent living support	3.93/5	Administration (*Administration* cluster)	3.63/5	Sports events on mobile	2.74/5
Free mobile surfing	3.92/5	Multimedia (*Multimedia* cluster)	3.57/5		
Find shops	3.92/5	Movie choice	3,54/5		
Tourist information (*Tourist* cluster)	3.87/5	Mobile help for studies (and work) (*Study* cluster)	3,43/5		

disregarded, this choice illustrates that decisions are sometimes made at the expense of the user-centred rationale. At this stage in particular, other factors were considered to be of greater importance to the decision to be taken by the project's industrial partners. These factors included some of the following: the substantial involvement of the inhabitants of Hasselt in their local community, the role of existing local news initiatives, the presence of a community of city reporters and the agenda of one of the industrial partners, which was a local content provider (Concentra) with a proper local TV news channel (TV Limburg) and which expressed the need for a cross-media approach.

During the same stage, the QoE of one particular application (i.e. Wapedia: a Wikipedia application for mobile access) was investigated in a controlled research setting. This study should be seen as a methodological sideline in the ROMAS project, focusing on the evaluation of QoE in a mobile living lab setting. In this context, we developed a five-step interdisciplinary approach for linking QoE to QoS parameters in living lab environments. This approach draws on hard technical parameters as well as more subjective (social, contextual etc.) elements and their translation. As a result, it not only considers the question of what is happening (e.g. on the network), but also the matter of why certain things are happening (e.g. why does the user feel frustrated?). It was tested in a pilot study of the Wapedia application. Ten test users, all recruited by a specialized recruiting agency, were involved. Instead of elaborating on the results (see Deryckere *et al.*, 2008), this paper limits itself to a discussion of the research process and the way the abovementioned challenges were tackled. We now briefly turn to the five stages.

1. *Pre-usage user research* to detect relevant QoE elements and user expectations. This stage included a semi-qualitative group session per two participants, who were asked to reflect on elements and factors influencing their experience with and expectations of mobile phone use. Methods used here included: free listing, questionnaire, brainstorming, QoE elements list, prioritizing exercise (card sorting) and conjoint analysis. The latter is used to determine which product features or attributes are considered to be most important when a set of them are offered. It allows us to analyse the preferences of the respondents. In our study, a set of six QoE elements was offered, resulting in a total of 15 combinations. Having calculated the mean scores of these elements, the following top five ranking was obtained:
   1. availability of network (connection at any time, anywhere);
   2. user-friendliness;
   3. interface;

4. battery lifetime plus security; and
5. response time.

2. *Pre-usage translation workshops.* The aim of these workshops is to find an optimal match between user-indicated QoE elements and measurable QoS parameters. The intention of this stage is to translate insights from the user research into workable requirements. In the pilot study, a photo-download application was for example developed to simulate different download times (ranging from 0 to 5 second scenarios). This application was shown to the test users, who were asked to indicate those scenarios that were acceptable to them (for a good experience) in a mobile context.
3. *Monitoring of QoS parameters during use.* In this stage, the respondents tested the selected application. Several usage scenarios had to be carried out, consisting of a number of tasks to perform with a PDA. These tests were performed in an indoor environment at four different locations with a different signal strength at each location. The four locations were at different distances from the access point, corresponding with different signal strengths (dBm). By using several scenarios, the influence of repeated tests was minimized. The test users were not aware that the signal strength was manipulated.
4. *Post-usage questions* on device (e.g. PDA). Immediately after the completion of each scenario, the test users were asked to fill in a short experience questionnaire of six questions (five-point scales), displayed on the PDA. The monitored signal strength and responses were saved on the PDA and automatically transmitted to the server. This resulted in 60 samples per location (total of 240 samples).
5. *Post-usage comparison* of expectations versus experience (based on information gathered in step 3 and further user research) in order to identify and explain differences/matches between them. In this stage, a similar methodological approach was taken as in stage 1. In this case-study, it was only signal strength that was related to perceived experience, with the aim of showing that there might be a relation between QoE and QoS. For example, we selected user 10 (male, 33 years old) to explain the results for an individual user. Figure 2 shows the rating of the answers given by user 10 to several questions (Q1, Q2, Q5, and Q6) as a function of the median signal strength at the different indoor locations (location 1 corresponds to a median P = −43 dBm and location 4 corresponds to −83 dBm for this user). User 10 shows great satisfaction up to −79 dBm, with ratings of 5 for expectations, reuse and general experience. At −79 dBm a slight reduction in speed is noticed by this user due to the much lower signal strength: more time is needed to load such things as pictures on the PDA, which causes the application to slow down. The ratings for speed and general experience drop significantly at −83 dBm. Expectations and reuse remain relatively high for user 10, and despite the bad experience at −83 dBm, user 10 would still reuse this application.

In this last section our aim is to illustrate how QoE might be measured by an interdisciplinary team and how insights from user research might be adequately translated into technical requirements. Future research will include the testing of this multimethod approach with a large number of users and several usage contexts and parameters in a living lab setting.

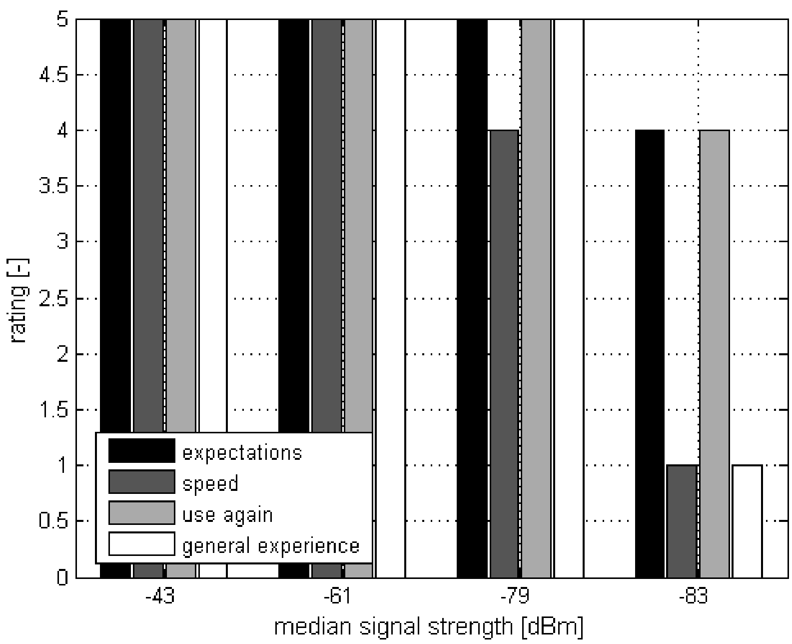

Figure 2 Ratings for user 10 on questions Q1, Q2, Q5 and Q6

Conclusion

In this paper, we have focused on the shift from traditional technology push to more user-oriented and user-led approaches in the communications industry. Drawing on a number of theoretical frameworks that have studied the relationship between technology and users/society in greater depth, we reflected on the implications of this new innovation context for traditional development processes. It was mentioned that this predominant focus on the user led to an expansion of the traditional range of user research instruments with methods and tools from other fields. However, it was argued that, notwithstanding this ongoing broadening and despite the emphasis on such interdisciplinary approaches, it still remains difficult to create a meaningful synergy between users and technology.

Given the implications of the notion of user-driven innovation and the traditional tension between user- and technology-centred strategies, two crucial challenges were identified: the need for continuous interaction with the user and the need for mechanisms to integrate the knowledge that is gathered in the increasingly multidisciplinary development process. Empirical findings from the interdisciplinary ROMAS project on future mobile applications were presented in this paper in order to illustrate how both challenges can be tackled. Drawing on results selected from three distinct points of user involvement in the process of developing new products (i.e. opportunity identification, concept evaluation and test market), it was illustrated how research in a living lab setting can be complemented by other research methods in order to fuel the user-driven approach.

However, it was also shown that in some cases there is still a discrepancy between theory and practice. Although in theory many projects start from a user- and pull-driven perspective, the mantra that ‘innovation should start with the user and end with the user’ is not always pursued. At the policy level, considerable effort has already been put into the creation of a new innovation system. In this respect, the support for the ENoLL, which already includes around 130 members from various member states, illustrates that the creation, integration and harmonization of these systematic innovation instruments is high on the agenda. But there is always room for improvement. From a methodological point of view, there is a lack of robust tools to enable context and co-creation research in living labs. Furthermore, even in living lab research the focus is still primarily on a certain technology or new application (e.g. mobile TV), rather than on the way users interact with different access networks in their natural environment. In this respect, the establishment of real user-driven living labs might provide a more accurate insight into users’ current and future needs. Putting user panels together on the basis of the devices and services people have already adopted and domesticated could be one way of doing this. In such a scenario, new applications that are tested in the natural environment would therefore only be an additional layer on top of the ‘domesticated’ networks and devices. This could be the next step towards a real user-driven innovation system.

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