Mobile data services usage - a methodological research approach

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Abstract

This paper classifies the existing research methods that are used to study mobile services and applications wishing to put things into an order. The paper examines these methods and proposes a combined methodological technique. This technique has been used as a research tool in a research study which explored mobile data services adoption of different features by existing users and usage process.

Mobile networked technologies and mobile data services have become inextricable part of people's daily lives since they are accessible anytime anywhere throughout a day. Conventional research methods that are used to study the use of mobile devices and applications are unable to collect useful fieldwork data in versatile use situations and thus methodological challenges still exist. Researchers have responded to these challenges by developing research methods that enable new ways of collecting data concerning mobile technology use.

The research method presented here is based on conventional research methods, on the use of mobile phone camera for capturing video and photographs during the use of mobile data services and on a commercial application to establish communication contact between users and researchers. The paper suggests that simple commercial systems can be used by researchers to conduct field studies.

1. Introduction

Mobile computing supported by broadband wireless and terrestrial networks already allow users to have information and communication outside their homes and workplaces when they are on the move being "optimally connected anywhere, anytime". These technological advancements are forming a multimedia mixed environment with increased online accessibility offering rich applications and services (Mobile Data Services) richer in context and information that are accessible anytime anywhere throughout a day. Mobile data services market, offers information rich services as the WAP services, which play a considerable role in enhancing brand image because they contribute in loyalty and retention.

A research study tried to identify the role of place, mobility and the "always online" benefit that mobile technologies provide on the decision to adopt different features by existing users and use mobile data services from the perspective of the end users who are on the move. The paper

discusses the data collection technique that is being used in this field study trying to highlight the strengths, the limitations and the opportunities of this method. Three data collection methods and tools are described: (1) the conventional methods of interviews, focus groups and observation, (2) a media elicitation method and a new form of feedback methods and (3) the use of the Service A platform to establish the communication link that keep the researcher and the users always in contact.

I use "Service A" (pseudonym) as the mobile data services platform for this study. This service is provided in Greece by company A which has been used to respect an assurance of confidentiality requested by the organisation in question.

The rest of the paper is organized as follows: In the following section, I provide a review of the challenges for the mobile technologies research methods. Section three presents a categorization of the existing data collection methods, presenting in more detail the methods used in this study. Finally, section four presents the methodological approach adopted, the technique used for the data collection phase and discusses how these methods address the field study challenges.

2. Approaches and challenges for mobile

data services research

Traditional adoption models cannot efficiently explain acceptance and usage of mobile data services because these have been applied mainly to static environments as home and workplace and specific technologies such as TV and PC. Although IS researchers [22], [46], have started to study the adoption of mobile data services, in the light of radical improvements in the mobile technology, research in the mobile territory is still in its infant stage [1].

Research methods which are strategies for data collection can be classified in various ways. However one of the most common distinctions is between qualitative and quantitative research methods. Both qualitative and quantitative social science methodologies have been applied in studies of mobile data services. The traditional methods of adoption and diffusion research have been closer to quantitative methodologies and usually from a positivist perspective as the traditional survey methodology [30] with questionnaires and statistical analysis. Legris [25], consider these measurements based on self-reported use rather than observing actual usage as a significant limit in technology

acceptance models research. Respondents, seems to underestimate enough factors that are crucial in their adoption or rejection decision and thus tell market researchers a different story from the one they live in. However, there are studies that have developed pure qualitative methodologies adopting a holistic approach – using concepts rather than numbers, like scenario analysis and roadmaps [51], analysis of future consequences of mobile data services adoption [12], focus group interviews investigating adoption behaviour and its consequences [6] , [36], [27] , [18] , [35] and combination of diary and log-based methodologies with different interview techniques [38].

When IS research moved from desktop applications towards mobile devices and services, the practical problems related to doing evaluation in mobile environments rapidly became known. Traditionally, user-centered research has relied largely on data collection methods such as direct observation in the workplace. But the ubiquitous nature of mobile devices means that are not bound to the workplace since we carry them with us, and we use them in a number of ways and situations both professionally and personally. Research methods typically must handle issues of scale not faced by desktop systems, functioning across multiple places, or over long periods of time or across multiple users [17].

More specific, because mobile technologies are typically integrated into everyday life researchers need to account for the physical movement and changing geographical location of users and the need to negotiate access to private and public spaces that are not defined by the rules of the workplace. For example, [33] studied people's shopping habits, [18] followed teenagers into their bedrooms and [4] tried to understand how groups of friends might use an SMS chat application to rendezvous at a particular location. In these cases researchers should apply the research into situations that data can be collected unobtrusively something that it is often difficult to happen.

Furthermore, the research methods should increase the amount of data colleted per site. This is due to the fact that it is difficult to gather data in mobile technologies research studies because evaluation events of ambiguous importance may go undetected, and critical events are often spontaneous and sparse since small bursts of usage are often extended throughout the entire day, and in many different places [23].

So, because the conditions for technology use are dynamic, varied, and difficult for investigators to directly observe as [37] argue, novel research methods must be developed to answer to these research challenges. The research community is trying to overcome both the physical and privacy/ethical issues of accessing data for mobile research by helping reconstruct the user's experiences. Thus the data collection methods rely on combinations of existing methods and concepts combined with valuable new opportunities created by mobile technologies themselves.

3. Categorization of Data collection techniques

The nature of the data collected is extremely important since there is much prejudice about the validity and reliability and the level of generalisability one can achieve with them since different kinds of data, generate different kinds of questions in the choice and evaluation of methods [14].

Starting from [20], who reviewed Mobile Human computer Interaction research methods and [40], who tried to understand the methodological responses to the complexities of mobile technologies, I classified the data gathering methods into autonomous research methods and present them in a new categorization scheme table (Table 1). These methods can be applied either autonomously as [29] and [45] who used the self reporting methods of mobile probes and video diaries, [44] who used simulations and [50] who conducted mobile heuristic walkthroughs or can be combined and produce more complicated methods as the majority of the researchers prefer to do. More specific [48], [2] and [7] combined conventional research methods as interviews and observation, [49] used observation, interviews, simulation and group sessions and [9] combined questionnaires, diaries, focus groups and direct observation. Other researchers combined media elicitation diary methods and video clips from mobile phones with conventional methods as interviews [47] or combined conventional diary method with the mediated data collection method of voice mail [37]. Finally, few others combined more methods as [11] who used a tool to log the actions of students using a handheld device in combination with student artefacts and observation, [16], who combined questionnaire and interview with observation and media elicitation method and [10], who combined expert walkthrough, direct observation, audio recording, time-stamped log and a semi-structured interview. The proposed categorization of the mobile technologies data collection methods is presented in Table 1.

Drawing on the above table, a brief description of the key advantages of each of the basic data collection techniques (interviews, group discussions, observations, self reporting methods) adopted for the field study is following.

Interviews
In depth interviews are common methods of data collection in IS field [21] since they contribute to a more detailed and sensitive analysis of possible issues relevant to personal reasons for and against usage of mobile data services. The type of interviews that used in this research is positioned by [52] in the middle of the spectrum analyzing distance and engagement of data-gathering methods.

Focus groups

Group discussions allow more rapid data collection than interviews. Carroll et al. [9] consider the success of their research to come from the combination of focus groups which provides concentrated interaction with the subjects of the research and direct observation which provides naturalness of setting and reliability of findings.

Basic Research methods							
Observations The researcher follows the individual and takes notes or photographs or record video	**Interviews** Face to face or using technology as mediator (interview by audio or video - conference). Structured vs semi-structured interviews.	**Focus groups** Face to face or using technology as mediator (interview by audio or video - conference).	**Self – reporting methods**				**Walkthroughs, surveys, Simulations and enactments** (tools that are used to make available experiential information sensitised to real contexts of use), **sketching and drawing,** **role playing**
			Diary methods (participants record events as they happen or triggered by the researcher another time)			**Cultural probes** (keep materials from an event)	
			The user keeps written notes in a diary	Use technology to keep diaries : Mediated Data Collection methods. The captured data sent to the researcher either automatically (synchronous transfer) or at another time (asynchronous transfer)		When employ mobile technologies as data collection tools we have Mobile Probes, SMS Probes and Experience Clips techniques	
			do their normal routines, carrying or wearing mobile recording devices	use the technology, and data is logged automatically	do the data collection by self-reporting, or keeping diaries, using their mobile devices.		

Table 1. *Categorization of autonomous data collection methods*

Observations

My work is supplemented by ethnographically inspired observations of mobile users in action. But environments of use of mobile technologies are not always helpful to these methods because this can be disruptive for the users and impractical in some other cases [37]. For this reason I will employ participants from my social environment for the observation phase to exploit the natural human behavior of sharing experiences with friends.

Self reporting methods

Self reporting methods are useful for field-based evaluation because they are participant-driven and thus easy to scale and robust to changes in context. The most popular types of self-reported methods which have been used extensively to study user behavior in field settings are the diaries and cultural probes [15], where users take on the role and responsibilities of data collection recording their experiences and activities. Cultural probes have been augmented lately through the use of mobile technologies themselves as reporting tools. More specific [45] have introduced Mobile Probes and Experience Clips accordingly as self-reporting methods, employing mobile technologies to collect data.

Diary studies gather more contextual data in comparison to interviews. The richness of the data can be seen as an advantage of the diary method and the challenge of the method lies in motivating the users to actively participate [37]. Diaries lately have been augmented through the use of mobile technologies. Penny Hagen. [40] referred to the emerging diary research methodologies as Mediated Data Collection methods where participants do the data collection by self-reporting, or keeping diaries, using their mobile devices. In these cases participants use the technology, and the collected data, the content and the metadata are logged automatically or they do their normal routines, carrying or wearing mobile recording devices (as sensors or cameras) which do the video observation and keep the data logs. The limitations and constraints of self-reported, mediated data collection methods when users do the recording with their mobile phone include the implications of recording in inappropriate places such as shops where photos or videos are prohibited and the impact of recording of an individual action without permission [33], [45].

Using video in recording use situations to be analyzed later has already become a popular research method [8]. But Mediated Data Collection

methods can provide richer material in more versatile usage situations than a researcher does by videotaping the user. This is true because videotaping in a public environment renders the usage situation somewhat unnatural. For example, having a video-camera in a pedestrian area restricts the mobility of the user, as the person with a videocamera cannot move very freely. Also, passers-by easily stopped to stare at the strange-looking pair moving oddly. One of the limitations of the Mediated Data Collection methods is that the

users need to be motivated to participate and to be instructed on what they are expected to capture and how they should do it. No extensive training or practice will be needed for the participants of this research since they will be asked to use their mobile phone with built in camera and the Service A service features that are very easy to use.

Researchers when study complicated phenomena, usually use a combination of these basic research methods as shown in Table 2.

formative research studies - stage before actual systems are built,	summative studies - evaluate already working systems - Service A		Feedback studies (ESM) Combination of diary study and questionnaire. The researcher asks participants to collect data and answer predefined questions whenever the researcher decides so.	Elicitation studies – media elicitation studies Combination of diary study and interview. Participants capture events, usually by taking a photo or a video clip that are then used as prompts for discussion in interviews	Combination studies. Combinations of **Mediated Data Collection methods**, Simulations and Enactment **tools**, as well as combinations of the established methods of interviews, focus groups and questionnaires.	Contextual Inquiry is an ethnographically based approach to the study of users in their context of interaction. Techniques used for conducting CI include informal observations (documented through note-taking), video observation sessions, sketching and drawing, semi-structured interviews.
	students in a university environment, the so called **laboratory studies**	real working environments and contexts, the so called **field studies. Techniques used are** observation or self-report studies or walkthrough or questionnaires or combination				

Table 2.   *Research studies that combine basic data collection methods.*

Within this research I have to apply summative techniques since the study concerns the use of Service A platform, which is an already working system, in real context. The methods that could be used to collect field data in this case include direct observation, walkthroughs and self-reporting methods or combination of them. Summative methods on user technology acceptance can be broken into two categories. The first one refers to those that are conducted with students in a university environment, the so called laboratory studies. But mobile technologies are particularly hard to test in the lab because their use is often highly contextualized within multi-person, multi-task settings. The second category refers to those that are conducted with individuals in real working environments and contexts by utilizing questionnaires, the so called field studies.

Part of my research technique involves synchronous communication with the users via the MSN

application provided by the Service A platform. This technchique has similarities with the media elicitation studies. In these studies users are given cameras and asked to take photographs or video clip either with or without specific assignments. The advantage of this method is that it allows quick capture during action and it is easy and less laborious than writing notes in diaries This method can improve memory since when a person is presented with cues about an event such as who was involved, where it occurred or what was done just before and after the event [39].

Recently [37], experimented with cell phones as a feedback medium [5], [34], used the same method to understand transaction decisions within working environments. The principle difference between elicitation and feedback studies is that elicitation studies involve synchronous communication between researcher and participant (interviews

immediately after the event occurs) while feedback studies involve asynchronous communication between researcher and participant (questionnaires). It can be argued that the two methods represent a tradeoff made between accurate recall but burdensome logging (feedback) versus potentially inaccurate recall but unobtrusive logging (elicitation) [10].

4. Methodological response and discussion

The exploratory nature of this study asks for a qualitative methodology approach by the researcher to study individuals' activities within a space and to identify unforeseen issues and give rich data and new insights about usage [24]. For example [26] and [43], focuses on qualitative methods of data collection rather than on the quantitative methods avoiding generalisations and "measurements". This research has adopted an interpretive approach; the units of analysis are end users within actual usage situations which will assist us to identify the actual tasks that users perform and the actual contexts of use. In field trials the individuals use mobile data services as part of their everyday life.

To achieve my objectives and access different types of information about users' experience I adopt the "combination" method followed by [7], [9], [10], [11] and [16] who they combined qualitative methods (interviews, focus groups and observation) with mediated data collection methods.

A combination of classic qualitative research in the form of in depth interviews and group discussions have been employed to extract the information needed on usage of mobile data services. However, given the inherit limitations frequently faced in qualitative research regarding respondents' ability to properly recall and deconstruct their usage behaviour I complement the qualitative study with self-report media elicitation methods and a piece of ethnographic research, namely observation, aiming at establishing a richer understanding of observed behaviour as well as enriching my findings. I modify and extend the self-report evaluation methods taking advantage of the large infrastructure of increasingly powerful mobile devices and messaging services. For that I propose an innovative technique which augments the feedback method allowing the user and the researcher to be always in contact having synchronous textual communication. The above methods combined with the mobile experience clip technique, can provide rich data about the emotions and experiences evoked by a mobile application and will lower the burden on participants and researchers while increasing the quality of data gathered. Finally I believe that the utilization of these methods enables the triangulation of information by depending on the specific advantages of each instrument.

Proposed data collection method

The main research question of this study asks about the role of place in the use of mobile data services. To capture this role I gathered data based on the articulation of the place in terms of Tuan's four dimensions [53]. For each of these dimensions I gathered data combining different methods. To identify the main locations (physical dimension) where individuals use mobile data services I needed versatile rich data, which came from the focus groups. To gather data that provide insights on how the participants experience the place where they use mobile applications (personal dimension), how social interaction is shaped by the space (social dimension) and how cultural elements influence the place (cultural dimension) I applied media elicitation study using mobile prompts accompanied by in depth interviews. In this phase I applied my technique which is an extension of feedback methods.

The questionnaire which was answered by participants during the interviews or during the online feedback method will highlight the sub-questions that ask about the role of mobility and always online benefit in the decision to use technology. Finally, since I wish to capture unconscious behaviour activities and cross check the data that will come from the other techniques I did direct observation with few selected users. Have to notice that the data were gathered with the consent of the participants.

The media elicitation method that was used is accompanied by the "synchronous feedback" method which maximizes participant recall and interview preparation while minimizing situated logging. The self reporting method I used is necessary since the use of mobile technologies is irregular and often occurred at times where observation is not feasible (such as outside of working hours). But keeping notes in a paper or a notebook requires users to sit down and start writing disturbing them from their normal activities. Also, some people may find writing about their emotions and feelings a difficult task. Mobile telephony on the other hand has created opportunities for capturing everyday activity in new ways as [45] who developed Mobile Probes as a way for participants to document their shopping experiences using the inbuilt camera and SMS functions of their mobile phones. I used the same method asking users to capture photos and video clips with their mobile phones and email this information via the Service A platform to a predefined email account. Where necessary, participants used their mobile phones to keep a hybrid photo/voice-mail diary a technique which is especially suitable for studying activity naturalistically and with minimal intrusion under mobile conditions.

The participants owned Service A enabled mobile handsets equipped with reasonably large color displays and digital built-in cameras capable of recording different media types like audio, images

and videos. The users were sending the experience clips to a predefined email account via email service that is provided by Service A mobile platform, allowing interaction between mobiles and between mobiles and PCs. The images, videos and sound recordings will be transmitted over the GPRS or 3G network. Participants were being asked in a preliminary brief interview to engage in self-photographing or in taking video clips accompanied with notes and audio recording of the environment they use Service A service. They were given a list of issues to report on, such as places they are in and their mobility status creating audio recordings and written annotations for each photo or video clip on their mobile phone. They were taking photos and videos for an entire day from the point they awake up to the point they retire in the evening and they will send the media clips directly via Service A e-mail service to my email account. This phase lasted for a two weeks period before the in depth interview takes place, Since I am concerned that requiring participants to use the method would erode participation in the two-week long study, I make participation in the voice-mail diary or written annotations optional.

Microsoft[1]-[2] and Service A service providers launched in 2006 a new mobile data service. It is the MSN Messenger on Service A which enables immediacy, gives the ability to chat with the users online when these are on the move and see the text of whole conversations. So, the users had been provided with the MSN service on their Service A devices and every time I receive a media clip from a user and decide that there are issues of interest then via this MSN service I had a short chat with the user. This will allowed me to identify on the spot, the emotions and experiences of the user. Since this method combines the ESM technique with a synchronous communication between user and researcher at the time the event takes place, I call it "synchronous feedback" method.

After the two weeks period, the participants were attended an interview for approximately one – one and a half hour. The mobile probs, along with the data from the chatting on the MSN were used as inputs to trigger discussion. These face-to-face interviews were audio recorded. The interviews were directed towards discovering interviewees' perceptions, experiences and feelings about using technology within natural environments trying to get "honest and open information" that is valid and reliable. This consisted of a mix of facts with personal non-replicable experiences and emotional reactions in response to the unstructured questions (e.g., why did you decide to use the mobile phone rather than the other system in a particular situation, or how different does it feel to receive a message on a mobile device as opposed to a desktop). After completing the interview I coded and analyzed both the interview and the captured data – photo and video. This technique minimizes the extent to which participants are distracted from their primary tasks since if at the time the event takes place they are busy they can send the data at a later time while researchers have the opportunity to prepare for elicitation interviews based on specific data. The proposed technique is presenting in figure 1.
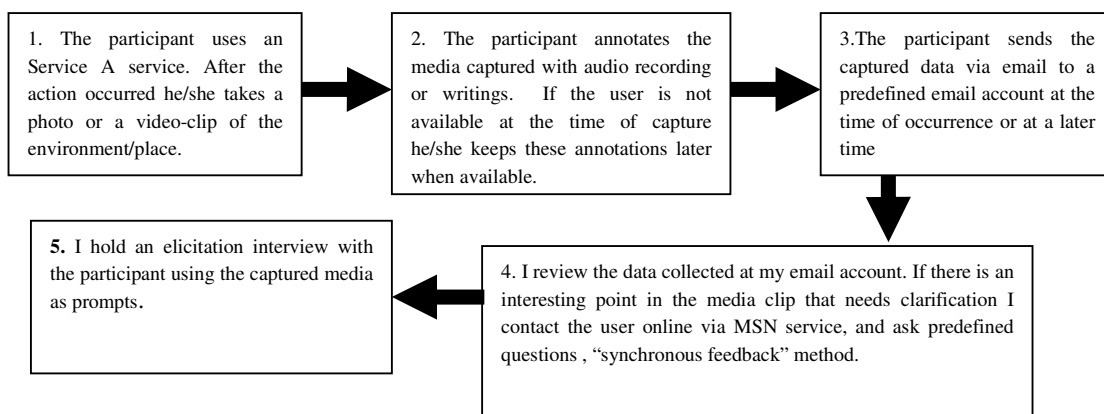
1. The participant uses an Service A service. After the action occurred he/she takes a photo or a video-clip of the environment/place.	→	2. The participant annotates the media captured with audio recording or writings. If the user is not available at the time of capture he/she keeps these annotations later when available.	→	3.The participant sends the captured data via email to a predefined email account at the time of occurrence or at a later time

5. I hold an elicitation interview with the participant using the captured media as prompts.	←	4. I review the data collected at my email account. If there is an interesting point in the media clip that needs clarification I contact the user online via MSN service, and ask predefined questions , "synchronous feedback" method.

Fig 1. Proposed media elicitation technique

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[1] www.microsoft.com
[2] www.msn.com

Users' motivation to participate, to complete the tasks and document relevant issues is the key to successful self reporting studies. In that sense the users' motivation was one of the driving forces when developing this technique. I found ways to encourage subject participation, including reward policy , the use of periodic reminders and reimbursement strategies. However, I created incentives to encourage participation which were the 50 euros participants received for participating in the media elicitation study and the 20 euros participants received for participating in the focus groups. An important issue to address is whether to ask participants to use their own mobile phones, or to distribute other mobile phones. The latter option although is an expensive method could also be an incentive for people to participate in the study, and may even eliminates the need for additional compensation. The field study was completed during 2007.

Discussion, limitations and opportunities

Although few other tools have been tested during the research design phase, as the Context Watcher[3] and the Context Logger[4] used by Reality Mining project at MIT Media Lab, Service A has been chosen finally for this research because it has extended brand awareness within the population, offers a pool of different mobile data services and its easier to establish samples across diverse[5] groups of users. The participants that will be selected will be familiar with the Service A service eliminating the need for extensive training on the use of the email and MSN applications. Service A's competitive advantages are the speed of access and the development of new applications such as e-mail, and MSN over mobile phones.

Computer-Supported Cooperative Work categorizes the applications using the distributed versus collocated and synchronous versus asynchronous distinctions [42]. Following this categorization, Service A is an application asynchronous and distributed in nature since users tend to be mobile and to change context often, making offcourse data collection more difficult and thus its study should be situated within real settings. Have to notice that the proposed method can be extended to study other than Service A services because it is based on applications (email, online chatting and photo and video capturing), that are supported by other mobile platforms as for example the Vodafone Live. Field studies are widely accepted as the methodologies that provide the most experimental realism [31] and can be used to gather context-dependent data. My proposed research method

addresses the field study challenges of scalability, data sparsity and unobtrusiveness, as following:

When scaling an evaluation, the time needed for researchers to conduct the study tends to scale as well. The solution I propose minimizes infrastructure deployment because it is based on known technologies as email, video clips, MSN and mobile phones, it lowers the per-participant researcher-hours introducing self-reporting, and encourage uptake via the motives it introduces. The focus groups on the other hand will provide versatile and rich data. Finally the situated annotations of the experience clips as well as the possibility to review the captured data and annotations before the elicitation interview takes place minimize researcher's burden facilitating their getting the most data out of limited interview time.

Critical events in mobile data services use, are spontaneous and sparse, so it is important to capture and gather feedback on as many as possible.

To aid data gathering in a field evaluation, my solution captures easily via mobile phone and encourages due to motives and the ability to have feedback from critical events at the time of occurrence via MSN.

In order the field evaluation to be unobtrusive, this technique uses devices and interfaces with which participants are already comfortable, it lowers participant interruptions and distraction costs leading to a rapid uptake.
The proposed technique provides lightweight situated annotation and researchers are able to review of captured events and have online feedback communication when necessary with users.
As far as concern the observation phase I will spend 1-2 days with individuals from my social network in order to capture unconscious behaviour activities. Part of the observation was conducted during leisure periods as for example during weekends. This is subject to a number of concerns as for example because participants had been observed in specific contexts as in leisure time, this might give biased conclusions.

This study represents the first media elicitation study using the proposed technique and the "synchronous feedback" method. As such I anticipate that the method needs to be adjusted in ways that fit with the specific conditions of each research asks for.

5. Conclusion

The purpose of this paper has been to present the data collection technique of a research of the use of mobile data services. A classification of the existing research methods used in the mobile data services area and a brief insight into the research methods

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[3]

http://www.lab.telin.nl/~koolwaaij/showcase/crf/cw.html

[4] http://reality.media.mit.edu/download.php

[5] Newspaper Vima 3 July 2005

used in the field study is presented in this paper. The combination of these research methods allows us to understand the researched phenomenon of usage of information data services within natural environments as a whole. More specifically, these research methods provide access to group (focus groups) and individual (self-reporting and observation) views, the mediated self reporting technique provides situated annotations which assist participants' post hoc recollections of actions in the interview phase and the synchronous feedback technique together with the participant observation interprets participants' actions in their everyday contexts.

The main conclusion that came out from this study is that researchers can use simple commercial products as research tools than develop tailor made complex research systems. The use of these commercial products as research tools simplifies and accelerates the research process since there is no need to educate users in the use of these systems.

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