ADOPTION OF NEAR FIELD COMMUNICATION TECHNOLOGY IN BUSINESS TO CONSUMER SERVICES

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Abstract: Touch based interaction has been found out to provide fast and easy way to use mobile services. Near Field Communication technology (NFC) is one of the most promising ways to conduct touch based interaction with mobile phones. In this paper our aim is to identify challenges of the adoption of NFC related business to consumer services. The results of this study are based on three pilot cases conducted in Finland in 2007. Our research presents findings based on qualitative company interviews and both quantitative and qualitative user questionnaires. We conclude that there are several challenges in the adoption of NFC-based applications. However, expect for the shortage of NFC enabled mobile phones, challenges of the adoption may be reduced with careful planning and implementation of NFC-based applications.

1 INTRODUCTION

Although the diffusion of mobile phones has been outstanding during last years, use of mobile services has not gained comparable success. One reason behind the slow diffusion of mobile services might be that the usability of mobile services has not been at a sufficient level. This is partly caused by the poor user interfaces of today's mobile phones, which can be experienced when, for example, trying to type text or navigate in menus using mobile phone's keypad. Difficult user interfaces may even totally prevent some users, such as elderly people, from using mobile services.

Difficult user interaction of traditional mobile services has created a need to develop easier and more intuitive user interfaces. A promising solution for this problem is based on a physical selection method, in which users interact with the digital environment by touching Radio Frequency Identification (RFID) tags with the mobile devices (Välkkynen, Niemelä & Tuomisto, 2006). According to the previous study by Riekki et al., services used by touching were experienced as ease to use and learn. Touching was also appreciated, because "it gives clear feeling of control" (Riekki, Salminen & Alakärppä, 2006).

Touch based user interaction can be conducted with a mobile phone by using new short range wireless communication technology called Near Field Communication (NFC). One of the main advantage of the NFC technology is that it can be used to communicate with other mobile devices or tags without a configuration (Calvet, 2005). Therefore, the communication with the NFC enabled mobile phone should be as simple as touching objects.

In addition to the advantages for consumers in form of usability, use of touch based interaction technology may provide business benefits for service providers. In the case studies reported in this paper, NFC technology was used by the service providers with an aim to improve the effectiveness of their service processes. Hence, besides increasing customer satisfaction, the service providers expected that the NFC technology might also provide indirect cost savings to them.

Despite the clear benefits of a touch based user interaction, the adoption of NFC has not been as fast and wide as some have expected (Balaban, 2007). After the fade of initial hype, there still exist some challenges that have to be overcome before the wide scale adoption of NFC is realized. This paper aims to identify and analyse these challenges using both quantitative and qualitative data obtained from three pilot cases conducted in the city of Oulu during the autumn 2007. Data contains both the service providers' and the consumers' perceptions about the challenges of adoption.

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The paper is organised as follows. Section two introduces a theoretical background and earlier studies related to the adoption of NFC technology and mobile services. In the section three, we present our research methodology and pilot cases. We will then present the results of our empirical studies in the section four, which is followed by the discussion and conclusion.

2 RELATED RESEARCH

Theory and experiences about the adoption and diffusion of innovations has been studied for years. Even today many papers are based on diffusion innovation model introduced in 1962 and later refined by Rogers (1995). Innovation adoption theories focus on identifying and describing factors that have some effect to the adoption. Kargin and Basoglu (2006), for example, introduce framework for adoption factors of mobile services. They state that usefulness of the mobile service and past experience influence on the consumer's attitude towards new technology and thus to the adoption of technology.

Although there is plenty of research about the adoption of mobile services (e.g. Nysveen et al. 2005; Bouwman et al., 2007; Carlsson et al., 2005), the research about the adoption of NFC-based mobile services is almost non-existent. Main reason for this is the novelty of NFC technology. Despite of the novelty, touching as an interaction technique in NFC-based applications has been studied in several studies. These studies consider touching with a mobile phone as a very promising interaction technique (Rukzio et al., 2006; Riekki et al., 2006; Välkkynen et al., 2006; Anokwa et al., 2007).

Some studies have already evaluated usability of the NFC technology in form of case studies. Jaring et al. (2007) survey the results of six small NFC pilots, which are focused on improving mobile solution workflows and usability. They conclude that NFC based solutions are easy to use, but the small and limited keypad poses challenges to the design of NFC applications. Häikiö et al. (2007) have studied the use of the NFC technology in elderly care environment. The study provides evidence that the adoption of the touch based interaction does not require a specific knowledge or experience with technology. In addition, elderly people, who had impaired motor skills, were able to use a touch-based user interface in the pilot test.

User acceptance of services is a crucial condition for the success of mobile services. Some existing acceptance models emerge issues, which can be used as an evaluation framework for mobile services. Kaasinen (2005) has developed Technology Acceptance Model for Mobile Services. This model has its roots in Technology Acceptance Model created by Davis (1989). In Kaasinen's model user acceptance of mobile services is consisted of three factors, which affect the users' intention to use a mobile service. These factors are perceived value of service, perceived ease of use and trust. According to Kaasinen (2005), the fourth factor, ease of adoption becomes more central, as a user proceeds from intention to the actual use. These fore-mentioned factors of Technology Acceptance Model for Mobile Services can be seen also as a foundation for examination of NFC-based mobile services.

3 RESEARCH SETTING

The purpose of our research was to examine suitability of the NFC technology to selected business to customer services and to find out general barriers to adoption of NFC technology. Since this topic is quite new, our research approach is explanatory and it presents finding of both qualitative and quantitative research conducted in three individual pilot cases. Table 1 summarises the characteristics of these pilots including the user amount, the duration, the user segment and the goal of the pilot. More detailed information about the pilots is presented in the following subsections.

The objective of the qualitative research was to find out detailed information about business actors' expectations, experiences and challenges considering the adoption of NFC in their service processes. Interviewed actors included upper level managers from two private companies and two public organisations. At least one interview was conducted in each of these four organisations. In addition, restaurant pilot included three interviews with operational level employees. All interviews were conducted after the finish of the pilots in the beginning of 2008. Interviews followed semi-structured format and lasted from one to two hours each. The interviews were recorded and transcribed for the further analysis.

Table 1: Summary of the analysed pilots.

Pilot #	Pilot name	Responses / Users	Duration	User segment	Goal of the pilot
1	SmartParking	48/51 + 5/5 traffic wardens	2 months	Frequent parkers/traffic wardens	Improve effectiveness of parking in city area. Provide fast, easy and efficient parking solution for customers.
2	Fast track of restaurant Pannu	23/27	5 weeks	Restaurant's regular customers.	Provide fast ordering and payment for busy lunch time customers.
3	Oulu city theatre	101/141	2 months (8 plays)	Employees from several different companies.	Improve customer experience and provide fast and easy ticket checking and refreshment reservation.

Companies selected to the pilots were expected to benefit from the use of NFC technology in their business processes. In order to find out a clearer vision for the NFC technology opportunities, the first section of the interview concentrated on organisation's background information, a position at the market and a current technology usage. The second part surveyed the effects of NFC technology, which were detected during the pilots. The aim was to find out what benefits and challenges are directed to the business actors' service processes. The last part considered pros and cons of the NFC technology in a more general level.

The objective of the quantitative research was to find a general overview about the drivers and barriers for the customer adoption of NFC in different services. The data was collected with web and paper based user questionnaires. Pilot participants received an e-mail with a link forwarding them to the questionnaire or they filled the paper questionnaire after a pilot period. The number of customers participating in the pilots is reported in the table 1. Altogether, there were 224 pilot participants who used NFC enhanced services in the pilots. Final response rates of questionnaires of pilot 1, 2 and 3 were 94%, 85% and 72%, respectively. The response rates can be considered to be very high especially in pilots 1 and 2.

All pilot participants received Nokia 6131 NFC phone for the pilot period. These NFC-enabled phones were equipped with proper applications for the pilot use. NFC related services and information was available without a charge to the individual pilot customers. Moreover, pilot participants were allowed to use NFC enabled phones for free of charge during the pilots, also for their own purposes.

3.1 Pilot 1: SmartParking

The objective of the pilot was twofold. Firstly, the aim was to provide flexible and efficient mobile parking solutions to the citizens. Secondly, traffic wardens tested a new NFC based parking control solution, which was envisaged to improve the effectiveness of the parking control. Although the NFC based parking control was highly appreciated by the traffic wardens, it will not be analysed in detail, since the focus of this paper is on the business to customer services.

A main pilot group consisted of 51 customers who parked frequently at the city area. Customers were able to use SmartParking for on-street parking and also in one parking hall located in the city centre. On-street parking transaction was initiated by touching an NFC tag attached to car's windscreen. A user had to then select a parking zone either by touching one of the parking zone tags attached to fare collection machines and lamp posts, or alternatively, selecting a zone code manually from the phones menu. The selection of the parking zone by touching is illustrated in Figure 1. Parking time started running after the touch to the parking zone tag and it ran until user came back to her/his car and touched again the tag on the windscreen. Hence, SmartParking allowed charging from the exact time the car was parked.

Figure 1: A user selects a parking zone by touching an NFC tag on the fare collection machine.

In-house parking was initiated when customers arrived at a gate of a parking hall and they touched

an NFC reader near the gate. The touch to the NFC reader opened the gate and parking time started running. Customers repeated the same operation when they left the parking hall, which stopped the parking time. In addition to the NFC-based parking application, customers had a possibility to download information to their phones by touching info tags, which were attached on parking meters.

3.2 Pilot 2: Fast Track of Restaurant Pannu

An initiating problem behind the pilot was that busy workers want to have fast service at the restaurant because of their short lunch break. However, since most employees come to the restaurant at the same time, traditional service, where a waiter asks for orders, may be quite slow. In order to find a solution for this problem, a new "fast track" service concept was developed. The fast track provides an opportunity for the busy customers to select their lunch by touching the RFID tagged menu with their NFC enabled mobile phones, which is illustrated in Figure 2. The lunch order was directed straight to the kitchen without intervention of the waiter. In addition to placement of lunch order, customers were also able to pay for their lunch using NFC phones and information tags provided a possibility to download information to the mobile phone.

Figure 2: Touching a tagged lunch menu with an NFC enabled mobile phone.

The objective of the pilot was to test the suitability of the NFC technology to the restaurant environment and find out if it could ease the rush time at the restaurant. Restaurant Pannu invited 27 of their regular lunch customers to participate in the pilot. Customers, who were selected to the pilot group, used restaurant frequently during lunch hours, but they also hoped to have faster lunch time service. 11 customers used the NFC enabled phone also for the payment of their lunches. The payment transaction was conducted by tapping the NFC enabled phone on the contactless point of sales terminal. The used terminal was a commercially available RFID based terminal provided by a cash register provider.

3.3 Pilot 3: Oulu City Theatre

The target of the pilot was to develop theatre's service processes and deliver more added value to theatre customers with more flexible and easier NFC-based activities. Since the queuing and slow ticket checking activities were seen as bottlenecks, one of the main activities in this pilot was a mobile phone specific ticket stored in the back-end system. The ticket was checked before entering to the play by ticket checkers' NFC enabled mobile phone. In practice, a theatre-goer and a ticket checker touched each others' mobile phones. Theatre pilot included also other NFC related activities, such as, pre-reservation for interval refreshments, reclaiming of a programme for the play, downloading information via info tags and downloading video trailers from smart posters.

The pilot participants, 141 persons with average age of 44.5 years, tested and used NFC based services before and during the plays. Each participant visited at least in one play. The participants were informed about the theatre pilot by sending related information to companies locating in Oulu region. Selected participants were groups of employees from diverse industry areas. After the participants had visited the theatre and watched the play, they received web questionnaire to give a feedback about the use of NFC in theatre environment.

4 RESULTS FROM THE PILOTS

Analysis of the data obtained from the pilots reveals several common challenges for the adoption of NFC based services. In the following these challenges are divided into two categories based on the actor whom the challenge primarily concerns.

4.1 Customers' Barriers to Adoption

The use of info tags revealed to be easy regardless of use experience concerning NFC-enabled mobile phone. Use period of NFC-enabled mobile phone was very short in the theatre pilot when compared to other pilots. However, users experienced touching

and learning to use the info tags very similar in the theatre pilot and the restaurant pilot. A following table present average values concerning experience about learning to use info tags and successful touching. The scales in questionnaires were from 1 ("very difficult") to 5 ("very easy) concerning learning and successful touch and from 1 ("totally useless") to 5 ("very useful") concerning usefulness of info tags' content.

Table 2: Average values concerning experiences about learning, touching and usefulness of tags' content pilot-specifically.

Pilot/Feature	Theatre Pilot	Restaurant Pilot
Learning	4.59	4.64
Successful touch	4.63	4.60
Usefulness of info tag content	3.00	3.07

Opinions about usefulness of info tags' content varied among pilot users. 14 out of 23 users used info tags in the restaurant pilot. Info tags were touched 143 times during the pilot. Thus, there were approximately 5 touches to info tags per user in the pilot. Those, who did not use info tags in restaurant, stated that they did not have need to use those tags or content of tags was not interesting. Three of those users, who used info tags, saw that info tag content was very useful for them. However, many users did not see available info tag content very useful for themselves in lunch time.

Set of info tags was also available for pilot users in the theatre pilot. Experience about usefulness of info tags' content was very similar with experiences in the restaurant pilot as shown in the table 2. Some users saw that info tags were nice extra to the theatre experience. In contrast, some users stated that info tags did not provide interesting information content for them. Info tags were touched 275 times in the theatre pilot. This means approximately 2 touches to info tags per user during the pilot. Smart poster tags, which offered information about theatre plays, were more popular. They were touched 345 times during a pilot period. Most of those users, who did not use smart posters, told they did not have time to use poster tags or they did not even notice these tags in the theatre.

The placement of info tag application in SmartParking pilot differed from the tag placement in two other pilots. The info tags were placed outside where those were attached to the parking meters (Figure 3). Context of use was clearly different than in other pilots, because car drivers wanted usually to get through the parking payments very quickly. Therefore, the other services in a parking meter were easily ignored. Moreover, many of those users, who used info tags, did not see the content of tags necessary for themselves during parking. For these reasons, the use of info tags was quite low in the SmartParking pilot.

Figure 3: Info tag menu in a parking meter.

None of the pilot users had ever used an NFC-enabled mobile phone before the pilot tests. Thus, in order to use NFC-based mobile services after the pilot period they should invest in a new NFC-enabled mobile phone. Although many users were willing to use NFC-enabled mobile services also in the future, a demand for buying a new NFC phone was experienced as a confine to the future use. Furthermore, because of the limited supply of NFC services, many persons were not ready to buy a new NFC-enabled mobile phone just for few services.

In the theatre pilot many users saw a price of services as an essential criterion for the future use of services in theatre environment. In the restaurant pilot 6 out of 22 users would be ready to pay for the services available during the pilot. Some users stated that they would use these services also in the future, if the service would be inexpensive. Overall, many users required that services should provide a clear benefit for them before they would be ready to pay for the services.

4.2 Service Providers' Barriers to Adoption

Service providers' challenges and barriers to the adoption are based on the interviews with business actors. Interviewed actors emphasized the fact that

benefits of the NFC technology are not expected to be realized immediately. However, they all believed that the NFC technology might somehow benefit their business in the future.

Firstly, interviewees experienced a low penetration rate of NFC enabled mobile phones to be main obstacles in short term adoption of NFC technology. The penetration rate was considered to be especially important in the cases of SmartParking and city theatre, which require large customer bases to be justifiable from the business perspective.

Secondly, substitutive technological solutions were considered as a notable challenge to the NFC adoption in piloted use cases. This challenge was highlighted in the discussions with managers of restaurant and parking operator. According to the restaurant manager's opinion, the need of NFC based ordering application may be questioned when waiters' wireless handheld devices become more general. However, interviewee considered NFC to be very potential complementary payment technology to be used in restaurants. From the viewpoint of parking operator, some other technological solutions, such as long distance RFID or licence plate recognition, are competing in the same category with NFC when investment decisions are made. Thus, interviewee from parking operator stressed that the new technology should bring some additional value in comparison with other potential technologies.

Lastly, interviewees regarded that the interoperability of NFC with existing information systems is of considerable importance. Municipality's parking supervisor stated that it would be very difficult to start using new parking solution that would be incompatible with existing mobile parking systems. Importance of interoperability was also noticed in restaurant environment. This was stressed in the interview with the restaurant's management, since some of the value that customer perceived from the mobile payments was eroded because of the integration problems of the NFC point-of-sales reader and the cash register.

5 DISCUSSIONS

In this section we propose a sequence of research propositions related to the barriers to adoption of NFC technology and suggestions how these barriers can be lowered or even totally removed. Following propositions are provided with illustrations and explanations from previously introduced pilot cases.

Proposition 1. *Real added value is a required for the customers' adoption of NFC enabled services, especially if customers have to pay for it.*

As the results presented in the section 4 point out consumers require meaningful content in the information tags, which provides added value for them. Furthermore, a content of info tags should be suitable with environment and the context of use. Significance of the environment was emphasized in the theatre pilot, as theatre play related information was more interesting than a content, which was not directly related to the theatre visit. In the SmartParking pilot car drivers tended to use a keypad of a mobile phone more frequently than zone tags in a parking zone selection. It is rather easy to remember the different parking zones in the city centre of a relatively small city, thus the perceived value of the NFC application can decrease in specific environment more than in another.

More meaningful services and content might also increase customers' willingness to pay for the services. As restaurant and theatre pilots pointed out, willingness to pay for the service and content varies clearly between customers. Many customers were not even willing to pay at all for the service or content available in the pilots. More personalised services might be one solution for this problem, since those could deliver more focused content to the customers.

To conclude, before an implementation of an NFC enabled mobile service, it would be essential to identify information and service contents, which can provide added value to the customer in specific environments. This is even more important in cases where service provider requires that larger customer groups would be ready to pay for the NFC-based services.

Proposition 2. *Penetration rate of the NFC enabled phones has to be substantially higher before a business to customer service intended for large customer groups can be profitable.*

Although there are several niche solutions where NFC technology can be currently used successfully, large scale business to customer services are still waiting to be rolled out. The main reason for the lack of large scale NFC enabled customer services is the same as the interviews with companies and public sector organisation pointed out: NFC services intended for the large customer groups require a wider diffusion of NFC enabled mobile phones. Therefore, the major challenge is how to get NFC enabled mobile phones to the users who do not even necessarily want a new phone. In addition, currently

the shortage of different models of NFC-enabled mobile phones limits users' possibilities to select a phone, which responds to their needs. The NFC phone model selection is expected to increase in the near future as different manufacturers have published plans to introduce new NFC enabled mobile phone models. So, at the moment, it seems that this challenge might be gradually fading.

Proposition 3. *Taking into use of NFC services should be made as easy as possible for a customer.*

A basic idea behind the NFC enabled mobile services is that they should be easy to use and adoption of use should not be difficult. Hence, in order that the adoption of a new NFC-based service would be as fluent as possible, it should not require too many preliminary operations from a user before the actual use of the service. Different initial preparations, such as registration and requirement to install an application, reduce consumers' interest on using the service. At worst, those can completely prevent the adoption of an application.

In the pilots of this study, users received pre-installed and configured NFC enabled phones for the pilot use. Therefore, users were able start the use of phone immediately without time-consuming preliminary operations. In commercial use the pre-installation of all NFC related application to the mobile phone is not likely to be feasible. One possibility to solve this problem is to offer settings and configurations into a mobile phone by touching an NFC tag. In that way the easiness of taking NFC services in to use might be ensured.

Proposition 4. *NFC service should be made interoperability with an existing technological infrastructure.*

Fourth proposition is very important in the cases where NFC based service is taken into use alongside with other information systems. The importance of a fluent integration is emphasized, because it may be very expensive and complex for the service providers to maintain two concurrent technological solutions. Major issues may arise, for example, if the service provider of an existing information system is not willing or capable to integrate NFC based services to the existing system. This may result in high costs, if the whole information system has to be redesigned or it may even totally prevent a company from adopting a new NFC based service.

Proposition 5. *Business value of NFC technology should be more clearly represented.*

A field of research is quite unanimous that the measurement of benefits of mobile technology is difficult and the assessment of potential future benefits is even more difficult (e.g. Heijden & Valiente, 2002). In spite of that it may be critical from the service provider's viewpoint to be able to assess the business value of an investment to new technology. Image benefits of being in the forefront of technology developers may be counted as a benefit by some business actors. However, when companies from more traditional industries plan and compare the investment on NFC technology to other technologies, pointing out the business value is essential. Therefore, more effort should be put on the assessing the total benefits of the NFC technology.

As opposed to the benefit assessment, more effort should be also set to assessment of the total costs of the NFC technology. Many indirect costs, such as management of the tags or protecting the confidentiality, integrity and availability of the services should be remembered when planning to implement touch based services for customer markets. These issues may turn out to be of significant importance if NFC solutions are used in public places where those are left without the supervision and those may be exposed to vandalism or difficult weather conditions.

6 CONCLUSIONS

NFC technology makes it possible to implement mobile services and applications, which are easy to learn because of intuitive and natural interaction technique. Although NFC technology has already been successfully adopted in some business to business services, there are still some challenges to be overcome before the wide scale adoption of NFC in business to consumer services can be reached.

Based on the results of three pilot cases, which were analysed in this study, the main barrier to the short term adoption is the shortage of NFC enabled mobile phones. Also other challenges were identified, however, these challenges can be taken into account at the level of individual company when NFC enabled services are planned and implemented. Therefore, these issues should be carefully considered before the implementation phase of the service.

Our research has some limitations, which leaves place to further research. Firstly, NFC services were provided free of charge to the customers during the pilots, which may not necessarily be the case in real

life. Although customers were asked about the willingness to pay for the services, more realistic long term pilot should be conducted to find out real business potential of the services. Secondly, the selection of pilot participants was mainly based on the customers' own eagerness. For example in the SmartParking case, the user segment of pilot customers was mainly restricted to frequent parkers. However, it would be important to know how customers who need parking services less frequently experience the service. Hence, future research should pay focus on different customer segments and their willingness to adopt NFC services.

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