Guidelines

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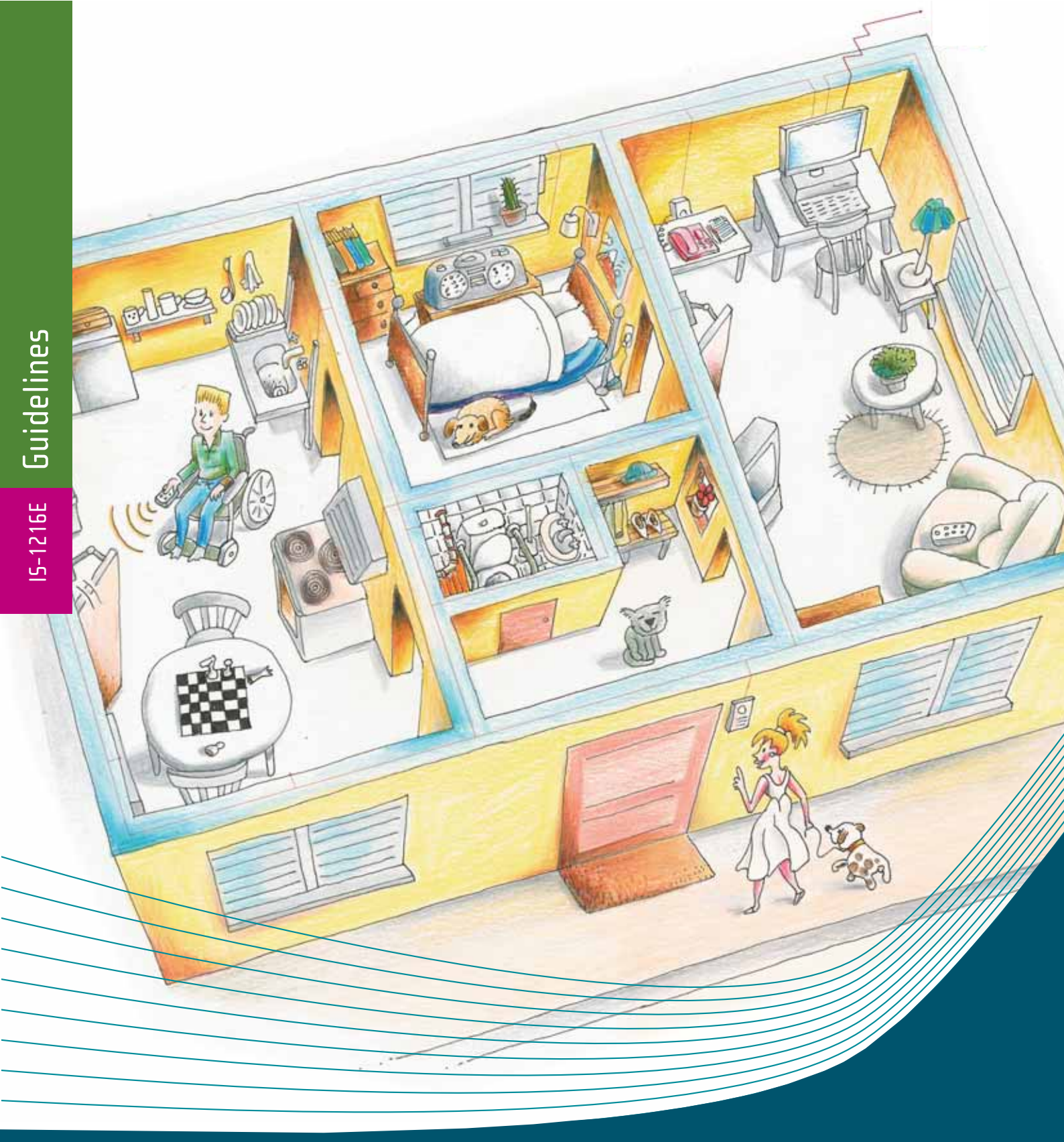

Smart Home Technology

Planning and management in municipal services

Sosial- og helsedirektoratet
Directorate for Health and Social Affairs
Delta Centre

SMART HOME TECHNOLOGY
Planning and management in municipal services

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Preface

Smart home technology as part of the municipal services was introduced in Norway almost 10 years ago. Several municipalities have made advantage of smart home technology in residential homes and nursing homes since the onset.

The Delta Centre has participated in several projects collecting the experiences on the use of smart home technology. Practise shows that smart home technology can be a valuable supplement to human assistance, when used in an ethically correct way. The projects also prove that the municipalities need guidance in the processes concerning choice of solutions and the practical use of smart home technology.

This guide provides an introduction to smart home technology and its use as part of the municipal services. The objective is to enable the reader to independently consider his needs and to participate in making specifications meeting these needs. Hence we aim at giving inputs to the practical work on planning, installing and managing smart home technology.

Some readers might miss more examples and more specific advise.
We have been reluctant to give this. One reason is that the technologies develop so quickly that today's advice soon will be outdated. Furthermore we know that no persons have exactly the same needs, and that similar technological solutions may be programmed in different ways to meet individual needs.

The buyer's challenge is therefore first and foremost to translate the user's needs in a clear specification of requirements. An important objective for the guide is to increase the ordering qualifications in these groups.

The target groups for this guide include all who participate in planning, installing and management of smart home technology for elderly and disabled people. This includes staff in technical departments, IT-departments, nursing and care departments, decision-making authorities on municipal level as well as users of smart home technology.

English edition
Oslo, July 2005

Toril Bergerud Buene
Director, the Delta Centre

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Introduction to the English edition

This guide is a translation of the Norwegian version, and for readers from other countries we will describe the context in which smart home techno-logy is used in Norway.

The Norwegian experiences started some 10 years ago, with the BESTA-project. As part of this project, smart home technology was installed in a home for 8 persons with senile dementia. The main aim of using the technology was to create increased safety for the residents.

For the last 10-15 years the focus has been on housing for elderly and disabled people in Norway. There has been a transfer of responsibility from governmental institutions to municipal home care services for an increasing number of user groups. This change is part of the welfare policy-related objectives of disabled people – young as well as old – to support their independent living. It is expected that technology will contribute to further these objectives.

The Norwegian State Housing Bank supported the building of residential homes through subsidies and propitious loans during the period 1998-2002. The houses are municipal property or organised as co-operative housing with the municipality having the right to allocate. Thus the houses are a part of the municipal housing services with the technology as an integrated part of the building.

The National Insurance Administration administer the system of assistive technology or technical aids in Norway. Disabled persons may apply for such support, which they might receive, free of charge, if the criteria for support are fulfilled. So far, smart home technology is not defined as assistive technology by the National Insurance Administration, whereas several devices that can be integrated in the smart home are. Examples are environmental control systems and some alarms.

The staff is organised in different ways. First and foremost, the residential homes are homes, not institutions. Basically, if you live in a residential home or in a separate flat or a detached house anywhere else, you are entitled the same services from the municipality. The home care services include health care, often supplied by nurses, and practical assistance with personal care and basic household work. The services are based on individual needs, and are allocated according to a formal decision.

The choice of technology and communication is dependent on several factors. One of them are the organising of the staff. In a residential home, there are at least three models of organising the staff:

- A permanent number of staff assist the residents, at all hours. The number is based on the formal decisions of all the residents. The staff have a staff-room in the building, and mobile phones or cordless telephones can be used for messages. This model is mostly used with residents with senile dementia or learning disabilities.
- The staff is permanent during day-time, and the residents are serviced by home care services in the municipality at night-time. This model seems to be used with residents more independent than in the above model. If cordless phones are used in the building during the day, it must be replaced with mobile phones at night.
- The residents are serviced by the ambulant home care services in the municipality at all hours. The staff will have no base in the building, and the alarms are transmitted via mobile phones only.

In a separate flat or a detached house, the third bullet-point describes the services. Smart home technology is to a very little extend installed in such singular dwellings, with the aim of supporting independent living. Environmental control systems, however, are widely used.

Because of the building of the residential homes, Norway ranks among the countries being most advanced in the use of smart home technology in municipal services.

In this guide we describe how smart home techno-logy can contribute to independent living. Furthermore we discuss possible gains for the municipalities, both concerning the quality of services and in economic terms.

To understand the potentials of technology, the elements are described, as are the relevant standards and what is used in Norway. Because of the on-going development in technology, the solutions described are those of current interest in 2005.

Ethical and legal concerns are closely connected to the use of smart home technology in municipal services. In the English edition the chapter is made short, as the Norwegian legislation is left out.

Financing and economy are two important topics regarding possible savings in excess costs. As the financing will vary in the different countries, the Norwegian model is not described in detail here. The economic aspects are highlighted through description of functionality made possible by smart home technology.

The users' needs form the basis in all planning, in the choice of technology, of structures and functions. There are several user groups of smart home technology, of different ages, life situations and technological competence. We illustrate which questions are relevant to ask, in order to achieve an optimal utilisation of technology. For this purpose two forms are enclosed, developed in one of the smart home projects.

The Norwegian experiences conclude that smart home technology is an useful supplement in facilitating independent living and in supporting the municipal services, when thorough planning is ensured.

The pages with adresses, contacts and references have not been translated.
Please contact the Delta Center for further information.

Smart Home projects

The Delta Centre has managed and participated in several projects in the field of smart home technology. Presented below are the three projects with the greatest impact on this guide.

A STUDY OF THE DISSEMINATION AND EXPERIENCES FROM SMART HOME TECHNOLOGY AS PART OF THE MUNICIPAL SERVICES

The Ministry of Social and Health Services asked for an overview of smart home technology as part of municipal services, and proposals for measures to be taken to increase the knowledge. The project was a co-operation between the Delta Centre and the National Centre for Telemedicine, with the Ministry of Social and Health Services as principal in 2001.

The survey was not on a national level, but it revealed several municipalities and research communities. Smart home technology was implemented in residential homes, and to some extent in nursing homes. No singular homes with smart home technology used for care and nursing purposes was revealed.

The project concluded that there is a need for additional knowledge in all fields of the municipalities; from those working close to the users to the allocating public authorities. The project revealed a great need for knowledge of possibilities and limitations in the technology, of the design of specification of requirements for individual users and the ethical and legal evaluations necessary as basic requirements.

INTRODUCTION OF SMART HOME TECHNOLOGY AS PART OF MUNICIPAL SERVICES

The aim of this project was to map the processes yielding optimal utilisation of smart home technology, to ensure as many users as possible having access to the technology most relevant for their needs. This project was also a

co-operation between the National Centre for Telemedicine and the Delta Centre. The employer was the Directorate for Social and Health Affairs, in 2003.

The experiences in four municipalities were studied in depth, and are a significant basis for this guide. The project concluded with three fields prominent in all four municipalities:

- Thorough planning and interdisciplinary organisation is decisive for the good utilisation of the technology. User participation and training played an important role in the successful use of the technology.
- The financing systems may contribute to a fragmented technological structure.
- The attitudes of the employees affect the use of technology. In some municipalities the employees were eager and enthusiastic, in others there were scepticism and reluctance to introduce smart home technology.

Factors facilitating and restraining the possibilities for implementation according to the original intentions of the municipalities are summed up in the project report.

SMART HOMES FOR YOUNG PEOPLE

The two projects above revealed smart home technology installed only in newly built residential homes and in nursing homes. In the project “Smart home for young people” the target group was young disabled people living in their own houses, neither in residential homes nor any other types of co-localised homes. The project assessed the installation of smart home technology in existing housing, and whether the financial aspects influence the choice of solutions. The project was run and financed by the Delta Centre in 2003-2004. The experience from the retrofitting is also a part of this guide.

The project carried out a smart home installation in the home of a disabled man. Several producers were invited to offer their products. The choice fell on the European Installation Bus, and Environmental Control Systems through infrared light. The disabled man applied for funding from the National Insurance, where he was granted the Environmental Control Systems, but not the infrastructure integrating the devices.

“Smart home for young people” is documented in the short film Smart Home[1].

[1] The film has English subtitles. A free copy may be ordered from the same address as this guideline.

Smart home technology yields flexibility

WHAT IS SMART HOME TECHNOLOGY?

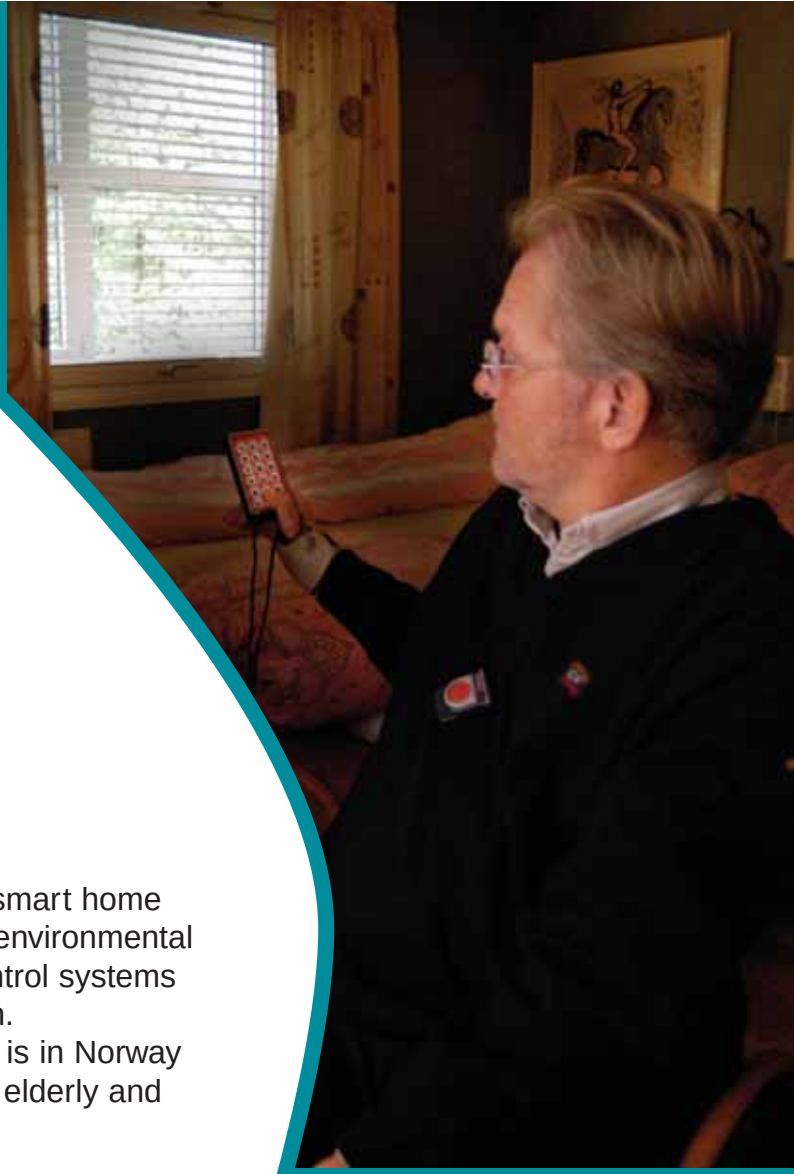
Smart home technology is a collective term for information- and communication technology (ICT) as used in houses, where the various components are communicating via a local network. The technology can be used to monitor, warn and carry out functions according to selected criteria. Smart home technology also makes the automatic communication with the surroundings possible, via the Internet, ordinary fixed telephones or mobile phones.

Smart home technology gives a totally different flexibility and functionality than does conventional installations and environmental control systems, because of the programming, the integration and the units reacting on messages submitted through the network. The illumination may for example be controlled automatically, or lamps can be lit as other things happens in the house.

Smart homes is the term for houses with smart home technology installed. Good physical access is a prerequisite for the optimal utilisation of the technology. The Norwegian State Housing Bank has developed requirements to accessibility as the basis for their funding of building projects. The requirements, called lifespan standards, represent a basic standard for physical accessibility.

CONVENTIONAL INSTALLATIONS

With conventional installations every action must be actively triggered. To turn the light on, a switch must be pushed. Every action on the television set requires the handle of the remote control. Conventional installations are still the most usual.



ENVIRONMENTAL CONTROL SYSTEMS

In this guide we make a division between smart home technology, conventional installations and environmental control systems, even if environmental control systems strictly speaking is conventional installation. Environmental control systems technology is in Norway often classified as assistive technology for elderly and disabled people.

Environmental control systems are most often operated by a remote control, often through one command from the user resulting in one response from the system. Environmental control systems can be used without attaching to smart home technology. If a network or a data bus is installed, the integration of the two systems should be considered.

Conventional installations and environmental control systems cannot monitor incidents in the house or effectuate automatic actions, as the integrated smart home technology can.

Smart home technology provides a totally different flexibility and functionality than conventional installations and environmental control systems.

Increased safety is of primary concern for the person living in a smart home.

Application

In Norway smart home technology is primarily used in residential homes and nursing homes where the technology was installed during the building process.

Residents may achieve:
- Increased safety
- Increased independence

Municipalities may achieve:
- Improved quality of services
- Improved working conditions for employees
- Financial benefits

SAFETY

Increased safety is of primary concern for the person living in a smart home, and often for the relatives and the employees too. The safety is based on the possibilities to register regular and irregular incidents in the house, as well as incidents not occurring. Such registrations can trigger off reminders or alarms.

Alarms are rarely or never bells or red lamps associated with alarms in the health and caring sector. Most often the alarms take the shape of a message to employees, for instance a SMS (short message sender), vibration or a telephone call.

Passive alarms may be triggered without the person having to take personal action. Passive alarms are used to avoid dangerous or harmful situations, and the use of such alarms must be carefully assessed ethically and legally.

Incidents like fire, a fall or unfortunate consequences of nightly wandering can be prevented. Sensors to register weight in the bed can activate the lighting of the route to the toilet, when the bed is left. The smart home can also register the time lapse before the person has returned to bed. If too long a time lapse might be connected with a dangerous situation, for instance a fall, an alarm can be triggered.

Sensors in the doors and windows register if these are open or shut. For example may the heating decrease when the door is opened during daytime, and an alarm can be triggered if the door is opened during the night. The last instance could be a sign of burglary or a resident on his way out. Ordinary burglar alarms can also be connected to the system, as can smoke detectors.

A “day/night” switch and a “home/away” switch are programmed so that, at the touch of one switch, the house is set in the desired state. At night potential fire-raisers, like coffee makers and television sets are disconnected and at day-time they are automatically re-connected. On leaving the house, the house is also set in the desired position. For a person who tends to forget important tasks, this may serve as a memory jogger.

Safety can include some negative aspects, especially if the border of surveillance is trespassed. For some people, in particular for the older part of the population, safety based on technology might seem frightening. The use of technology can be experienced as alien and cold, whilst the regular care from employees is experienced as “real” care. Other users happily use smart home technology exactly to limit the number of calls, and thus the number of persons visiting them. The main point is to emphasize the need of individual assessments and adaptations.

At night potential fire-raisers, like coffee makers and television sets, may be disconnected.

Independence

An important bonus regarding independence is the possibility to live in your own apartment, to govern your own life, and to lock your own door.

Several of the functions providing safety in the smart home, may also yield increased independence. An important bonus regarding independence is the possibility to live in your own apartment, to govern your own life, and to lock your own door. For some persons, for instance persons with senile dementia or learning difficulties, smart home technology can be an important prerequisite for independent living.

Independence increases when the resident can master several tasks, and determine the time and way it should be done. By integrating environmental control systems in smart home technology several actions can be automatically triggered, for instance the drawing of the blinds as the television is switched on in daylight.

Smart home technology may serve as a memory jogger and reduce worries about potentially dangerous situations. Technology can be a support both for physical and cognitive functions, for instance through integrating environmental control systems like opening and closing doors. Opening doors can be physically exerting and remembering to lock them might be mentally demanding. Saved personal energy can be invested in more meaningful activities.

QUALITY OF THE SERVICES AND THE WORKPLACES

Employees in residential homes with smart home technology claim that their work has become more calm and structured, and that the technology has made their planning of the day easier. Experiences show that this tranquillity also affects the residents. This was particularly emphasised by employees in residential homes for persons with senile dementia. The wireless receivers make alarm bells and monitors in the corridor or the staff room superfluous. Hence, the staff may concentrate on the care tasks.

Smart home technology can be a support for memory. A time switch increases security.

The introduction of new technology in a workplace can be a challenge. For some employees the smart home technology has yielded new and meaningful tasks, giving new perspectives to care and nursing occupations. Others emphasizse the frustration when the technology fails, and the feeling of being forced to deal with new tasks. Several employees emphasized the importance of good training in the systems.

FINANCIAL BENEFITS

Financial benefits from the use of smart home technology as part of municipal services have not been investigated to any large extent. First and foremost the technology is introduced as a support for the residents and the staff and not as a replacement for human resources. In describing how technology might contribute to increased safety and independence, it is tempting to estimate the number of man-labour years that might be saved. The use of technology can yield better exploration of staff resources.

None of the investigated municipalities had estimated possible additional costs followed by the installation of smart home technology versus conventional installations. The tenders had been made according to specifications of requirements related to one type of installation, making comparison impossible. In a possible comparison of costs, one must nevertheless compare two systems with very dissimilar functionality, making precise conclusions regarding costs and financial benefits difficult.

The majority of the municipalities had included central management of energy-control as a part of the smart home technology. Some of those responsible for this central management believe that there are potential economic benefits in energy economising and that both the municipality and the residents are winners. The municipality may control heating and electricity consumption in common areas and offices as can the residents in their apartments.

The debate on financial benefits includes a diversity of arguments. The municipality must decide on the quality of the municipal services, and it must consider quality against economy. In the investigated municipalities the decisions on standards were dominated by the different parties' arguments.

Movement sensor (above) activate lights or alarms. Humidity sensor (below) activates an alarm when wet.

Technology – structure and elements

In order to understand the potential of the technology, we will describe the different elements, which standards are relevant and what is applied in Norway.

In general the components are divided into:

- Sensors; monitoring and submitting messages in case of changes
- Actuators; performing a physical action
- Controllers; making choices based on pro grammed rules and occurrences
- Central unit; rendering possible programming of units in the system
- Networks; allow communication between the units and possibly to the surroundings
- Interface; the users communication with the system

SENSORS

Sensors monitor and measure activities in the surroundings. Examples are movement and heat sensors, humidity sensors, bed mats, thermometers and smoke detectors.

ACTUATORS

Actuators perform physical actions. Examples are door- window- and garage door openers, curtain- and awning engines, automatic light switches and relays. Several of the components of environmental control systems are actuators.

CONTROLLERS

Controllers make choices based on programmed rules and occurrences. Controllers are microprocessors often built-in with sensors and actuators. They receive and process values from the sensor or other controllers. For instance the controller of a thermometer can be programmed to submit a message to switch off the electric heating when the temperature exceeds 22 degrees. This message is received by the heating controller, which will start the actuator. If on a hot day the temperature exceeds 23 degrees, a message can be submitted to the window opener to open the window.

CENTRAL UNIT

All units in modern, decentralized bus systems have their own microprocessors (micro controller). Thus in principle no controlling central unit is necessary to manage the system after having programmed it. In practical terms however, a central unit it is useful for the re-programming, maintenance and changes in the system. Some units are delivered with their own central units, whilst others use a PC with additional software.

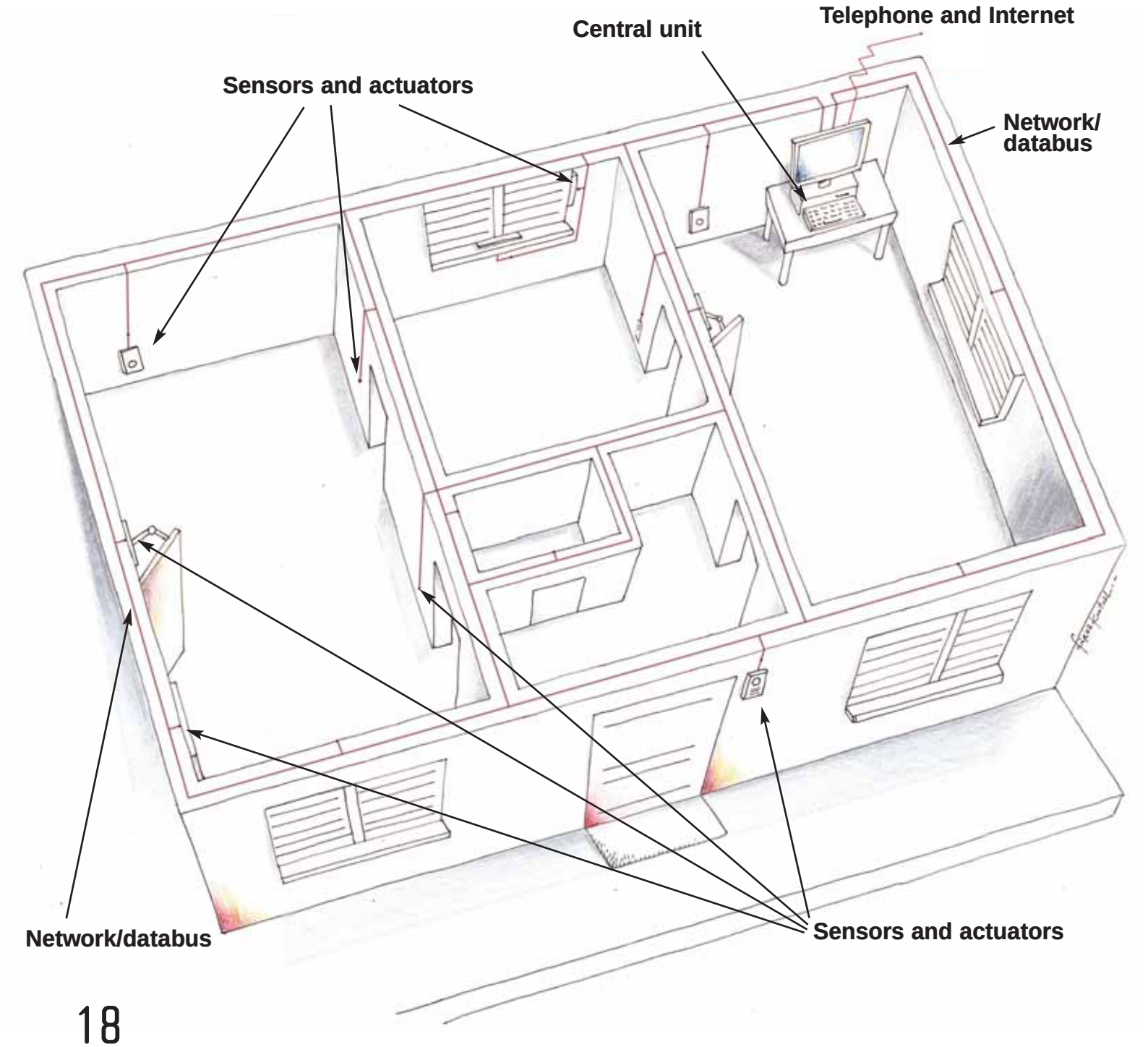
In residential homes the programming and re-programming of the system must be simple and intuitive. A good user interface, documentation of the system and training of the staff are important factors for the system to be used in an efficient way. Residential homes often have one or two “super users” responsible for the reprogramming of units, which is password protected programming.

In residential homes or institutions with a staff room, a PC will receive all the alarms. Such solutions can be combined with cordless telephones, for instance through using PCs during daytime and cordless telephones or cell phones during night time for the receiving of alarms.

NETWORK/DATA BUS

The network is the transmitter of the signals in the system. The most used transmitters are signal cable (twisted pair), strong current cable (power line), radio signals (RF) and to some extent lights (IR or optical fibres). All modern smart home systems has a bus-based network.

In a bus-based net all the units in the system may read all the messages. The messages include the address of the one or several units who are to



receive the message. The system unit or units recognising their own address react to the content of the message. A unit can receive a message individually or as member of a group. Hence, in one case a message can be submitted for one lamp to light, and in another case a message for all lamps to light.

Bus standards

The units in the system must “speak the same language” in order to interact. This implies the same standards regarding physical interfaces, cabling, contacts, electrical current levels and in the structure of messages to be interchanged. There are several standards both on the physical and the logical level.

Open or proprietary standards

Producers of smart home equipment must choose the standards their equipment are to follow. Some producers have made their own standards, where one or a few suppliers own the rights and are the sole suppliers of equipment for this standard. Such standards are called proprietary. By choosing such systems the customer might be dependent of the supplier for management, extensions and repairs of the system.

Other standards are developed through co-operation between the industry and interested parties within the framework of public standardisation bodies. These standards are accessible for all and are called open standards. Systems based on open standards provide the customers with greater freedom of choice in relation to suppliers, or in choosing another supplier or service company.

By choosing equipment with proprietary solutions, one must either relate to the sole supplier or “translate” between the standard used by the bus system and the signalling system of the equipment. This usually implies the installation of additional equipment to convert the signals. This might be cost increasing, imply loss of functionality and impede maintenance.

Systems based on open standards are the most beneficial, because one is in a better position to choose freely between equipment and service suppliers.

The most relevant standards are:

EIB (European Installation Bus) is an open standard widely used in Europe. All municipalities in our surveys used the EIB. EIB is available for powerline (EIB.PL), signal cable (twisted pair: EIB.TP) and radio (EIB.RF). EIB.TP is currently the most widely used in smart homes.

KNX is a new standard resulting from an amalgamation of three European bus standards, with EIB being one of them. KNX is expected to replace EIB in the near future. Today we refer to “EIB / KNX” as a common term.

LON (Local Operating Network) is a proprietary standard, used for energy-control, steering machinery and access control systems in industry and larger buildings. The standard is mostly known for powerline signalling, but also supports signal cables (twisted pair), coaxial cables, radio and fibre optical transmission.

X10 is a standard for powerline signalling, widely used for management of domestic electrical commodities, like lamps and radiators. It is also used in environmental control systems in single houses. The protocol has a small range of commands, limited to start and stop.

BACnet is a standard developed in the USA for the control of functions in larger buildings, but has so far not been observed in European smart homes. BACnet is supposed to easily communicate with the EIB.

Internet protocol (IP) is not used as a bus system, but is relevant for communicating in and out of local networks during re-programming and maintenance.

Networks based on the mentioned standards are able to communicate with other systems, but the functionality in the interconnected system will not be better than its weakest link. A standard called OPC (Open Connectivity) describes the interface for interaction between networks with different standards.

Mediums for transfer of signals

Medium	Advantages	Disadvantages
Signal cables (twisted pair)	High capacity. Few disturbances. Long range.	Expensive to draw cables in existing buildings. Visible cables may be perceived as not aesthetic.
230V cable net (powerline)	Utilises the cabling for 230V. May imply simple installation. Easy to move units between existing socket points.	Noise on the net must be filtered away yielding additional costs. May need “bridges” for signals between different phases on the 230V installation to ensure communication. Need for filters between apartments in the same building. Slow/low capacity.
Radio signals, range over a wide area; 100 – 300m when good visibility.	Little or no cable drawing. Easy to move units.	Walls and installations in the building reduce the range. This may be solved by repeating units, passing on the signals. Any batteries must be changed. Users with body-worn transmitter may be hard to localise.
Bluetooth; specific standard for radio transmission. Short range, up to 10m. There is a variant with a range of approx. 100m.	The advantage and disadvantage is the range, limited to the room in which the receiver is placed. Easy to localise the origin of the triggered alarm. Receivers have to be installed in all rooms where the system is to be used.	The advantage and disadvantage is the range, limited to the room in which the receiver is placed.
IR (infrared light)	As Bluetooth	As Bluetooth
Ultrasound	As IR/Bluetooth	As IR/Bluetooth

Capacity and net speed

Signals and messages to be transmitted in smart homes are normally short messages with relatively little information content. It is normally not critical if an alarm is received in 1/1000 second or 1/10-second, even if waiting periods between the user activating an occurrence and the occurrence being executed must be avoided. It is probable that all the mentioned protocols have good capacity for transmitting signals. Reservations must be taken for the powerline signalling, which should not be used for larger common installations. The reason is that signal cables, both optical and twisted pairs, have a higher capacity and are less sensible for disturbances than are powerline or radio transmission. Other transmission of data, such as speech, videophone or ordinary television signals will normally have separate cables.

Communication in and out of the house

Alarms and management/maintenance of the system are the two types of traffic most relevant for outward and inward communication in the house. Alarms are priority traffic and must get through immediately. It is important to be aware that the SMS protocol does not guarantee delivery of text messages within given time limits.

Other possibilities for outward communication from the house are fixed telephones and Internet based communication.

Management and maintenance tasks can be carried out by the central unit being connected to the Internet. In that way configuration, fault location and re-programming in principle may be carried out from anywhere.

INTERFACE

Standard units

The interface allowing the communication between the user and the smart home technology are often equivalent to mainstream installations, such as a light switch, a door lock or a cooker. The devices are utilized by the resident, when needed. However, one should be aware that the design and function might be unfamiliar, for instance if there is a “switch-on” and a “switch-off” for the lamps. Such designs may thus be a challenge to use.

A smart home can include several interfaces between the resident and the system. Examples are a medical alarm (a press-button to call for attention) or special buttons and remote controls for the managing of curtains and awnings. The units must be simple to understand and to use, and they must endure the use for which they are designed. Remote controls should for instance survive being dropped on the floor, impacts and vapour. In addition they should be of a good design, well fitting into the flat.

Staff are receiving the alarms and messages from the system, they check on the situation and then sign out the alarm. There are several possible solutions for the transmitting of alarms. The transmittances must be reliable, be simple to read and easy to sign out the messages.

Mobile phone

Several municipalities have chosen SMS messages for transmitting occurrences, in particular where the receiving person is ambulating. It is important to be aware that the SMS service does not guarantee that a message reaches the receiver within a given time, or reaches him at all. Many users of SMS have experienced this particularly on very busy days, for instance on New Year’s Eve.

The solution to this problem is to send a new message to another receiver if there is no response to the first one within a given time, and then to a third one, maybe back to the first again, until the message is signed out.

Another way of dealing with this is to carry out regular controls of important lines. Alarms in lifts are operating from such lines. Both fixed line connections and GSM can be checked in this manner, and it is possible to subscribe to such regular checks. Dependent on the type of subscription, lines may be checked anytime from once a day to several times a minute.

Routines for fault locations, and plans of action in case of faults is highly imperative, as faults will occur from time to time.

Cordless DECT telephones

Within a local digital telephone network, cordless telephones can be used to receive messages on the display, equivalent to SMS in the mobile network.

STANDARD INSTALLATION/BASIC PACKAGE

During the planning of residential homes and institutions, consideration must be taken on what standard infrastructure and standard equipment is to be installed in all apartments (basic package), and what might be activated and installed for individual residents. A thorough assessment must be done as to how the infrastructure should be for all apartments, to reduce the need for later installations.

Elements relevant to consider, include:

- Automatic lighting the in bedroom, hall and bathroom on leaving the bed
- Heat sensor above the cooker
- Humidity sensor in the bathroom
- Fire alarm, automatic lighting in escape corridor and unlocking of electrical door-locks, if installed
- Sensors in windows and doors

For persons with reduced cognitive capacity it might be relevant to install sensors (magnetic contacts) in windows and doors, which send messages if they are opened or closed. It can be relevant to have time control on the cooker and on coffee machines, as well as a humidity sensor in the bathroom. Another requirement could be for electric door openers on the main doors and a camera and a gate telephone at the main entrance.

It is important to aim at a common system for alarms to be received by the staff. Some places the staff must carry several portable units in order to receive alarms from different systems. As these units might have different ways of signing out of the alarms, it becomes a stressful and unpractical situation for the employees.

DURING THE BUILDING PROCESS OR LATER?

The ideal situation is to enter the planning process at an early stage when constructing new buildings. In particular where structured cabling is installed, i.e. cables drawn to fixed points in all units, it will be simpler, cheaper and neater to include this during the building. It is recommended to install at least one point for signal cables in each room, preferably in places where further cabling can be kept at a minimum.

The installation of windows and doors should be dimensioned for electric openers. Sometimes there is a need for power supply in “unusual places” like above the door case, in addition to the signal cable. The additional cost through drawing of cables for future planning, should be compared with costs and inconveniences arising from later installations.

Some of the advantages of installing smart home technology during the building process:

- Cheaper
- Part of a totality
- Savings also for parts of conventional installations
- The installation can be concealed

IN CASE OF POWER FAILURE

Normally one includes emergency power in all installations, even if this is not required. The emergency power unit, called UPS (Uninterrupted Power Supply), must serve both the central unit, transmission systems, lights and door openers long enough for the residents to communicate or to escape. As there are several ways to utilize emergency power, the choice must be made for each installation.

Ethics and law

The use of smart home technology as an integrated part of the municipal health and care services raise several ethical and legal questions. Smart home technology provides the possibility to save electronic traces from individuals and the technology may hence be used in infringing ways. To ensure legal protection and the integrity of the individual, thorough ethical assessments is imperative.

INFRINGING TECHNOLOGY?

The technology is here divided into different categories, according to the ethical difficulty. That is, to what degree technology is regarded as infringing or in conflict with the integrity of the individual. (The deviding is based on the Report to the Storting No 28 (1999-2000) Care 2000).

Smart home technology makes the use of passive alarms possible. This implies the triggering of an alarm as certain, predefined criteria are fulfilled, for instance a resident opening the door at a certain time.

Technology controlled by the user

Technology utilized by the user does only to a limited degree raise ethical questions. One example is a medical alarm, which is activated by the resident. Environmental control systems are another example on technology generally not raising ethical discussions.

Passive alarms

Smart home technology makes the use of passive alarms possible. Passive implies the triggering of an alarm as certain, predefined criteria are fulfilled, for instance a resident opening the door at a certain time. Such use of alarms require thorough ethical assessments, because the occupant is not necessarily aware of the alarm being triggered and the subsequent information being transmitted.

Passive alarms are often used in housings for residents with learning disabilities or senile dementia. Many of these persons have reduced abilities to consciously agree to such use of the technology, and this reinforces need of thorough ethical assessments.

The alarms can be selective, and may be activated and used in different ways. Among others, an electronic chip can be attached to the individual resident, activating an alarm as the person passes a sensor, for instance at the entrance door. With such a selective alarm, it will not be triggered as other persons pass the sensor.

Certain solutions are ethically less problematic, while others imply great restrictions of the resident's private life. With these kinds of alarms one can avoid dangerous situations, or call for assistance. The resident himself may not necessarily feel the need for assistance. The resident might not even view his own need for assistance in the same way as his relatives or the welfare services. It may, however be ethically unjustifiable not to use technology that yields greater safety.

Tracking systems

Technology allowing tracing a lost person is available, by equipping the person with an electronic chip. This type of technology are mostly used for persons being disoriented and having lapses of memory. This type of technology is regarded as less radical than the locking of exit doors and may, for certain people, be a good alternative to such locking. All the

same it is emphasised that tracking systems can be more radical than the use of alarm systems, because they can be used to trace a person continually. The use of tracking systems thus raises a series of ethical questions.

Monitoring systems

Monitoring systems transmitting sound and pictures of individuals are regarded as far more impeding on the resident's integrity than are alarms and tracking systems. Monitoring submit a large amount of personal information and the use of such systems should be avoided.

Solutions limiting individual freedom

Technology can be used to limit individual freedom. The locking of doors and similar measures implies a limitation of freedom and is, according to current legislation, in most cases illegal. An example of using technology is a selective door-locking system, as mentioned above. The ethical questions are linked to the locking of doors, not necessary to the use of tecnology. The most important aspect is the retention, not the technology.

NORWEGIAN LEGISLATION

Norwegian legislation requires a legal basis for the use of retention measures. There are two legal bases:

- Informed consent
- Statutory basis

Informed consent

Norwegian legislation is based on the principle that the individual decide whether or not assistive technology is what he or she wants, that is, a consent is required. For health services this follows the Patients' rights legislation in Norway. Other types of assistance follow non-legislative regulations.

Some persons can for various reasons not be able to give their consent. This include persons with senile dementia, learning disabilities, brain injuries and some times persons with mental diseases. Other residents, in particular elderly, can have difficulties in understanding and give an informed consent to the use of advanced technology.

Informed consent implies that the person receives sufficient information on the assistive technology concerned and that he understands enough to make his own decision. An informed consent implies not only information on the technology itself, but also of the implications of the use of the tecno-logy.

It should be considered whether the person is able to give an informed consent, and viewed in relation to how the technical solutions are to be

used. A trustee or supporting guardian may in certain cases give consent on behalf of the person. The Norwegian Health Personnel Act opens for the possibility that relatives in certain cases can give their consent. In practical terms it is a problem that many persons unable to make such decisions do not have trustees or supporting guardians.

If not possible to get an informed consent, a statutory basis is required for the use of radical technical solutions.

Uncertain statutory basis?

In many situations it will be unclear if authorisation is given to implement a radical measure. In these cases it is important to clarify the legality of the measure before it is eventually implemented. The municipality is respons-ible for the legality of the implemented measure.

Legal considerations always include an element of assessment or judge-ment. It is important to make a thorough account of the assessment that the proposed municipal initiative is based on, including the ethical aspects.

(The Norwegian version of this guideline includes more details on the Norwegian legislation. This is not translated to English, as the reader has to study the legislation in his country).

ETHICAL PRINCIPLES AND ASSESSMENTS

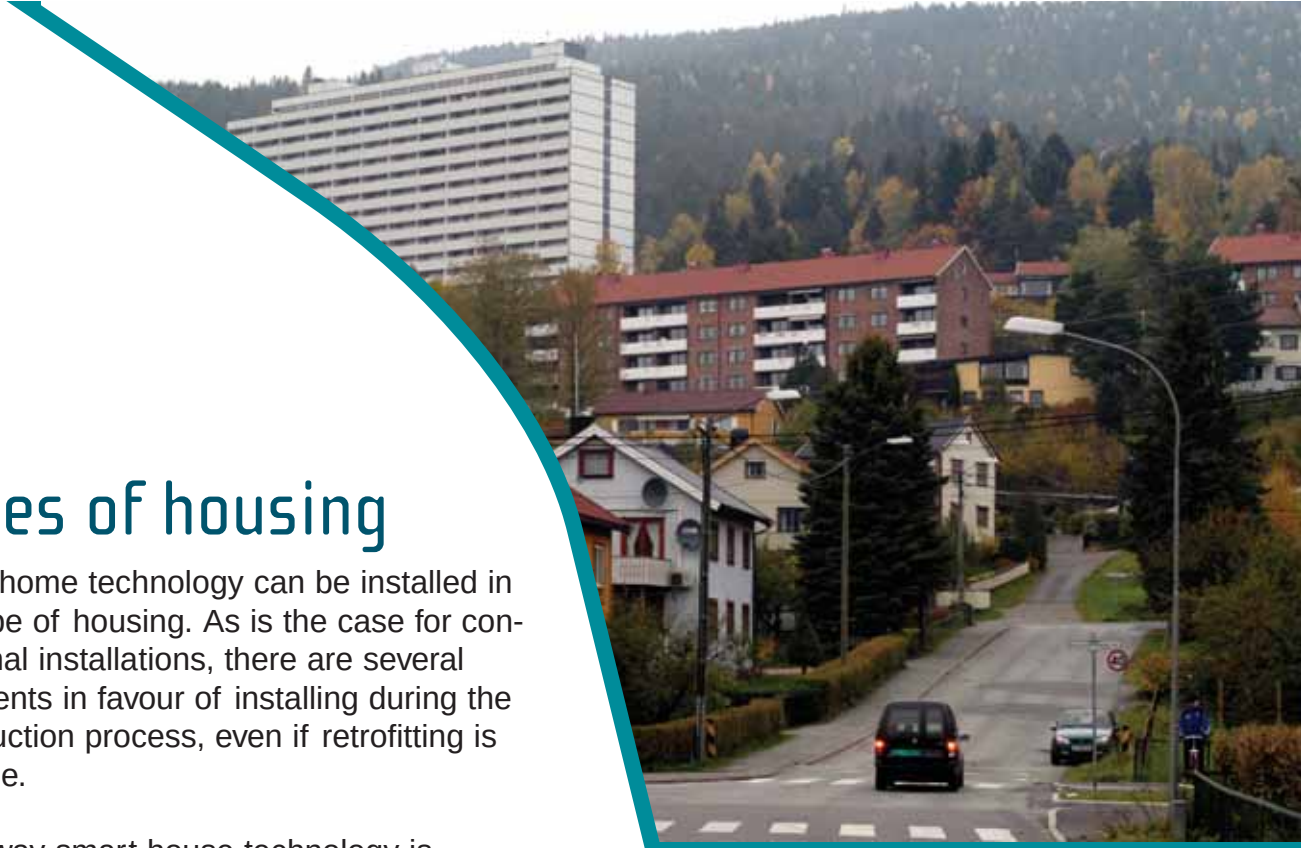
Regardless whether the chosen solution is regarded as radical or not, the use of technology must fulfil the needs of the individual, and not be a bad excuse for lack of human care.

Employees and decision makers must among others assess whether:

- Is it professionally and ethically proper to use the chosen technical solution?
- How much of an infringement does the technical solution imply on the person's private life, independence and personal freedom?
- Is the technical solution necessary in order to prevent or limit damage?
- What kind of damage is there a risk of?
- How probable is it that not using the technology will result in damage?
- Is the infringement resulting from the use of the technology proportional to the danger we want to avoid or reduce?
- How well suited is the technical solution to meet or avoid the dangerous situation?
- Are there any alternatives not implying infringement or less radical? For instance is it possible to alter the home help?

As a general principle the least radical alternative should always be chosen.

A heating monitor by the cooker sends a signal to disconnect the electricity in case of overheating.



Types of housing

Smart home technology can be installed in any type of housing. As is the case for conventional installations, there are several arguments in favour of installing during the construction process, even if retrofitting is possible.

In Norway smart house technology is installed as part of the municipal services during the construction of residential homes and in nursing homes. This guide is based on the experiences from housing, not institutions. The housing is among others called care homes, group homes and multi-occupied houses. We have chosen the term residential homes as a common term. The main point is that they are homes and not institutions. The municipalities often allocate the houses to persons in need of municipal domestic services.

In the private market housing smart home technology is more frequently offered to all kinds of buyers. These apartments often have a relatively high standard and are relatively expensive. An increasing number of apartments with a so-called “senior profile” are constructed privately, incorporating smart home technology. The target group is elderly people planning their old age. In addition providers and electricians inform that they more and more often are employed in installing smart home technology in private homes.

Smart home technology in private projects is used to increase security, comfort, energy economising and entertainment. The technology installed for such purposes should be utilised if the occupants at a later stage need alarms or environmental control systems because of normal ageing or disabilities.

The network installed in private housing should be utilised if the occupants at some stage need smart home technology because of ageing or disability.

Financing

As the financing will vary in the different countries, the Norwegian model is not described in detail here. In short, the smart home technology is financed as part of the building as it mainly is during the building of residential homes the technology is installed as part of the home services. The cost of the installations is covered by the rent, as is the rest of the construction cost.

THE NATIONAL INSURANCE ADMINISTRATION

The National Insurance Administration administer the system of assistive technology or technical aids in Norway. Disabled persons may apply for such support, which they might receive, free of charge, if the criteria for support are fulfilled. So far, smart home technology is not defined as assistive technology by the National Insurance Administration, whereas several devices that can be integrated in the smart home are. Examples are environmental control systems and some alarms.

The smart home technology is financed as part of the building.

The financing was tried out in the project “Smart home for young people” where a disabled man applied for support for the retrofitting of smart home technology in his flat, which was not in a residential home. He was granted the environmental control system, but not the network, hardware or software to integrate it all, in order to make the system “smart”.

FINANCIAL CHALLENGES

The challenges with the financing of smart home technology are connected to the splitting of expenses, ownership and responsibility in the building of residential homes. The government partially funds the building, the municipality is managing the building and the National Insurance Administration may contribute with assistive technology to individuals.

During the planning of residential homes it should be made clear who is financing what. Are the installations for all, and hence the responsibilities of the building owner, and are there any individual needs for assistive technology to be financed by the National Insurance Administration? Analyses of the assumed needs of most of the residents must form the basis of a standards installation on all the apartments.

The financial challenge in separate flats or detached houses is at present the fact that smart home technology is not classified as assistive technology.

Users

User requirements

The users' needs must be carefully assessed before planning any technological solutions. There are several groups of users of smart home technology as part of the municipal services:

- The residents
- Home care staff
- Technical services or management staff
- The municipality as an organisation and decision maker.

The needs of all these groups forms the basis of the planning. The needs are transformed into user requirements, which in turn form the basis for a specification of requirements.

THE RESIDENTS

In the case of private building of single-unit dwellings and of retrofitting in singular houses, the technological infrastructure can be planned for the individual or for the persons to live there.

Residential homes are normally projected before the flats are allocated to the residents, and the ideal of individual planning is not possible. The engineering phase is thus based on the assumed user require-

On assessing a person's needs for technology, the municipality is recommended to follow the same procedures and the same multidisciplinary approach as used for all types of assessments.

ments, and on the municipality's need for housing for different user groups.

In residential homes the standard installation has an effect upon the utilization of the technology for the individual resident. With a well-planned basic package adaptation to new residents is made easy with few and simple measures. Adaptations can furthermore be made easy with the change of the residents' function. Ageing and illness can result in increased need of technological solutions. The need might be transitory or permanent. In assessing the residents' needs, one should be aware that some residents will not need any smart home functions at all.

On assessing the individual needs for technology, the municipalities are recommended to follow the same procedures and the same multidisciplinary approach as used for all types of assessments. The user requirements must be developed in co-operation with the residents, sometimes also with their relatives. The development of user requirements is a dynamic process where assessment and need for adaptation must be continuously evaluated.

The user's needs and wishes for activity throughout the day forms the basis for the development of user requirements. The form "Smart home technology, description of user function" provides a quick overview. The form is based on bodily functions as defined in the "International Classification of Function, Disability and Health", ICF.

The level of function forms the basis for further assessments, directly connected to technological solutions. Assessment of the persons abilities, linked to the issues of activity and participation in the ICF, is required.

The form "Smart home technology, description of user needs" is made for describing how activities of daily living can be supported or carried out with the use of technology. The form presents several activities to reveal possible problems. The section for comments in the form must be used for additional information, as a base to the specification of requirements.

The user interface for residents must be understandable, intuitive and based on the principles of universal design. Electrical installations should for instance look like mainstream products. A light switch divided into five vertical sections, with a steel or bronze coloured surface, may be perceived as strange and confusing for some people.

Written documentation of the connected and programmed functions should be available in the apartment. Newly employed staff and visitors can thus quickly obtain relevant information. It is no good making coffee during a visit if the electricity for the coffee machine is connected only at set times.

Specific documentation is imperative when passive alarms, tracking systems or other installations infringing on the integrity of the individual are activated. On connecting such alarms, routines must be developed for information and the granting of consent from the resident and maybe from the relatives or trustees.

Summing up of the user requirements for the residents:

- Interdisciplinary based
- Thorough assessments of individual needs
- Technical solutions should be simple, intuitive and based on the principles of universal design
- Good routines and guidelines for information and the granting of consent
- Written documentation of connected technical solutions should be available in the apartment

HOME CARE STAFF

The specification of requirements must also consider the interests of the employees, as technology becomes an important part of their work conditions.

The alarms must be easy to sign out and the number of keystrokes should be kept at a minimum. A receipt must be sent for signed out alarms. Smart home technology makes possible the use of differentiated alarms, which means that the recipient receives a message on which alarm or sensor was activated. In many situations it is important to know if for instance the door alarm or a fire alarm was activated. Programming for new residents and changes in the programme must be intuitive, with a user interface adapted to the computer knowledge of the employees.

The specifi-cation of requirements must also consider the interests of the employees.

Summing up of the user requirements for the staff:

- The technology must be reliable
- The employees must be trained
- The alarm receivers/telephones must be easy to learn
- The alarm receivers/telephones must be handy to carry
- The alarm receivers/telephones must tolerate bath-room vapour
- The alarm receivers/telephones must tolerate being dropped on the floor
- The alarm receivers should give differentiated messages

TECHNICAL SUPPORT STAFF

Several municipalities have involved the technical support staff in central and technical management of the building. Hence the smart home technology also affects their working situation. Some employees in technical departments claim that training and the use

of smart home technology as a managerial tool is a positive experience yielding increased motivation and interest in their work.

Often the smart home technology manages and controls the heating, ventilation and technical alarms. Technical support staff has special passwords for such technical management. Guidelines for level of authority for changes and adjustments must be available.

Summing up of user requirements for technical support staff:
- Technical support staff also need training
- Clear routines and distribution of responsibility for changes, adjustments and programming
- Clear routines and distribution of responsibility for service and maintenance

Smart home technology as a managerial tool can be a positive experi-ence.

THE MUNICIPALITY

There are great differences in the municipalities regarding their knowledge of and experience from, smart home solutions. In the current situation we can divide the municipalities into three groups:
- Municipalities having knowledge and experience with smart home technology
- Municipalities having knowledge on smart home technology, and chosen not to use it
- Municipalities lacking knowledge and thus also experience with smart home technology

The needs of the municipality must be analysed in a cross-departmental and multi-disciplinary way, because smart home technology affects several areas of responsibility and services. Those most affected are the health-, nursing and care services, technical support services and house allocation services. Smart home technology is a topic for political decisions regarding housing, in discussions on the quality of the nursing and care services and as part of discussions on future needs for the inhabitants.

Central issues affecting municipal decisions are:
- Which standard should the nursing and care services have?
- How may smart home technology affect these services?
- Which level of technological expertise does the staff have?
- How are the receiving of alarms to be organised?
- Who is to have the overall responsibility for the smart home technology?

The list of questions might be even longer and will vary in the different municipalities.

Specification of requirements and the tender

A specification of requirements is based on the user requirements, and is more of a technical document than the user requirements. To ensure a good result it is important that the developers of the specification of requirements have a close co-operation with the users and their representatives. Experience proves the necessity of allocating resources to understand each other's terminology.

The specification of requirements is a description of the basic installation in all units during multiple apartment house building. In the case of installation in a single flat or house, either during building or retrofitted, the specification of requirements is developed for one specific person or family.

In the case of construction of public buildings relevant legislation includes the Public Procurement Act and the Norwegian Tender Standard. The municipality must discuss whether price or functionality shall decide the choice of contractor. The EU has recently revised their legislation on public procurements, which also affects Norway through the EEA agreement. In the new legislation it is made possible to include clauses on so-called "social concerns" in the specification of requirements in public tenders. This can among others include requirements for goods and services to follow the principle of universal design.

The responsibility for fulfilling the requirements rests on the supplier. Often this is a contractor who is responsible for procurement and construction, including the electronic installations. Experience proves that it can be a good investment for the municipalities to participate actively during the installation of smart home technology. Even minor derogations from the specifications might have great consequences for those who are to utilise the technology.

MANAGEMENT AND SERVICE CONTRACTS

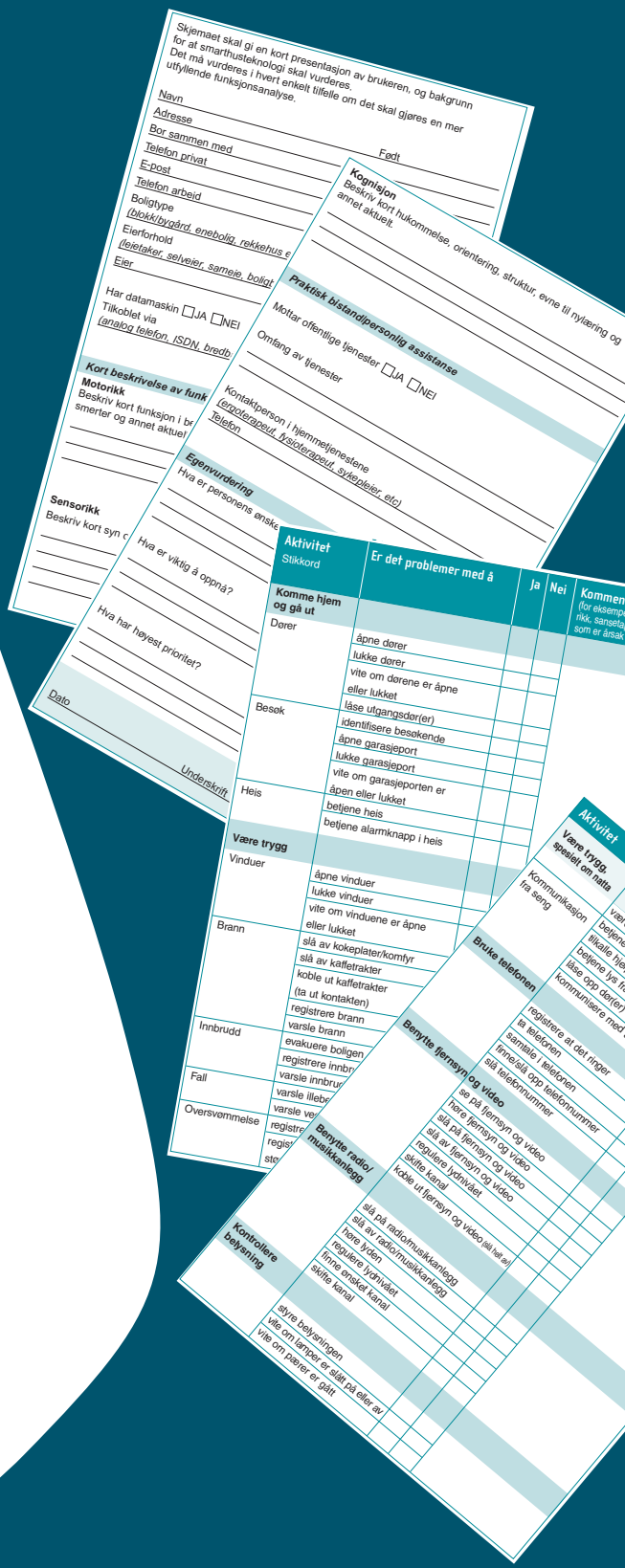
When developing the specification of requirements one must consider whether permanent management and service contract with the electrician/supplier/contractor is to be made, including the level of quality for such a contract. The alternative to a contract is to purchase the mainte-

It is a good investment for the municipalities to participate actively during the installation of smart home technology.

nance and other services according to needs. Several of the municipalities have experienced this to their cost, because the needs for management and service were not estimated when the requirements were developed.

There are various cases, from long-term and very expensive contracts with a single supplier, to no contracts at all. Some will claim it to be a cheaper solution to buy services when needed. Our knowledge is too limited to give advise in this field, but we will emphasize the necessity of discussing the issue of service, and also the importance of having a clear plan on how to ensure management and service. Several municipalities have a hard time because of inadequate or lack of clarifications on the issue of service and maintenance.

Disagreements may arise regarding the responsibilities of the technical support staff in the municipality and the supplier in the case of repairs and other management tasks. Some updating and maintenance require top competence from the contractor.



Success criteria

When introducing smart home technology, the success criteria depend on a number of factors. It is not sufficient that all the requirements in the specification have been fulfilled. The specification of requirements is based on the needs, wishes and expectations of both the residents and the staff. Whether one has succeeded or not will probably also be a matter of opinion.

The success criteria below are the ones mentioned by several municipalities. Interviews with the employees revealed how culture and stories about technology have an impact on attitudes and ability to recognise the possibilities it provides. In some municipalities the smart home technology yields enthusiasm and commitment, in others scepticism and resistance.

Success criteria are here sorted according to topics:

POLITICAL AND ADMINISTRATIVE DECISIONS

- Early involvement of staff in the planning processes
- Training in the possibilities of smart home technology
- Involvement, both from political and professional management
- Decisions on financial framework and budgetary control

PLANNING

- Multidisciplinary organisation and involvement
- Training in communication with, and making demands towards suppliers and contractors
- Co-operation with the residents, relatives and other user representatives

USER NEEDS AND SPECIFICATION REQUIREMENTS

- Thorough, correct and multidisciplinary assessment of the residents' needs and wishes
- Thorough estimation and analyses of the staff's needs and wishes
- Communication between all parties during the development of the specification of requirements
- Thorough assessment of needs for, and content of management and maintenance contracts

Several municipalities emphasise the necessity for participation of all parties concerned during the planning.

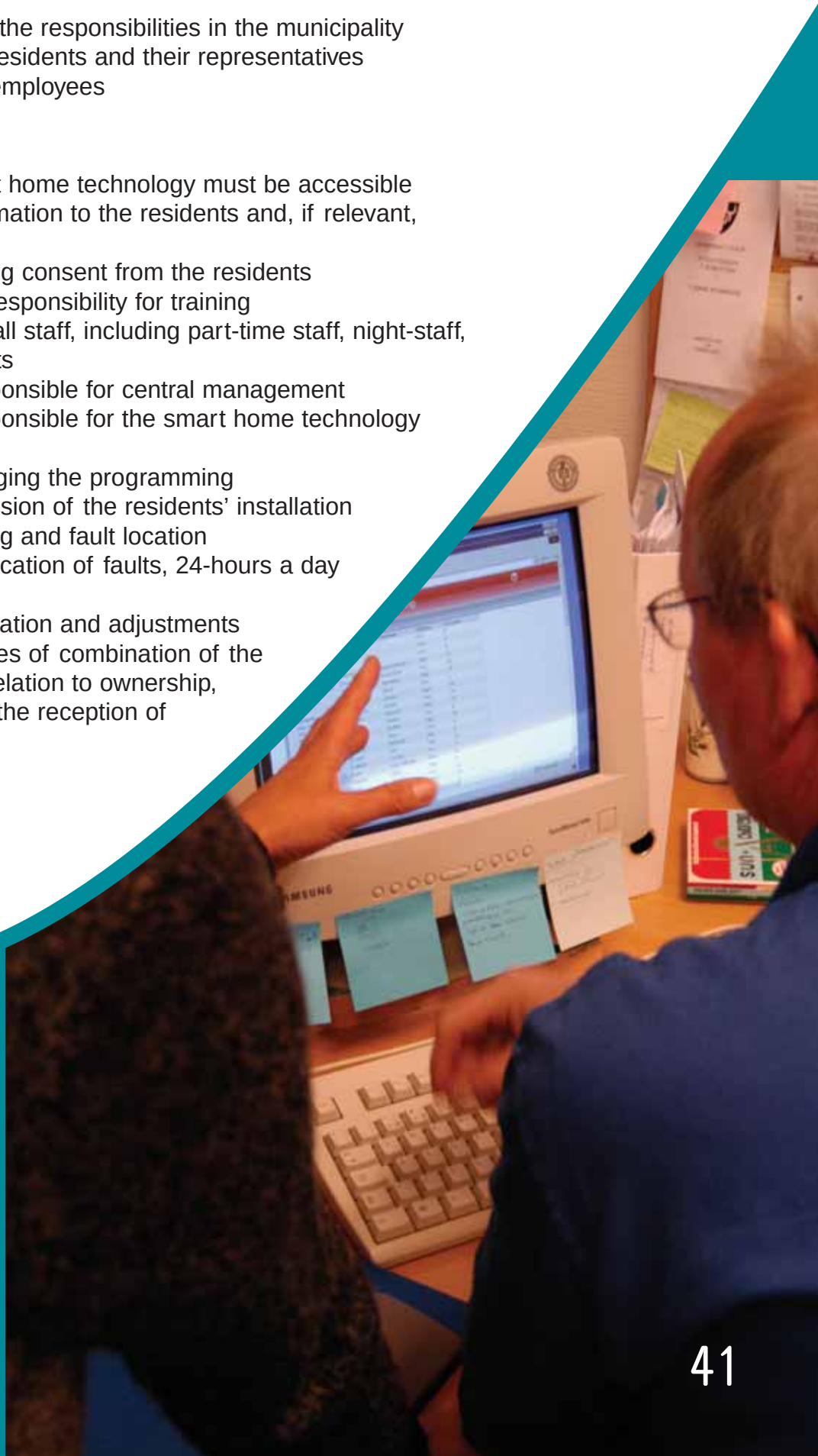
Success criteria

INSTALLATION

- A clear allocation of the responsibilities in the municipality
- Participation of the residents and their representatives
- Participation of the employees

MANAGEMENT

- Information on smart home technology must be accessible
- Procedures for information to the residents and, if relevant, to their relatives
- Procedures for getting consent from the residents
- A plan and defined responsibility for training
- Practical training of all staff, including part-time staff, night-staff, deputies and students
- Training of staff responsible for central management
- Training of staff responsible for the smart home technology as a whole
- Procedures for changing the programming
- Procedures for extension of the residents' installation
- Procedures for testing and fault location
- Procedures for rectification of faults, 24-hours a day and 7 days a week
- Procedures for evaluation and adjustments
- Exploit the advantages of combination of the different alarms, in relation to ownership, transfer system and the reception of alarms.



Training based on adequate documentation and the possibility for repetitions is a vital success criterion.

Is there a need for increased safety or for independence?

Why choose smart home technology?

This guide describes how smart home technology yields another functionality than conventional electronic installations. On discussing advantages of one system versus the other, one must be aware of the different functionalities. Today smart home technology is a cost-increasing item on the construction budget, and a thorough assessment of the needed functions is imperative.

Why smart home technology

THE FOLLOWING IMPORTANT QUESTIONS CAN CONTRIBUTE TO THE ASSESSMENT OF NEEDS FOR SMART HOME TECHNOLOGY:

- Will savings be achieved in the field of energy economising?
- Will there be advantages related to central management?
- Will there be an improved quality of home-based services?
- May more independent residents influence the staff structure?
- Will there be an increased quality for the residents?
- Is increased safety achieved through the use of alarms?
- Is there a need for passive alarms?
- Are there any benefits connected to the co-ordination of alarms?
- Is there a need to change the functionality from time to time?
- May the number of functions related to technology increase?
- Are there any benefits from programming several events into a chain?
- Are there any advantages from programming incidents at set times?

The cost of smart homes technology is for some people an argument against the choice of such installations. The best advice before decisions are made, is to analyse the different needs and requirements and answer the above-standing questions. This guide has as its objective to enable the reader to estimate the needs, and to participate in the development of a specification of requirements that meets these needs.

Municipalities considering smart home technology should stimulate local political and professional discussions. As described in this guide there are several professional, ethical and economic considerations to be made. For some technology will represent possibilities and development, for others technology is synonymous with estrangement and surveillance. Today the truth lies between these two extremes.

Annex

Smart home technology, description of user function

This form provides a brief presentation of the user, and the reason for considering smart home technology. Further functional assessment must be considered.

Name _____ Date of birth _____

Address _____

Lives with _____

Phone private _____ Mobile _____

Phone work _____ E-mail _____

Type of housing
(block of flats, detached, terraced, etc) _____

Ownership
(renter, freeholder, co-operative ownership, etc) _____

Owner _____

Has computer ☐ YES ☐ NO Internet ☐ YES ☐ NO

Brief description of funcion

Physical function
Shortly describe leg- arm- and handfunction, spasms, fatigue, pain and any other relevant information.

_____

_____

_____

_____

_____

_____

Sensory function

Shortly describe eyesight and hearing

_____

_____

_____

_____

_____

_____

Cognitive function
Shortly describe memory, orientation, structure, ability to learn new matters and other relevant information.

Practical and personal assistance

Receives home care ☐ YES ☐ NO

Scope of services

Contact person in the municipality
(occupational therapist, physioterapist, nurse etc)

Telephone

Self evaluation

The persons wishes and expectations?

What is important to achieve?

What has the highest priority?

Date Signature

Smart home technology, description of user needs

Activity Key word	Are there problems conserning	Yes	No	Comments (for example if the problem is linked to physical, sensoric or cognitive function)
Coming home and leaving home				
Doors	Opening doors			
	Closing doors			
	Knowing whether doors are open or shut			
	Locking exit door(s)			
Visitors	Identifying visitors			
	Opening garage gate			
	Closing garage gate			
	Knowing whether garage gate is open or closed			
Lift	Operating the lift			
	Using the alarm in the lift			
Saftey				
Windows	Opening the windows			
	Closing the windows			
	Knowing whether windows are open or closed			
Fire	Turning off the cooker			
	Turning off the coffee maker			
	Disconnecting the coffee maker (unplug)			
	Registering fire			
	Alerting in case of fire			
	Evacuating the house			
Burglary	Registering burglary			
	Alerting in case of burglary			
Falling	Alerting about general malaise			
	Alerting in case of falls			
Flood	Registering a water leak			
	Registering unplugged sockets, which should be plugged in			

Activity	Problems concerning	Yes	No	Comments
Being safe, especially at night				
	Being safe when visiting the toilet			
Communication from the bed	Operating the telephone from the bed			
	Calling for help from the bed			
	Operating the lights from the bed			
	Unlocking door(s) from the bed			
	Communicating with other rooms			
Managing the telephone				
	Registering that the telephone calls			
	Picking up the phone			
	Having a phone conversation			
	Finding/looking up a phone number			
	Dialling a phone number			
Managing the televison and video				
	Watching television and video			
	Listening to television and video			
	Turning television and video on			
	Turning television and video off			
	Adjusting the sound level			
	Changing channels			
	Unplugging television and video (turning completely off)			
Managing the radio/stero system				
	Turning the radio/stereo system on			
	Turning the radio/stereo system off			
	Hearing the sound			
	Adjusting the sound level			
	Finding the desired channel			
	Changing channels			
Managing the lights				
	Controlling the lights			
	Knowing whether lamps are turned on/off			
	Knowing if a bulb has blown			

Activity	Problems concerning	Yes	No	Comments
Managing curtains, blinds and awnings				
	Drawing and pulling			
	Knowing if it is drawn or pulled			
	Regulating awnings			
Managing the heating				
	Keeping desired temperature			
	Controlling energy consumption			
Managing a computer				
	Managing the keyboard			
	Managing the mouse			
	Managing the printer			
	Learning new software			
Managing economy				
	Keeping an overview of own economy			
	Paying bills			
Transport				
	Ordering transport			
	Responsibility for car-maintenance			
	Responsibility for maintenance of			
	electric wheelchair			
Responsibility for own health				
	Taking correct medicine			
	Taking correct dosage			
	Responsibility for own health			
Others				
	Knowing what the weather is like			
	Registering abnormal sound			

Notes

Notes

Notes

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