

# GPS for Demented, an Analysis of Success Criteria and of Health and Care Workers' Attitudes to Using Tracking Technology

Beate Thorsen<sup>a</sup>, Geir S. Nilsen<sup>b</sup>, Carl Erik Moe<sup>c</sup>

<sup>a</sup>Lørenskog municipality, Norway

<sup>b</sup>Kristiansand municipality, Norway

<sup>c</sup>University of Agder, Norway

## Abstract

*The demographical development in Norway will lead to a huge increase in the number of elderly by the year of 2050. There will be fewer employees per person in need of care, and this will be a challenge for the health care sector if services are to be kept at the current standard. New technology may help to alleviate this problem. Consequently we carried out a qualitative study focusing on the use of GPS technology as a wander management system in five municipalities in Norway. The data were analyzed with Leavitts diamond and The DeLone & McLean Model of IS Success [1] as reference models. The informants found the GPS's easy to use. Health workers were able to locate patients equipped with a GPS and the technology was sufficiently accurate to map patients outdoors. Health care workers and relatives experienced increased safety and freedom of movement for all patients. However there were challenges with battery capacity, organization of the services and in securing that the GPS was carried with the patient. Furthermore, the respondents claimed that large scale deployment will require organizational changes, to enable employees to manage the technology.*

## Key words:

Health care workers, GPS, wander management systems, demented, tracking technology

## 1. Introduction

The media regularly report on demented not finding their way home and consequently efforts to locate them [3-6]. Most incidents end well, with the missing person being found. However there are also some incidents that end tragically [7-9]. In Denmark 4-5 demented disappear from their homes every day, and on a yearly basis 10-15 persons die because they do not find their way home [10].

At home, relatives take care that demented do not wander off alone. However when they are not capable of doing this anymore, the municipality will have to assist with nursing homes, where doors may be locked [11]. Alarms and wander management systems may contribute to more independence from relatives and health and care workers, and to maintaining freedom of movement [12].

The current demographic development will incur great socioeconomic challenges. There will be a vast increase in the amount of elderly, and relatively fewer employees left to take

care of the elderly [13]. Norway will need three times as many employees in 2050, if we do the same tasks with the same quality and in the same ways as today.

Technological appliances may contribute to addressing this challenge. A Danish project showed how use of GPS technology may resources to be allocated differently. The technology allowed demented to remain in average 6 months longer in their own homes, and the municipality of Kolding could save the equivalent of 12 man-years [14].

There are several issues that need to be taken into account when implementing GPS technology as a wander management system for demented. Health- and care workers are expected to play a pivotal role in its success. In this study, experiences of health care workers and relatives of demented in municipalities that have implemented the technology, were investigated to answer the research question: "What technological and organizational issues are important for health care workers to succeed in implementing GPS based wander management systems for demented?".

## 2. Background

The proportion of people suffering from dementia increases rapidly with age. In the age group 65-69 only 0.9 % is demented, whereas in the age group of 80-84 the proportion is 17.6 %. Among the above 90, as many as 40.7 % have developed a dementia. The number of people above 80 years of age is expected to increase considerably in the Nordic countries in the coming decades, and consequently, a huge increase in the number of demented is expected.

Dementia is caused by a brain disease. The disease affects cognitive functions such as memory, navigation, comprehension, calculations, learning, language and judgement. The loss of memory usually affects registration of new information, but old well known information may also be lost, especially in the later stages [15, 16]. Daily tasks do become more difficult and as time goes by, impossible.

Dementia usually occurs in combination with other diseases and general loss of functions. Sufferers require many different services, and huge resource expenditure from the health services. One common phenomena is wandering, without a clear goal or purpose, more than 60 % of demented develop this behavior [17]. Physical activity may delay development of the disease [18-20].

Wander management systems use GPS technology to track and locate demented. GPS (Global Positioning System) is the most well-known example of absolute positioning, which with

the help of satellites the show longitude and latitude with an accuracy of +/- 10 meter [21]. It is common to use equipment with both GPS and GSM (Global System for Mobile Communications) [22-25]. GPS does not work well indoors, nor in congested areas with tall buildings and narrow streets [21]. Since GPS is the most accessible system for Norwegian users, we will be using the terms wander management systems and GPS interchangeably in this paper.

Users need to carry with them a GPS unit, which enables tracking the user's position via satellite. Care providers or relatives need access to a computer or a cell phone with Internet connection to track patients who may be missing. The GPS tracker can track in real time, or zones can be specified to trigger an alarm if the demented moves outside the zone.

During the last few years a lot of projects have been testing use of tracking technology for demented. GPS works in general well enough, but the tracking units are encountered as big and clumsy, and the battery capacity is not good enough [23, 25, 26]. These findings are somewhat dated, and the technology is constantly developing [27], however low battery capacity [18] and size still remains a problem [25, 27]. Care providers have stressed the importance of units being light and small, at the same time as being comfortable to carry and use [28].

There are several challenges related to implementing wander management systems. Difficulty in training personnel, making sure staff that are able to handle the equipment are on duty, and general lack of basic IT skills among the employees may all pose problems for implementation [29]. Both care providers and relatives are positive to use of GPS units, as long as this is done within acceptable limits [21, 28-32]. Relatives and care providers have in general a positive attitude to use of tracking technology to manage wandering of demented [25, 31]. Relatives are concerned about their family members freedom and possibilities to move around unrestricted, whereas health workers are concerned about the legal ramifications if a user gets injured while wandering on his/her own [27]. However a study carried out by the Norwegian Association of Local and Regional Authorities (KS), showed that health and care workers were concerned that patients might not be able to find their way back home (Holbø et al., 2009) but at the same time, they had ethical concerns with monitoring.

There is limited research on implementations of tracking technology in the health sector; hence we have chosen to see if there is research on implementation of other technologies in this sector which may have implications for our research question. Gagnon et.al [33] recommends active involvement of users in all stages of implementations. The feeling of ownership this creates will contribute to the perceived ease of use and usability. Sufficient training does contribute to the perceived usability and reduces opposition to the system. In implementation of telemedicine there are some very important factors that can affect the process. If health personnel views the technology as useful and as having possibilities for tailoring to the specific group of patients, the implementation will most likely be easier. On the other hand low perceived usefulness, limited possibilities for tailoring to the patient and technical worries will be a barrier for implementation [33].

Based on studies of implementation of electronic patient journal, Ludwick and Doucette [34] point to involvement of top management as important for implementation of new technology.

Experience from a project with 180 users of GPS in Denmark, showed that it was more difficult to implement new technology in large municipalities, both due to the many levels of administrations and a longer decision process. It is harder to reach all parts of the organization and engage everybody. They recommend introducing technology in a limited area in large municipalities to make sure it runs smoothly, before disseminate lessons learned to other parts of a municipality [14]. The biggest challenge is, according to Ausen et al. [18], to establish and maintain routines for use, implementation and maintenance of GPS units as an integrated part of the health- and care services. In order to succeed with GPS technology, it is important that the employees feel ownership, and see the need for the target group [18].

Use of tracking technology does raise issues related to ethics and protection of the individual, especially when used for the most vulnerable groups [12]. Monitoring may contribute to protect a person with dementia, or to being able to move with less restriction. Use of tracking technology opens up for faster reaction if the demented can't find his or her way. But it may also open up for monitoring, control and registration of data which may be perceived as humiliating. Due to this, ethical reflections are important for health- and care providers with responsibility for managing the technology. They have to decide whether it does benefit the patient, whether their involvement has been taken care of and how they perceive using it. Ethical considerations should focus on the feeling of safety for the relatives of the patients and the employees, and for sense of freedom of movement and needs for activity for the patients, their quality of life. In Norway tracking technology is not allowed if the patient resists. For persons with dementia consent in legal terms is not possible if they do not understand what consent implies.

### **3. Methods and framework for analyses**

In the following we will discuss the research method applied in our research. We will also report on our choice of informants, on how the study has been carried out and how the findings have been analyzed. We will further reflect on the reliability and validity, or to use another term, the trustworthiness of the results.

We have used DeLone and McLean's model of IS success [1] to understand what health- and care workers view as success criteria for implementation of tracking technology for demented. In addition we have used Leavitts diamond [35] to help in understanding how technology in interaction with structure, organization and tasks can affect a successful change process.

### 3.1 Research design

Since there is rather limited research on use of tracking technology for demented we need a better understanding of the whole topic area and of instances where health and care providers manage the technology. Qualitative methods are well suited for a deeper understanding of issues related to a limited group of respondents. We collected data through interviewing 11 health- and care workers from 5 different municipalities in Norway. The interviews lasted from 30 to 90 minutes. They all had experience with using GPS units for demented. Since the goal with the research was increased understanding of what technological and organizational issues health- and care workers regard as important for success of implementation of GPS units for demented, it was important to get their perspective.

We initiated the study by contacting the employee in charge of use of tracking technology in the different municipalities. We asked them to recommend employees for interviews that had worked with implementation of the technology and had used it for persons with dementia. There is of course a risk that the employees in charge deliberately selected respondents who were positive to use of tracking technology. But, due to the limited use of GPS it was difficult to set further selection criteria. Prior to the interviews we sent everybody a letter of information and a letter of consent for signing.

### 3.2 Collection of data

Through interviewing employees we learnt about their experiences, and about their attitudes and expectations to use of GPS for demented. The interviews were designed to be flexible and offered the opportunity for follow-up questions and clarifications. However interviews are time-consuming and hence there were strong limitations in the number of respondents.

The interviews were all semi-structured. Prior to the interviews, the informants were sent a letter with information on the topic for the interview, so they could be prepared. This way we made sure the informants all got the same questions, and that we covered the same issues. They were also told that the results would be treated as confidential, and they all agreed to the interviews being taped.

Objectivity in qualitative research means letting the interviewees talk without researchers influencing them in any way [36]. To achieve this we carried out all the interviews in their own work-place, except for one telephone interview. For all the interviews there were two researchers, to make sure they were carried out the same way. Prior to the interviews we carried out two trial interviews.

### 3.3 Data analyses

In qualitative research the presentation and interpretation of results is done in one consecutive phase. This is challenging and requires a lot of work, especially because the data is unstructured and diverse. All our interviews were transcribed, and we have tried to preserve as much as possible of what happened in the interviews. Two of the researchers transcribed half the interviews separately, and systematized the material with the interview guide in mind, to see if our interpretation of

the interviews were the same. We split the interview texts in smaller and smaller units, to grasp the different parts of what the interviewees had said. The small units were interpreted and then summarized. We based this work on Giorgi's phenomenological analyses [37]. This work was again carried out by two of the researchers before comparing the results and where there were differences, we worked towards a shared understanding of the material.

### 3.4 Trustworthiness

Reliability is dependent on what data is used, how they are collected and analyzed. It has to do with whether other researchers can reproduce the results. In qualitative research however, this is not really possible since the researcher is used as an instrument in the data collection and analyzes [38], hence we rather use the term trustworthiness to

We have used conversation in our data collection, and for this reason we describe the research process in detail to increase the trustworthiness of our results. By having two researchers coding the data independently the reliability is increased, and by collecting data from 5 different municipalities, of different size, our findings should be applicable to other implementation of tracking technology in other settings.

### 3.5 Models for analyses

Organizations can be viewed as complex systems where particular four variables affect each other. The four variables are tasks, structure, technology and organization. Structure, functions, organization and technology exist in mutual interaction [35]. Leavitt diamond is primarily a model for organizational change. Introduction of new technology will affect the employees, their duties and the structure of organization.

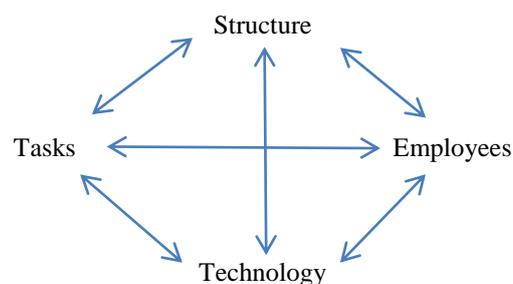


Figure 1. Leavitts diamond, which shows that changes in technology will affect tasks, but also the employees and the structure of an organization [35].

We have to have a system view on organizations to effect changes. If tasks are changed or new tasks added, it is important to see the connection with the existing tasks that the organization already carries out. According to Leavitt [35] *"most efforts to effect change, whether they begin with people, technology, structure, or tasks, soon must deal with the others"*.

We apply the IS Success Model [1] in our study of factors that are important for health and care workers to succeed in implementing tracking technology. The model is based on prior research on how to achieve success from information

systems. It has been tested and verified in a number of studies, and is shown below.

The model consists of six factors which together captures the concept of IS success. There are three dimensions of quality that affects use and user satisfaction. Information quality can be defined as properties of the information that the system delivers. The information must be understandable, complete, relevant, consistent, accurate and secure. Ease of use will also be an important factor.

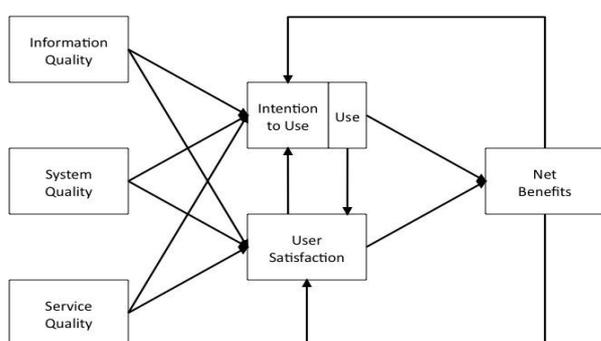


Figure 2. DeLone and MacLeans IS Success Model [1], which shows that information quality, system quality and service quality affects intention to use and user satisfaction of a system, and finally the success (or net benefits) of the system.

System Quality will be an important criterion for users to use the system. It means that the system is user friendly, accessible, reliable, flexible / agile and fast response time is important. System reliability is a factor that means a lot for system quality. If for example, GPS technology has a lot of downtime; it would be irresponsible to rely on when in use, while this in turn will affect the use of the technology.

Service quality is the quality of support that users receive from IT personnel. For example, response time, accuracy, reliability, technical expertise will be important factors in such a situation. If the system would have downtime, you are dependent on help, so that the system as quickly as possible is up and running again. The various dimensions of quality will affect the use and user satisfaction, and increased user satisfaction contributes to increased use. User satisfaction and usage are requirements for a net gain of a system[1].

## 4. Results

Before presenting our results, we briefly describe the cases the survey was made in. The table below describes what kind of GPS the 5 municipalities used, if they were in a test phase and if it is still used. It also shows whether there was support from the top management in the municipality for the use of GPS. Municipality 1 has tried out the GPS on three users, two of them had dementia and one was a wheelchair user. The project is now finished, and the municipality has two GPS systems available to use for people with dementia living at home or in nursing homes. Municipality 2 participated in a pilot project where they tried out the GPS on three demented people. The municipality will further test GPS on 20-30 people with dementia living at home. The management wants to introduce

GPS in a large scale for dementia patients so they can live longer at home and have an active and meaningful life.

	Municipality 1	2	3	4	5
Number of inhabitants	6 <sup>6</sup>	100 <sup>6</sup>	15 <sup>6</sup>	170 <sup>6</sup>	25 <sup>6</sup>
Anchored in management	No	Yes	No	Yes	Yes
Test phase	No	Yes	No	Yes	Yes
In use	Yes, for one user	Yes, and increasing	Yes, on one user	Yes, and increasing	Yes, for three users
Still want to use GPS	Yes	Yes	Yes	Yes	Yes
Type of GPS	Safe-tracker	Safe-tracker	Safe-tracker	Safe-tracker	Careto

Table 1. Description of the municipalities involved.

Municipality 3 has completed a project at a nursing home, where they tried GPS for tracking people with dementia. They have used GPS for over three years, and they describe their experiences as positive. Municipality 4 participated in a research project where they tried to use GPS on people with dementia. Their experience is based on using GPS on two people with dementia. The municipality is still running a project and plans to expand the use to 20-30 people with dementia. The management is initiating the use of GPS, and they regard it as necessary to meet the challenges of the future.

Municipality 5 is participating in a pilot project on tracking people with dementia. They participate because they want to collaborate with the university in testing tracking technology. GPS is tested on three people, two of them are living at home and one user is in institution.

### Information Quality

For accurate information staff must rely on the technology and they can manage to find the person if the GPS is accurate. The staff in this survey had no trouble finding people with dementia using the map function. This indicates that the information was easy to understand, regardless of whether they used a PC or a smartphone. The staff said it worked regardless of whether patients were in the terrain or in a city. All respondents told us that the computer program worked satisfactory. This is consistent with previous findings, the detection of dementia is described as accurate and they were able to locate them fast [22, 24, 29]. When the map didn't work satisfactorily the respondents experience was that the missing person was inside a house or in a building.

### System Quality

The informants pointed out various challenges in terms of using tracking technology. A major challenge is the battery capacity. The battery lasts up to 72 hours, but when it's in active use it must be recharged daily. Searching when a person has disappeared necessitates a charged battery. Ausen et.al [18] and Dale [29] also points out that the battery capacity should be improved.

We know from previous research that technical concerns may be a barrier to implementation of technology[33]. Although it

appears from our results that the battery capacity can be a challenge, the informants didn't see it as a barrier for use. They said good procedures for recharging the battery is sufficient for relying in the technology.

All our informants report an impractical size of the device. They find it difficult to secure fastening of the device to the person with dementia. They have challenges in ensuring that the user actually brings along the GPS. Without the tracking technology, health and care providers are unable to perform a search if a patient disappears. This finding is consistent with previous results [22-27].

Our study also show there is a need for smaller units to trace. Development of small GPS device designed for people with dementia is important in order to extend the use to a greater extent. Another possibility is to use the devices today, but knowing the user's behavior patterns so well that one is able to ensure that the GPS is brought along with the demented when he / she goes. The approach is however much more difficult for employees, and may not be realistic if there are many users of GPS. One other important criterion for GPS units is robustness. They should be used outdoors under all weather conditions.

In spite of the experienced challenges the system was perceived as easy to use by as many as 9 of our 11 informants. Those who found it more difficult were using the more advanced features of the GPS. One of the reasons why the respondents thought it was easy to use is that most of them only used the simple features of the GPS.

Three of the respondents tested other features in the GPS. They used geofencing, where the carrier of the tracking device can move freely within a given area. Once the user moves outside the predefined area, the staff is notified through an SMS alert on their smartphone. This turned out to be difficult, and they received several error messages. But with help from the providers they solved the problem, so the system worked as intended. However, one municipality had inadequate follow-up from the supplier, and they stopped using geofencing. Cooperation with the supplier seems important for use of the more advanced functions.

### Service Quality

There were differences in experiences both between and within municipalities in relation to cooperation with the supplier. One health worker stated that there had not been any need for cooperation with the supplier, while another felt that there was a big need, and that the cooperation wasn't good enough. Different roles and positions within the municipality were probably one of the main reasons for that. According to Holbø et.al [21] one should not underestimate the need for education when introducing new information technology, ICT projects have stranded due to inadequate education. One municipality felt that the education was a bit limited, but they said the use of GPS was very simple. There was support from the company when they connected, and it was also supported by an electrical company that promotes this product.

We may anticipate that the need for closer cooperation with the supplier will increase, if we use GPS units on a larger scale. Possibly those who are good on computers and can master the technology have been assigned the responsibility

when only a few employees are involved. When the numbers of GPS increase and more employees get involved, the need for training will increase drastically. Already today some employees say they get too little training.

Use and user satisfaction are closely related. And as mentioned previously, health and care providers want to use GPS on demented. This is reflected in terms of satisfaction with the system, which in turn will have an impact on net benefits. The fact that employees and their families see the benefits of use of GPS on demented is important. This contributes to achieving the goals such as increased activity, and helps demented in living longer at home before entering nursing homes. Technology helps in making health workers, relatives and users feel safe. Health and care providers do also experience respect for the individual user's integrity. Table 1 below gives a summary of the most important technological issues:

Battery capacity
Bulky / low aesthetic
The GPS function is not good enough indoors
Good mapping, easy to find a person with dementia
Ensure that the GPS is carried with the person

Table 2: Technological issues affecting implementation of tracking technology

### Leavitt's diamond

An attempt to change one part of the organization through introducing GPS, will lead to changes in other parts of the organization [35]. If one fails in implementation in terms of one or more components in Leavitt diamond, the result may be lack of use the GPS and hence less benefits. We found in this study that grounding in management can be important when implementing new technology. Five of eleven respondents said that the use of GPS was not rooted in the administrative management and in these municipalities there are no preliminary plans to increase the use of this technology. Six of the respondents said that in their municipality the decision to use GPS is rooted in the leadership, and these municipalities have further plans use GPS on larger scale. Eight of the eleven respondents believe that it is important for a successful implementation that use is rooted in the management. This is consistent with previous findings [39], they point out that involvement of management is an important factor in implementation of new technology. Our results indicate that without support from top management, a greater prevalence of GPS is not possible. The table below shows some important organizational issues:

Involvement of employees early in the process of using GPS
The technology should be rooted in organization
Training of personnel and procedures
Organization of tasks such as how to handle alarms from the GPS
Competence use of personnel

Table 3: Organizational issues affecting implementation

## Conclusions

Municipalities have to innovate to meet the challenges that come with an increasing number of people with dementia. We need to work in different ways to meet the needs of this rapidly growing group. We will not be able to provide everybody in need with nursing homes and will be forced to look for other solutions. GPS technology alone will not solve this challenge, but it can be a help for health and care providers and for relatives, and the demented may be able to live at home longer. There is little knowledge about the use of tracking technology among health professionals today and there are obstacles in the legislation that must be resolved before one can start with using GPS on a bigger scale. We have used a qualitative approach and our findings are therefore not possible to generalize. But even with such a small sample, we believe our findings to some extent may be possible to transfer and give value for other municipalities starting similar projects.

Our findings confirm previous research, but also show an increased interest in using this technology. Tracking technology may help healthcare professional, their families and the demented, and increase their safety. Increased freedom for the ones with dementia does also contribute to the intention to use this technology.

Our analysis is conducted on the basis of the theoretical framework. We can see that information quality is good enough for health professionals and they should be able to use the technology. They can easily use the map function to find the demented. System quality is also demonstrated as good enough, they find best practices to ensure that the battery at any time is charged, and the demented brings along the GPS when he or she goes out. System Quality is not shown as a barrier for the technology to be used.

Service quality is also regarded as good enough, but it appears that the ideal would be to have local suppliers who are available to health professionals when needed for support. Support of senior management also emerges as a key success criterion for a successful implementation of new technology on a large scale.

There were both positive experiences and challenges with use of GPS. The main challenge has been the battery life and how to ensure that the GPS unit is brought along when the person with dementia goes out. Through the interviews we found that only the most basic features of the GPS was used. The use of GPS was not rooted in the management in all municipalities. Municipalities where they lacked top management support, only has sporadic use of the technology, and there were no plans to increase the number of users with GPS.

Organization issues are also important for health personnel. Widespread use of GPS requires some type of monitoring center to receive alarms and tracks the person with dementia.

The technology must be adapted to the individual user by mapping of the individual movement patterns and habits. Examples here could be to attach the GPS to the keychain if this is something that a user has to adopt out on a trip. This is time consuming and requires detailed knowledge of user's daily patterns and habits.

Further research on health personnel's management of technology for demented is needed. We need quantitative research collecting experiences from health professionals who have used GPS units for some time, and where there are more users of technology with dementia. We also need to know more about the needs of the users. What do they need, how much battery capacity is "good enough" and how should the design be to ensure that the user brings the GPS with him? Further knowledge on these issues is important for acceptance from demented, to avoid some of the problems we are experiencing today.

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