

## GSM-Based SMS Time Reservation System for Dental Care

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### Abstract

In this article we focus on the application of a mobile time reservation system for dental care. The specific application allocates cancelled dentist times to new customers and new customers are searched from a waiting list with Global System for Mobile Communication (GSM) Short Message System (SMS) messages.

This article shows how standard, widely used technology – when used innovatively – can bring many benefits to many stakeholders with reasonable costs and changes in business processes.

We present and analyze the function of an SMS message-based dental service appointment reservation system that has been implemented in Lahti, Finland. The analysis contains a description of the system's function, as well as some assessment of the success from the service provider and customer point of view.

The Internet has opened new avenues for customer communication, even for the public services. However, there remains the doubt that not all the capabilities and opportunities of the new technology are utilized to the full extent. Processes can be made faster with the new communication media, but one should simplify them. In this article we focus on the application of a mobile time reservation system for dental care. The specific application allocates cancelled dentist times to new customers and new customers are searched from a waiting list with Global System for Mobile Communication (GSM) Short Message System (SMS) messages. From the very beginning, the new application – in connection with other methods – could restrict the share of time slots totally lost to less than 10% of cancellations.

This article shows how standard, widely used technology – when used innovatively – can bring many benefits to many stakeholders with reasonable costs and changes in business processes.

As a theoretical background, we use the transaction cost approach. Reserving, cancelling and reallocating dentist care time spots are all transactions. They should be conducted in an efficient and effective manner. We analyze the components of transaction costs in the application area and discuss how SMS messaging can affect them.

We present and analyze the function of an SMS message-based dental service appointment reservation system that has been implemented in Lahti, Finland. The analysis contains a description of the system's function, as well as some assessment of the success from the service provider and customer point of view.

In our case the SMS system has also brought many benefits. However, we feel that its potential is still far from being exhausted. Further work on implementing the system more effectively in this

environment is needed, as well as efforts to take similar systems into use in different application areas.

## Introduction

Internet technology is penetrating every aspect of modern life. We speak of e-commerce, e-learning, e-health, e-everything. Health care is one of the industries in current societies where information technology is being adopted very quickly. However, the industry was late in starting. So far, the development of information systems in health care has been several years behind the general development in most other industries (Ragupathi, 1997).

Finland has been one of the pioneers in the development of mobile communication solutions (Aarnio, Enkenberg, Heikkilä & Hirvola, 2002). The environment in Finland is that of GSM (Global System for Mobile Communications). The GSM Association (2006) defines Short Messages Service (SMS), which are a core technology in our article, as follows: “Short Message Service; a text message service which enables users to send short messages (160 characters) to other users. A very popular service, particularly amongst young people, with 400 billion SMS messages sent worldwide in 2002”. The user interface of an SMS is usually a mobile phone, but other solutions may also exist. SMS is a central application platform in the GSM system.

Several solutions have been tested, even in the health care sector. Mobile messages should improve the organization and delivery of care for the elderly in their homes (Epstar, 2003), and possibilities of getting drug information and prescribing drugs through a mobile interface have been studied (Han, Harkke, Mustonen, Seppänen & Kallio, 2004). In general, it is widely accepted that mobile solutions are increasingly being accepted, even in health care (Hameed, 2002; Porn & Kelly, 2002; Turisco, 2000).

Electronic communication in the health care sector in general has many advantages over traditional face-to-face meetings. Electronic communication is usually characterized as (MacDonald, Case & Mertzger, 2001):

- Informal
- Thoughtful
- Asynchronous
- Self-documenting
- Relationship enhancing
- Inexpensive

When it comes to SMS messages, they are usually very informal in the daily use by private people. The SMS messages in the system to be presented here are highly structured. They are always extremely thoughtful, and allow for asynchronous communication. They are relatively inexpensive and self-documenting. The aspect of relationship enhancing remains most open, especially if compared with face-to-face discussions.

Mobile communication made possible by the GSM and future UMTS technology is just one area of development. Big advances are being made alongside the Internet (Bakker, 2002; Klecun-Dabrowska & Cornford, 2000; Suomi, 2001). The application of mobile devices in health care is by no means new in health care settings, but so far we have not found any research reporting on how to perform interactions with customers via mobile phones in the dentist applications. In this way this study is of pioneering value.

Our research question in this article is:

*“How can SMS technology lower transaction costs in health care appointment scheduling?”*

The article is heavily oriented towards empirical research on the actual appointment reservation system implemented in Lahti. For that part of our research, the research question is:

*“Is the SMS-based system for dental care appointment reservation in Lahti effective and is it eliminating transaction costs for the parties involved?”*

Methodologically, our study is one of evaluation of a system. The approach contains both hermeneutical (Boland, 1991; Westrup, 1994) and grounded action research (Avison, Lau, Myers & Nielsen, 1999; Baskerville & Pries-Heje, 1999) elements.

Our article unfolds as follows. In the second section we discuss how the transaction cost approach can be used to structure and understand transactions and their associated costs. In the third section we introduce the actual system implemented in Lahti, and provide some results that have been gained from the evaluation of that system. Finally, in section four we draw conclusions.

## **The Transaction Cost View of Appointment Scheduling Interactions**

The literature is rich in articles about patient scheduling, mostly from a queue-theoretical point of view (Klassen, 2004; Rohleder & Klassen, 2000). However, other points of view have also emerged, such as catering for customer satisfaction when waiting (Katz, Larson, & R.C., 1991).

Since the classics in the field (Bailey, 1952, 1954), the key problems in patient scheduling have been:

- 1 appointment time to the customer as soon as possible (minimizing the lead time to start the service)
- 2 elimination of idle time for resources
- 3 minimizing waiting time for customers waiting to be served

The literature has paid very little or no attention to the operating costs of the scheduling system.

Fortunately, not all health care transactions are as complicated as the “Real Life” model presents. Our focus here is on the appointment scheduling activities that happen before the actual patient contacts, and even there in a situation when unplanned free time emerges to the service providers, usually because of customer cancellations of reserved time. The process we are discussing is presented in Figure 1.

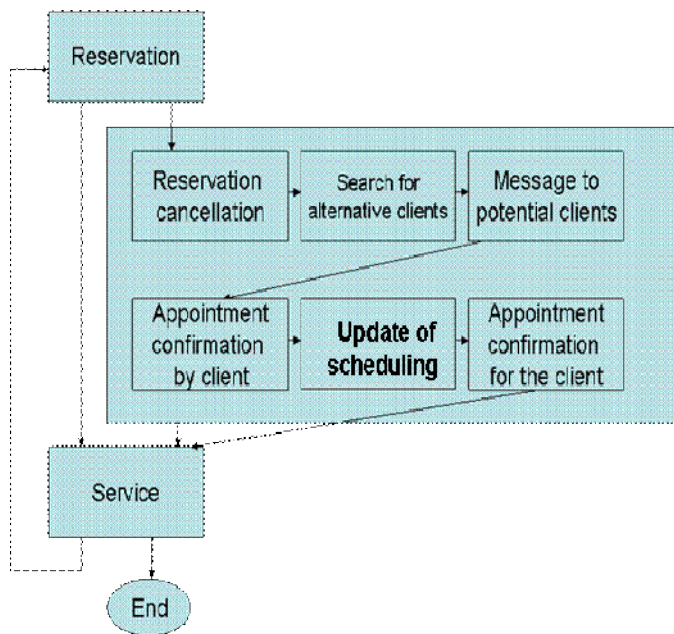


Figure 1. The total process of dental service appointment scheduling with the new SMS-based system

We now briefly discuss the transaction costs in this setting. The concept of transaction cost is central to the transaction cost theory. Transaction costs are costs arising from business transactions. They are *the costs of running the economic system* (Arrow, 1969). As with all kinds of costs, they inhibit economic activities. In our discussion the “economic system” is that of allocating appointments to dental services.

According to the theory, a firm is established because markets fail to perform the exchange transactions. Within the firm, transactions can be performed more efficiently than in the market setting. The transaction cost theory also sees the archetypes of markets and hierarchies as platforms for performing transactions. In our case the market we speak of is one of exchanging dental services. The system to be presented will lower the transaction costs of the exchange.

Transaction costs can be compared to friction, a term used in the engineering sciences:

A transaction occurs when a good or service is transferred across a technologically separable interface. With a well-working interface, as with a well-working machine, these transfers occur smoothly. In mechanical systems we look for frictions: Do the gears mesh, are the parts lubricated, is there needless slippage or loss of energy? The economic counterpart of friction is transaction cost. (Williamson, 1985)

An appointment scheduling system would work smoothly when the appointments are allocated to the clients quickly and with low costs.

The level of transaction costs is dependent on three main determinants (Suomi, 1990):

1. the actors in the transaction
2. the channel through which the transaction takes place
3. the object of the transaction (the good or service to be exchanged)

In our analysis the actors in the scheduling transaction are the customer and the scheduling agent working on behalf of the service provider, the dentist. The big change happens in the channel of the transaction. The old channel for the transactions was that of voice telephony and sending letters. The new channel is that of SMS messages, which are partly generated automatically without the activities of the scheduling agent. The object of the transaction, the appointment, is not changing because of the new system.

When introducing new technology, we should perform business process redesign. Business process redesign should be separated from the daily operational development of organizational routines. It should concentrate on value-adding processes, making them shorter and faster, and bring radical benefits (Davenport & Beers, 1995). It is typical to perform business process redesign in connection with introduction of new technology, such as the Internet (Broadbent, Weill & St. Clair, 1999). In our case of appointment scheduling some business process redesign took place in the way in which free time slots are allocated. This was a difficult political decision, as many thought that no customers should get any benefits because of the technical system they are using, and that people agreeing to use the SMS reservation system should have no advantage over other customers.

There are six types of transaction costs (Casson, 1982):

- 1 information costs
- 2 costs caused by requirement analysis
- 3 costs caused by negotiating
- 4 costs caused by initiating the transaction
- 5 costs caused by monitoring the transaction
- 6 costs caused by making the transaction legal

The system presented here has a positive effect on most of these transaction cost components. With the system, potential new customers can be easily found as an appointment time becomes free, so the information costs caused by searching for customers are reduced. The SMS message calling for a reservation and the answer to that message by the potential clients redesign the negotiation and initiation phases and, accordingly, their costs. As all the messages are automatically taken to the system's log data, monitoring of the appointment reservation becomes automatic and loaded with lower transaction costs.

Thomas Malone et al. also introduce facts to support this assessment. Several developments based on the use of information technology contribute to the balance shifting towards the markets, and eventually electronic ones (Malone, Yates & Benjamin, 1987):

- 1 Electronic Communication Effect
  - More information can be communicated in same amount of time or the same amount of information in less time.
- 2 Electronic Brokerage Effect
  - The number of alternatives that can be considered increases;
  - The quality of the alternative eventually selected increases;
  - The costs of the entire selection process decrease.
- 3 Electronic Integration Effect
  - Changing and tighter coupling of processes that create and use information.

In our case all these effects materialize very easily. The reservation appointment agent can contact many potential clients with less effort than in the case of the old manual system. The whole activity is about brokering, and bringing together service providers and customers. The number of alternatives grows from one (telephone call) to four (SMS message to four potential clients). As all the transaction parts are automatically recorded in electronic media, the electronic integration effect is very strong.

## **The Lahti Pilot Project with SMS-Based Reservations**

### **Introduction to the Environment**

The City of Lahti, with 98,500 residents, offers its inhabitants the possibility to obtain oral health care services at public dental clinics. The oral health care is provided by 28 dentists, 11 oral hygiene specialists, and 46 dental assistants and receptionists. Specialist dental care is offered in clinical dental care, correction of irregularities of the teeth, and oral surgery. In 2003 visits by clients numbered around 84,000, and half of these were by clients under the age of 18. In addition, about 60 full- or part-time private dentists work in the city. There are 18 dental clinics for clients in different parts of the city. Of these, three are larger in size and the other 15 operate near to schools for the most part. Also, mobile staff makes visits to the wards of care institutions and hospitals, and to homes.

All Finnish citizens have been entitled to public oral health care since 2002. Citizens could thus seek either municipal oral health care, or private care subsidized by health insurance; customers have selection possibilities. There is evidence that the availability of different communication channels with health care professionals and efficient scheduling solutions are key selection factors when customers select their health care providers (Gopalakrishna & Mummaleeni, 1993).

Even the public health care is not free for the adult population in Finland. The customers typically pay some 10-50% of the real cost in direct payments (and the rest through taxes of course). In the private sector, the customers, after state subsidies, pay some 50-95% of the real costs. The established way of operating throughout the whole country is that dentist appointments that are cancelled at least 24 hours before the appointment are free; in later cases an office fee (usually 10-30 euro) is charged. However, this charge is not applied to schoolchildren, who do not face any penalties for not using their dentist times. Anyway, the schoolchildren cater for the most of the unused times.

In 2003 the calculated costs to the City of Lahti arising from unused oral health care appointments amounted to around 170,000 euro (at a calculated cost of 50 euro/unused appointment). The costs arising from appointments left unused by 7- to 17-year-olds were about 132,700 euro. Some of these costs are covered by inviting another patient in place of the one that has cancelled, and by a charge of 27 euro per noncancelled, unused appointment for clients over 16 years of age. Nevertheless, considerable costs are incurred due to unused appointments.

Before the introduction of the new system, clients were put on a waiting list at a dental clinic, which also manually managed queues for all the other dental clinics. Maintaining the waiting list manually was rather laborious. Clients were invited to the clinics either by telephone or by letter. Appointments that were cancelled the same day often remained unfilled, which remained a big problem.

## **Methods and Data Collection**

A pilot project for SMS appointment reservation was launched in May 2003, and its evaluation was begun at the beginning of 2004. The aim of the evaluation was to obtain immediate feedback in order to improve the application and adopt it for regular use. We examined mobile phone appointment reservation from the perspectives of its effect on work procedure development, client satisfaction and waiting list management. As to development of work procedures, the point in question is what effect the new wireless service has on the workload and working methods of reception staff in particular. Customer satisfaction indicates how usable and functional the service is, as well as reflecting the clients' conceptions of the quality of the reception services. Waiting list management relates the study to the "treatment guarantee" (implemented as changes to the Finnish "Kansanterveyslaki" (Kansanterveyslaki [Law on public health], 1972) and "Erikoissairaanhoidonlaki" (Erikoissairaanhoidonlaki [Law on special health care], 1998) and in detail specified in a special act (Valtioneuvoston asetus hoitoon pääsyn toteuttamisesta ja alueellisesta yhteistyöstä [Act on delivering health service and regional co-operation], 2004)), which specifies the maximum waiting times for access to treatment. In addition, we looked at the economic effects of the service. Taken together, these perspectives of the study create a foundation for evaluating how necessary, functional, and useful the SMS service is.

As regards the development and study of working methods, we launched a new invitation procedure for appointments in which we invited clients to the clinic by means of text messages. The staff, together with the designers of the SMS solution, took an active part in developing the working procedures for appointments. The task of the study was to compare the developing work method with the original operational model. We interviewed eight receptionists, eight dental assistants, and six dentists. We asked the interviewees what effect SMS appointments had had on procedures for appointment making and reception of clients. We asked the respondents to specify the change factors from the standpoint of the traditional and the SMS appointments. Finally, we cross-checked the validity of the change factors with different people. The staff confirmed the identified changes in reception work.

Our study of customer satisfaction is based on the customer relationship management approach (Campbell, 2003), in which attention is drawn to the handling of the client relationship and to organizational learning. In our examination the client relationship is maintained by the appointment method using GSM technology. We requested feedback from dental clinic clients concerning the usability of SMS appointment reservation and the quality and characteristics of the reservation service. We looked at the different modes of the SMS appointment reservation service, that is, filling cancelled appointments and informing waiting clients of the precise times for emergency appointments. We investigated each service by means of a semistructured questionnaire involving both structured questions and open responses. The customer satisfaction survey covered a total of 212 customers aged 15 to 80 years. In addition, we supplemented the questionnaire through open interviews with 10 people.

In the evaluation of waiting list management we used the city's statistics on kept appointments and cancelled appointments in oral health care, as well as the log data on the SMS service for 2004-2006. We followed the numbers of kept and cancelled dental clinic appointments through the statistics, and also the degree to which the SMS service was used. The aim of this examination was to identify changes that had taken place in the length and duration of the waiting list.

## **Operational Model for Mobile-Based Appointment Reservation**

Next we discuss making appointment reservations by mobile phone in order to reallocate cancelled dental appointments and invite urgent emergency clients. The studied activities cover mobile-based appointment reservations and waiting list management in the oral health care services in the City of Lahti.

When managing the reservations by mobile phone, the dental clinic informs clients on the waiting list about the cancelled appointment time by SMS. The mobile-based reservation in this application concerns cancelled appointment times that are reallocated within the same day (2-8 hours). For the mobile phone reservation, appointments manually recorded on paper are transferred to a database, that is, a waiting list file. In the database the clients may be grouped into either one waiting list or several, depending on the grouping principle. The basis for the grouping may be, for example, the treatment unit, the medical priority, the waiting time, or the local area. Clients can be added to or removed from the waiting list according to need. The opportunity for SMS reservation is presented to clients who wish to accept cancelled appointment times by mobile phone.

In the first service a receptionist or dental assistant sends the cancelled, available appointment time to five clients simultaneously by one press of a button. He/she only enters the free appointment time on the computer screen. The first of the five clients to reply to the text message can reserve the free appointment time. The other four clients are informed that the appointment has been filled, and they return to the top of the list to wait for the next time that becomes available. This electronic invitation, which may be either free to the client or subject to a charge, costs the service provider the price of one text message.

The content of the invitation for reallocation of cancelled times corresponds to the following pattern:

Cancelled appointment time at Laune Dental Clinic, Laune Street 74, 31 March at 12.00. Please reply immediately: write HA and send to the number 18444. Wait for confirmation!
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*Figure 2. Example of an SMS message informing of a free appointment*

It is important that the text message looks like an official message and comes from a trustworthy source – a service number that is unavailable to individuals (service numbers in Finland have just five figures – individuals have phone numbers of operator pre-suffix and seven numbers thereafter). Needless to say, when in wider use, such messages could become a playground for jokers, especially for schoolchildren. Eliminating this possibility from the very beginning was very important in the message design.

In the second service, an urgent case, the client is given a precise time at an emergency clinic. Previously, clients reported to the emergency reception desk in person. In the pilot project – in addition to personal visits – enrollment by phone was introduced. In phone enrollment the receptionist puts questions to the client and, on the basis of these, assesses the treatment needed and its urgency. In an urgent case the client is sent a text message with the precise time of the approaching treatment, one hour before the desired arrival time. The message goes automatically as soon as a client coming from treatment is checked out. In that way the emergency client can move around freely and need not wait in the waiting room. The client's GSM number is recorded in the



database. The SMS invitation system is intended for emergency clinics where waiting times can extend to several hours.

The content of the invitation to urgent emergency clients corresponds to the following pattern:

Your emergency dental appointment is approaching. appointment time is 13:15. clinic!	Your estimated Welcome to the City Hospital emergency dental
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*Figure 3. Example of an SMS message confirming an appointment*

The whole problem of waiting list management actually concerns those on the non-urgent list. A screening method is being planned for non-urgent cases. The non-urgent waiting list is formed by order of contacts made. The SMS list, taken from this, is visible online at all the dental clinics.

### **Changes in Appointment Reservation and Working Methods**

The mobile phone appointment reservation system has resulted in some changes in reservation procedures. The changes have concerned client service, the reception process, and, to a greater degree, forms of waiting list management. As a new tool in client service, reallocation of cancelled times and invitations to urgent emergency clients makes the everyday routines of the receptionists easier to some extent. However, bigger changes are possible when they all combine and centralize their appointment reservations. Appointment reservation by phone is therefore concentrated on one contact centre, from which the appointment times, including cancelled appointments handled by SMS, and are filled for all the dental clinics. The organizational learning procedures are presented in Table 1, where the traditional operating model is compared with the SMS service.

	<b>Traditional reservation</b>	<b>SMS reservation</b>
Waiting list processing	Manual recording and assignment to a dental clinic	Recording in the database and online monitoring of the waiting list
Waiting list management	Separate waiting list for each dental clinic, so several persons work in reception	Joint waiting list for all the dental clinics, so one waiting list manager arranges all times
Reservation channels	Telephone most used in reallocating cancelled appointments; others are supporting procedures	Text message most used in reallocating cancelled appointments; others are supporting procedures
Contact information	Checking of clients' phone numbers afterwards	Recording of clients' phone numbers immediately on contact
Emergency duty	Continual emergency duty tied to a particular clinic	Continual, mobile emergency duty and management of own work
Size of dental clinic	Reallocating of cancelled appointments difficult when working in pairs	Reallocating of cancelled appointments possible when working in pairs
Selection from waiting list	Selection difficult from the same waiting list and using the same criteria, at many dental clinics	Selection possible from the same waiting list and using the same criteria, at many dental clinics
Cancellation	Cancellation previously haphazard, by phone or on the spot	Cancellation now active, via many channels (text message, phone, answering service)
Clients' arrival at the clinic	Clients wait in the waiting room at the clinic	Clients mostly wait somewhere other than the clinic, so the waiting room is more peaceful

*Table 1. Comparison of traditional and SMS appointment reservation*

SMS appointment reservation is based on maintenance of the waiting list database. The waiting list is visible at each of the dental clinics in real time, and each clinic can make additions to and deletions from it. In this way the clients' positions in the waiting list can also be monitored in real time. In the pilot experiment, besides the person's name, his/her GSM phone number has become a key data item for identification. The waiting list database, however, is separate from the electronic client history and the clients' data privacy can be ensured. According to the staff, the waiting list database has made it easier to distribute the appointments and monitor the waiting list.

The job of waiting list manager has been created as another consequence of the waiting list database. Previously, the receptionist at each dental clinic used to issue appointment times from the waiting list of the particular clinic concerned. Nowadays, the waiting list manager centrally arranges appointments and offers cancelled appointment times. With the reorganization, the need for reception staff has decreased from nine receptionists to two.

During the course of the pilot experiment, there has been a move from telephone calls to text messages for making contacts to reallocate cancelled appointments. The receptionists use text messages in the first place, and telephone calls second. According to the interviewees, the ready-structured text messages are easy to send in between other tasks. The SMS appointment reservation increases the receptionists' and dental assistants' mobility in their work to some extent, as well as its ease of management. The reallocating of cancelled appointments also succeeds at the small dental clinics staffed by just a dental assistant and a dentist.

Different selection criteria can be taken into account in SMS appointment reservation. It is possible to select from the waiting list database those clients who, from the dental point of view, have the most urgent need for treatment. Invitations for the reallocation of cancelled appointments can be directed to clients in order of priority.

Earlier, clients were served on the premise that cancellation of appointments was neither a desirable nor a responsible way of using the services. Appointment cancellation has been made easier in the new system. The aim is to minimize unused appointments. Because SMS reservation makes it easier to reallocate cancelled appointments, clients can also be encouraged to actively cancel their dental appointments if they are unavoidably prevented from keeping them.

The SMS urgent emergency client system is suitable for larger emergency clinics where waiting times may extend to several hours. The invitation system operates in an emergency client situation where there are at least 10 people on the waiting list and the duration of the treatment sessions, varying from a few minutes to an hour, cannot be predicted in advance. If the waiting list is shorter, the person working in reception can estimate the approximate treatment time. Furthermore, if the treatment time is constant, the person in reception is similarly able to inform a client of the predicted time.

The urgent emergency client system has made clinic waiting rooms more enjoyable and peaceful. Previously, the clients concerned had to wait their turn in the waiting room, sometimes even for hours. Nowadays, they can move around freely and, having received an invitation, they have an hour in which to arrive at the emergency clinic. For the staff, this has eased clientele management at the clinic.

### **Client Feedback on SMS-Based Appointment Reservation**

Clients of the dental clinics were asked for feedback on the use of the SMS appointment reservation and urgent emergencies. This was collected through a form they could fill in when waiting for their dentist time.

In the new enrollment procedure a client can communicate the need for treatment both on the phone and on the spot at the clinic. In fact, we asked clients to express their views as to whether they would rather report directly to the emergency clinic or enroll by phone. According to the results, clients do consider phone enrollment a desirable way to report for emergency dental care. However, the responses can be divided into two groups: those who have used the SMS invitation service and those who have not. As a general rule, those who have used the SMS invitation system think phone enrollment for dental treatment is more flexible than reporting directly to the emergency clinic (80% agree, 20% disagree, 0% cannot say). Among the non-users, there are a lot that enroll by phone and also a considerable proportion that would rather report in person (69% agree, 28% disagree, 3% cannot say).

One objective of the urgent emergency client system is to free clients from having to wait in the clinic waiting room. The time within which the SMS invitation is sent can vary from 1-1.5 hours and depends on local distances and traffic conditions. According to the results, 93% of the clients mostly waited for a treatment time somewhere other than the dental clinic, and only 7% stayed to wait all the time in the waiting room. Of the clients who waited somewhere other than the clinic, 48% waited at home, 21% in the city, 16% at work, and 7% elsewhere. The results show how the mobile phone invitation gives clients the opportunity to wait for their treatment time in a place of their choosing.

SMS appointment reservation was found to be easy to use, and clients of all ages succeeded in making an appointment with no trouble. One of the respondents expressed it as follows: “The reservation succeeded easily.” The replies highlighted the fact that SMS appointment reservation was trouble-free, the system functioned rapidly, and its use was easy; 89% of the respondents considered the SMS reservation system easy to use.

All age groups were of the opinion that the quality of the client service was improved by SMS reservation. Users were in agreement that the utilization of SMS made the service more efficient (89%). Those clients using the SMS service experienced that it speeded up access to treatment. One interviewee replied: “I received the message in the morning, and at midday I got in.” The SMS reservation alone, however, does not have a substantial effect on shortening the waiting lists.

On the whole, the text message invitations – as a component of multichannel communication – are a necessary part of client service in present-day society. Clients who have used the service are unanimous on the subject (100% agree, 0% disagree). Non-users similarly consider the service necessary (73%), but among them are people who consider it unnecessary (14%) and those who expressed no view on the matter (13%).

According to the results, there are problems connected with SMS appointment reservation if it is only implemented as a text message service. The short messages do not give all clients sufficient information on how the appointment is to be reallocated in practice. During the pilot experiment it was possible for two or three clients to come to the clinic at the same time. They were in too much of a hurry to wait for confirmation of the appointment. The short messages do not tell the client enough about the operating principle of the reservation system as a whole, neither can they give the client sufficient guidance on how to proceed. For this reason, clients also need written instructions concerning the procedure for SMS appointment reservations. It is necessary for the SMS service to be supported by information provided at the dental clinics, in the local papers and on the Internet.

## **Results of SMS-Based Appointment Reservation**

The efficiency of the SMS service depends on the number of clients on the waiting list, how many cancelled appointments there are, and the number of unused appointment times due to drop-out.

The SMS service will produce calculated savings for the City Corporation when at least 50 cancelled appointments are reallocated through the service per month. This result is based on a calculation whereby the costs of cancelled appointment times (at 50 euro) are compared with the costs of maintaining the service and using the services of the teleoperator.

It is shown that the system currently saves the work of two dentist–dental-assistant pairs. This easily amounts to around 200,000 euro per year.

For the service provider, SMS reservation saves about 15-20 minutes of receptionists' working time per appointment reallocated. For the customer, the service itself is very easy and fast, and considerably shortens the often painful and irritating waiting time for dental services.

SMS reservation has enabled almost all appointments cancelled by adult clients to be reallocated within the same day, at 2-8 hours' notice. On the other hand, SMS reservation cannot do anything about unused appointment times where the client does not inform the staff of cancellation. Indeed, in order to improve cost efficiency in oral health care services particular attention should be given to unused appointment times and to ensuring that clients feel some responsibility for appointment times allocated by the public dental service.

A search of the databases of the dental clinic management of Lahti showed a significant difference in the proportion of dental appointments that were cancelled and those that were left unused, by adults (aged 18-80 years) and by school-age children and young people (aged 7-17 years). In the case of cancelled appointments, those for children and young people constituted 48% of the total. As to unused appointments, however, 78% of the total was for the younger age group. The results clearly showed that young people left appointments unused much more often than adults did.

When taking a transaction cost analysis view of the system, the major benefits of the system realize themselves in the category of "initiating the transaction" in the list by Casson. The system delivers no services to the last two phases of the list of post-transaction character. The phases of information cost, requirement analysis, and negotiating are in a marginal role. When customers get to the public health care, they know they get the standard service at the lowest possible price, and that there is little room for negotiation. The care requirements are usually of a very standard nature, but, on the other hand, the customer can be sure that if something more special is needed, the dentist will give

the best service possible; only in some special, pricey services (say more of a cosmetic nature) are the customers forced to turn to private services. In short, using the public dentist health care service has low transaction costs, the main costs just realizing in the scheduling. This system focuses on lowering transaction costs in this category.

The electronic communication effect by Malone et al. is very visible in our service. A lot more communication, leading to more efficiency, can be performed through automation. Efficiency is gained in two ways. First, the receptionist communication is made more efficient, saving his/her working time. The second, bigger efficiency benefit comes when the dentist working time can be used more efficiently. As we speak of the standard service with clearly the lowest prices, electronic brokerage effect is in a marginal role in this service. In the same way, the electronic integration effect is marginal in a private customer application.

### **Redesign of Waiting Lists Because of the New System**

Appointment reservation for dental clinics in Lahti, and in other Finnish municipalities, is governed by the national recommendations for access to treatment (Finnish Ministry of Social Welfare and Health, 2003). Assessment of access to treatment is based on the need for it and how urgent it is, according to the following categories: those in urgent need of oral health care, those awaiting treatment assessment and measures within three months, and those coming for basic examination and care of the mouth within six months.

The recommendations have resulted in a four-phase waiting list procedure:

(1) In the City of Lahti, urgent treatment is carried out in accordance with the recommendations. All urgent cases gain access to treatment the same day. The number of urgent treatment sessions in 2003 was 7,100, and in 2005 it had risen to 8,900.

(2) The waiting list proper begins when a client reserves a non-urgent appointment time. At the end of 2003 there were 4,690 clients on the non-urgent waiting list in Lahti; at the end of 2005 there were 2,400. In this case, according to the recommendations, a treatment assessment ought to be made within three months.

(3) The third list comprises those clients who visit a dentist or a dental assistant for a check-up and for whom the need for treatment or further treatment is confirmed. In Lahti, some of the assessments of treatment need are made by an oral hygiene specialist or by dental assistants. In 2005 there were a total of 79,900 dental clinic sessions. Of these, 54,700 were visits to a dentist, 18,500 to an oral hygiene specialist, and 6,600 to a dental assistant. The treatment sessions provided by oral hygiene specialists and dental assistants have substantially reduced the number of clients on the waiting list.

(4) The fourth phase of waiting list management concerns those clients who have to wait for their treatment on dental grounds and/or whose treatment has been phased into several visits. According to the recommendations, the treatment ought to be started within six months at the latest. In Lahti, the longest waiting time was 16 months in 2003. By the end of 2005 the waiting time had shortened to seven months, and by mid-2006 to less than six months.

### **Conclusions**

The providers of health care services are beginning to take advantage of the opportunities provided by modern communication technologies. The most promising technologies are those of the Internet and mobile computing, within which SMS messages provide an interesting niche. The literature documents that in general the acceptance of these new means of communication is good.

Scheduling for dental appointments is a typical transaction and can be analyzed in transaction cost economizing terms. As we turn communication into SMS messages, we change the means of communication. This new media brings many savings in transaction costs as such and partly through the business process redesign it makes possible.

Our empirical part shows that most of the positive effects to be expected from electronic communication really materialize in practice. This is also confirmed by the positive feedback from users and customers.

Issues related to our research questions have been tackled all through the article, but here we briefly return to them and summarize our findings in light of the research questions.

*“How can SMS technology lower transaction costs in health care appointment scheduling?”*

SMS technology lowered transaction costs in our case, especially those transaction costs related to information search, negotiation, and initiating the transaction. The electronic platform also provides an excellent basis for monitoring the appointment scheduling transaction.

*“Is the SMS-based system for dental care appointment reservation in Lahti effective and is it eliminating transaction costs for the parties involved?”*

The SMS-based reservation system has enabled almost all appointments cancelled by adult clients to be reallocated within the same day, at 2-8 hours' notice. The replies highlighted the fact that SMS appointment reservation was trouble-free, the system functioned rapidly, and its use was easy; 89% of the respondents considered that SMS reservation was easy to use. All age groups were of the opinion that the quality of service was improved by SMS reservation. For the staff members and the organization, the benefits in saved working time are even bigger: now a cancelled time can usually be filled with just a few keystrokes, whereas before, each arrangement took at least 15 minutes with phone calls and manual data input.

In our case the SMS system has also brought many benefits. Its potential is still far from being exhausted. Further work on implementing the system more effectively in this environment is needed, as well as efforts to take similar systems into use in different application areas. Actually, that process is already happening in Lahti. In November 2004 the system presented here received a national prize for best practices in the information society, in the area of health care applications, presented by the Finnish Prime Minister Matti Vanhanen.

The big issue for the whole system, and even for the whole of the Finnish health care system, is whether systems like this can be taken into use in different health care services. Based on the system platform, new applications are already in the development pipeline, some already in test use. It remains a task both for the practice as well as for academic research to show whether or not the concept can be adapted to new areas.

Until now, our research in the system has been in a secondary role in the work around the system. The main issue has been getting the system up and running, and, just on some critical points, some

background viewpoints and recommendations from academic discussion and theory have been collected and used in the project. The system deserves a thorough study, in which, for example, more insight should be gained from the financial and customer service viewpoints. In addition, how the system has been developed under tight political decision maker control should be a source of much insight.



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