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Would you share? Predicting the potential use of a new technology

Lidwien van de Wijngaert [a,*], Harry Bouwman [b,c]

[a] Institute for Information and Computing Sciences, Utrecht University, Padualaan 14, Utrecht, The Netherlands
[b] Faculty of Technology, Policy and Management Delft University of Technology, The Netherlands
[c] IAMSR, Åbo AKademi, Turku, Finland

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Abstract

In this paper, we describe the case of wireless grids, an emerging technology that enables ad hoc sharing of resources (such as screen, signal and microphone) on edge devices (such as PDA's, laptops and mobile phones). We look at the circumstances under which people are willing to share the resources on their edge devices using a technology with which they are not yet familiar. We collected data among students from a University in the North-Eastern USA ($N = 284$) through a policy capturing design (also known as factorial design or conjoint measurement), and analyzed the information via multilevel regression analysis. This approach allowed us to explore factors that explain the use of emerging peer-to-peer technologies among consumers as well as context-related characteristics. Context-related characteristics, in particular trust in communication partners, explain the willingness to share and, consequently, the use of wireless grids.

Keywords: Adoption; Innovations; Conjoint measurement; Wireless grids

1. Adoption and use of new technologies

Wireless grids (McKnight et al., 2004) are among the many communication technologies that may take its first steps out of the laboratory into the real world. Wireless grids allow ad hoc sharing of resources (such as screen, signal and microphone) on edge devices (such as PDA's, laptops and mobile phones). As such, it is a technology that may have many user applications that are still largely unknown. However, the success of this new technology to a large extent depends on the degree to which it actually matches user needs and fits the context in which customers need to use the specific functionalities (Van de Wijngaert, 2004). However, given a specific user context, it is hard to assess potential user needs with regard to an application or service that has not yet appeared on the market. Rogers (1995) states that the fast adoption of innovations depends on the degree to which people can observe others using the innovation or the extent to which they are able to try

* Corresponding author. Tel.: +31 30 253 6417; fax: +31 30 251 3791.
E-mail address: L.vandeWijngaert@cs.uu.nl (L. van de Wijngaert).

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the innovation without further obligations. For a technology that is still unknown to the public at large, as is the case with wireless grids, this may pose a significant threshold. Moreover, research into the future adoption of new, emerging technologies, has shown that, although most people indicate that they have an interest in adopting new unfamiliar technologies when asked, in many cases the actual adoption lags behind when such technologies are marketed (for an overview, see Bouwman and De Jong, 1996, also Klopfenstein, 1989). To a large extent this is because the use of a new technology is related to a specific context. This means that it is only when that context is provided given in surveys on potential adoption that users are in a position to assess the potential value of specific innovations. The concept of context is, however, rather ambiguous. McCreadie and Rice (1999) draw a distinction between context – the broader picture in which potential users operate – and situation – the particular set of circumstances from which a need for information or communication may arise. In the mobile communication domain context-aware services relate more to what McCreadie and Rice refer to as situation. We will use the concept of context to refer to the very concrete environment in which a technology is going to be used.

To understand the need for a new technology we need a different approach than the traditional surveys used in diffusion of innovation (Rogers, 1995) and technology acceptance model/unified theory of acceptance and use of technology research (Davis, 1989; Venkatesh et al., 2003) is required. Both approaches are limited due to the very generic way in which they conceptualize adoption and use are. Relative advantage, perceived usefulness and perceived ease of use are the central exploratory factors and as a consequence the context in which the technology adds value to the user is ignored, as is the technical characteristics of the technology (Orlikowski and Iacono, 2001). In short, there are severe doubts about the possibility of predicting the future adoption and use of new technologies based on survey/questionnaire type of approaches, mainly due to the fact that the match between need and use within a specific context are poorly conceptualized.

The objective of this paper, is to obtain insight into the factors that influence the use of wireless grid applications before a given technology is actually introduced on the market. We are explicitly not interested in the adoption of the wireless grids technology per sé, but in the preceding question if people are willing to share resources, i.e. the condition that have to be fulfilled will the adoption of wireless grids will be relevant at all, and will be considered to be used. To achieve this objective we use policy capturing, also known as factorial design, vignette studies or conjoint measurement (Rossi and Nock, 1982; Karren and Woodard Barringer, 2002; Gustafsson et al., 2003; Bouwman and Van de Wijngaert, 2005). This approach makes it possible to assess the combination of context-related and user-related characteristics that influence people's decision whether or not to adopt and use a wireless grid application in the long run. Respondents are presented with a number of use-cases, which are based on a systematic variation of context-related characteristics and they are then asked whether they are willing to share resources. This question precedes questions with regard to adoption and in the long run actual use. Because the cases that are presented to the respondents vary systematically, it is possible to analyze the effect of the different context-related characteristics in relation to the (future) use of new emerging technologies, while taking differences between user-related characteristics into account. This information can offer directions for the further development of wireless grid applications, adjusting them to user preferences, and it can help prevent major disinvestments due to the premature or unsuccessful introduction of new applications. Before we explain how the policy capturing research was set up and how the multilevel data-analysis fits in, we take a closer look at wireless grids, and discuss relevant literature in order to understand what context-related characteristics may play a role in people's decision whether or not to use wireless grids. We use wireless grids as a technology because they are a typical example of a peer-to-peer technology that is as yet relatively unknown. Based on a literature review we present our hypotheses.

2. The case of wireless grids

Grid computing is usually referred to as a type of network computing in which the unused processing power of numerous computers is combined, the goal being to solve information intensive problems that are too large for individual computers to handle. A well-known example is the analysis of radio telescope data to search for extraterrestrial intelligence (SETI) (Anderson et al., 2002). In contrast to the sharing of processing power in these large, predefined projects, the sharing that takes place in wireless grids is McKnight et al. (2004):

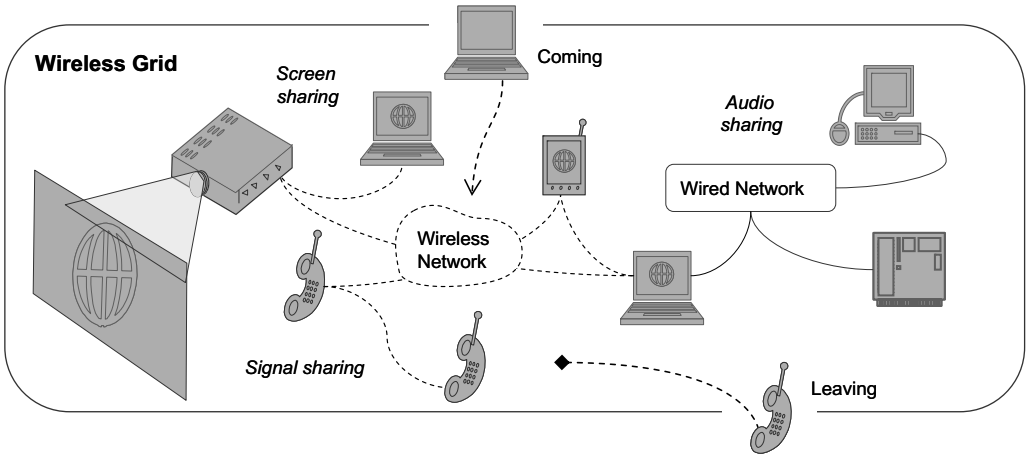

Fig. 1. Wireless grids configuration.

- not only directed at sharing processing power, but at combining a wide range of other resources such as screens, wireless signal, microphones on edge devices such as cell phones, PDA's, or laptops.
- more locally and ad hoc oriented: users can come and go in the local and ad hoc wireless network.

Examples of wireless grid applications (McKnight et al., 2004) are ad hoc screen sharing (hook up any laptop in a room to a projector without having to connect through cables), distributed audio recordings (using the microphones of wireless devices such as mobile phones and laptops to create stereo or surround sound recording) and location aware PDA's (create smart buildings that help visitors navigate through the building and communicate with others). As is shown in Fig. 1, wireless grids connect the resources of edge devices with each other and with wired grids. Ad hoc distributed resource sharing allows these devices to offer new resources and locations for grid computing. McKnight et al. (2004) provide an extensive description of wireless grids.

In order to realize applications, the wireless grid software basically has two functions. Firstly, it is capable of discovering resources within the (wireless) network and, secondly, it facilitates the sharing (or mixing) of resources. So in contrast to, for example, Bluetooth, wireless grids does not create the wireless infrastructure, but uses the available resources, whether they be Bluetooth, WLAN or 3G+. It uses the available infrastructure to provide applications such as screen sharing on top of these infrastructures. To summarize, the most important characteristic of wireless grids in this research is that it allows for the sharing of resources on edge devices. Sharing can take place in a public and private context, between partners that are known to each other or that may be strangers.

We would like to emphasize that, although there are currently some demonstrations applications available, this technology is not readily available to users. With this paper, we want to show that it is possible to obtain insight into some of the considerations that users may have when it comes to adopting and using this new technology. In other words, while using wireless grids merely as a case, we provide a theoretical framework, which we present in the next section. In our literature review we begin by discussing the literature on adoption and use, before focusing on the context-related characteristics that are relevant to a technology that is geared toward the sharing of resources.

3. Theoretical framework

The basic starting point in the field of adoption and use of new technologies is probably Rogers' diffusion of innovations (DoI) (1995) theory. Concepts like relative advantage, observability (or visibility and result demonstrability), triability, complexity (ease of use) and compatibility, are fundamental in describing the diffusion of innovations (see also Plouffe et al., 2001). However, although Rogers' concept of adoption only

refers to people's decision whether or not to adopt, it does not focus on what happens after people have adopted an innovation and find a permanent use for a specific technology. Although Rogers highlights reinvention, he pays relatively little attention to the day-to-day use of technology. The widely used TAM/UTAUT model (Davis, 1989; Venkatesh et al., 2003) also proposes that perceived usefulness (the degree to which a user expects that a need will be met by a specific technology) is an important predictor of day-to-day technology use. However, TAM and UTAUT view technology as a black box. Both the characteristics of a technology and the context in which it is used are largely ignored, Future use of specific technologies in a specific context cannot be analyzed on basis of the DoI or TAM concepts.

To gain insight into what lies behind perceived usefulness we turned to the basic assumptions of the uses and gratifications theory (Palmgreen et al., 1985). Palmgreen et al. state that a perceived need is the basic motivation for a user to take action. In other words, the day-to-day use of a technology emerges from people's need. However, this approach has a hard time linking perceived needs (such as the need for information, communication, entertainment and transaction, or instrumental or social, emotional use, as proposed by Bergman et al., 1995) and people's actual behavior (using a particular technology to fulfil the need).

Theories like media richness theory (Daft et al., 1987) and the social influence model (Schmitz and Fulk, 1991) focus on the match between technology and task characteristics in relation to the effectiveness of communication. By examining that match, they attempt to open the black box of user needs and technology characteristics. However, the problem, especially with media richness, is that it assumes that people behave in a rational manner. In the social influence model, external factors like vocational learning, norms and social behavior, as well as social norms (normative influences) with regard to rational behavior are discussed.

Starting from less rational premises, social shaping and social construction of technology (Williams and Edge, 1996; Lievrouw and Livingstone, 2002; Winston, 1998) and domestication (Silverstone and Haddon, 1996; Mante-Meijer and Haddon, 2001; Frissen, 2000) literature helps us understand the social and cultural mechanisms behind the adoption and use of emerging technologies. These more critical approaches emphasize that the adoption and use of technology are part of a dynamic process that changes over time, and that they are context-dependent. Although these theories appear to grasp the complexity of the adoption and use of new technologies and discuss both technology-related and context-related characteristics, predominantly in a very generic way or through very detailed qualitative descriptions, they are less effective when it comes to analyzing and understanding people's day-to-day behavior, as well as quantitative testing of hypotheses in terms of concrete, context-related behavior. Although these theoretical frameworks provide valuable starting points for understanding the use of new technologies, they are limited when it comes to taking the specific usage-related context into account as an explaining factor.

Summarising the above, we can say that there is a great variety in theoretical starting points with regard to the diffusion of new technologies. Moreover, different approaches have different advantages and disadvantages. For example, domestication provides a very detailed picture of the diffusion process but is hard to apply when it concerns new, non-existent services. TAM, in contrast, does provide the possibility to look at future adoption but treats both technology as well as its users as a black box.

In order to establish which (combination of) theoretical approach is appropriate, we have to go back to the goal of the research. As stated earlier, the goal of this research to obtain insight in the diffusion of wireless grids, a service which is unknown to the public at large. Earlier in this article we stated that it is not possible to obtain insight into peoples likeliness to adopt wireless grids. However, we can obtain insight into the circumstances under which people are willingness to share resources. When we assume that the willingness to share resources is directly related to the adoption and use of wireless grids, we can reach the goal of this research. We are explicitly not interested in the adoption of the wireless grids technology per sé, but in the preceding question if people are willing to share resources, i.e. the condition that have to be fulfilled will the adoption of wireless grids will be relevant at all. Using the basics from frameworks like uses and gratifications and media richness we focus on the characteristics of the context (i.e. need, task) and characteristics of the individual to explain willingness to share resources. Comparable to Webster and Trevino (1995) we use context-related characteristics to construct the use-cases (vignette or conjoints). Moreover, we use individual characteristics to analyze the differences in the decisions with regard to sharing resources as indicated by the respondents involved. With this approach we combine the strength of several theoretical frameworks: we can obtain insight into possible future behavior as well as obtain insight into the richness of real life behavior.

In order to understand sharing behavior in a specific context we thus have to analyze the relevant context-related characteristics, as well as individual user characteristics. We first discuss contextual factors that may affect people's decision whether or not to share resources, as enabled by wireless grids. We then take a look at the characteristics of the person who has to decide if he or she is willing to share resources and to make use of wireless grids, given the specific context. Both the contextual as well as the personal factors, which we will consider in our research, were emphasized by participants in focus group sessions on wireless grids (McKnight et al., 2005).

3.1. Contextual characteristics

Although sharing is a common theme when discussing the sharing of content or files between Internet users (for example Napster, Gnutella, KaZaA, or YouTube), or information sharing in supply chains or other (inter) organizational settings (for instance Kolekofski and Heminger, 2003), hardly any research has been conducted in relation to the sharing of IT resources between users. Sharing is closely related to cooperation, i.e. the day-to-day spontaneous pro-social gestures of people's accommodation to the needs of others (Smith et al., 1983, p. 653). In contrast to sharing information, the partners with whom one wants to share functionality on edge devices have to be physically present, or at least nearby. In such a setting issues like trust become highly relevant.

3.2. Trust

The results of focus group research (McKnight et al., 2005) with regard to wireless grid indicate that, although people see the relative advantage of wireless grids, they feel reluctant to share the resources on their edge devices with people they hardly known or in a social context with which they are not familiar. Issues relating to security and privacy create a lack of trust. Research in the domain of information systems and information sharing (Kolekofski and Heminger, 2003), as well as research concerning transactions in general (Zucker, 1986), and e-business and e-commerce in particular, also indicates that trust between partners is very important. Soliman and Janz (2004) and Grabner-Krauter and Kaluscha (2003) suggest that one of the critical factors that affects the decision whether or not to exchange information between systems is trust. Although trust can be created when transactions become routine and familiar, lack of trust initially is an important threshold with regard to the use of wireless grid applications. We therefore hypothesize that people are more willing to share resources enabled by wireless grids when they have the feeling that they can trust the partners that operate within a specific familiar context (trustworthiness of context).

H_1 People are more willing to share if they trust the partners that operate within the specific familiar context that requires a service enabled by wireless grids.

3.3. Emergency

Because we expect trust to be such an important factor when it comes to the adoption and use of wireless grid applications, we find it important to find out whether it is possible to influence trust. It has been demonstrated that people are more willing to help when there is a (public) emergency (Shotland and Stebbins, 1983). Fischer et al. (2006) show that in situations where the potential dangers are limited, people were more likely to give assistance in a solitary condition than in a bystander condition. Bystander effects are to a large extent reduced in an emergency, implying that when the costs of not helping are high people are more willing to help. Although our focus is not directed at bystander effects, we may conclude from this that people are expected to be more willing to share resources enabled by wireless grids when the context is emergent. We hypothesize that people are more willing to share in an emergent context.

H_2 In a given context people are more willing to share when there is an emergency, even when they do not trust the partners in that context.

3.4. Mutual benefits

The context is also defined by the potential outcome of sharing resources via wireless grids. The main question is whether the person who is going to share only behaves altruistically, or whether he or she also benefits. In the domain of game theory decision-making that involves multiple actors, as is the case with wireless grids, this question has been studied extensively. The positive or negative outcome for a player depends on the strategies and interactions of all the players. We can see people's willingness whether or not to share resources as an interaction in a game that involves two players, one of whom is requesting the resource and another one providing the resource. Mannak et al. (2004) found that users share resources based on reciprocity, and according to Kolekofski and Heminger (2003) self-interest and reciprocity are relevant to the sharing of information. Users share their files via the Internet with the intention of keeping peer-to-peer system running. Organizational units share information if both of the parties involved benefit (Barua and Ravindran, 1996). In a similar vein, we hypothesize that:

H_3 People are more willing to share resources enabled by wireless grids in a given context when both partners involved will benefit. In cases where only one of them will benefit, people are less willing to share.

3.5. Gender

The final dimension, that plays a role in defining the context in which people have to decide whether or not to share, has to do with the characteristics of the people involved. In addition to gender, we could also have included characteristics like age or ethnicity, but due to our research design (see next section) we are limited in the number of concepts we can include. Within psychological research there is a long tradition showing that people whose appearance is similar are more likely to help each other. This effect is even stronger for men than it is for women (Emswiller et al., 1971; Belansky and Boggiano, 1994). Based on the shared identities approach, Levine et al. (2005) have confirmed that a shared social background between victim and bystander will lead to increased likelihood of intervention. Analogue to this reasoning we hypothesize that:

H_4 Men are more willing to share resources enabled by wireless grids when the person requesting support in a specific context is a man, whereas women are more willing to share with women.

The four context characteristics discussed above will serve as dimensions in constructing the use-case, defining the context in which the sharing of resources that is enabled by wireless grids will take place.

3.6. Individual characteristics

In the previous sections, we have explained how contextual characteristics may influence people's decision whether or not to share recourses. However, because this decision is also a personal decision, individual characteristics may be important. Experience with information technology, the personal altruism-level, as well as gender come into play here. We have deliberately selected these three variables, one of which is related directly to the use of IT, relevant form an adoption point of view, while the second one is related more to relevant individual attributes. We selected the third one, gender, in particular in relation to H_4. We now elaborate on each of these individual characteristics.

3.7. IT experience

Experience with information technology is relevant to the adoption and use of information technology. Corbitt et al. (2003) and Teo (2001), for instance, suggest that people are more likely to purchase from the web if they are more experienced in using the web. Van der Veen and De Haan (2003) also argue that when people have used a PC and the Internet for a longer period of time, they are more likely to try new applications

and functions. When we translate this to the domain of wireless grids, we can formulate the following hypothesis:

H_5 Experienced IT users are more likely to share resources by making use of a new technology such as wireless grids.

3.8. Altruism

Experience with IT is related to the adoption and use of technology, while altruism is more related to the decision to share. Altruism includes all discretionary behavior that has the effect of helping a specific person with a task or problem (Organ, 1988). The focus on other people is typically associated with an understanding of their needs. In organizational research, altruism is conceptualized as organizational citizenship behavior (Graham, 1991). Citizenship behavior means going 'beyond and above the call of duty'. In social psychology literature, citizenship behavior is negatively related to emotional instability and positively to extraverts, but also to "beliefs in a just world". With regard to demographic variables, education and urban versus rural origins play a role, but not gender (Smith et al., 1983).

In general we can hypothesize that:

H_6 People who are more altruistic in nature are more willing to share resources via wireless grids.

3.9. Gender

Altruism and helping are still pre-dominantly associated with women (Kidder, 2002). Also, Allen and Rush (2001) have found that women are more likely than men to engage in organizational citizenship behavior. Studies concerning citizenship behavior (Kidder, 2002; Farell and Finkelstein, 2007) do not show a gender-based difference, but conclude that both men and women are likely to help and take responsibility. On the basis of a literature review on helping behavior, Eagly and Cowley (1986) found that men are more likely to help. However, the picture is more nuanced when we include social-role theory. Female sex roles basically promote caring and nurturing behavior, empathy et cetera, while male sex roles stereotypically involved more heroic behavior. This stereotype is also confirmed in information sharing studies. Ilie et al. (2005) and Bergman et al. (1995) state that women and men communicate differently: men are more focused on sharing information and utilitarian use, while women are more geared toward a social use of Information Technology, trying to built consensus, to keep in touch, and accommodate the communication process. Men tend to accomplish tasks and judge technology in terms of its usefulness, while women are more socially oriented and tend to be influenced by social standards (Venkatesh and Morris, 2000; Ilie et al., 2005, p. 17/18). Based on these studies, we hypothesize that:

H_7 Men are more willing than women to share resources enabled by wireless grids in order to get specific tasks done.

We are aware of the possible interactions effects of gender with IT experience (see for instance Venkatesh and Morris, 2000) and altruism (Kidder, 2002). We will come back to these possible interaction effects in the next section. Fig. 2 provides a graphical overview of our core hypotheses.

4. Methods

Research into the adoption and use of new unfamiliar technologies in which contextual and individual characteristics play a role, is hindered by the fact that respondents have little or no idea about the specific characteristics of the wireless grids and its possible applications. Research into complex decision-making

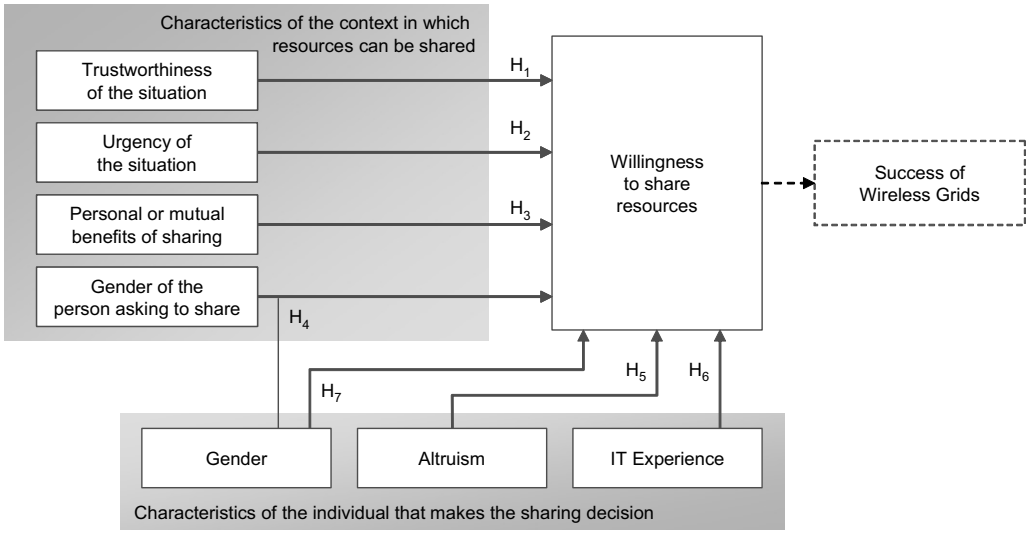

Fig. 2. Conceptual model.

processes in which contextual and individual differences need to be examined requires an alternative research method.

Decision-making can be studied successfully by presenting people with short stories (vignettes or use-cases) describing a context in which they have to make a decision (Van de Wijngaert, 1999; Bouwman and Van de Wijngaert, 2002, 2003; Bouwman, 2004). The idea is to systematically rotate some attributes of the cases, i.e. the contextual characteristics, and then analyze the effects of these changes on the dependent variable, the choice whether or not to use wireless grids to share resources. Thus, multivariate experimental designs is combined with sample survey procedures.

This research approach is based on three research methods that to a considerable extent overlap: factorial survey (Rossi and Nock, 1982), policy capturing or vignette studies (Zedeck, 1977; Karren and Woodard Barringer, 2002) and conjoint measurement (Vriens, 1995; Molin, 1999; Gustafsson et al., 2003). Although these approaches are quite similar, they are more or less unrelated and come from different research domains. For instance conjoint measurement is especially popular in marketing and product design, while policy capturing is popular in organizational studies. Typically, in studies or methodology books there are no references between one method and another. All three research methodologies borrow and adapt the concept of manipulation of factors (in this case contextual characteristics such as trust in the partners that operate within the specific familiar context and the question as to who benefits) that influence some dependant variable (in this case willingness to share resource enabled). From the survey tradition they borrow the greater richness of detail and complexity that characterizes real-life circumstances, by using short stories that describe real life contexts, and the ability to collect data on a large number of subjects. McBurney et al. (2002) mention conjoint analysis as an adequate method to estimate market demand.

4.1. Creation of the cases

The context characteristics that influence the decision are the starting point in the creation of the cases. A unique combination of values on all the concepts involved characterizes a case. The set of all possible combinations of all values of all concepts is called the factorial object universe (Rossi and Nock, 1982). A simple calculation demonstrates that only a few concepts, with a few values yield a large number of cases. Because respondents can only consider 10–20 cases before they become too tired or bored, the researchers are forced to make a decision: (1) either to include only a few variables, with a few values, and present the respondents with all possible combinations, (2) to use a large number of variables and/or values and present respondents with a representative sample of the cases, or (3) to use an orthogonal design.

Table 1
Overview of all cases

Gender of the requestor	Who benefits	Trusted		Distrusted			
				Normal		Emergency	
Male	Asker only	1a	1b	5a	5b	9a	9b
	Both	2a	2b	6a	6b	10a	10b
Female	Asker only	3a	3b	7a	7b	11a	11b
	Both	4a	4b	8a	8b	12a	12b

We decided to focus on four contextual predictors (trust in the partners that operate within the specific familiar context, benefactor, gender of the person requesting to share, and emergency of the context). Every concept had two levels, with one exception. The combination of a situation in which partners are perceived as trustworthy and the entire setting of the case is not unusual and familiar does not correspond to an emergency situation. Emergencies are not supposed to be familiar. Therefore, we do not draw a distinction between a normal trusted situation and a trusted situation in which there is an emergency. In the latter case descriptions were dropped from the analysis (see Table 1). Consequently, we ended up with 12 different cases. An example of such a case is:

> Suppose you are waiting for a bus at the bus station. Another traveller observes that you have an iPod. He tells you he has a special subscription with which he can download some music for both of you by sharing the network to which he has access. You would really like to have the music, but you are suspicious about the whole context and the person involved.

In this particular case, the gender of the person requesting (the requestor) to share is male, downloading music is not an emergency, both partners benefit and the context is unfamiliar context, which means that trust is an issue.

4.2. Validation of the cases

We used two strategies to validate our design and case descriptions. First, after the cases were created, we pre-tested them in relation to the degree to which they genuinely express the values of the concepts and with regard to the realism of the descriptions. A small group of ten (test) respondents were asked to review the cases, with the emphasis on completeness and realism. They were given the test design and asked to comment on the 12 case descriptions. Based on their remarks, the case descriptions were adapted and new (test) respondents were asked to review the cases based on the same criteria. In several rounds the cases were thus finalized.

As a second step in checking the validity of the cases we used multiple case descriptions for each unique combination of values. This allowed us to check whether two different stories (an a and an b variant, see Table 1) that were based on exactly the same characteristics resulted in the same level of willingness to share resources via wireless grids.

As a consequence of this design, the stories of cases 1a–3a (and 1b–3b) are exactly the same, although they vary with regard to the gender of the requestor. This allowed us to present fifty percent of the respondents with the combination of cases 1a and 3b, and the other fifty percent with cases 1b and 3a. This way, respondents were presented with different stories for the same combination of values in the male and female versions. We expected this approach to be less confusing for the respondents than having read the 'male' and 'female' versions of the same story. After the data was collected, it turned out that the average level of willingness to share was relatively similar for the a and b versions of the cases.

4.3. The questionnaire

The pen and paper questionnaires consisted of a description of the 12 cases. In the introduction of the questionnaire wireless grids were introduced as follows:

> Wireless grids, . . .allows you to ad hoc share resources on edge devices such as your cell phone, PDA, or laptop. Examples of wireless grid applications are ad hoc screen sharing (hook up any laptop in a room to the beamer without the cable hassle), distributed audio recordings (use the microphones of wireless devices such as mobile phones and laptops to create stereo or even surround sound recordings) and share network connectivity (to make a phone call even though your phone does not have a signal). In other words, wireless grids is a new technology with a sense of sharing.

After respondents were presented with a case, they were asked to what degree they would feel like sharing resources in that particular context. The framing of the question was as follows: *I would feel like sharing my resources in this situation*. Respondents could answer this question on a five point scale ranging from 'Not at all' to 'Very much'. The question about resource sharing was explicitly disconnected of the technology of wireless grids, but not of the core concept that is proposed by wireless grids, i.e. sharing of resources. The questionnaire also contained questions concerning individual characteristics, such as gender, experience with the use of specific technologies and items for measuring altruism. Finally, we included some questions designed to measure whether respondents found the cases and the corresponding questions easy to understand.

4.4. Sample

Data was presented to students from a large university in the North Eastern United States in 2004. In total, 257 students from all schools of the university and all class standings were included in the convenience sample. The majority of the respondents were Master Students from The School of Information Studies. Almost 48% of the respondents were men and around 52% were women. Generally speaking, the respondents were well-equipped with edge devices: most of them owned a mobile phone and a laptop or PV. A smaller portion owned

Table 2
Statistics for aggregated data, respondent characteristics ($N = 284$)

Gender of the respondent	%	Average WTS	*T*-test (independent sample)		
			t	df	*P*-value
Women	47.7	2.64	3.96	279	0.00**
Men	52.3	2.91			

Ownership of IT	% Have	Average WTS		*T*-test (independent sample)		
		Do not have	Have	*t*	df	*P*-value
Cell phone	92.2	2.69	2.78	−0.75	27.22	0.46
Laptop/PC	74.5	2.69	2.81	−1.47	116.25	0.14
Wireless router	39.7	2.70	2.90	−3.07	263.34	0.00**
PDA	22.7	2.73	2.93	−2.41	104.78	0.02*
iPod	23.8	2.75	2.88	−1.64	282.00	0.10

Correlation usage level	Average	SD	Spearman's Rho with WTS	
			ρ	*P*-value
Internet	4.71	0.58	0.03	0.62
Laptop/PC	4.67	0.76	0.11	0.06
E-mail	4.56	0.72	0.04	0.49
Cell phone	4.05	1.18	0.13	0.03*
Instant messenger	3.67	1.48	0.18	0.00**
P2P	2.23	1.33	0.27	0.00**
VOIP	1.64	1.23	0.17	0.00**
Gaming	1.66	1.06	0.15	0.01*

Correlation altruism	Average	SD	Spearman's Rho with WTS	
			ρ	*P*-value
Altruism	4.26	0.72	0.15	0.02*

*$p \leqslant 0.05$ and **$p \leqslant 0.01$.

a PDA, iPod or wireless router. On average, the respondents owned 2.5 devices. Computers, Internet, e-mail and mobile phones were used most often. Instant Messaging, peer-to-peer networking, gaming and VOIP were used less often. See also Table 2 for detailed figures with regard to these variables.

Although the decision to select students as our research population is somewhat arbitrary, we expected them to be the most likely owners and users of sharing technologies, as well as to be familiar with KaZaA, Napstear and the like, which meant that later on in their careers they would be one of the prime target groups for wireless grids. Moreover, because the goal of a conjoint analysis is to examine the effect of manipulation of the vignettes, the representativity of the sample is of less importance.

4.5. Scales

IT experience was measured as a series of items regarding the frequency of different IT applications, both basic applications (such as Internet, e-mail and mobile phone) and applications that are aimed more at sharing (such as voice over IP, instant messaging and gaming). The Cronbachs' α for the use of these application was 0.65, which means the scale should be handed with care (Field, 2000). In order to reduce the strain on respondents we used a short version of an altruism scale that was developed by Nickell (1998). The items we used are listed in Appendix. The Cronbachs α for these items was 0.88 so we were able to construct the scale.

4.6. Data-analysis

Ordinary least square regression is a data-analysis method that can be used to find out what the explaining force is of the different independent variables is. However, the structure of the data tells us that there are basically two levels in the data: that of the individual ($N = 284$) and that of the cases ($N = 284 \times 12 = 3408$). So, in contrast to many studies where a multilevel issue emerges, here the cause is less related to the structure of the research object (departments within organizations or classes within schools). Instead, it is a consequence of the way the research was designed. Individual respondents evaluated multiple cases containing contain four contextual characteristics. We used a two level linear regression model (Hox, 2002) to analyze the data:

Level 1 model

$$\text{Willingness to share}_{ij} = \beta_{0j} + \beta_{1j}\,\text{trust}_{ij} + \beta_{2j}\,\text{urgency}_{ij} + \beta_{3j}\,\text{gender asker}_{ij} + \beta_{4j}\,\text{who benefits}_{ij} + e_{ij}.$$

Level 2 model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,\text{gender resp}_j + \gamma_{02}\,\text{IT experience}_j + \gamma_{03}\,\text{IT altruism}_j + u_{0j},$$
$$\beta_{1j} = \gamma_{10} + u_{1j},$$
$$\beta_{2j} = \gamma_{20} + u_{2j},$$
$$\beta_{3j} = \gamma_{30} + \gamma_{31},\ \text{gender resp}_j + u_{3j},$$
$$\beta_{4j} = \gamma_{40} + u_{4j}.$$

5. Results

Before we turn to the advanced multilevel regression analysis of the data, we analyze the direct, straightforward effects based on aggregated data, using more traditional data-analysis tools.

5.1. Individual characteristics and willingness to share

Table 2 provides an overview of the distribution of individual characteristics in the sample. In order to create the table we aggregated the data to the level of individual respondents. The value for willingness to share was computed by taking the mean of the 12 cases which were presented to the respondents.

Willingness to share is significantly higher for men. Although students score high on altruism (the average score on the altruism scale is 4.26 on a five point scale), students with higher levels of altruism are significantly more likely to share resources. Students who own a wireless router and/or PDA are significantly more willing to share resources. There is no difference in willingness to share if we consider possession of a cell phone,

laptop computer or iPod. No significant differences were found for usage level of PC, laptop, Internet and e-mail. In general, we may conclude that respondents who possess and use more advances IT applications, like wireless routers and PDA's, are more willing to share resources.

5.2. Differences between contextual characteristics

In Table 3, the results of independent sample *T*-test for each of the contextual factors is presented. We can conclude that a trusted context, an emergency and the requestor being a woman leads to higher levels of willingness to share. There is no significant relationship between the willingness to share and whether or not both parties benefit.

Using these simple descriptives and basic tests, we can already conclude that most of our hypotheses (expect for H_3) seem to hold. Before we draw our final conclusions, we will integrate the results of our research into a single multilevel model.

5.3. Multilevel analysis

Table 4 finally presents the results from the multilevel regression analysis. The table indicates that there is only one predictor that does not contribute significantly to willingness to share. People are not more willing to

Table 3
Statistics for contextual characteristics ($N = 3408$)

Characteristics of the context	Mean willingness to share				*T*-test (independent sample)		
	0		1		*t*	df	*P*-value
Trust	Distrust	2.28	Trust	3.80	−34.37	3401	0.00**
Urgency	Normal	2.74	Emergency	3.04	−4.66	3401	0.00**
Gender asker	Man	2.71	Woman	2.87	−3.33	3401	0.00**
Who benefits	Asker	2.76	Both	2.82	−1.33	3401	0.18

*$p \leqslant 0.05$.
** $p \leqslant 0.01$.

Table 4
Final estimation of fixed effects with robust standard errors

	Coefficient		Standard error	*T*-ratio	Approximate df	*P*-value
Intercept β_0						
Intercept	γ_{00}	0.73	0.24	2.99	275	0.00**
Gender resp	γ_{01}	−0.30	0.07	−4.14	275	0.00**
IT experience	γ_{02}	0.21	0.05	4.26	275	0.00**
Altruism	γ_{03}	0.17	0.07	2.39	275	0.02*
Trust β_1						
Intercept	γ_{10}	1.75	0.06	27.64	278	0.00**
Urgency β_2						
Intercept	γ_{20}	1.02	0.06	17.94	278	0.00**
Gender asker β_3						
Intercept	γ_{30}	0.16	0.05	3.35	277	0.00**
Gender Resp	γ_{31}	0.00	0.07	0.01	277	0.99
Who benefits β_4						
Intercept	γ_{40}	0.07	0.03	2.39	278	0.02*

All predictors were entered uncentered.
* $p \leqslant 0.05$.
** $p \leqslant 0.01$.

Table 5
Model fit

	Random effects	Variance component		Total		Explained variance	
		τ (u_{0j})	σ	Variance		R_1^2	R_2^2
[a]	Baseline model	0.20	1.77	1.97	Compare	Cases	Respondent
[b]	...With situational predictors	1.08	0.25	1.34	a–b	0.32	0
[c]	...With individual predictors	0.15	1.77	1.93	a–c	0.02	0.13
[d]	...With both types of predictors	1.08	0.21	1.29	a–d	0.34	0

share resources enabled by wireless grids when the person requesting support has the same gender. All other hypotheses were supported. The strongest effects are related to trust and emergency.

5.4. Model fit

In multilevel regression it is not possible directly to compute explained variance in terms of R^2 the way in which OLS regression is used. We can, however, determine how much variance can be accounted for by different parts of the model by comparing the different models. Formally, this multilevel 'R^2' values should be computed by using both random intercept and slopes. However, this is quite a complicated procedure, and Snijders and Bosker (1999, p. 101) argue that differences in the levels of explained variance using only a random intercept are small. Therefore, we use a much simpler method to compute the R^2 values, by only using a random intercept and no random slopes.

In order to compute the explained variance we compare differences in the total variance for the baseline model [a] with three other models: [b] the model including only context-related predictors, [c] the model including only respondent predictors and [d] the model including both contextual and respondent predictors. In order to find the explained variance at the level of the cases (R_1^2), we first compute the total amount of variance for each model by adding $\tau + \sigma^2$. To see how much variance is explained by a given set of predictors, we compare the baseline model with one of the other models. To do so, we take the difference between the total variance of the baseline model and the total variance of one of the other models and divide it by the total variance of the baseline model.

The procedure for computing the explained variance for the level of the respondents (R_2^2) is practically the same as at the contextual level, the difference being that now we compute the total variance by dividing τ by the number of cases (12 in this research) and add it to σ^2. The results of this procedure are presented in Table 5.

Based on Table 5, we conclude that at level 1, the context level, adding situational predictors explains 32% of the variance. Adding respondent characteristics at this level only adds 2% to the explained variance. The total explained variance for the entire model [d] at this level is 34%. R_2^2, the explained variance at level 2 (respondent level), is 13% for adding respondent characteristics to the baseline model. Adding context-related predictors adds no explained variance. In general, we can conclude that contextual characteristics are far more important predictors of willingness to share than are the individual characteristics of the respondent.

6. Discussion and conclusion

6.1. Success or failure of wireless grids

The goal of this research was to obtain insight into the factors that could turn a new and unknown communication technology, namely wireless grids, into a potential success from a user point of view. The analysis of the cases gave us insight into the question whether or not people are willing to share resources as enabled by wireless grids. Moreover, it allowed us to investigate why sharing resources may be interesting to people, and whether it is contextual or individual factors that is more important in this respect. Contextual factors appear to be much more important predictors than individual characteristics of a person's willingness to share.

Among the context-related characteristics, trust is the most important predictor, followed by urgency and the requestor's gender. The central results of this research can be summarized as follows:

- Trust and emergency: Trust turns out to be the most important predictor. However, trust can be influenced. In this research, our use of the relatively obvious factor of an emergency made it clear that people are willing to share, even in a situation in which they would normally experience distrust.
- Gender of the person who is sharing and the one who is asking to share: Generally speaking, men are more willing to share than women. Although the requestor's gender is significant, it does not interact with gender of the respondent.
- Who benefits: Although the relationship was significant, it was not very strong. A possible explanation is that a person who is asked to share his or her resources may expect the requestor to be prepared to share his or her resources in the future. This is also referred to as a 'shadow of the future'.
- IT experience: In the past few years the Internet, e-mail and cell phones have become common, especially among university students. As a consequence, the use of these applications no longer has any predictive value when it comes to the adoption of innovations. The use of more advanced applications, such as VOIP, gaming and peer-to-peer networking, has a higher predictive value.
- Altruism: There is a main effect for altruism, although it is not very strong. A possible explanation is that people are more likely to share in case of an emergency.

The implications of this research with regard to theory are that a focus on TAM-concepts like ease of use, or perceived usefulness, or the traditional diffusion of innovation concepts may be too generic to help us understand the mechanism at play in understanding the use of new technologies. Context-related variables are more likely than personal characteristics to define usage behavior. This study indicates that it is possible to gain insight into the underlying factors of perceived usefulness.

From a product design point of view, using an approach based on vignette type of studies or conjoint analysis helps us better understand the potential use of new technologies, and allows us to pre-test concepts of new technologies and their potential usefulness in more detail. With regard to wireless grids, this study offers both good news and bad. The bad news is that people are only willing to share in a trusted context, what limits the potential use of this technology The good news is that trust can be influenced. During the research design, the concept of trust turned out to be both a key factor, as confirmed by earlier qualitative research (McKnight et al., 2005), and a very complicated issue. Future research can benefit from a more detailed and subtle operationalization of trust. Further research should focus on how trust can be created through the service that is provided or through the context in which it is provided.

There are also some reasons to be cautious when examining the results of our study. First of all, the respondents were university students and a convenience sample, which makes it hard to project the results onto a broader population. Having said that, the students may have extensive experience with peer-to-peer technologies, and they are the likely future users. Future research should focus on a different, non-academic population. Secondly, the research included a very limited number of individual and context-related characteristics, with a limited number of values. In future, we intend to include a greater number of variables, as well as a greater number of values for each of the variables in the research model. In order to do so we can make use of a sample out of all possible combinations of relevant variables, or to use an orthogonal design. An alternative is to use conjoint analyzes in an iterative way, by selecting the variables discussed in this paper, and add other relevant variables, and repeating this a number of times. Third, we explicitly did not relate the question about sharing resources with the technology that might enable this, i.e. wireless grids. Our motivation was that we did not want the unknown technology to be central, but the intended functionality that would be enabled by wireless grids. In future research, when the technology is available, a conjoint approach in an laboratory setting, enabling use of wireless grids following defined conjoint scenario's will lead to a more realistic setting.

To obtain an answer to the research question we used conjoint analysis research in combination with multilevel regression. This combination allows us to obtain insight, not only into the question whether people find new technologies useful, but also when they find them useful. By taking this approach further, we can open the boxes that have remained closed for a long time and include individual and context-related as well as technological characteristics. Although in this case we only varied across individual and context-related characteris-

tics, it is easy to imagine a research design in which technology characteristics can also be varied. An important application of this kind of research would, for example, be to discover price-elasticity of new services, or specific interface characteristics or service platforms. In the end we will be able to answer questions like: What are the chances of success for a service with characteristics a, b, c that costs k, l, m, given the conditions p, q, r and individual characteristics x, y, z?

Appendix A. Cases overview

The 12 different cases that were used in the research are presented below. For each case there was a parallel case that included the other gender (see Table 6).

(1) Suppose you and your good friend Jamie are at the Library using your laptops to work on your own writing assignment that is due shortly. All of a sudden the screen of Jamie's laptop goes down. Because the rest of the laptop seems to work fine, he asks you to share your screen so he can submit his assignment in time.
(2) As you plan to study the whole evening, your reliable friend and neighbour Roger knocks on your door. He asks you to share your satellite dish signal so he can watch his favorite movie on HBO. His satellite does not connect his TV to the station that provides the movie. With the wireless grid, he can see the movie.
(3) Suppose you are at the quad on a sunny day with your all time best friend Kevin. He says that he has downloaded the new song of your favorite band to his PDA, but that it does not have the right player. Your laptop can play the music and therefore he asks you to share the software so you can both listen to the music.
(4) Suppose you are working on your group project with your team mate John at the Crouse-Hinds building. There is very weak signal in the building for the wireless network. John suggests combining the signal, so you can both get better access to the internet and work on the project.
(5) Suppose you are leaving The Inn Complete around one a.m. and you are waiting at the parking lot for your friend to pick you up. While you are waiting a man comes up to you. He tells you he wants to contact his friend but the situation fills you with distrust. He asks you to share your signal as his is not strong enough.
(6) Suppose you are using your laptop to e-mail some friends while you're having lunch. People say that the guy who is sitting next to you is not trustworthy. He is creating a complex 3D picture on his computer. To render the final hi-definition version of the picture he needs a lot of processing power. He asks if he can share the processing power on your laptop.
(7) Suppose you are waiting for a bus at the bus station. Another traveller observes that you have an iPod. He tells you he has a special subscription with which he can download some music for you by sharing signal. You would really like to have that music but feel suspicious about the whole situation.
(8) Suppose you are waiting in line to purchase tickets to an SU basketball game. The line is not very long anymore. A guy whom you do not confide in, is standing next to you. He asks you to share your signal with him so that he can order tickets for both of you through the Dometix website on his PDA.
(9) Suppose you are driving in a secluded area. You stop at an empty rest station on the highway where a total stranger approaches you and asks to share your GPRS signal since his signal has suddenly ceased. You do not trust the situation but the man says he really needs to find his way to the nearest hospital for an emergency.

Table 6
Overview of cases

	Familiar or like	Unfamiliar or dislike	
		Normal	Emergency
Asker	1, 2	5, 6	9, 10
Both	3, 4	7, 8	11, 12

(10) Suppose you are waiting to give a presentation for a job interview. You know one of the other applicants. You have worked with him in a project and think he is not to be trusted. He approaches you and asks to share your screen since he uses Macintosh platform which is not compatible with the projector.
(11) Suppose you are having lunch at Schine. Word gets around that your professor has graded the final exams. A guy you mistrust because he notoriously spreads viruses comes up to you. If you share the internet connection on his PDA with the browser on your laptop you can both see the final grades.
(12) Suppose it is late and you have just missed the last bus. You are about to call a taxi when you find out the battery of your mobile phone is dead. A man comes up to you and proposes to share resources. You do not trust the situation but when you share you will both be able to call a taxi and get out of the situation.

Appendix B. Items in altruism scale

– When given the opportunity, I enjoy aiding others who are in need.
– Helping friends and family is one of the great joys in life.
– It feels wonderful to assist others in need.
– Volunteering to help someone is very rewarding.
– Doing volunteer work makes me feel happy.
– I donate time or money to charities every month.
– I try to offer my help with any activities my community or school groups are carrying out.
– I feel at peace with myself when I have helped others.
– I feel proud when I know that my generosity has benefited a needy person.

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