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The Hidden Impact of Mobile Information Systems: a case study of social interaction

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Abstract

Laptops have been around since the 1980s, but the revolution in smaller handheld computing devices has given organisations many opportunities to develop and expand their enterprise information systems while posing a number of new challenges to designers and users. The use of handheld devices removes many of the traditional constraints associated with using corporate information systems through stationary computers. However, this newfound freedom may lead to major and unexpected changes in human behaviour and social interaction amongst handheld users and their clients. This paper reports on some implementation experience in the use of handheld computing devices in a major Australian healthcare provider. The case study shows that the social interaction between system users and between system users and their clients may be impacted significantly by the use of handheld devices. The case study further highlights the importance of understanding the social impact of using handheld devices in situations where the service delivered by the organisation depends on a personal relationship between system users and their clients.

INTRODUCTION

Mobile computing devices such as handheld computers, personal digital assistants and mobile phones have become phenomenally popular. Statistics released in the USA the reveal that sales of personal digital assistants (PDA) in 2001 would be close to 20 million units (Flisi, 2000). The major buyers of PDA's have been individual users with many organisations seemingly slow to take up PDAs for their corporate information systems. However, vendors such as Palm, IBM and Extended Systems are increasingly providing software and other services for mobile enterprise information systems as they see corporate PDA use as a large and untapped source of potential revenue (Palm, 2002). Albright (2002) further indicates that the corporate PDA market is now becoming fiercely competitive.

The mobile phone is currently by far the most popular mobile computing device and with more phones able to access the Internet these devices will become first class citizens in corporate information systems. By 2004, it is estimated more than one billion mobile phones will be in use globally, with more than 80 per cent of these enabled for mobile Internet access (Johnson, 2002). In this paper the term mobile device refers to all mobile computing and/ or communication devices such as PDAs, mobile phones, sub-notebooks, notebooks, etc.

These technology developments are now starting to have an impact on the way that organisations are conducting their business activities and it is likely that this impact will become much larger in future. Information system developers face new and exciting challenges as they design and implement corporate information systems using mobile devices in conjunction with stationary desktop computers and servers. Significant technical challenges arise in areas such as connectivity to corporate networks, synchronisation of

handheld information with corporate databases and the limited capabilities of the mobile devices themselves. The rapid rate of change in mobile device technology means that technology-based limitations and constraints are constantly shifting. Design options that are infeasible today, may be easily implemented within a very short period.

The use of mobile devices removes some of the traditional constraints associated with using corporate information systems with stationary computers. Corporate information systems involving mobile devices typically allow users to access the system from many different physical locations – the home, the office, the car, or even while walking in the street. Corporate information systems involving mobile devices also provide much greater flexibility in the times at which the system may be used. It may be possible to use the system at any time, not just within working hours – early in the morning before work, while travelling to work, late in the evening after work or perhaps even while relaxing at the beach during the weekend.

This newfound freedom sets the scene for a hidden impact of mobile information systems: its potential influence on the social interaction of system stakeholders. Some researchers have recognised that as computers become a larger part of our everyday lives, they may either inhibit or promote social relationships. They have suggested that system designers need to develop a social computing view of mobile computing systems (Dryer *et al.*, 1999).

This paper describes research undertaken to determine the way in which the use of mobile devices impacts on the personal relationship between corporate information system stakeholders – system users themselves and the relationship with their clients. Furthermore, the paper will attempt to describe how this impact should influence the design of information systems utilising mobile devices.

Section 1 of the paper provides an introduction to mobility and an outline of the paper. Section 2 reviews previous work undertaken covering social computing in the use of mobile devices. Section 3 describes the organisation in which the research was undertaken. In order to protect anonymity, the organisation is referred to by the pseudonym*, NursingInc* and the project which was the focus of this study is referred to by the pseudonym*, MobileCare2000*. This section also provides details of the research project itself and the research instrument used. Section 4 discusses the findings of the research while Section 5 concludes with a reflective evaluation of the lessons learnt and makes some suggestions for future designers.

SOCIAL IMPLICATIONS OF THE USE OF MOBILE DEVICES

The use of mobile devices is as much a social challenge as it is a technological challenge (Dryer *et al.*, 1999). Mobile devices affect not just the user of the mobile device but also impact the way in which the user interacts with other stakeholders (Dryer *et al.*, 1999; Kakihara and Sorensen, 2001). Dryer *et al.* (1999) named the social challenge – *social computing* and define it as: 'the interplay between persons' social behaviours and their interactions with computing technologies'.

The area of social computing as it relates to mobile technology draws on a number of other areas of research: computer supported cooperative work (CSCW) (Dryer *et al.*, 1999; Weilenmann, 2001), computer mediated communication (CMC) (Dryer *et al.*, 1999; Kakihara and Sorensen, 2001), human computer interaction (HCI) (Dryer *et al.*, 1999; Abowd and Mynatt, 2000; Weilenmann, 2001), and sociology (Kakihara and Sorensen, 2001).

A model describing the effect the design of mobile devices has on a number of other aspects is described. The model will be used to shed some light on the case study described in the next section. Furthermore, different modes of mobility that affect the interaction of people in everyday life will also be discussed.

Model for social impact of mobile devices

The model developed by Dryer *et al.* (1999) for framing the "social" dimension of mobile devices consists of four inter-related factors:

- system design which refers to aspects such as accessibility, familiarity with the device, whether the device allows sharing of input and output information with nonusers and the usefulness of the device within its context of use.
- human behaviour which refers to the actions individuals take while interacting with the mobile device. Factors include whether the device makes the user appear awkward, whether the device interferes with the interaction, whether the device distracts the non-user and whether the device changes the control between the partners
- social attribution which refers to judgements that are made by a person about a stakeholder's disposition, traits, roles and group membership
- interaction outcome which refers to the outcome of the interaction between stakeholders. It includes situations in which the interaction has been successful, unsuccessful and whether the interaction will be desirable in the future.

Another aspect that affects the use of mobile devices is the ideal of ubiquitous computing i.e. information technology should be an integral and seamless part of people's lives (Weiser, 1991) and would be effectively invisible to the user (Weiser, 1993). At this stage the ideal is still a challenge and the focus of ongoing research efforts (Abowd *et al.*, 2002; Davies and Gellersen, 2002; Satyanarayanan, 2002). Abowd and Mynatt (2000) identify three themes for the development of ubiquitous systems: natural interfaces, context aware systems and finally automated capture and access to information. Natural interfaces support natural forms of communication instead of the desktop paradigm of keyboard/ mouse/ display. Context aware applications use information from the physical environment and computational environment to adjust behaviour. The last theme for ubiquitous systems attempts to automate the capture of real experiences and to give access to these experiences at a later date (Abowd and Mynatt, 2000). The research emphasises that the information system available on the mobile device will impact on the use scenario not just the type of mobile device.

Dimensions of mobility

Kakihara and Sorensen (2001) identify three dimensions of mobility: spatial mobility, temporal mobility and contextual mobility. Spatial mobility is not just the movement of people, but also the mobility of objects (such as mobile devices), symbols (such as images) and space (use of the internet). The use of mobile devices will increase the mobility of objects, symbols and space. For example a nomadic worker will be able to use a mobile device and access images through the Internet anywhere and anytime.

Temporal mobility refers to the acceleration of work and saving time. The introduction of information technology has an impact on the temporality of social life and work life. Barley (1988) (drawing on Hall's (1959; 1962) work) uses two contrasting terms to describe the organisation of temporality: monochronicity and polychronicity. Monochronicity refers to the organisation of work in time slots – where people do one thing at a time. Polychronicity refers to a divergence of structural and interpretive attributes of the temporal order of work. Polychronicity refers to people doing more than one thing at a time. The concepts of monochronicity and polychronicity have been researched in relation to information technology by a number of researchers (for example: Bellotti and Bly, 1996; Dix and Beale, 1996). Information technology impacts the organisation of work and will further impact the organisation of the work that individuals do. Mobile devices will further impact on both monochronicity and polychronicity. The case study will show that there will be more opportunities to undertake work coming from different sources such as mobile devices. But, at the same time the use of the mobile device within a specific context will cause workers to do one thing at a time.

Contextual mobility refers to the particular context that frames and is framed by human activity. In the case of mobile devices the technology is taken with the user to the work environment. The work environment is not necessarily adapted for the use of a mobile device.

MOBILE TECHNOLOGY IMPLEMENTATION CASE STUDY

Case study research is especially appropriate in new topic areas (Eisenhardt, 1989) and is a research strategy that allows for an in-depth description of the relationships in a particular situation (Galliers, 1991). The case research strategy was chosen here due to the novelty of the implementation of mobile technology within organisations. The case study reported here was based on an explorative case study design (Yin, 1989) and focused on the mobile technology implementation processes of *NursingInc* which is a non-profit organisations specialising in home nursing and healthcare services in Melbourne, Victoria, Australia. The research was conducted in one of the centres of *NursingInc*.

Data collection, analysis and interpretation

The data for this study was collected between July 2000 and December 2001. Formal and intensive rounds of data collection were interspersed with periods of informal data collection. An initial pilot study followed by a formal baseline study was conducted in July 2000. The first round of formal interviews were held in April-May 2001 before the implementation of the mobile technology. Follow-up interviews (mostly with the same interviewees) where held in September – December 2001 after the mobile technology has been implemented and used for two to three months. Data were also collected on a more informal basis over the duration of the study by means of regular e-mail and phone contact, lunch meetings, discussions and by attending presentations at the organisations.

Mostly qualitative (and some quantitative) data were collected from a variety of actors who were involved in the implementation of the technology in these organisations. After gaining initial access to the organisation, the interviewees were identified with the help of the managers in the organisation. The managers identified interviewees in three categories: those who were indifferent to the implementation; those who did not want the implementation to take place; and those who "could not wait" for the new technology. Almost 80 formal and 10 informal interviews with various stakeholders were conducted over the period of the study. Interviewees included 36 registered nurses, other nursing staff and administration personnel.

The interviews were semi-structured and comprised of open-ended questions derived from the implementation literature and similar research studies. An initial before-implementation and after-implementation questionnaire (for use by the interviewers) were used in a small pilot study and were subsequently refined to improve ease of comprehension. The before-implementation questionnaire was used for the initial formal baseline study and served as a basis for reference in the after implementation interviews. Interviews were transcribed and shared with the interviewees to correct possible errors and omissions and to evaluate the validity of the interpretation of their "story" (Benbasat *et al.*, 1987; Klein and Myers, 1999). Based on all the data and transcripts, rich descriptions of the various roles were obtained at each case organisation.

NursingInc

NursingInc is the leading provider of home nursing and healthcare services in Victoria. It provides clients living in the Melbourne metropolitan area with an effective and efficient quality home nursing and healthcare service in partnership with other health providers. In any year, over one thousand nurses and two hundred allied health staff coordinate and deliver in excess of 600,000 hours of direct care provided by over one million visits.

NursingInc is currently providing handheld computers utilising infra-red technology for communications via the GSM network to the nursing staff located at each of its centres. This implementation, known as *MobileCare2000* commenced in December 1999 and is expected to take 2 to 3 years to complete. The mobile devices used by nursing staff are a Sharp PV5000A (Windows CE handheld computer) and an Ericsson SH888 GSM mobile phone.

Before the implementation of the mobile devices nursing staff received demographic information about their clients on paper. The nursing staff would record their activities such as travelling time and consultation details on paper. The details of the consultation would be copied onto more official documents and data entry clerks would enter the information into a

stationary server based computer system. The computer system would then generate the accounts sent out to the clients.

The new handheld information system allows client appointment schedules together with client demographic and clinical data to be downloaded from a corporate client information system located on a stationary server to the handheld computer. The system also allows updates to this information to be uploaded to the client information system. The information provided to the nursing staff on the handheld is more comprehensive than the equivalent paper based system. The turnaround time for changes to the client information or the schedule for consultation is also shorter. The goal for the handheld information system is that the system will significantly improve efficiency and data transfer in community nursing and ultimately contribute to better client care.

DISCUSSION OF THE RESULTS

In evaluating the results in terms of the social interaction a number of stakeholders can be identified: field staff, centre staff (which include the administrative staff and centre management), head office staff (specifically IT services) and clients. A number of relationships can be identified: field staff with one another, field staff with centre staff, centre staff and field staff with head office and finally field staff with clients. The case study highlights the impact the mobile device has on the relationship between field staff themselves and between field staff and clients.

At the start of each shift prior to introducing the mobile devices, all field staff would come to the centre to collect their schedule of client visits and the demographic information relating to each client on their schedule. At the conclusion of their shift the field staff would return to the centre to complete the day's paperwork and submit it for keying into the Client Information System. These start of shift and end of shift periods were a real hub of activity when all field staff of the shift were present in the centre. This time was not only used to pick up and deposit paperwork, but also to catch up on news, share ideas and experiences and to network both professionally and socially. A number of interviewees commented on the impact the handheld might have on the social interaction that take place between field staff during the before implementation interviews.

> *I am concerned about the social aspect as in peer social interaction. I am aware that, that is a problem that I think we need to work at. I think there is a danger that they (field staff) will not talk to one another. The beginning and the end of the day is the social time and that will suffer. You need to have that peer support, because you spend most of the time on the road.*

(Consultant 1, April 2001)

> *Most staff members visit the Centre in the morning and afternoon and this may be reduced as these activities could be done on the road.*

(Consultant 2, April 2001)

The introduction of the mobile technology would potentially allow completely new work patterns to emerge. It would become possible to dial up from home and download the client schedule and demographic/clinical information without even going to the centre at the start of a shift. It would also become possible to upload individual or aggregate client information to the Client Information System server from any location at any time. It would therefore not be necessary to return to the centre at the end of a shift. The mobile technology could enable major changes to human behaviour and social attributions in relation to field staff interactions.

Surprisingly, the after implementation interview guide revealed that the start of shift and end of shift periods had become even more important than before due to the need to successfully synchronise all handheld devices with the Client Information System. The Centre location provided a higher bandwidth network connection and therefore faster completion of the synchronisation process. It also provided nearby and easily accessible peer support for any technical problems that arose during synchronisation. Only a small number of staff on the afternoon or evening shift synchronised at home instead of coming to

the Centre. Many field staff members felt that synchronising from home was an intrusion on their personal and family life and they preferred to maintain a strong separation between their work related activities and their personal lives. The start of shift and end of shift periods therefore continue to allow field staff to catch up on news, share ideas and experiences and to network professionally and socially. The mobile devices have not significantly changed this aspect of the social interaction between field staff. One interviewee who indicated that she logs on and off from home stated the following:

> *Access to the server is a problem. I have found a spot at home where I can log on. Even if the system is down you learn how to fix it. Logging on and info downloading was a problem.*

> (Consultant 1, October 2001)

On the problems with the logging on and off interviewee commented as follows:

> *It takes a long time to download in the morning and evenings. It takes longer than using paper.*

> (Nurse, October 2001)

> *I always use the [network] card. I come 30 minutes earlier to work to log on.*

> (Nurse, October 2001)

The communication between field staff with respect to the exchanging of information about clients did change. Before the implementation of the mobile device field staff would verbally exchange information about specifics of clients. They would also have a paper card with demographic information about the client. In the event that a specific nurse could not visit a client, the client's information could only be passed on verbally. The mobile device creates a more flexible system in respect to the transferring of information of clients through the wireless network. Each person who visits a client can add visiting notes on the electronic record of the client and this information will be passed on to the next person who visits the client. Some comments that were made about this aspect were:

> *You have your paperwork [before the handheld] and you organise your work here at the centre. Then you hit the road and once you have done the actual work [visiting clients] you have to write it in on the sheets. Now [after the implementation of the mobile device] you've just got to punch it in on the computer… it does make it a little bit easier to access information of the client. If you need to chase up something while you are at the client, it looks more professional.*

> (Nurse, October 2001)

> *The handheld is like a diary and I have access to all the clients appointments. I can change future appointments more easily than on the paper system. They [other field staff] keep the information more up to date on the handheld than with the paper system.*

> (Nurse, October 2001)

During the before implementation interviews it became apparent that all staff were told that they should not use the handheld in the car, but that all work should be done in the client's home. In the after implementation interviews, interviewees identified that they use the handheld in the car. The use of the handheld in the car is problematic with glare the major concern. Various strategies for overcoming this problem was suggested by the interviewees, such as using a towel, twisting and turning in their car seat to try to control the glare. All of them reported that some kind of improvement in glare because of this, but that it was not satisfactory. An example of a comment by one of the interviewees:

> *I have eyestrain when using the handheld in the car because of the glare on the screen. We expect that the glare would be worse in the summer.*

> (Nurse, September 2001)

Introduction of mobile technology could also have an impact on the relationship between clients and field staff. Instead of taking written notes while meeting with each client the field staff would enter the information into their handheld device. They require a workspace suitable for using the handheld in the client's home. Field staff would need to look at the screen and use the keyboard while dealing with their client, without appearing to be disinterested in their client's needs. Use of the mobile device would not be ubiquitous or invisible and could easily detract from the special relationship existing between field staff and their clients.

The before implementation interview guide revealed that field staff members were concerned about using mobile devices at the client's premises may inhibit their interaction with the client and possibly reduce the level of care provided. Some were concerned that they would need to spend more time at the client's premises due to the need to enter all the required information. Many were concerned that the relationship with their clients could be disrupted by untimely hardware and software failures and/ or the inadequacy of their own technology skills should anything go wrong. Examples of comments include:

> *The device will make my work significantly slower as I will have to type up information on the computer instead of making quick notes on paper. This may make our jobs more difficult.*

(Nurse, April 2001)

> *I think there will be more work with me and the computer and then between me and the client. [sic] I will talk to the client. Then I will say that I have to enter this into the unit and I'll do that.*

(Nurse, April 2001)

> *I am worried about using the handheld on the road – what will happen when things go wrong? I am worried about the troubleshooting.*

(Health Aid, April 2001)

> *Clients might be put off by the handheld. They might see the handheld as a sort of a barrier or they might be suspicious about what are we putting into the computer about them.*

(Nurse, April 2001)

The after implementation interview guide revealed that some field staff confirmed that using the computer in the client's home detracted from the quality of their relationship with the client. Although clients had not complained directly to them, the field staff felt uncomfortable when their attention was focussed on entering information into the handheld rather than listening to and supporting their client. Examples of comments by interviewees are:

> *First of all it was a novelty. People would say: "Oh you've got it. But after a while you get the feeling that when you're talking to them they would rather be talking with you not having you sit there tapping at the screen. …It's just the impression I get.*

(Nurse, November 2001)

> *Then I had a feeling that after the novelty wore off a lot of people seemed to like your undivided attention. You can get around it with scribbling on a bit of paper and still talk to them, but not tapping on the handheld.*

(Nurse, December 2001)

Slowness of the handheld device in navigating from screen to screen exacerbated this problem. Some staff members overcame the problem by entering client information into their handheld in their car immediately after completion of the visit. This triggered other problems including inappropriate posture when using the handheld, difficulty in reading the handheld screen due to sunlight glare in the car and security concerns about being seen by passers-

by when using the handheld in the car. These issues highlight the importance of system designers understanding the variety of possible usage locations/contexts for mobile devices and identifying the advantages and disadvantages of each. The human behaviour and social attribution issues related to each context of use should form an important part of this analysis.

Other field staff explained their strategy of using the mobile device in the home as follows:

> *Most people are interested and curious and if not I make them. I do talk about it*

(Nurse, October 2001)

Other field staff explained that they do not use the mobile device in the home because they cannot find a suitable position to place the handheld. Other identified poor hygiene in the house as a reason for not using the mobile device in the house. An example of a comment about this aspect:

> *I don't actually take it in because there is nowhere to put it. There might be dirt, or there is no appropriate place to put anything*

(Nurse, September 2001)

A number of interviewees commented on the size and weight of the device. Some said that they were surprised at how large the mobile device was. They expected a small device that would fit into the palm of their hand. The common term used for the mobile device in NursingInc is the handheld which also created the expectation for a small device. One reviewer verbalised this aspect as follows:

> *I have problems in lugging the handheld around. I now just take the handheld without the case and only open it if I have to change an appointment. I just bring the device into the house for security reasons. The handheld is a hindrance not an enabler.*

(Nurse, October 2001)

CONCLUSION

Mobile devices promise access to information anywhere, anytime, but as the model developed by Dryer *et al.* (1999) indicates the mobile device impact on the social interaction. In the initial empirical work done by Dryer *et al.* the type of mobile device and the impact the type of mobile device has on the social interaction were tested through two laboratory studies. In the case study evidence was found that the information system available on the mobile device also significantly impacted on the social interaction between field staff and between field staff and their clients. The impact of the mobile device can be summarised in the following table:

Social Computing Aspect	Between field staff	Between field staff and client
Mobile system design (i.e. mobile device design and the information system available on the mobile device)	The mobile device appears similar to a laptop.	The mobile device appears similar to a laptop. Mobile information system is slow and impacts on the relationship and other work the users have to do.
Human behaviour	Problems with synchronisation emphasised the importance of social activity at the start and end of the shift.	Some evidence that the use of the mobile device is seen as a disruption and a distraction.
Social attributions	No impact.	Some evidence that the use of the mobile device impacts on the relationship between the client and the field staff.
Outcome of the interaction	The social interaction at the beginning and the end of the shift has become more important.	Mixed results – some users do not use the mobile device with the client and others do.

Table 1: The impact of the mobile device

The device resembles a laptop, but the mobile device does not have the same computing power as an actual laptop. The Sharp PV5000 is smaller than a laptop, but has a keyboard and an 8.2-inch screen. The clients and the users of the mobile device were thus familiar with the device. In the field experiments done by Dryer *et al.* (1999) it was found that the laptop was more acceptable because it permitted the sharing of input and output and it is familiar to most of the users. One important aspect that clouded the use of the mobile device is the information system that was available on the mobile device. On the one hand it provided access to data anywhere anytime through the wireless network, but the slow response time became an obstacle in its use. All the interviewees complained about the slow response time of the information system. Some of the interviewees felt that the advantages outweighed the disadvantages but most felt that the slowness should be addressed. In terms of the social computing model the slow throughput affects the users' social attributions such as agreeableness, extrovertness and socially attractiveness. Some of the clients in the case study referred to this or the field staff felt uncomfortable in using the handheld in the home.

The human behaviour in the social interaction between the field staff did not change, but the social interaction that took place during the start and end of shift became more important. The human behaviour with respect to the social interaction between the client and the field staff was impacted. Various strategies are followed by the field staff: some do not use the mobile device in the home, others use it only in certain homes and other changed their own behaviour to include the client in what is happening on the handheld. Here the effect of monochronicity is apparent. The user of the mobile device cannot do more than one thing at a time when they key information into the mobile device. When paper was used as recording method the clients did not even realise that the staff were recording information. The slowness of the information system further impacted on this aspect as the handheld detained the user. The use of paper was ubiquitous whereas the mobile device became the focus of attention. The mobile device made the user appear awkward and it interfered with the interaction between the user and the client.

The social attributions in the social interaction between the field staff did not change. The same issues raised in the human behaviour impacted the interaction with the client. No clear evidence of why this aspect was impacted came from the case study. The user might appear disinterested at the client because the mobile device "intrudes" into the relationship.

The interviewees revealed mixed results in terms of the interaction outcome between the client and the field staff. Some of the interviewees indicated that they use the device within the home and others indicated that they only use the device in the car. The interaction outcome became more important in the relationship between the field staff. The field staff faced the same problems and found support, acceptance and help from one another.

The case study exhibited spatial mobility on all three levels: of the mobile device (object), the information needed by the field staff (symbols) and of space – the use of e-mail. The most important dimension that became apparent in the case study is the contextual mobility. The context within which the field staff has to use the mobile device – home, car and centre created interesting issues for the design of information system as well as the device. The glare, weight of the mobile device, situation in the home, ergonomics in the car and the interaction with the client affected the success of the use. The specific mobile device was chosen as it provided a large enough screen for reporting information. The CIO of *NursingInc* indicated that a smaller mobile device was considered but it was felt that field staff will only be able to do data entry and would not be able to receive information as well.

Designers should take the context of where the device will be used into consideration when a mobile device is chosen. The context should not just be speculated upon, but should be observed firsthand by the designers. Furthermore, the impact the design of the information system available on the device will have on relationships should be carefully considered. The case study quite clearly identifies that the response time of the information system impacted on the relationship between clients and field staff. The three themes identified for ubiquitous computing (natural interfaces, context aware systems and automated capture and access to information) should be included in the design of the system as these will lessen the intrusive impact the use of a mobile system will have on the social interaction.

The study has the following limitations. First, we interviewed the personnel of *NursingInc* and the views of the clients were not studied in this research. Second, the study was conducted in the Australian context. Research is needed to examine how the findings reported here manifest in different settings. Further longitudinal studies are needed to determine the long-term effect the mobile system will have on the social interaction.

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