Facilities Management and Health Care at Home

Doctoral Thesis

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The topic of this thesis is the new requirements that will be put upon the facilities management when the elderly are living longer in their own homes, in spite of illness, impairment and old age. For many reasons, especially demographic ones, this issue has come to the fore and since it has substantial political impact and considerably affects our living conditions, it will most certainly appear on the agenda of most Swedish housing companies in the near future.

The growing number of inhabitants in need of care and rehabilitation is a current subject in many countries of the industrial world. More medical conditions can be treated, but often at an ever increasing cost. Care and housing are often interlinked and more interest is being paid to the possibility of offering care to elderly in their own homes.

This development must lead to a discussion of the home as a hospital ward from time to time, and the demands it places on facilities management and security. So far the prospects of telecare services and 'Smart homes' has been very little discussed in parallel, although in many aspects they share the same technological base.

The principal interest of the housing companies is to find a role in accordance with their mainstream business, and at the same time co-operate with other municipal actors directly in charge of offering assistance and service. There has been only limited study and research into the complex interaction between technology, home-based social service and the housing company.

The purpose here is to develop an understanding of the requirements placed on both the housing company and the CP when a tenant is to be subjected to minor and more extensive care at home, or suffers from an illness or an impairment which requires special equipment or technical adjustment in the home. A model to interpret this situation has been developed in this thesis.

**Key words:** facilities management, elderly, cognitive impairment
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1 Introduction

This thesis poses the following question: is it possible to deliver safe and sustainable Home Care to people in their own homes without extensive co-operation between the Care Provider (CP) and Facilities Management (FM)?

This research addresses one of several crucial issues arising from the fact that the elderly are living longer in their own homes, in spite of illness, impairment and old age. It examines the sustainability of the built environment and takes into account the implementation of new technologies in Home Care services. For many reasons, especially demographic ones, this issue has come to the fore and since it has substantial political impact and considerably affects our living conditions, it will most certainly appear on the agenda of most Swedish housing companies in the near future.

The growing number of inhabitants in need of care and rehabilitation is a current subject in many countries of the industrial world (Gordon 2000; Socialstyrelsen 2004; Chu and Chen 2006). More medical conditions can be treated, but often at an ever increasing cost. Care and housing are often inter linked and more interest is being paid to the possibility of offering care to elderly in their own homes (Miskelly 2001; Herzog Lind 2003; Demiris Skubic et al. 2006). At present the situation is not acute but from about 2020 onwards (Lindgren, Lindström et al. 2005; Statistiska centralbyrån 2006) it will become more critical in Sweden. Many European projects have focused on independent living in a person’s own home (Lansley 2001). Development of a large number of technical aids of different kinds is on-going, of safety alarms and smart sensors, remotely monitored devices, memory aids and gate cameras, for example. Much of the work is initiated from a medical perspective (Tinker and Lansley 2005).

It is not only technology and care that matter; an equally important issue is how well the dwellings are adapted to care, both from a spatial perspective and in supporting new technology (Tang and Venables 2000). In addition, it is important to understand how the home care service can be organised in order to meet requirements satisfying the quality criteria. It is a relatively widespread opinion that ICT (Information and Communication Technology) has the potential to support the resources of the caring professions without reducing the quality of the care itself. The complexity of relatively simple technology in use with Home Care and telemedicine is often underestimated; there are many obstacles.

The principal interest of the housing companies is to find a role in accordance with their mainstream business, and at the same time co-operate with other municipal actors directly in charge
of offering assistance and service. There has been only limited study and research into the complex interaction between technology, home-based social service and the housing company (Tang and Venables 2000).

The purpose here is to develop an understanding of the requirements placed on both the housing company and the CP when a tenant is to be subjected to minor and more extensive care at home, or suffers from an illness or an impairment which requires special equipment or technical adjustment in the home. This could be approached on three distinct levels. The first level is the design of the dwelling, viable technical equipment and systems, and appropriate communication solutions. The second level concerns business related issues, and the third level addresses the institutional barriers between the different participants. In this thesis the focus is on the first level.

Today, only some equipment, such as automatic door openers and wheelchair ramps, is being installed in peoples’ homes to provide support for various kinds of impairment. Installation is carried out with the agreement of the landlord if the apartment is rented, but with little consideration about who is going to take responsibility for the equipment. One day when, for instance, the automatic door opener ceases to function, the tenant calls the FM, which dispatches a service team. But is the door opener their responsibility? And if it is not, who should pay for the service delivered by FM? Is it the tenant, or is it the organisation responsible for the care, or is it the organisation that made decision to install the equipment? Who is responsible when a safety alarm cannot reach the alarm centre because the standard telephone lines were changed to an Internet-telephone system? What will happen when advanced medical treatment is taking place in one apartment and FM turns off the electricity, unaware of the treatment?

Assistive technologies for Home Care and telemedicine are developing. Much more sophisticated and complicated technology is in the laboratory and at different test sites. Most technologies are still using standard telephone lines for transmission. The systems are vulnerable, however, and a conscious implementation involving both FM and the CP must be sought.

1.1 The Research Questions

Ageing in situ, supported by assistive technology, will most certainly bring new technology into people’s homes, and the questions for the thesis are:

- Do FM and the CP have a mutual interest and derive benefit from cooperating in the issue of care in the patient’s own home?
- Why do they not cooperate when they have a mutual interest in doing so?

The hypothesis for this work is that it is necessary for FM and the CP to cooperate in order to achieve a safe and efficient Home Care and FM. If this is not done problems will arise for both FM and the CP.
1.2 Setting and Writing

This thesis is the result of two phases. The first one concerns FM and Information Strategies. It was presented as a Licentiate dissertation in 1997 at the Institute of Infrastructure and Social Science, KTH (The Royal Institute of Technology). The use of more sophisticated computer systems was emerging on the FM scene and the question was “How and what kind of information is used by different staff members in a housing company?” Information was regarded as an important and valuable asset in the field of FM and part of it was used to form the companies’ strategic behaviour. The use of different kinds of traditional building-related information in a housing company was studied to understand use by staff of such information. The purpose was to find out if the different roles in a housing company were reflected in the use of strategic information. This study is presented in Paper 1. In another study, carried out in a housing company, the goal was to develop a method of archiving and retrieving the organisation’s digital documents. The use and benefit of information is directly related to the possibilities of retrieving it. This is presented in Paper 2. In a conceptual discussion, game theory was used to study the relationship between two different housing companies with apartment blocks in the same neighbourhood, and how the behaviour of one influenced the other. It showed that, depending on the landlord’s owning strategy, different kinds of responses could be chosen as a response to the other’s actions. The information at each owner’s disposal was a key factor for the outcome of the silent bargaining situation.

The second phase, carried out ten years later at the School of Technology and Health at KTH, is a study showing how FM and home care are to a great extent interconnected activities. In this work, information is also a key issue for the likely success of the philosophy of ‘aging in situ’ supported by technology. Paper 4 presents a model illustrating how home care and FM are related to each other. This paper also discusses the way in which different projects in Sweden handle this relationship. Paper 5 describes difficulties in implementing a new safety alarm system for the elderly. The problems are to a high degree related to the infrastructure of each building.

1.3 Structure of the Thesis

Section 1 of the thesis contains an introduction to the field in which the investigation is carried out. It consists of a presentation of the questions, the hypothesis and the overall structure.

Section 2 is a presentation of the background of FM as it stood at the end of the 1990s, and its current discourse. It also describes the demographics in which home care is developing and the trends in home care today. Section 3 presents the methods and scientific framework on which the thesis is based. Section 4 contains a summary of the six accepted or submitted papers upon which this thesis rests. Section 5 presents the results of the work. In Section 6 the conclusion of the work is reached and this is where the questions from Section
Introduction

1 are given an answer. Finally there is a discussion summarising the findings and outlining some important areas of future research.

Section 7 contains a list of references and following this the six papers are reproduced. Papers 1 to 3 have also been translated into English.
2 Background

In Sweden in 2004 there were approximately 2.3 million dwellings in apartment blocks (Statistiska centralbyrån 2006a). About one third of the apartments were owned by Sweden’s municipal housing companies, another third by tenant-ownership associations and one third by private housing companies.

During recent decades there have been great changes in the property market which has led to new methods of facility management. The housing market was until then best known as conservative and not especially keen on new ways of approach. However, during the 1990s housing companies in Sweden were given new conditions in which to work. One thing that dramatically changed the playing field was the removal of subsidies in the housing market. This led to a reduction in the demand for apartments and thus a much smaller market for newly built homes. At the same time more and more of the traditionally authority-supervised building was handed onto the open market for housing companies to take care of by themselves. The authorities gave them the rules but it was the housing companies that ensured everything was handled in the correct way. This was called self-control. Many other things were also changed during this period; for instance, much infrastructure traditionally managed by the state was put onto the open market.

The Swedish telephone company was privatized, as were the railways and many energy companies previously owned by the local authorities.

For the housing companies with dwellings in their property portfolio it was no longer self-evident that what they built would be rented to tenants. Market forces were getting stronger and involvement from local authorities weaker.

Today it is not simply the apartment itself that is the product let to the tenant: it is only one part of a service concept. The focus is more and more on service. The market is regarded as fragmented, with special needs and target groups (Eriksson and Klingberg 1989). The perspective has shifted from the dwelling to the customer. What was earlier regarded as an anonymous person is now considered a client and customer. In FM this has become apparent as housing companies attempt to find out what the customer wants and try to sell them additional services. This means that FM has to deal with new issues and has to act more strategically. FM is also much more influenced by what others do. Their results are affected by neighbouring property owners as much as by internal decisions. During the 1990s much attention was focused on information and information strategies through IT-systems. Questions were raised: what kind of information is
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relevant for FM? How and by whom is it used? How is it kept and in what ways can ICT rationalize the business?

It is notable that this was what practically every housing company in Sweden was paying attention to at that time. A couple of years earlier the main interest was accommodation for young people when they left home (Lundberg and Modig 1984), and some years before that it was the reconstruction of the cities that was the focal point of both industry and researchers (Boendeutredningen 1974; Blomberg 1991).

The question today is care of the elderly at home and the environmental impact of the construction process and the buildings (Brunklaus 2005).

Traditionally, housing companies have put a great deal of effort into the development of FM. They have tried to implement ICT in the control of the buildings’ infrastructure in order to save costs and to boost efficiency. So far, the interest has mainly been in the measurement of heat, water, ventilation (HVAC) and electricity. There have been some efforts to provide the tenants with individually based fees for these services. There has also been some interest in house automation in order to remotely control and survey lifts, lighting, and washing machines in communal laundry rooms. A report from the Swedish Association of Municipal Housing Companies, (SABO), says in regard to Broadband: “Stable and permanently online communication to and from the buildings is important in the future, when controlling and follow up a in real time environment will become more interesting.” (Johansson 2004). It is notable that when the report discusses the kind of services that can be beneficial for tenants, nothing is said about services to elderly through broadband networks. Little or no interest has been directed towards technology installed in apartment blocks or buildings to provide assistance for people with functional impairment. The municipalities and their social services departments provide these installations and therefore this kind of equipment has fallen outside the responsibility of the technical administration. One exception is a municipal housing company in Lund (LFK). It has installed a new information system and a whole new infrastructure in order to provide individual energy bills. As an extra feature it is also planning to provide technology assistance as a service to its elderly tenants. It will be possible, for instance, to send an activity alarm to a relative if the tenant has not moved around in the apartment for 24 hours (Lundberg 2006).

The property companies are fairly diversified. There are those who own apartment blocks in order to run a business by providing apartments or premises to companies or individuals. Other companies own apartments as a long-term investment. There are also differences between small and large companies in how they handle the housing stock. In Sweden, apartments for renting are mainly private, tenant cooperatives or council housing. The conditions for the property companies have been quite different depending on whether they were
involved in business premises or the residential market. The business premises market conditions have been governed by supply and demand, but the housing market has been ruled by negotiations and subsidies. But times are changing and today the possible future conditions for rented apartments are being reflected on the premises market. This means that it will become important for FM in the housing market to deliver the kind of service the market demands. At the same time new demands regarding the environmental impact of the apartment blocks and their internal materials are becoming more important.

2.1 Facilities Management

FM of today has its roots in the 1980s when there was a property crisis in Sweden as a reaction to the fact that a great deal of building activity was based on expectations of rapidly rising values in the market (Fernström 1994). When the building of new houses went down the interest in managing the already built houses grow. This resulted in a new way to look at the FM (Johansson 1994), one which meant focusing on the residents and their service demands. Today FM is to a great extent based on service delivery (Lundström 1989; Bejrum, Lundström et al. 1991; Andersson and Cars 1993; Hrdlicka 1996).

The FM concept was interpreted in different ways within the property business during the last decade, mainly because of the absence of a common definition of the term. Basically, FM stands for a process in which resources are used in different kinds of activities. One concept (Byggforskningsrådet 1994) is to divide FM into a number of divisions: technical, financial, caretaking and supervising. The FM caretaking division deals with daily activities such as cleaning and general upkeep. The financial division handles renting, financial matters, statements of accounts, taxes and wages. The technical division of FM carries out repairs using subcontractors, plans long-term maintenance and plans all new build and renovation of property, and the FM supervision division is responsible for and runs the overall organisation. The borders are sometimes unclear and often overlap. Each property company has its own way of organising the company but in general it follows the divisions above. A similar way of describing FM is used by Karlsson (Eriksson and Klingberg 1989), who declares that the FM first of all is to be understood as a technical, economic and administrative facilitating, but the FM of apartments also includes the surroundings and the functionalities of the house and the apartment for the tenants. The disadvantage of the term the FM is that it makes one think only of the technical art of the facilitating of the estate according to Jensfelt (1996). The advantage is that the term is well known by all in the construction sector.

FM is sometimes regarded as a part of the construction process, which is in turn subdivided into projecting, construction and facilitating (Wikforss 1993). This subdivision is mainly focused on the construction phase and is less focused on the FM phase. It can be noted, however, that at the end of the
Background

90s the turnover in the FM phase was many times greater than the turnover in the construction phase of a building. During a 30-year period of FM the accumulated turnover is about three times the turnover during construction. According to calculations (Öhrming 1987), on an apartment block of 125 apartments built during the years 1944 to 1945, the accumulated turnover in FM in relation to the initial outlay for building and land was about twice as big in the year 1983. Also, according to Öhrming the FM turnover in 1983, was 2.8 % of the construction costs during the first year of FM, but in 1997 it was calculated as being about 10 %. (Bejrum, Hanson et al. 1994), state that the FM of an estate is in itself a process, and the whole construction process can be regarded as a sub-process when seen from the FM perspective.

It can therefore be argued as to what extent FM is a part of the construction phase, or whether the opposite is the case. During the 90s this caused lively debate as FM was becoming more and more a focal point, gaining in importance in the construction process. Facilities managers today are well placed to influence, if not decide, all building-related expenditures (Wood 2006).

2.1.1 The Qualities of Housing FM

Housing companies are only one part of all property companies. In this thesis, those companies which are dealing solely with premises are called premises companies. In some respects they differ from the housing companies, for instance by the customers they approach and the way they price their products. Also in this thesis; only the housing companies which have apartment to let is studied. Such housing companies’ marketing is aimed at domestic households and the prices are fixed once a year following strict rules of negotiation between the residents’ association and the municipality-run companies. Private housing companies then set their rents in line with the municipality companies’ rents. The premises companies act in an open market and the pricing is set according to demand and supply. This difference is also reflected in the respective FM organisation.

The FM of housing is also different from the FM of premises, as they act within different time horizons. The spaces are also utilised in different ways: apartments are used in a continuous way whereas premises are used during work hours and are generally empty at night and during the weekend. Renovation in the premises business takes much less time than in the housing business; an apartment is thoroughly overhauled after about 25 to 30 years, while business premises can be refurbished after only 5 years to suit the customers’ needs. It all depends on how often a customer needs to change their premises for reasons of space. Another difference between FM for homes and for premises is that the premises companies normally have fewer but larger customers, while the housing companies have smaller but many more customers. This places different demands on the respective FM teams. The load is more widely spread and is more varied in housing developments than it normally is.
in business premises. Despite those differences, the similarities dominate when compared with the rest of the construction process; both produce services.

2.1.2 The Four Functions of FM

FM can be separated into four functions (Byggforskningsrådet 1994). They are:
- The Company Function
- The Marketing Function (MkF)
- The Management Function (MgF)
- The Construction Function

The first is the company function of running the company. The second is a marketing function to monitor changes in the market, handle public relations and have general control over the customers’ demands. The third is the management function which operates, runs, maintains, deals with lettings and provides services, and the fourth is the construction function which defines, controls and carries out construction projects. The company and marketing functions are general functions and it is only the management function and the construction functions that are characteristic for housing management companies.

In the construction phase the information flow has its own structure and content. It secures the building to be built in accordance to an agreed quality, cost and time schedule. Furthermore, the construction function (CF) handles contracts and other agreements between the owner, the contractor and the subcontractors in the construction process. Only a minor part of all this information is later necessary in the daily FM operation. The management function (MgF) is the one which has the closest contact with the buildings and can provide knowledge about the dwellings and the facilities. It is the marketing function (MkF) and the MgF that have a direct relationship with the customers and are considered the ‘face of the company’ in regard to the customer.
Interest in MgF has become more prominent in the housing companies. The marketing function has also become more important to the housing companies in relation to the decreasing construction activity which has been seen in Sweden since the end of the 1980s (Högberg and Högberg 2000). It is often in the marketing function of the company that the resources are applied when an ICT implementation is carried out (Kärnekull and Lundberg 1995). A possible market adjustment among the housing companies will make the marketing function more strategically important and will have an impact on any decisions regarding changes in a housing company.

The conditions during the late 1980s and 1990s in the construction business might have had an impact on the relative importance between the marketing function and the construction function. The construction function (CF) is usually outsourced today (Brunklaus 2005). The MgF has always been regarded as less qualified than the CF and has therefore had a lower status (Tornée 1989). This has also influenced university course structure which has paid less interest to MgF compared with the construction business.

2.1.3 Information in FM

Information used in housing management can be structured according to the function or the level of decision where it is used. Information is important on all levels of the company, but the type of decision and the frequency of decision-taking varies depending on the level on which the decision is taken. Strategic and tactical decisions are made on a long-term basis and are handled on other conditions than the operational decisions that can be taken several times a day. Strategic decisions are taken based on information material from the top of the information hierarchy, whereas the operational decision making is based on information obtained from daily maintenance and caretaking. The strategic moves a company makes are strongly related to the supply of information; i.e. the content and the organisation of the information. Information on a tactical level is obtained from the internal account statements and by following the development of prices and costs. On the strategic level most of the information is external but on the operation level it is mainly internal.

In the conceptual study (Paper 3) the housing company is regarded as an actor in a strategic game because the economic mechanisms are outruled by superior decisions and restrictions. The actors do not have to know much about the conditions or about the other actors’ moves, or about forces outside of their control, not even if they have an impact on the game in one or another direction. Each actor has an amount of information that at a certain point on the time line of the game describes the possible successive positions based on the actual position of the actor. The actor can separate these possible successive positions through direct observations. In the empirical study (Paper 1) the information about areas and dimensions has been regarded as being of strategic importance to the
housing companies, in addition the budget and account information.

Information used on a tactical level is based on the company’s internal decisions for its business. This is activity information for economic analyses with the use of ABC (Activity Based Costing) or ABM (Activity Based Management) (Lindblad 1992). There is also information about the consumption of heat, water and electricity. Information on an operational level is such as is used in FM and its operations. It is used in the daily administration and in customer relations, for instance handling rent contracts and dealing with complaints.

The information that is related to the operational function of FM is the kind that is delivered to FM when newly constructed and renovated dwellings are taken into operation. Examples of such information are drawings, area and dimensions, as well as statements of inbuilt material, maintenance and operation instructions.

When a business is governed by certain economic goals (Ljung 1994), it normally applies cost efficient information adapted to the decision. The company can do this by using systems divided into three levels: the strategic, the tactical and the operational.

The strategic level comprises results, profit and market considerations. The tactical level focuses on the overall function, while the operational level ensures the parts function. For each of these levels there is a control system consisting of internal and external data.

The strategic control system concerns results and profits while the tactical control system concerns internal costs cash flow. On the strategic level there are models to simulate the effect of actions, and there is a tenant inquiry system. However, there is not a great deal of systematic collection of external

Figure 2    Governing respective information systems (Ljung 1994)
Background

Data and alternative profit calculations which are not based on the property.

On the operational level there are market plans and action plans but little in regard to systematising and using existing experiences (Ljung 1994).

2.1.4 Long-term FM

A building that is not maintained is assumed to have a linear declining functionality. This assumption is based on the principle that all included components become worn out and weakened and this accumulates in with time in a linear function. To reduce this development and to slow it down, it is up to the MgF to continually maintain the apartment blocks. The requirements on MgF entails being able to judge what has to be done and when in order to keep the property in good shape until a renovation can be carried out. This is shown in Figure 3. Without maintenance the life of the building will be relatively short, but with maintenance the buildings can operate for much longer.

The purpose of Figure 3 is to point out the importance of the information held by the caretaker. He sees the apartment blocks everyday and knows when it is time to take action in order to maintain the performance of the property in the block. This indicates a need for information about the expected longevity of each of the components in the building, and of information about how to handle them to keep them functioning for as long as possible. Since a building is a collection of very many different parts, it would be convenient to organise them into objects. The quality of the object is then a function of the quality of each of the

![Figure 3](image_url)

**Figure 3** The relation between the standard of a building and its maintenance
Background

The research about building product models is based upon this idea (Björk 1993). It will be an important link in striving to obtain ICT-based FM information.

At a certain level the entities become outdated or dilapidated and it is necessary to carry out a renovation in order to regain the full functionality of the building. At that moment a new lifecycle begins and in this way FM can be regarded as cyclical. In Norway a ‘status inspection’ based upon a Danish model was used during the 1990s to decide when to maintain and when to renovate. By systematic observation of the building’s condition and by comparing it with a ‘desired’ condition, the right actions aimed at keeping the building in good condition can be carried out (Figure 4).

In a market with open competition, the activity of other players in the market will have significant impact for the alternatives between which FM can choose. An efficient FM will possibly have to make decisions based upon strategic considerations where other actors’ strategies must be correctly judged in order to make the best decision for the operation.

Figure 4 Using a long-time FM perspective the maintenance is undertaken at an early stage. From (Omang 1994).
2.1.5 Lack of Information Creates Problems

One of FM's problems is to find the optimum between a FM that gives priority to maintenance and a FM that is more concerned with renovation, which becomes necessary every twenty or thirty years. Several factors are involved in the technical processes through which a building passes. Besides the expected wear and tear of the materials and technical systems in the building, its use has an impact on its longevity. Several reasons have been cited as actions that can lead to errors during FM. The following is an ordered list with deviation from an expected development as the organising principle (Bröchner 1989):

- unexpected environmental load during the construction phase
- unexpected environmental load during the FM phase
- unexpected user applications during the FM phase
- unexpected user load during the FM phase
- unexpected operation and maintenance techniques during the FM phase
- imperfect geometry between different construction details

As it is almost impossible to predict the use of a building in the future, there is no exact way of calculating the life of a building. There is, therefore, a need for frequent monitoring of the actual status of a building in order to choose the right action at the right moment. The unexpected has a tendency to be a major cause of many of the problems that occur during FM.

In a construction process the various experiences of the architect, constructor, builder and so on, can immediately be reported back to the project manager and be utilised in the next project; in an experience cycle of 1 to 5 years. For FM in the premises business, this might be undertaken after 5 to 10 years, but for a housing company the experience cycle of a building might be up to 30 years. This puts FM in housing in a special situation and should lead to different strategies for discovering early warnings about hidden and potential damage. It is important that the frequency of acute maintenance is kept as low as possible in favour of planned maintenance. It is also of importance to follow the social conditions in the environment to be able to hinder vandalism or segregation, for example. Today it has also become obvious that the situation of the elderly and their day to day living calls for special attention in order for them to remain in their own homes for as long as possible. For FM to improve its decision making it is important that information is treated as a valuable asset.

In the 1990s the need for an adequate FM information infrastructure became more and more marked. Such a system would make it possible to share information between different systems and to promote the transfer of information between systems. In research work the use of the standardised building product model - a STEP model - was judged to be a possible useful common information model for FM (Svensson 1995). In a
survey carried out in Sweden as a basis for an R&D programme within the building research foundation (BFR), it was found that the efforts in other Scandinavian countries were far in advance of those made in Sweden. In Denmark especially, the BPS-centre (Byggeriets Planläggningssystem) had been working since 1974 with the development of quality and efficiency in the Danish construction business. In 1991 the Danish Facilities Management Network (DFM) was established, working with key figures for FM and an EDB (Computer Aided Facilities Management) system, as well as a project on how to use CIS-CAD in cooperation with the BPS. The development of terms had already begun in the 1980s and was a base upon which computerised FM could develop. Since 1996 all official construction projects must deliver information and data about the building in digital form. The same also applies to all buildings built with government subsidiaries (Kärnekull and Lundberg 1995). Today the DaCapo requirements are a detailed instruction on how to deliver information from the projection and construction phase to FM (EBST and byggestyrelsen 2006). It comprises the method of delivering data from XML-files and even from IFC STEP-files, which means there is a powerful, if not yet fully utilised, system of creating a very detailed database of information about a building. (See also Christiansson 1999.)

The role of FM and intelligent buildings (IBI) is today, according to Christiansson, regarded as more organic and cooperative in its support of the needs of different users and it will to a large extent support the communication of users’ information. It will be equipped with sensors and actuators for manipulation of the building’s functions (Christiansson 2000).

2.2 Elderly Care
2.2.1 Demographics

Today people are living longer and lead active lives late in life. All over the world inhabitants are getting older and older (Gordon 2000). In Sweden there

Figure 5  The demographic trend in a number of industrialised countries
After Prof. Kose, Japan
are today, in 2006, about 1.5 million inhabitants aged 65 years or older. Figure 5 shows how the population aged over 65 will become a growing part of the total population in the industrial world. In the year 2015 they will make up more than 20% of the total population (Statistiska centralbyrån 2006).

Looking at the industrial world the situation is the same. Compared with Japan Sweden is better off, but on the whole the situation is the same, with an ever increasing aging population for society to cope with. Japan is in the lead, closely followed by Italy, Germany and Sweden. The consequence is that more and more resources will be allocated towards the ‘older’ elderly and less and less to those who are relatively ‘young’ elderly. Behind this development in Sweden lies the fact that mortality has decreased very quickly. This has led to a significant increase in the number of people aged 80 years and over. When compared with 1950, the number of people aged over 80 in 2005 has more than quadrupled. In 1950 there were 106 000 people who were more than 80 years old, and in 2005 there were 487 000 people in the same age category.

According to the Statistics Sweden (Statistiska Centralbyrå) there will be no significant increase in the number of people over 80 years old until 2020, when the number will rise considerably. At that time and during the following

Table 1  Numbers of people aged 65 - 79, 80+ and 65+. 1950 – 2050, in thousands.

<table>
<thead>
<tr>
<th>Year</th>
<th>65 -79</th>
<th>80+</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Sum</td>
</tr>
<tr>
<td>1950</td>
<td>325</td>
<td>289</td>
<td>614</td>
</tr>
<tr>
<td>1960</td>
<td>403</td>
<td>344</td>
<td>747</td>
</tr>
<tr>
<td>1970</td>
<td>504</td>
<td>419</td>
<td>923</td>
</tr>
<tr>
<td>1980</td>
<td>603</td>
<td>496</td>
<td>1099</td>
</tr>
<tr>
<td>1990</td>
<td>636</td>
<td>521</td>
<td>1157</td>
</tr>
<tr>
<td>2000</td>
<td>588</td>
<td>490</td>
<td>1078</td>
</tr>
<tr>
<td>2005</td>
<td>576</td>
<td>502</td>
<td>1078</td>
</tr>
<tr>
<td>Prognose</td>
<td>2006</td>
<td>580</td>
<td>511</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>644</td>
<td>592</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>725</td>
<td>679</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>787</td>
<td>744</td>
</tr>
<tr>
<td></td>
<td>2030</td>
<td>784</td>
<td>755</td>
</tr>
<tr>
<td></td>
<td>2040</td>
<td>837</td>
<td>815</td>
</tr>
<tr>
<td></td>
<td>2050</td>
<td>793</td>
<td>773</td>
</tr>
</tbody>
</table>

Source: (Statistiska centralbyrån 2006)
ten years the number of people aged 80 and over will increase from 525 000 to 763 000 (Table 1).

Sweden’s population is expected to grow from 9 million in 2005 to 10.5 million in 2050. In 2005, 17% of the population was aged over 65, and in 2005, the end of the prognosis, that same category is expected to constitute about 24% of the total population (Statistiska centralbyrån 2006). According to the same prognosis there will in the same period be only a weak growth in the population of working age, that is people between the ages of 20 and 64 years. The period when young people establish themselves on the labour market is judged to be somewhere between 20 and 30 years of age, but the trend is moving up in age. The consequence of studying and unemployment among youth makes this age of establishment more likely to be 25 rather than 20 years of age. At the other end of the interval of working age the trend until the beginning of the 2000s has been to leave work before the age of 65. This has now changed and the number of people aged 60 and over and still in work has increased.

One major concern with this tendency is that at the same time as people are living for much longer, young people tend to stay in education longer, continue in higher education or take time out to travel, and so on, with the result that there is an ever decreasing group that has to provide for the growing group of elderly inhabitants.

In Sweden, care professionals will be too few to handle this task when the elderly increase in number. The Swedish Department of Employment has warned of a shortfall of care professionals ten years from now, but the acute deficit of care professionals has been temporarily reduced because of financial constraints on local authorities which have lead to reduced numbers of personnel. “We calculate that the present relief in recruitment problems only is temporary. In the long run the deficiency of educated nursing specialists will grow larger and even become troublesome. This is due to several factors: partly new technology and new methods, partly large groups of retired inhabitants. Also, the supply of nurses with basic training will become scarce, partly due to increasing needs in elderly care” (Gustavsson, Strannefors et al. 2005).

The financial problems that all municipalities in the country are encountering do have an impact on the delivery of care to the elderly and the possibility of purchasing new technology to provide them with comfort, safety and security in their own homes. Inhabitants aged over 65 years are heterogeneous; some are in a perfect health, others in great need of assistance and medical treatment. The older a person gets the more medical resources are needed. Improvements in medical treatment have meant that people are living longer today than before, but also that the cost of treatment is more expensive and intensive when it is needed.

2.2.2 Living Conditions of the Elderly

Most of the elderly live in their normal
Background

homes. In 2005 only 6% of people aged over 65 lived in some kind of care home. The care homes are dominated by people in higher age brackets. Of those aged 80 and over, 17% were living in a nursing or residential home in 2005, compared to only 2% of those aged between 65 and 79 years old (Socialstyrelsen 2001-2006). Of those still living in their own homes 2005, 3% of those aged between 65 and 79 were receiving home care services. Of those aged 80 years and over, 20% received home care. In Sweden, two thirds of the money that local authorities spend on care of the elderly is spent on nursing and residential homes and one third on home care for those still living at home. This is an important reason to facilitate elderly people being able to stay where they are and give them support in their own homes; this is also normally the wish of elderly people (Miskelly 2001).

Between 2000 and 2005 the number of people living in nursing and residential homes decreased by about 18%. At the same time the number of people receiving home care increased by about 5% (Table 2).

This represents two important reasons for facilitating home care instead of a move to a nursing home for the elderly. First of all the majority want to stay in their own homes and secondly, the cost to society is lower. Together this constitutes a powerful force for the development of more and more technology for use in home care. For most people an independent life is an important factor for maintaining self-respect and retaining control over their life (Gustavsson, Strannefors et al. 2005).

2.2.3 Home Care Trends

The first home care agencies in the United States were established in the 1880s. By 1963 there were about 1100 agencies and by 2003 their number had grown to some 20 000. Medicare's enactment in 1965 accelerated the industry's growth. Medicare made home care services, primarily skilled nursing and therapy, available to the elderly

<table>
<thead>
<tr>
<th>Year</th>
<th>Nursing homes</th>
<th>Home care</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>122 703</td>
<td>128 324</td>
<td>251 027</td>
</tr>
<tr>
<td>2002</td>
<td>110 902</td>
<td>127 983</td>
<td>238 885</td>
</tr>
<tr>
<td>2004</td>
<td>105 231</td>
<td>132 517</td>
<td>237 748</td>
</tr>
<tr>
<td>2005</td>
<td>100 444</td>
<td>134 961</td>
<td>235 405</td>
</tr>
</tbody>
</table>

Source: The National Board of Health and Welfare, statistic 2006

Table 2 Number of people aged 65 years and over living in nursing homes or receiving home care
Home care is a growing service industry. Homecare of the elderly today is administered by a team consisting of different care professionals: medical personnel such as general practitioners, district nurses or physiotherapists and home help service personnel in charge of non-medical services such as the patient’s daily hygiene (Koch, Hägglund et al. 2005).

In Sweden the ‘old people’s homes’ in the beginning of the 1900s replaced the poorhouse that had a similar function for people who could not manage to support themselves and were in need of support from society. This was the only social elderly care until the pension reform in 1948.

In Sweden, at the end of the 1800s, accommodation for the elderly was built by the Friends of the Pauvres Honteux 1863 in the centre of Stockholm. It provided voluntary support to women. The apartments were originally only given to women but today both men and women can apply for the apartments. Others followed and in 1882 a home for women was established in Göteborg. The same type of voluntary support for elderly existed in many countries at the end of the 1800s. Towards the end of 1930 the government created subsidies to build pensioners’ home for people whose only income was a pension. In 1958 those subsidies were terminated and replaced with rent subsidies for pensioners. In 1947 the guiding political principles stated the goal of giving ten percent of those in receipt of an old age pension a place in a home for the elderly.

In 1959 the first home care service was started as a private initiative. The idea of independent living for the elderly in their own home was first presented as a political goal during the 1960s, when it was clear that homes for elderly people were too expensive to build to the extent required. Instead, a home care service voluntarily performed by housewives at the end of 1950s was incorporated into local authority service provision (Jennbert 2006).

In 1984 the political housing report Bo på egna villkor (Living on Your Own Terms) (SOU 1984:78) stated the right for everyone to live in an individual apartment, even those with extensive need of care. This was implemented as requirements regarding space and equipment in the apartment by legislation and subsidies from the government. It raised the standard of housing for the elderly, which also gave the home care personnel better working conditions, since the new apartments became more spacious.

In Sweden there is today a widespread opinion that the elderly should receive as much care and treatment as possible in their own homes, even in extreme old age. This is a driving force behind different kinds of assistive technology for the elderly. It has also been reported that care at home is often preferred by the elderly themselves (Renwick 1996; Miskelly 2001; Rantz, Marek et al. 2005).

The goal to provide care at home has now, in the industrial world, become even more pressurised due to financial reasons (Johnston 2000; Dansky, Palmer et al. 2001; Hopp, Woodbridge et al. 2006, Brownsell, Bradley et al 2001;
Background

Escourrou, Luriau et al 2000), and it is essentially only those with a very high demand for care and treatment who can live in today's nursing homes. The cost in Sweden for one individual in a nursing home is about 44 000 Euros per year, and for home care about 22 200 Euros per year (Jennbert 2006). Since the 1980s there has been a focus on the individual's right to make their own choices of different kinds. Today in Sweden, many municipalities have given the elderly the possibility of choosing the home care organisation from which they wish to receive service. This is a manifestation of adaptation to the needs of the individual.

Today, however, all people who move into a nursing home are in such need of care that a postponed move would in most cases not be possible, as reported by the National Board of Health and Welfare in Sweden (Socialstyrelsen 2006b). Thing have changed since the National Board's special follow up, started in 1978. At that time elderly people were in much better condition when moved to a nursing home than they are today. The National Board of Health and Welfare does not however rule out the possibility that the introduction of support in an early stage would possibly affect and postpone the move to a nursing home for some of those who today could not put off that move any longer.

The reason for transferral to a nursing home can in the main be explained by two factors (Westlund, Persson et al. 2006). They are:

- Orientation problems, basically (45 %) and
- The need for care (35 %)

The move to a nursing home on the above grounds is made when the limit for home care is reached. The same result has been reported by the National Board of Health and Welfare (Socialstyrelsen 2006b).

2.2.4 ICT and Home Care

Developments in technology have significantly contributed to the opportunity for elderly people to stay in their own home to a great age. Technology such as sensors, video surveillance, remote health monitoring, fall detectors, door monitors, bed alarms and smoke and heat alarms on the cooker are equipment that can improve the safety and security in older peoples' homes (Miskelly 2001; Finkelstein, Speedie et al 2000; Finkelstein, Speedie et al 2004). The safety alarm is the most common assistive technology used in Sweden and is regarded as one of the first moves to make when supporting the choice of staying at home.

ICT is being used in home care both to provide high-quality patient or tenant care and to reduce the cost of care (Johnston 2000; Dittmar, Speedie et al 2003). In home services to the elderly the use of safety alarms is today standard equipment and is hardly regarded these days as an ICT support. One way to save costs in hospital care is to discharge the patient as soon as the medical treatment is completed. Rehabilitation can be relocated to the
patient’s own home, therefore reducing the cost of hospital care (Rodriguez, Arredondo et al. 1995; Papazissis 2004; Vincent, Reinharz et al. 2006).

When medical treatment at hospital continues to be for a shorter length of time and the return home after an intervention takes place when people are still in need of care and treatment, peoples’ homes become the arena for the provision of medical treatment and care (Chumbler Mann et al 2004; Rosser, Prosst et al. 2000).

In some cases advanced treatments are now moved to the patient’s home, treatments such as dialysis, COPD treatment and other therapies (Rogers, Small et al 2001; Rodriguez-Ascacho, Villalar 2002; Maio, Mohamed et al. 2003; Lindahl 2005). Patients with chronic diseases can be supported at home by way of telemedicine equipment and receive advanced help and monitoring by specialist consultants at a distance from the hospital (Koizumi, Yamaguchi et al. 2003; Bratan, Jones et al 2004; Koizumi, Takizawa et al. 2005). Also, in order to minimize the need for hospital treatment and to reduce the length of stay and recurrent hospitalisation of patients with a chronic illness, the patient can receive help and regular control by telemedicine at home and by a visiting nurse equipped with medical devices (Kim 2004; Averwater and Burchfield 2005; Vontetsianos, Giovas et al. 2005). To facilitate the chronically ill patient’s self-management and to reduce visits from nursing staff, patients can be equipped with a patient-managed home telecare system with integrated clinical signs monitoring (Black, Andersen et al 2001; Celler, Lovell et al. 2003), or with educational and informational support to relatives (Magnusson 2005), based on ICT. Other systems can send an alert when critical functions in the apartment have been left on while the patient has gone out or has gone to bed. To provide patients with distance healthcare, telemedicine, video and telecommunications can be used (Chae, Heon Lee et al 2001; Burdick, Mahmud et al. 1996) to replace long distance travel, give the patient a better quality of life and also reduce treatment costs.

The telemedicine system can also be assessed by intelligent home monitoring devices (Cheek, Nikpour et al 2005; Meystre 2005). Normally telemedicine systems have a broader and more individualized approach than the ‘Smart home’ system (Rantz, Marek et al. 2005a; Rantz, Marek et al. 2005). For elderly people and those with different kinds of impairments, modifications and adjustments to the apartment often provide the chance to stay at home (Renwick 1996). It has also been shown that the elderly do not hesitate in using new technology and they also appreciate telecare as a mean to stay in their own home longer (Östlund 1995; Levy, Jack et al. 2003).

In Sweden, as in many western countries, home care of the elderly is shared between different healthcare provision organisations (Lind, Sündvall et al. 2002). This calls for a consistent flow of information in order to provide all the actors in the process with correct information at any time, but it also demands a robust transmission system.
Incorrect documentation, information and possible time loss because of incorrect information or problems in accessing the information are concerns that must be resolved in order to provide safe home care.

This development must lead to a discussion of the home as a hospital ward from time to time, and the demands it places on FM and security (Soberman 2001). So far the prospects of telecare services and ‘Smart homes’ has been very little discussed in parallel, although in many aspects they share the same technological base (Tang and Venables 2000; Sixsmith 2000). In medicine there is an ongoing discussion about medical home care regarding inflexible transition of hospital routines and norms to the home when treating patients in their own home (Lindahl 2005). In this discussion the patient’s home is the arena for various personnel from the medical profession, each with different perspectives. It is also reported that one reason children dependent on ventilators spend more time in hospital than was necessary or desirable is because of poor management within the hospital organisation and also in collaboration with other external services, complex social issues and housing problems (Noyes 2002). A qualitative study of user perspectives published previously by Noyes found that children and young people who are dependent on ventilators spend many months and in some cases years in hospital despite the fact they no longer have a medical need or wanted to be there. Noyes has identified six issues as significant barriers that prevented the children and young people from being discharged. These were: the attitudes of professionals; the lack of joint commissioning and accounting responsibility; general poor management both within the health service and in collaboration with other services, complex social issues, housing problems and a general lack of auditing and outcome measures. The home is thus an important arena in the home care service but the importance of FM in home care has not yet been explored to any extent. The ‘Smart home’ is one aspect of FM and in recent years there have been papers published about the relationship between ‘Smart homes’ and the telemedicine (Tang and Venables 2000; Rialle and Duchene et al 2002; Rialle, Lamy et al. 2003; Demiris 2004; Koch 2006) and the need for information transmission of medical and care data from the home to the carer. This is still mainly implemented from the medical perspective and less from the FM perspective.

(Footnotes)

1 Socialstyrelsen (2001-2006).
3 Methods

3.1 The Scientific Approach

This section contains an introduction to some of the philosophy of science relevant for the research theme and a declaration the scientific framework in which the research is to be found. It starts with a short presentation of some different philosophies of science in order to place this work in its scientific context. One paper uses game theory to analyse the possible outcomes of the interaction between different FM groups and between one FM group and a CP. A short presentation of the basic concept of game theory is given here. During the first part of this work an interactive approach was used in which the implementation of a storage system for one FM organisation was carried out. The interaction utilised the action research approach and a brief presentation of this form of scientific work is also presented in this Section. In the methodology the work and its methods are presented. Finally the limitations of the work are given.

3.2 Related Philosophy of Science

This research is conducted in the field of social science. There are several different disciplines in the social sciences, for example economics, psychology, sociology and administrative science (Mo 2003). Social science and natural science have in common a basis in positivism, but social science cannot make any predictions in the way natural sciences believe they can. This means that ‘explanation’ must be replaced by ‘understanding’, since there is no way a form of social behaviour can be predicted. Human beings act upon theirs reasons and what they do must be meaningful for them and therefore based on motives and on rules of the context (Lundequist 1995). There is no ‘cause’ and ‘effect’ in the field of social science. Objects can be observed and they follow laws of nature; least of all do they think (Mo, ibid), although there can be measurable data collected in social science and in that instance social science research is positivistic. It is related to some data which is real and that can be censored. Habermas (Mo, ibid) have divided science into three different groups: Natural Sciences, which are empirical and analytical, and whose interest is technical and gaining control in able to produce what we need for material existence; Humanities, which are historical-hermeneutic, with a pragmatic theory of truth, helping people communicate through knowledge, and the Social Sciences, the critical science. Truth is connected to the meaning of what is happening. Habermas means that research in social science leads to reflection in action. Collingwood emphasises the importance of the scientists to ask themselves (sensible) questions about the material
with which they are working. By using clever questions and logical reasoning the material can give us a picture of what is the truth. In the same way the hermeneutic asks questions to test hypotheses and new questions to include what was not covered by the first one, and enters into a ‘hermeneutic circle’ which can never be ended, since the truth is actually not attainable, but it is possible to get closer and closer to it by this way of questioning. Chalmers (Chalmers 1999) writes that since deduction is not possible in any other science but mathematics, and induction also has limitations, the closest one gets to the meaning of science is achieved by using actual knowledge today and by performing new experiments. He is in favour of the New Experimentalist, at least when discussing natural science.

Most of the work is based on empirical sources and written studies. The philosophy of science approach is therefore close to post-positivism and realism. It tries to go beyond post-positivism in that the analyses go into the possible reasons for why certain behaviour has been found. The aim of Positivism as a philosophy of science models observed phenomena in nature leading to tentative laws of nature in order to predict, and control nature (Mo, ibid).

3.3 Game Theory

The analysis of interaction between two actors, FM and the CP, which is a conceptual approach, has been carried out with the help of game theory, by using some well-known games. In the licentiate dissertation this conceptual study analysed the interaction between two FM companies. In this thesis, game theory has been used to analyse the conditions for interaction or cooperation between FM and a CP. This is chosen as a way of studying how two actors, who are not actually interacting, would appear if, in fact, they were interacting.

3.3.1 Basic Definitions of a Game

In describing a game1 some essential elements are used: players, actions, information, strategies, payoffs, outcomes and equilibria. A game must include at the very least players, strategies and payoffs for which the actions and information are entities used to build the game. A combination of the players, the action and the outcomes is collectively called the rules of the game. The goal for the constructor of the game is to find the equilibrium with the use of the rules.

In a game the objective is to find an equilibrium, that is, the strategies players pick to maximise their individual payoffs. To decide on the best strategy there must be an equilibrium concept. There are only a small number of equilibrium concepts generally accepted; one is the Nash equilibrium and the other is the dominant strategy.

3.3.2 Dominant Strategy

A dominant strategy is the player’s strictly best response to any strategies the other players might choose. If there is no dominant strategy the players must work out each others’ actions in order to pick out their own best strategy.
3.3.3 The Nash Equilibrium

The Nash equilibrium is a set of strategies, one for each player, such that no player has an incentive to unilaterally change their action. This means that all of the players have chosen their best strategy and no one will change their strategy.

3.3.4 Cooperative and Non-cooperative Games

A cooperative game is a game in which the players can make binding commitments, as opposed to a non-cooperative game. In a cooperative game the players can split the gain by making side-payments. In a non-cooperative game they instead add extra actions.

3.3.5 Information Sets

A game information structure is often obscured in strategic form. The information set is used to describe in a precise way the knowledge each player possesses and at what point in the game they attained this knowledge. All players do not need to know equally as much about all conditions for the game or other players’ moves, or about forces beyond the control of the players.

In a perfect game all players know exactly the same thing and there is only one possible direction to take at each point of decision. Nature is a pseudo-player who takes random actions with a specified probabilities. Everyone can observe Nature’s moves and they know where they are in a game-tree\(^2\). No moves are simultaneous because in that case another player cannot make their moves based on the knowledge of the other players’ move. In a game with certain information Nature is not allowed to make a move after the players have made their moves. If the outcome of the game is dependent on Nature as the last player, it is a game with uncertain information.

A game with asymmetric information is a game where a player has private information. In a symmetric game a player must have the same elements in his information set as all the others. Thus a simultaneous game can be symmetric, since all players have the same information, Table 3.

<table>
<thead>
<tr>
<th>Information category</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>Each information set is a singleton</td>
</tr>
<tr>
<td>Certain</td>
<td>Nature does not move after any player moves</td>
</tr>
<tr>
<td>Symmetric</td>
<td>No player has information different from other players when he moves, or at the end nodes</td>
</tr>
<tr>
<td>Complete</td>
<td>Nature does not move first, or her initial move is observed by every player</td>
</tr>
</tbody>
</table>
3.3.6 Simultaneous and Sequential Game

In a simultaneous game all players’ moves are made at the same time and they have the potential to see what moves the other has made. In a simultaneous game the information is not perfect. If the players’ moves were made sequentially the information would be perfect if all players knew equally as much as the others about the moves already made. The order of the moves is often important for the development of the game and can change the outcome of the entire game. A housing company acting in a situation with prices governed by the municipality housing companies will be able to use that in their own stock since the municipality housing companies set the price first.

3.4 Action Research

Action research is known by many other names, including participatory research, collaborative inquiry, emancipator research, action learning, and contextual action research (O’Brien 1998). It has its roots in the late 1940s when Kurt Lewin, a social experimental psychologist, was interested in social problems and conflict handling. He first coined the term ‘action research’ in his paper *Action Research and Minority Problems*, 1946 (Lewin 1997). The method is used in real situations since its primary focus is on solving real problems. Stephen Kemmis has developed a simple model of the cyclical nature of the typical action research process. Each cycle has four steps: plan, act, observe and reflect (Kemmis and McTaggart 1997).

Figure 6 clearly displays the iterative

![Figure 6](Simple action research model (Maclsaac 1996))
nature of action research along with the major steps of planning, action, observation and reflection before revising the plan. This is similar to the numerical computing technique known as successive approximation; the idea is to close in upon a final goal or outcome by repeated iterations.

3.5 Methodology

This work has been carried out in two separate phases. The first was terminated with the licentiate dissertation in 1997 and the second phase is the one introduced in this thesis. The two phases are linked together in their common arena: housing and FM. When the first phase was conducted one of the most discussed issues was the implementation of ICT in the building industry and in FM. Work flow and document-handling systems together with digitalizing drawings was on the agenda. The information used in the FM industry was somehow unclear and the need for more knowledge about information handling, especially strategy on how to use information in FM, was requested. The purpose of the licentiate dissertation was therefore focused on the handling of information in FM. By studying what kind of information that was used and how it could be stored in the emerging ICT used in FM, it was apparent that the kind of widespread information used in FM called for appropriate ways to store and manage all information. Since the FM companies are divided into different functions, the information was also different in the various functions. The drawings with their own huge A0 format cannot easily be stored in the same way as documents in the traditional A4 format.

3.5.1 Research During the Licentiate Dissertation

The first phase of this work studied different aspects of information and the use of information in FM. One of the studies focused on the use of information and where in FM the information was used. Another study focused on how information could be stored and retrieved in FM. The first phase took the form of a questionnaire put to the personnel in two FM companies. In the second study action research was used as a method. One of the two companies in the first study was involved in the second study. In the third conceptual study the possible interaction between two FM companies was analysed using the game theory as mentioned before. This third study has now formed the foundation of a similarly analysis where one FM company and a CP are the players in a game.

3.5.2 The Companies

The companies involved in the first enquiry were AB Härmod Bostaden in Umeå (HB) in the north of Sweden, and AB Stångåstaden in Linköping (SS) in central Sweden. At that time, in 1995, HB managed 11 500 apartments and 150 000 square metres (m²) of premises. In the city of Umeå there were about 97 000 inhabitants and a total of about 41 500 apartments, and HB was the biggest FM company in this region with 230 employees. At the same time SS managed about 19 000 apartments and 87 450 m²
of premises. In the city of Linköping there were about 129 000 inhabitants and a total of 59 000 apartments. SS employed 330 members of staff.

3.5.3 The Questionnaire Used in the First Study

The questionnaire in the first study was divided into seven different parts. The first part was about the respondents’ own working conditions in general. The remainder of the questions concerned the following issues: general information about the houses, contract and finance, drawings and technical documents, FM documents, and technical systems. (The questionnaire is presented in Lundberg (1996).

3.5.4 The Extent of the First Study

During 1992 the questionnaire was submitted to all personnel in the two companies. The respondents were selected in two steps and in the first step all 325 persons answered the questions. Since it was unknown which of the personnel in the companies had contact with any kind of information the study was looking for, everyone was included in the first selection and, depending on whether or not they did have contact with any kind of information in their job, they were included in the final material of the study. In this way the answers of 196 people were included in the study.

3.5.5 The Second Study

The second study was a case study of the development of a prototype for a digital archive in the company AB Härom Bostaden in Umeå (HB). Work with the prototype was followed through the whole development process in the years 1993 to 1995. Documents were read and discussions were attended. Those in the personnel affected by the new archive routines were interviewed. The study was set up as an action research project where the findings were discussed with the development group in order to find a more efficient solution. The details in this work have been separately reported (Lundberg 1996) and are not covered in the paper included in this thesis.

3.5.6 The Research Model in the Second Phase

The research in the second phase is focused on the ‘aging in situ’ philosophy, which is today how the growing number of elderly should live. This is a trend which has emerged from the limits of society and without any deeper knowledge, so far, of how this affects FM. A certain amount of research has taken place in this area but very little where both home care and FM are considered together. In order to understand the kind of situations that might arise in the establishment of home care, a theory model has been developed.

Distance care, where medical treatment and social service are provided at home, must rely on an indirect contact with the CP during the time the care staff are not in place or do not have direct contact with the patient. In advanced medical care at home the hospital can monitor the home by surveillance systems, which can also alert the hospital if any critical changes occur in health status.
Elderly people must be able to call for assistance themselves if in need of help. Distance care means that someone else other than the CP manages the space where the patient receives ward. In the direct care situation, the CP controls the whole care process (Lind, Sundvall et al. 2002). That includes control over the treatment, surveillance and all spaces where care is given. This is illustrated in Figure 7.

A care establishment in this case could be a nursing home for old people with severe cognitive impairment or a hospital where qualified medical treatment is given. At a hospital patients in a critical condition can be supervised by the care staff, Care(i), and Technology(i). An example of Technology is a patient surveillance system with control of saturation, pulse and heart frequency, non-invasive blood pressure readings and with alarms and readings continuously monitored by personnel in an intensive care ward. Another kind of technology is the existing and supervised computer network inside the hospital where the journal data, X-ray pictures and other care related information is kept. Hospital technology, Technology(i), is based on equipment redundancy, careful support and regular control of functionality. The establishment is organised and managed by the CP’s FM(i), and the CP has access to all spaces and handles the whole infrastructure in use. FM(i) includes the medical technicians, the facilities technicians and the computer experts. When a hospital is planned and built Technology(i) is an important part of the planning process. It means that all technology in use is adapted to the CP’s infrastructure and that all parts of the technology work smoothly together.

If an emergency occurs normally all the care resources, Care(i), are found in-house. That is, the specialist physicians, specialist nurses and care personnel, and an error in the technology would be discovered and treated quite rapidly. The risk of a patient being left without

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**Figure 7**  Care in a nursing home or hospital
supervision for an extended period of time is minimal.

In a nursing home the care personnel are present 24 hours a day, 7 days a week and a resident in a nursing home does not normally have the same need for medical treatment as that of a hospital patient. However, if an acute situation arises, the organisation must be able to deliver assistance with all possible speed. Care(i) in the case of a nursing home is based upon the nurses and the care staff. The CP also has routines for taking care of the residents depending on the situation; for example if there is a power-cut or a shortage of staff. The Technology(i) in a nursing home consists of the administration computers and an alarm receiver if the alarms are not sent directly to an alarm central. It also comprises the alarm unit at the resident's bedside. FM(i) might be divided into one management team for the administration of spaces and one management team for the building and the infrastructure. The Care(i) might also buy the FM(i) as a service instead of having it in-house. There is normally a close relationship between Care(i) and FM(i), even if they do not belong to the same company.

When care is provided from a distance the situation differs in many ways. In this case the CP has full control only over limited time periods and parts of the whole care process. Distance care also means that the CP only has direct contact with the resident during short but regularly recurring occasions in the person's home. In the meantime, during care absence, contact must be sustained with the help of technology and a method of communication that suits the resident (Jakobsen 2002; Savenstedt, Zingmark et al 2004). For a patient receiving more advanced medical care at home, it can include surveillance through different kinds of sensors attached to the body, together with analysing technology which automatically give an alert when the levels deviate from expected readings. For a resident with home service the communication might be facilitated by a safety alarm or an inactivity control, both connected to the resident's telephone connection. To handle acute and unplanned activities during care absence, the CP must make use of unscheduled care provided at short notice (Figure 8). To be able to call for unscheduled care during periods of care absence, technology is a prerequisite. Unscheduled care means care given by a mobile team with access to information about a specific resident at any time, but normally at night or at week-ends and holidays. The team also needs to have access to the resident's home without the person's assistance, and to be able to get in contact with back-up support if necessary.

For the care process to function the CP must rely on the technology but might not have control over all components included in that technology. Figure 9 illustrates this situation. The care technology, both in the home, Technology(h), and at the CP, Technology(c), is connected to a technical system in the building, Technology(f). Examples of the Technology(f) are electricity, lockers, telephone lines and WAN supported by the FM of the property. The
Methods

Technology(h) in home care is normally a safety alarm managed by the CP. The Technology(c) consists mainly of different kinds of alarm receivers and communication equipment supported by the CP organisation.

The consequence is that the CP is dependent on FM because the infrastructure of the property is a part of the care process. This is implicit and not discussed between the CP and the FM. The only direct contact, if any, between the CP and FM is when the CP needs information about how to enter the property to reach the resident, but this can also be handled by the resident and the CP directly.

The hypothesis here is that this is a hidden but important connection between the CP and FM and that the

Figure 8  Reliable technology is a necessary requirement during the care-absence

Figure 9  Technology interfaces for distance care
Methods

The significance of this relationship will be even more important if more and more advanced medical treatment is to be provided at home. This relationship must be made explicit and structured to secure the quality of future medical treatment and care in the home. The demand for cooperation rises when the technical aspect of care and medical treatment in the home grows; that is, when the Technology(h) becomes a more and more important part of delivered care. It is also necessary always to keep the Technology(h), Technology(f) and the Technology(c) compatible with each other.

3.5.7 The Extent of the Second Phase

The second phase consists of three different studies. One is a qualitative study based on thirteen projects all over Sweden. The goal is to analyse the way in which FM and the CP are involved together in a project regarding assistive technology for the elderly using ICT solutions. The sample has been presented for an expert panel within The Swedish Association of Local Authorities and Regions (SALAR), which had the option to include or omit projects in the total sample. The inclusion criteria were three:

1. The project must comprise a new method of technology or new ways of implementation of known technology for cognitive support in the home.

2. The implemented solutions must not be primarily medical.

3. The solutions must deal with any of the following areas:
   - Memory support
   - Safety and security
   - Communication

Each project has been visited or contacted for interviews. The thirteen projects, including the subprojects, have been studied and of these, ten strictly fulfil the inclusion criteria. From each of the projects written material has also been collected and studied in addition to the interviews. The material has then been analysed according to the models presented in the introduction of this second phase.

The projects have been sorted in the way they have been implemented (stand-alone, interconnected and installed in the home). The ten projects all deal mainly with elderly people and cognitive impairment. The projects are:

- The Swedish Handicap Institute (SHI), At Home with IT
- Stockholm (ICT to support independent living)
- Tierp (ICT to support independent living)
- Hudiksvall (ICT to support independent living)
- Göteborg, VisIT (ICT to support independent living)
- Linköping, ACTION (ICT support for relatives)
- Huddinge, Tentaculus (Cognition support)
- Halmstad, The alliance for health technology (ICT to
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support independent living)
- Norrköping, The new Home of Health (ICT to support independent living)
- Lund, (ICT for energy control including support for elderly safety)
- Stockholm, Vallgossen (‘Smart home’)

The projects have been studied according to their way of solving any of the three problems in the inclusion criteria.

The second study is a case study where the installation of assistive technology in the home of an elderly man has been studied in order to understand the complexity of even very simple installations when they are performed in the homes of elderly people. Many actors are involved and FM is a part which has not yet conceptually included technology for care and medical treatment into their area of responsibility.

The third study in the second phase has been carried out as an action research project. The implementation of a new sophisticated Safety alarm system for residents with home care from a CP was investigated. The CP staff undertook the implementation. The whole project started on 29 January 2004 and was concluded on 28 October 2004. A safety alarm was installed in the homes of 142 residents during a five and a half month period (March to August). In September, 80 of the alarms were replaced due to malfunction. The safety alarm was not only a passive alarm (an alarm triggered when the resident pushed a button on a wrist unit) but it was also able to send an alarm if the resident fainted or left the apartment. It also kept track of the use of the safety alarm unit. The safety alarm was connected to the resident’s normal telephone lines and it had all the communication features of a standard safety alarm. When an alarm was triggered it was sent to the CP where it was received by the personnel both on a computer and on a mobile phone. All alarms were logged and the log was saved on the computer.

The study is based on action research together with interviews and correspondence by letter with the management of the CP and the personnel responsible for the alarms. The alarm reports have been confirmed, as has the supplier’s correspondence in each case. The alarm receiver log has been studied at every visit to the site. The result is based on 31 reports regarding difficulties or faulty equipment. The site has been visited once a week during the period January to May and again during the period August to October. The author has also attended meetings between the supplier and the CP where the alarm situation has been discussed.

3.6 Limitations

This work is approached from the perspective of FM in a housing company as being a part of the home care process. Also, the study is limited to the situation in residential apartment blocks. This work deals with the home environment and the mutual arena this creates for the staff in home care and in FM. It is also the home of the individual living there. Many aspects of
this situation can be discussed and some borders must be drawn to indicate which aspects are to be studied. In this thesis the design of the apartment and the working conditions for the home care staff have not been scrutinized although they are as important as the question of infrastructure and the information processes. This work is concerned with information and here information is to be understood as different kinds of data and their transmission. This means, then, that a document or a phone call is a piece of information, but so also is the safety call from an old person to a call centre. When discussed in this thesis, infrastructure means the communication and the transmission structure in a dwelling or in a building that is being studied, or different kinds of communication networks connected to the building or apartment. In several projects in Sweden and around the world the supply of information to home care staff is developed and studied. The project Old@home (Koch, Hägglund et al. 2005) and VIHO (VIHO 2006) in Sweden are examples of such projects. This angle of information handling is not covered in this work, but in the future it will be important for the mobile team to be sure to make contact with their base in order to get instant access to information about a patient, and here the infrastructure of an apartment could be of importance.

New assistive technology for elderly, used in some projects, has a close resemblance with so-called ‘Smart homes’ (Rantz, Marek et al. 2005). In many ways they use the same technology in sensors and radio based control systems, but they are used for a different purpose. The eventual marriage between these two types of system has not been studied in this work, but the similarities have been noted and are discussed.

Home care in Sweden is the responsibility of the municipality/local authority and is primarily undertaken by nurses and care personnel. Home care does not deal with medical treatment, which is the responsibility of the county council and not the local authority. In this work the focus is primarily on the home care situation and not on home medical treatment. The effect of the infrastructure on the medical treatment at home is, however, as important as it is in home care but it is not discussed in this work. The effect and results concerning the home care operation can in many respects be transferred to the medical home treatment, but it is a different set-up and its conditions differ and must be studied on their own terms. In this work there are a number of references to the technology used in medical home treatment to illustrate use of infrastructure or as examples of distance care. What is said here about home care normally also applies to medical home treatment, and the reverse.

An important issue also connected with the question of distance care, telemedicine and care at home in different forms, is finance. It is a fact that in Sweden the costs for social services and elderly care will become a heavy burden to that part of the population in work and that this is an important incentive for proactive action. This aspect has not been the focus for this
study and is only infrequently referred to in this work.

(Footnotes)

1 The description of games follows Rasmusen, E. (1994)
2 A game-tree is an extensive presentation of a game
Methods
4 Published (and Submitted) Papers

4.1 Paper I

The first paper was a study about what kind of information is used by which people in a housing company. The study was based on the hypothesis that the use of information could be predicted depending on where in a company a person was working. A functional model (Figure 10) of the housing company was presented which described the company according to a function in FM.

Figure 10  A housing company and its production organisation

The function model consists of an overall management function and one for production of products (that is, the hardware such as apartments and premises), and one for the production of services. The idea was that it would be possible in advance to decide where different information in the housing company would be used in the flow of information during a construction. In this way it would be easier to prepare documents about the building for FM and to give adequate information to all categories in FM. At the time of the study it was not always apparent that the caretaker would be given information about handling the material in the houses to keep them in a good state. Questions such as “What kind of solvent can be used on linoleum?” must be answered. This is also the kind of information that should be transferred to the tenants in order to provide them with guidelines for maintenance. Since the life of a building depends on all the included materials, it is important for FM to get as much information as possible to keep the building intact and productive for as long as possible before renovation must be carried out. Also,
the construction industry deals with a large amount of new material and assembly methods, which makes it important to have an information system, which provides the relevant function in the FM company with correct and current information.

The information has its qualitative aspect and in this study the aspect was divided into three levels of information: strategic, tactical and operational. The assumption is that strategic information is used by the management in long-term strategical decisions for the company, such as profits, market and competition analysis. The tactical information is used to keep a check on cash flow, regulations and legislation questions. The operational information concerns how to do things and how they are done.

The study was conducted in two local authority housing companies in the form of a questionnaire put to the staff. The questionnaire was divided into seven different parts. The first part concerned the respondent’s own working condition in general. The rest of the enquiry covered the following: general information about the buildings, contract and finance, drawings and technical documents, FM documents, and technical systems.

The answers showed that there was a correlation between the arrangement of the staff into the model and the use of information. It was strong enough to be used as a guideline for the constructor to make a package of information dedicated to the different functions in the housing company.

4.2 Paper II

This paper is a case study of the way in which a housing company developed digital archiving for the company’s old and new documents. The study was carried out from 1993 to 1995 as action research.

In the 1990s it became clear that more and more information was being collected concerning buildings and apartments than ever before. It was important to know what was delivered and on what terms. At the same time the global network was evolving with a new way of communicating: the Internet and Email. It was an opportunity for increased productivity for the companies, but at the same time it called for a new type of digital information structure. Those who have their information in digital form have the potential to benefit from the advantages of an electronic mail system.

From a housing company’s point of view the information serves different purposes. First of all it is used to manage a certain task. Documents that are needed to enable the reconstruction of a course of events should be archived; in this way it is possible to see afterwards what has been done and how it was done. These are important issues in insurance matters, for example.

A general assumption regarding the documents a housing company needs to archive is that they contain unstructured information of high value, and access to that information must be simple and fast. Unstructured here means that the archive has to contain information
from a variety of sources: drawings and pictures, as well as contracts and calculation.

When documents are archived in a digital form it can help to makes decisions more precise and accurate because all information needed to underpin the decision is easy to retrieve. It is also much easier to get hold of all the facts in a case in a much shorter time.

The question of how to use information in a company is therefore important to answer in order to choose the right method of archiving. It must be possible to meet new demands within the archive system during its lifetime. The solution for handling the information must be robust and sustainable.

Questions were raised during the development of the digital archive system: What should be stored and by whom? Where should it be located in the company that was spread over a large geographical area? Should it be separated, with a local archive in each sub-organisation? How would this be adapted to the new organisation and others to come?

New demands for customer adaptation, resulting in individual agreements, and each apartment being equipped for the individual customer, created much more information to be handled.

The archives in the company were located and investigated. These archives were the property archives, the drawing archive, the account archive and the construction archive. The most important was the property archive. It contains documents which will always be used over time and they describe the history of a building from the time it was built until its current status.

The archived documents were in fact only used sporadically because it was difficult and time-consuming to access them. The property archive can be used to make financial analyses over the company’s entire housing stock over time. In practice, most of the current documents were stored in the clerks’ offices. This made them even more difficult to access and use for others in the company. The need for a common and fast way to both archive and retrieve documents, regardless of where in the company they were needed, was self-evident.

The many different document types were a problem. A traditional way to create and store drawings is, for example, to use a CAD system. But CAD is a skill that requires knowledge and much practice to master. It is rather over-doing it in a FM company. The FM staff need to make a note on a drawing when a minor change in the apartment or the building is carried out, and can therefore use a less complicated system for drawings, but as drawings actually come from the construction phase as CAD-drawings, a sort of hybrid is needed.

For each of the different documents there were different needs. A basic demand of the system was for it to be able to handle all the different kind of documents.

The most important reason for the company to establish a digital archive was reorganisation of the company, and
future reorganisations. The investigation of the routines and handling of documents showed that it is closely related to the company organisation and that a digital archive would be a way of solve many different problems occurring in a reorganisation.

The staff were highly involved in the development process as they described how they were working with documents. They were also asked about their demands on an archive. This engaged the staff and gave them expectations of the digital archive.

One important requirement of the digital archive was that it should be possible to navigate inside it as if it had been a traditional paper archive. This led to an interface much like a flap system in a folder. The same structure as in a traditional folder system was also used to facilitate the search for a document.

The work was accomplished in several steps. It was interesting to note that what at the beginning was a limited use for documents later became a complete digital working environment.

The structure of a digital archive was seen as an important way of organizing the information according to the use of strategic, tactical or operational purposes. In fact, it was regarded as a necessary system to handle all the different information created today in the construction industry which must be delivered to FM in the operating phase.

In the concluding section the importance of digital documents in FM for a safe home care delivery will be discussed.

4.3 Paper III

This paper is a conceptual study of the strategic actions of municipal housing companies, based on information from within the organisations and from external sources. The study is based on game theory and the use of some simple games presented in the literature by several authors. In this paper the presentation by Rasmusen (Rasmusen 1994; Susskind and Cruikshank 1987) has been followed. In three different games this idea is tested to see what outcome can be acquired when used in situations where housing companies are involved. The first one describes a situation where two housing companies act in the same locality where the quality is low and the movement among the tenants is high. It is a traditional situation in an area where people do not feel comfortable and have difficulties in identify with the area. An area as such often functions as a transition to a more desired housing area. The costs to the companies in keeping an apartment in good condition is high. The apartments are exposed to wear and tear and must be repaired and decorated after one household has moved out and before another can move in. It is preferable, therefore, if the area can rise to a better standard and have higher quality to reflect people's demands. To model this situation the game known as 'The Prisoners' Dilemma' is used. In this game two actors are involved in a situation that damages them both because their incentives lead them away from a cooperative action. As used in this model, both housing companies are in competition with each other and the
way they can compete is by changing the quality of their apartments and the external properties of the buildings. The payoff reflects the investments they have to make in order to reach better quality in their buildings and the surrounding environment. If they invest in high quality both internally and externally, the quality of the housing area rises and that benefits both housing companies, even if only one of them raises the standard of their property. But the payoff is highest if both make the same kind of investment in the area. The result shows that there will be no action towards a higher standard in the area if this game is only played once, but if the game is repeated the players can make other commitments and in this way start resource enforcement in the area.

The second game reflects the consequences of the new establishment of a new housing company in an area where there are already a number of actors, and with one company that dominates the apartment market. What strategy should the new company choose in order to gain as much of the market as possible? The game has a weakly dominant strategy and is analysed step by step.

The new company (NC) has two different actions to choose between: to take a shortcut by buying property in the area, or via a longer route – building new homes. The dominating company (DC) can also act with a short perspective and has the advantage of already being established in the area. If DC chooses a longer perspective it gives NC a better chance of presenting an attractive offer to the market.

For the DC it is the same whether the choice is the short or long-term if NC chooses short. Therefore DC chooses short. NC can only choose the longer route if it has already been chosen by the DC. The player has the same action set [Long, Short] but their payoff is never the same. This is illustrated in Figure 11.

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th>Long</th>
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<tbody>
<tr>
<td>NC Short</td>
<td>(200,-200)</td>
<td>(200,-200)</td>
</tr>
<tr>
<td>NC Long</td>
<td>(100,-100)</td>
<td>(300,-300)</td>
</tr>
</tbody>
</table>

Payoff (NC,DC)

The figure shows that if NC chooses the long route DC is better of with the shorter way. But if DC chooses the short way NC is better choosing short, too. The strategy set (short, short) will be the most likely one they choose.

In the third game the issue is to make a decision about demolishing a building in its stock. The company has to choose between demolishing one which is of inferior condition but well-liked by the tenants, and one which is in a better condition. It is rather an odd situation but is has happened. The situation is reminiscent of those decisions that were taken by companies in areas with plenty of empty apartments. It is an example of a cooperative game where the actor who makes the first move will decide...
the result of the game.

The paper shows that games can be utilised in strategic thinking in the housing market and it can be a useful way of identifying the situation where traditional market forces are displaced by other forces such as laws and regulations. The game theory approach is used in chapter 5 in order to analyse the tacit game in which the FM and the CP can find themselves.

4.4 Paper IV

The paper covers a qualitative study based on 13 projects all over Sweden during 2006. There were three inclusion criteria:

1. The project must comprise a new technology or new ways of implementation of known technology, for cognitive support in the home.
2. The implemented solutions must not primarily be medical
3. The solutions must deal with any of the following areas:
   a. Memory support
   b. Safety and security
   c. Communication

Each project has been visited or contacted for interviews. The thirteen projects, including the subprojects, have been studied, and of these ten strictly fulfil the inclusions criteria. Apart from the interviews, written material has been collected and studied from each of the projects. The material has then been analysed according to the models presented in the introduction.

The different projects represent different regions in Sweden. All projects but one start with the assumption that the demographic trend will result in new demands in care for the elderly and in a rising economic burden on social home help and home care. Since this is the case over the entire industrial world, many companies consider this to be a most interesting future market. Therefore these ideas bring companies and communities together in co-operation and alliances to develop solutions to this prospective problem. The development is basically business driven, which means that there are often one or two companies behind the resources for development of the new technology. The community is involved in delivering the empirical data and the knowledge about the kind and the magnitude of the problems to be solved. They also act as a test-bed for forthcoming solutions. Knowledge built in this way never crosses the borders of the alliances and therefore the same problems are investigated over and over again by new developers and new companies. In neither of the studied projects is there a universal recognised body of knowledge that can be developed by a company.

The result shows that the involvement of FM in a project concerning home care is not common. There are especially two areas of problems that are of certain interest here:

- The door lock and
- Telephone communication

There are several projects that have identified the lock problem. The CP must have a key for every resident for whom they provide service. That adds up to a lot of keys and a huge
responsibility for keeping the keys well-secured. Safe handling of the residents’ keys involves complicated routines that must be followed by the personnel each time a key is to be taken out of its place of safety. While the staff carry the keys there is no way of guaranteeing that a key will not be copied; the very possibility is a potential risk. It would be much easier for the CP if a key were instantly in place when needed. One way to do that is to use some form of electronic key. Such keys can use access controlled by a mobile phone, for instance. The solution of an electronic key must be discussed with the FM otherwise a traditional key is still needed to get in through the main entrance of the building. The solution as a part of the care process is interlinked with FM.

The conclusion is that both the CP of care at home and the FM have a joint interest in keeping each other informed on what is going on in each respective profession, so they need to cooperate if more advanced home care can become a reality.

4.5 Paper V

The purpose of this paper is to demonstrate the complexity of assistive technology when it comes to putting it into practice. The Paper refers to a case study performed in a suburb of Stockholm where a reminder alert was installed in the home of an 80-year old man with mild dementia. The disease was progressing and his neighbours were at this stage forced to check his apartment whenever he left his flat. In this situation it was decided to install a reminder alert.

This case study tries to demonstrate how the installation process is one aspect in a much broader context. It is related to a property owner’s facility management and to the overall objectives. The paper also tries to point out what kind of problems the installation could be expected to address. The installation is only one of several different elements that have to be thoroughly documented. It is the outcome of the identification process that has to be carried out by medical experts and occupational therapists. A certain kind of cognition problem in certain kinds of living circumstances results in one specific treatment scheme and sometimes in the installation of assistive technology, while in another context it would give a different treatment. When the remedy has been described the installation process takes place. It is often done under the supervision of an occupational therapist.

In the two ‘worlds’; care and technique, the approach is basically the opposite. The occupational therapists concentrate on the individual and the individual’s needs. Sometimes personnel in the caring profession have a tendency to hesitate when applying new technology and prefer to avoid it. There is a fear of exchanging human care with robots. The technician on the other hand is mostly concentrated on how the gadget actually works and not necessarily on how well it fulfils its task for the person to be helped.

Some of the questions that have to be answered are:
- What kind of investigation in the customer’s home must
be carried out before the installation?
• By whom?
• What kind of documentation is needed for a successful home installation?
• How much preparation can be done in advance, before the installation has begun in the customer’s home?
• How can the process be monitored at all stages?

Before the installation a technician visited the customer to check all installation details. All the parts needed for the installation were enumerated and for most of them their serial number at manufacture was given. An installation plan was drawn up and an installation firm contracted. That firm in turn had to employ a subcontractor for the power installation. The occupational therapist chose a preferred day for the installation with the customer and could agree it with the installation firm.

On the first day the installation took about eight hours. The occupational therapist had to make a new appointment with both the customer and the subcontractor. After another week the subcontractor had still not been to the customer’s home; it took almost two weeks to complete the installation.

After the installation was finished and the system was up and running, the occupational therapist sent all the material to the housing company so that they could make a note of it in their apartment register; in that way the installation could be managed in future by the housing company. The installation had now passed to the second stage where the management of the installation had to take place.

A couple of weeks after the installation described above was finished, a check was carried out to find out whether the documentation had been taken care of by the facility management organisation; it had not.

This process illustrated several problems of, from a technical point of view, quiet a simple installation.

It is obvious that there needs to be close and active cooperation between the organisation that will be responsible for maintenance (in this case the housing company) and the organisation responsible for the installation of the assistive technology. It is also important that a routine is put in place and followed. If assistive technology is to be an important part of the care program for elderly people then it is hugely important that the installation process works smoothly and easily.

4.6 Paper VI

This paper is a study of the implementation of a new and technologically advanced safety alarm system for elderly. The implementation and the study were performed during 2004 in the homes of 142 elderly people. A total of 31 reports of problems with the safety system is the basis for this study.

All of the residents in this study had a traditional safety alarm to help them get in contact with the CP during a time of care absence. They were all used to the functions of a safety alarm and the only
obvious difference in the new model was the wrist unit. They were also all informed about the new equipment and the benefits to be gained from the new facility. The automatic alarm that would be activated in the event of a fall was especially appreciated.

Before the installation, the training of five ‘super users’ was launched on 29 January 2004. The same week as the implementation began (29 March), there were complaints from the personnel about the alarm equipment. The installation was much more complicated than claimed by the supplier.

On 13 April alarms were installed in the homes of fourteen residents. Two days later, on 15 April, the first report of a customer’s problem with the alarm was issued. The alarm could be triggered without warning in the middle of a telephone call that the resident was making. The technical explanation was that the alarm had the highest priority and they could therefore terminate the ongoing call. Other complaints came from relatives who could not get in contact with their elderly relative, which caused them anxiety. When the trial was terminated on 28 October, all the users went back to their conventional safety alarm.

The evaluation of the trial showed that the powerful alarm system was able to send so much information about the resident’s activity and behaviour that the telephone lines of the residents were often engaged. Previously, the residents triggered the alarm themselves, but now the alarm itself decided when to send an alert. A close check of the structure of the alarm system also revealed that there was no internal strategy that gave different classification to different alarm types. Since the alarm was set to collect all possible kinds of information from the user, there was also an overflow of information sent from the user to the CP. This meant that all lines were busy in the alarm receiver when all the information was sent from the users. The alarms were acting according to the supplier’s specifications but the specifications did not match the communication system in the homes of the residents. The conclusion was that even if it would have been of interest to have all kinds of information about the resident to improve surveillance at a time of care absence, the infrastructure in the building was not able to handle all of that information, nor was the infrastructure at the CP capable of allowing such huge amounts of information to pass through the telephone lines.

The CP wanted to improve the quality of services in the residents’ homes and chose a safety alarm which could deliver much more than a traditional alarm. The concept of care absence is a reality to the CP, but how to replace this absence with virtual presence was not analysed thoroughly enough. The solution they chose was in fact transferred from an institutional alarm system. But in the home, telephone lines have not enough capacity to transfer huge amounts of data.

This study shows how important it is to analyse the whole chain of delivery before any new technology is implemented in a care situation. Facility management controls one of the most important parts of this
Published (and submitted) Papers

chain. Today the infrastructure of new buildings in Sweden is equipped with a digital signal system instead of the old analogue telephone lines. This will affect the equipment used by the CPs to maintain life-line support for the residents. The new infrastructure in the buildings requires contemporary safety alarms which can send alarms either on digital lines or by GSM. Whatever transmission system the care sector uses for its system, there will always be a shift in the infrastructure to modern and more efficient systems. Thus there is a constant need for cooperation between the CPs and FM.
5 Results

The first phase of this work, the licentiate dissertation, ended with the following statement: “The housing companies’ external information exchange with other actors around the FM needs to be furthered developed”. That is what the second phase of the work, this thesis, wishes to emphasize. Much has happened within information management inside property companies and housing companies during the past decade. The importance for FM to cooperate and exchange information externally has become even more urgent in the light of the ‘aging in situ’ trend among the elderly and in society.

This Results presentation begins with a reiteration of the results from phase one and places it within the framework of this recent research work and purpose. The sketch for the first phase, Figure 12, forms a conceptual interpretation of the various studies undertaken.

The studies mainly concentrated on the internal information handling of the housing company. In the renovation process of the housing companies, there was an obvious need for information on the general running of the buildings on all levels. The caretaker was going to have a greater amount of responsibility for tenant, in other words, customer,

Figure 12  A Mental model for the licentiate dissertation
satisfaction with the service and also for the financial results of their district. This was supported by the way the housing companies were organised according to different functions (Figure 13).

![Diagram of the four functions of Facilities Management]

**Figure 13**  The four functions of Facilities Management

In the sketch (Figure 12) the three studies are interlinked and form the basis for the licentiate dissertation. Information use, storage and the game analysis were all studied in the context of the companies’ performance. The next step taken in this thesis is to broaden this perspective to include one of the other significant external actors with whom interaction is crucial. The perspective cannot be that of the company’s performance only, it must be added to those actors who also have the tenants’ apartments as their location for service delivery.

Firstly the results from the licentiate dissertation are provided, followed by the results from the new studies.

5.1 The First Study

In the first study the information structure and the use of information was the main issue. A sample of information from five categories was presented to the staff in two different housing companies in Sweden. Both companies were members of SABO as well as being municipal housing companies. The information studied was that produced during a construction process. This was due to the ongoing digitalisation of information primarily from this process at that time. There is also a tradition of handing over a certain kind of information from the constructor when the building has been completed, meaning that there was a structure to follow when the sample was taken. In the property companies this digitalisation focused at the start...
on the blue prints. The respondents were included in the questionnaire on the basis on their contact with this information. All personnel were approached at the beginning of the study but only those who themselves confirmed any kind of use for this information were later included. This was an inclusion criterion. From the answers of a total of 325 members of staff, 196 individuals have been included, based in the inclusion criterion. The sample of questions regarding the use of information was collected from the following categories.

Table 4  Information Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Decision level (assumptions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic information</td>
<td>Strategic/tactical/operational</td>
</tr>
<tr>
<td>Agreements/calculation</td>
<td>Strategic</td>
</tr>
<tr>
<td>Consumption</td>
<td>Tactical</td>
</tr>
<tr>
<td>Blue print/technical information</td>
<td>Operational</td>
</tr>
<tr>
<td>FM documentation</td>
<td>Operational</td>
</tr>
<tr>
<td>Technical system</td>
<td>Operational</td>
</tr>
</tbody>
</table>

The connection between the decision level and the information category was made in the model described by (Ljung 1998) Figure 2 and (Omang 1994) in Figure 3 (See page 13 and 14). The classification was tentative and would be revised if necessary after the inquiry. The respondents were ordered according to the function they belonged to in the companies. The numbers of respondents in each function is shown here.

Table 5  The Respondents

<table>
<thead>
<tr>
<th>Function</th>
<th>Numbers of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management (M)</td>
<td>9</td>
</tr>
<tr>
<td>Construction (C)</td>
<td>10</td>
</tr>
<tr>
<td>Service production (Se)</td>
<td>177</td>
</tr>
</tbody>
</table>

The number of respondents mirrors the model (Figure 2) and the hierarchy of a housing company. In the Services function can be found the caretakers, the technicians and the foremen, as well as the area managers. The goal was also to reach those members of staff who are not often considered, such as the cleaning staff and the gardening staff, since they would need to have instructions on how to handle new materials and plants. However, they did not regard themselves as being among those in contact with the information delivered from the construction phase, and therefore they were not included, in line with the inclusion criteria. The Management function consists of the financial managers and the account managers. In the Construction function the production managers, the project leaders and the constructional engineers...
can be found. The answers from these members of staff are shown in the following table. The abbreviations in the table should be read as follows:

<table>
<thead>
<tr>
<th>Cat</th>
<th>Category</th>
<th>T</th>
<th>Tactical,</th>
<th>O</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Strategic,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Management,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Strategic,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Management,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6  The use of information

<table>
<thead>
<tr>
<th>Cat</th>
<th>No</th>
<th>Information</th>
<th>M</th>
<th>C</th>
<th>Se</th>
<th>M%</th>
<th>C%</th>
<th>Se%</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>1</td>
<td>Numbers of apartments</td>
<td>9</td>
<td>8</td>
<td>110</td>
<td>100,0</td>
<td>80,0</td>
<td>70,1</td>
</tr>
<tr>
<td>S</td>
<td>2</td>
<td>Numbers of premises</td>
<td>8</td>
<td>8</td>
<td>86</td>
<td>88,9</td>
<td>80,0</td>
<td>54,8</td>
</tr>
<tr>
<td>S</td>
<td>3</td>
<td>Areas</td>
<td>9</td>
<td>5</td>
<td>59</td>
<td>100,0</td>
<td>50,0</td>
<td>37,6</td>
</tr>
<tr>
<td>S</td>
<td>4</td>
<td>Agreement and contract</td>
<td>6</td>
<td>2</td>
<td>34</td>
<td>66,7</td>
<td>20,0</td>
<td>21,7</td>
</tr>
<tr>
<td>S</td>
<td>5</td>
<td>Calculation</td>
<td>6</td>
<td>4</td>
<td>25</td>
<td>66,7</td>
<td>40,0</td>
<td>15,9</td>
</tr>
<tr>
<td>S</td>
<td>6</td>
<td>Accounts</td>
<td>5</td>
<td>3</td>
<td>17</td>
<td>55,6</td>
<td>30,0</td>
<td>10,8</td>
</tr>
<tr>
<td>T</td>
<td>7</td>
<td>Electricity consumption buildings</td>
<td>6</td>
<td>3</td>
<td>40</td>
<td>66,7</td>
<td>30,0</td>
<td>25,5</td>
</tr>
<tr>
<td>T</td>
<td>8</td>
<td>Electricity consumption apartments</td>
<td>3</td>
<td>2</td>
<td>30</td>
<td>33,3</td>
<td>20,0</td>
<td>19,1</td>
</tr>
<tr>
<td>T</td>
<td>9</td>
<td>Heat consumption</td>
<td>7</td>
<td>6</td>
<td>48</td>
<td>77,8</td>
<td>60,0</td>
<td>30,6</td>
</tr>
<tr>
<td>T</td>
<td>10</td>
<td>Water consumption</td>
<td>7</td>
<td>5</td>
<td>41</td>
<td>77,8</td>
<td>50,0</td>
<td>26,1</td>
</tr>
<tr>
<td>O</td>
<td>11</td>
<td>Surface layers</td>
<td>0</td>
<td>6</td>
<td>49</td>
<td>0,0</td>
<td>60,0</td>
<td>31,2</td>
</tr>
<tr>
<td>O</td>
<td>12</td>
<td>Facade areas</td>
<td>1</td>
<td>4</td>
<td>22</td>
<td>11,1</td>
<td>40,0</td>
<td>14,0</td>
</tr>
<tr>
<td>O</td>
<td>13</td>
<td>Window areas</td>
<td>1</td>
<td>5</td>
<td>39</td>
<td>11,1</td>
<td>50,0</td>
<td>24,8</td>
</tr>
<tr>
<td>O</td>
<td>14</td>
<td>Ventilation system</td>
<td>3</td>
<td>7</td>
<td>84</td>
<td>33,3</td>
<td>70,0</td>
<td>53,5</td>
</tr>
<tr>
<td>O</td>
<td>15</td>
<td>Water system</td>
<td>0</td>
<td>7</td>
<td>82</td>
<td>0,0</td>
<td>70,0</td>
<td>52,2</td>
</tr>
<tr>
<td>O</td>
<td>16</td>
<td>Electrical installations</td>
<td>2</td>
<td>5</td>
<td>73</td>
<td>22,2</td>
<td>50,0</td>
<td>46,5</td>
</tr>
<tr>
<td>O</td>
<td>17</td>
<td>Apartment plans</td>
<td>4</td>
<td>6</td>
<td>62</td>
<td>44,4</td>
<td>60,0</td>
<td>39,5</td>
</tr>
<tr>
<td>O</td>
<td>18</td>
<td>Façade plans</td>
<td>2</td>
<td>4</td>
<td>30</td>
<td>22,2</td>
<td>40,0</td>
<td>19,1</td>
</tr>
<tr>
<td>O</td>
<td>19</td>
<td>Installation plans</td>
<td>1</td>
<td>7</td>
<td>52</td>
<td>11,1</td>
<td>70,0</td>
<td>33,1</td>
</tr>
<tr>
<td>O</td>
<td>20</td>
<td>Technical building information</td>
<td>4</td>
<td>7</td>
<td>40</td>
<td>44,4</td>
<td>70,0</td>
<td>25,5</td>
</tr>
<tr>
<td>O</td>
<td>21</td>
<td>Material information</td>
<td>1</td>
<td>5</td>
<td>85</td>
<td>11,1</td>
<td>50,0</td>
<td>54,1</td>
</tr>
<tr>
<td>O</td>
<td>22</td>
<td>Lists of built-in equipment</td>
<td>1</td>
<td>6</td>
<td>72</td>
<td>11,1</td>
<td>60,0</td>
<td>45,9</td>
</tr>
<tr>
<td>O</td>
<td>23</td>
<td>Gardening information</td>
<td>0</td>
<td>2</td>
<td>74</td>
<td>0,0</td>
<td>20,0</td>
<td>47,1</td>
</tr>
<tr>
<td>O</td>
<td>24</td>
<td>Updated plans</td>
<td>0</td>
<td>7</td>
<td>19</td>
<td>0,0</td>
<td>70,0</td>
<td>12,1</td>
</tr>
<tr>
<td>O</td>
<td>25</td>
<td>Operation instructions</td>
<td>0</td>
<td>7</td>
<td>36</td>
<td>0,0</td>
<td>70,0</td>
<td>22,9</td>
</tr>
<tr>
<td>O</td>
<td>26</td>
<td>Maintenance instructions</td>
<td>0</td>
<td>6</td>
<td>59</td>
<td>0,0</td>
<td>60,0</td>
<td>37,6</td>
</tr>
</tbody>
</table>

N=9 10 177

If the answers are sorted according to frequency in the Manager function for each of the information types, the usage can be illustrated in a diagram, Figure 14.
The use in categories other than the Manager function is broader and covers all aspects of information. The managers' use of information is strictly focused on the business management of the company. Finally, if this result is used to sort out the information types in the categories of Strategy, Tactical and Operational information, they are sorted as in following table, Table 7.

Table 7  Information Types Categorized by Use

<table>
<thead>
<tr>
<th>Manager</th>
<th>Construction</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of apartments</td>
<td>Number of apartments</td>
<td>Number of apartments</td>
</tr>
<tr>
<td>Number of premises</td>
<td>Number of premises</td>
<td>Number of premises</td>
</tr>
<tr>
<td>Areas</td>
<td>Technical documents</td>
<td>Material information</td>
</tr>
<tr>
<td>All consumption</td>
<td>Blueprints</td>
<td>Ventilation system</td>
</tr>
<tr>
<td>Agreements &amp; calculation</td>
<td>Operation instructions</td>
<td>Water system</td>
</tr>
<tr>
<td>Accounts</td>
<td>Energy consumption</td>
<td>Surface layers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lists of Equipments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventilation system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water system</td>
</tr>
</tbody>
</table>

Here the information types used by more than 50% of the personnel in the function are included. The use of statistics about apartments and premises is the only information that is used all through the companies.

The use of information is clearly divided between the management of the companies and company operations. All the information used by the manager...
function is strategic or tactical. The managers use none of the information regarding systems or the equipment of the buildings. It is important to bear this in mind when cooperation with other external services and organisations is discussed.

5.2 The Second Study

In the second paper the archiving and retrieval of information is studied. The study was performed at a time when major changes were taking place in document handling methods. Electronic mail was just appearing and there was intense activity surrounding the question of how to transfer information between the construction process and FM. New research programmes were planned within this area; (Kärnekull and Lundberg 1995) is one example. For the housing companies this discussion led to the insight that digital documents must be stored somehow and at Bostaden AB, Umeå in the north of Sweden, this triggered an archive project. In a study it was shown that the cost of archiving documents in the traditional way could be estimated to be 70% on wages, 20% on storage volume, 5% on equipment and 5% on consumables (DAFA 1993). It was also reported that within an organisation people make on average nineteen copies of each internal message despite the fact that it is already stored on computer. This was, therefore, not only a question of how to archive the company documents; it was as much a question of how to change the organisation’s way of working.

The project was driven by technological interests but the personnel were soon involved in order get the correct idea of how the information was used in the company. The project dealt with the existing archives and documents as a starting point. It showed that a number of different archives existed in the company, some of considerable value, such as the blueprints archive, but they where not treated as valuable assets to the company.

![Figure 15: The archive structure](image)

Figure 15 illustrates the many archives in the company. Basically in the company there were four archives holding altogether about 30 000 blueprints and 150 000 documents of different kinds.

Besides the four archives several of the employees held their own archives in which some of the documents were more updated than those found in the main archive. The information was thus divided and unstructured and there was an obvious risk of someone unfamiliar with this unofficial structure not being able to find the correct and most up to date document. It was necessary to know who was in charge of a certain matter in order to get hold of the right document. Each year the
amount of documents coming into and sent from the company increased. At the time they were handling 17 500 invoices from external service deliverers and they had to send invoices to 11 500 tenants. Besides this there were new constructions in progress, facilities matter to take care of, and so on. But the archives where poorly handled and the employees could not find the archived documents, or could not be certain that they had ever been archived in the central archives at all. Therefore, to compensate for this, they created their own small archives in their offices. The four archives were the core of the archived documents and it was not possible to manage the operations without them.

When the manager of the company initiated discussions about a new organisation with local FM offices close to where the buildings were situated in the city, the question of the archives suddenly became an important issue. Should the archives be split or should they stay central? The possibility of having an electronic central archive which everyone could access from anywhere in the organisation was now very attractive. The most complicated archive to fit into the same mould as the others was the blueprints archive, for two main reasons: they were physically much larger than the organisation’s normal documents, and they were of importance because they helped FM keep up to date with minor renovations of the buildings.

FM does not need to have advanced CAD tools but it does need to be able to make notes about the changes on the drawings. In most construction and FM companies the drawings are regarded as crucial documents in the FM process. Currently there are reports of the kind of problems Swedish companies such as SKANSKA, KF Bygg AB and Televerket experienced in the archiving of drawings (Repab 1989). In Table 8

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>General view of document types is missing</td>
<td>Drawings are archived in an unstructured way, a list over contents is missing</td>
</tr>
<tr>
<td>The actual archiving methods are not efficient</td>
<td>They are not able to take care of drawings produced in different ways. (Cad or manual)</td>
</tr>
<tr>
<td>The drawings are not updated.</td>
<td>No one takes responsibility for the archives</td>
</tr>
<tr>
<td>No coordination of drawings made in different ways</td>
<td>The integration between CAD, manual and microfilms of drawings is lacking</td>
</tr>
<tr>
<td>There is no strategy for drawings in the company</td>
<td>Methods to develop archives for different types of drawings are missing.</td>
</tr>
</tbody>
</table>
the various difficulties are listed.

There are different kinds of problems linked to the drawings of a building. One example is that they not are updated in the correct way in order to show the existing content and design of an apartment. One circumstance that became apparent at the ‘Empowered living’ project’ launched by The Swedish Handicap Institute (SHI) in 2004 is that the housing companies do not keep track of the kind of installations that have been carried out in the apartments. The installations or renovations have been undertaken on the basis of social support to people with a range of impairments. This means that when the tenant leaves the apartment, another tenant with the same need for support or assistance could benefit from the installations already in place. However, since the housing companies do not have a routine for archiving these installations, the apartment is normally refurbished to its former content and let to someone waiting in the queue, with or without any need for a refurbished apartment. If the trend for much more individual assistance for the elderly continues, making provision for them to stay put in their own homes, it will be necessary to keep a record of what adaptation has been made and what assistance it provides. In this respect it is important to manage the archive in a well-structured and retrievable way. This will be discussed in the Section 6, Conclusion, which in turn leads to the next paper, Paper 3, in which a conceptual study of the interaction between different actors on a common arena interact, either tacitly or by open commitments.

5.3 The Third Study

In the third study a game theory approach has been used in order to find methods by which strategic decisions in a housing company are supported by internal or external information. The strategies are chosen with the help of information about the status of the buildings and the surroundings, or the expected action from the market. The game approach is interesting to use when the market is highly regulated and other variables have to be observed in order to make a strategic decision. How will a municipality housing company act in such a market where the traditional competition is eliminated? It has to be achieved in another way, and that is according to quality and services.

5.3.1 The Components of the FM Game

Let us assume that the different actors in a limited geographic area are dependent on each other and that they act according to the principles of the game theory; that is, to choose strictly the best strategy. The actors are, in addition to the housing companies and FM in the area, people and organisations that in one way or another influence changes in the housing companies’ property stock. The environment, also, is in a way an actor as it has an impact on people’s behaviour. The task for FM is to make the right decisions based on those patterns and signals it can deduce from collected information and compared with company policy.

The actors can be listed in the following way:
• The housing companies
• The tenants
• People living in the area
• Tenants in the market place
• Service operators
• Financial operators
• The municipality, the county council, the state

The behaviour of the actors under certain conditions can be examined in different ways. The most common way is to present the actors with a couple of alternatives and then ask them to make a choice. Another way is to use statistics of the population, quality of the dwellings, social composition in the area, age structure and so on. Some of the actors can be regarded as background factors and they can be assumed to react in the way they have reacted in earlier cases. Between the actors different levels of interaction is expected. Between the housing company and the tenants there is repeatedly recurring direct interaction. It begins with a rental contract and continues with maintenance, renovations and fault reports. In some companies the tenants have the possibility of ordering additional services, which makes the interaction even more frequent. The housing companies in the area do not need to have direct contact with each other; if they do not have contact they can observe each other’s behaviour in the area. They all have continuous contact with the residents’ association and every year negotiations about the following year’s rents are carried out on the basis of central negotiations.

In Figure 16 a number of different interactions between the actors in the local arena are illustrated. The dotted lines show a weaker interaction and the thicker the line the more powerful the interaction. Depending on how the

Figure 16    Different interaction between the actors
Results

housing company (S) and (P) chooses its target group, some of the groups can be found in the target group of both companies.

The strategies the companies have to choose between can be described as proactive, as new housing for elderly, or adaptive to well known demand. Thus, if a company wants to reduce movement in the apartment stock in order to reduce the cost connected with house-moving, one strategy is used, and another if the company wants to attract a completely new category of customer. Some examples are showed in Table 9.

The strategies can be chosen as individual decisions or based on interaction between the actors. In some cases an interaction can be regarded as a natural way of solving common problems, and such activities can also sometimes occur spontaneously. According to Axelrod (Axelrod 1984) some social interaction is regarded as an ecological system where some strategies are more fitted to survive than others and therefore occur spontaneously.

Besides the direct interaction of the different actors there are also a number of background factors which have a direct influence over the actors’ possible movements. In game theory these kinds of factors are called Nature. This can be such things as taxes, subsidies and even accidents or problems.

The arena of the games is modelled as a reduction and simplification of the real world, and in doing this trying to concentrate the game on the most important factors due to the strategies tested. Here the market is first reduced to two housing companies (S) and (P) and they are assumed to act in any possible competition.

When a game is modelled, the real situation is described in a couple of strategies and a calculation of how the different strategies affect the payoff for the player. In the following, the game ‘The Prisoner’s Dilemma’ (Rasmusen 1994) has been used as a model. The game uses the 2 by 2 form. According to Axelrod (Axelrod 1984) the quality can be used instead of a price function,

Table 9     Different Strategies

<table>
<thead>
<tr>
<th>Changes in the Building</th>
<th>Developing services</th>
<th>Improved common goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renovation</td>
<td>New service to the tenants</td>
<td>Cooperation with other actors in the area</td>
</tr>
<tr>
<td>Cautious renovation</td>
<td>Enforced facility management</td>
<td>Renewed environment</td>
</tr>
<tr>
<td>New buildings</td>
<td>New technology in FM</td>
<td>Premises for communal activities</td>
</tr>
<tr>
<td>General maintenance</td>
<td>Renewing of the infrastructure</td>
<td>Cooperation for services</td>
</tr>
<tr>
<td>Sale or buy</td>
<td>Actions for new target groups</td>
<td>Cooperation in management of communal spaces</td>
</tr>
</tbody>
</table>

56
and be the payoff the game is about.

Between the housing companies (S) and (P) there has been a long history of interaction since they own apartment blocks in the same vicinity. They can therefore be assumed to be dependent on each other’s actions. What they get paid depends on how the other company takes care of its property in the same area. For this reason they might have an incentive to cooperate in the management of the common environment (G).

In a high status area the desire to stay put is strong within an economically strong group, which would give a high stated preference simply because of the location of the apartment. People with a weak economy must accept living in a low status area. In a certain location the willingness to pay more for one apartment than for another of the same size, also exists. The price must therefore be made up of several factors. What FM sees as a stated preference is the sum of all different evaluations of the factors made by the tenant. A common term for this could be the quality. For simplicity we assume that the customer sees the quality of the environment (ym), the external status of the property in the neighbourhood (ys), the communal spaces of the block which contains their own apartment (hg) as well as the customer’s own apartment (hb). The stated preference (Wp) could then be expressed as a function of the quality of those components:

\[ W_p = \text{quality(ym,ys,hg,hb)} \]

The quality evaluation made by one customer is taken by the whole group of customers as a summary evaluation of the different components.

The income (I) for one of the housing companies could then be formulated as:

\[ I(S) = \text{rent} \{\text{quality stock}(S) + \text{quality stock}(P) + \text{quality}(G)\} \]

where the qualities within the apartment, the communal spaces and the surrounding environment are taken into consideration.

If one of the housing companies had decided to sell the property within the foreseeable future, that housing company would not have an incentive to cooperate with the rest. This would be the case by looking forward and reasoning backwards (Dixit and Nalebuff 1991). The housing companies above have two qualifications they can compete with: the internal and the external quality. In addition they can also have an influence of the customer by their service provision. The housing companies can decide and affect the internal quality as they chose. All housing companies in the area share the same external qualities. Such qualities are the geographical location, the local services, green areas and so on.

The housing companies find themselves in a kind of Prisoner’s Dilemma. If they cooperate to keep the common qualities high, they all will benefit. They are also in a game situation which is repeated and where the future always casts its shadow over the present since the actors cannot move their buildings (Axelrod 1984). In the short-term a building can be neglected and benefit gain in the form of saving money, but at the
same time it can have the quality of environment in the Wp-function. This is only possible for a short time, after which building quality decreases, as does the Wp-function.

If the action set of this game was: High, Low, the strategies for the player(i) would be

\[ S_i = [\text{High rent}, \text{Low rent}] \]

But as the competition concerns quality, the strategy set instead would be

\[ S_i = [\text{High quality}, \text{Low quality}] \]

The following game is from the housing market in a place called Bollunda. It is a game of Prisoner’s Dilemma in which both players have a dominant strategy. It concerns two housing companies with property in the same vicinity; in the suburbs and built during the ‘million-programme’ at the end of 1960s. By cooperating about the communal spaces and by renovation, the companies can create a more stable situation with less movement by the tenants.

Players: The housing company (F1) and (F2)
Information: Symmetric
Action set: [Reconstruction, Stay Put]

Both players have the same action set. There are four different possibilities for each of the player to consider, Table 10.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>The strategy set for F1</th>
<th>The payoff for F1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F2(Renovation) chose Renovation</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>F2(Renovation) chose Stay put</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>F2(Stay put) chose Renovation</td>
<td>-10</td>
</tr>
<tr>
<td>4</td>
<td>F2(Stay put) chose Stay put</td>
<td>-5</td>
</tr>
</tbody>
</table>

The other company which, on the other hand, chose Renovation, will have increased costs for the renovation and will not benefit as much from the action as it would have done if they were both to renovate. The neighbourhood has a lower profile than it otherwise would have. The net gain for the company carrying out the performing the renovation is therefore negative (-10) and the summary effect for the area is only (10). If no one chooses Renovation the quality of the area will decline even more and movement increase, as will the cost. This is the worst case scenario for the area.

When the players maximize their payoff this leads to both actors choosing Stay put, which is the jointly worse case scenario for the housing companies and so also for the area, with the summary effect of -10. This is because the dominant strategy for both is ‘Stay put’. If F2 chooses Renovation, F1 faces a payoff of 20 for Stay put and 10 for
Renovation, and does better with Stay put. Since the game is symmetric the incentives for F2 are the same (Figure 17).

\[
\begin{array}{c|cc}
\text{F2} & \text{Renovation} & \text{Stay put} \\
\hline
\text{F1} & (10,10) & (-10,20) \\
\text{Renovation} & (20,-10) & (-5,-5) \\
\text{Stay put} & & \\
\end{array}
\]

Payoff (F1,F2)

Figure 17  The Housing Cooperation Game

The player finding himself trapped in a Prisoner’s Dilemma will try to get his own company the highest payoff and in that way harm the collective interest. If F1 could find a way of making a deal with F2 to chose Renovation, but instead cheated on F2, and F2 Renovated unaware of the coming defection from F1, this would lead to the best payoff for F1 and at the same time his lowest cost.

It is not possible to create mutual cooperation in a game of Prisoner’s Dilemma, a game played only once, but if the players were to meet each other again in the future, the game can create incentive for cooperation. That is if they remember each other’s behaviour (Axelrod 1984; Dixit and Nalebuff 1991). There is no need for a controlling authority for this to happen; it is simply the influence of expected future meetings that governs this potential reciprocity.

From this game another situation is illustrated which deals with a home CP and a FM company acting in the same arena, the apartment of a tenant and patient. This is the situation for home care in the homes of elderly people. A CP proves home care or health care in a patient’s home. The home is in the housing company’s property and FM handles issues concerning the infrastructure and services in the building.

5.3.2 The FM/CP Game

Both the FM and the CP (CP) act in the same arena, the apartment where the tenant/patient (T/P) lives. They use the same infrastructure to provide the T/P with service. If FM is not aware of the kind of assistive technology the CP installs, FM might take responsibility for equipment that belongs to the CP or the T/P. This effect has been shown in the project launched by the Swedish Handicap Institute where a municipality housing company found itself paying for equipment installed by the municipality in an apartment where people with a physical impairment lived. One such example is the automatic door opener in the entrance of a multi-dwelling building. It is installed by the municipality to support one person living in the house, but when the door opener ceases to function the tenants call FM to get it repaired. FM will repair it to the cost of 20.000 SEK even though it is not the FM’s responsibility. But FM is not aware of the fact that it should be mended by the municipality, or at least paid for by the municipality. If new equipment is to be installed in order to help elderly stay in their own homes for longer this might be a
problem if FM does not keep track of such equipment.

If FM and the CP do not cooperate in order to prolong the T/P (an elderly person) staying at home, they will both have extra costs. For the CP it is more expensive to provide care in a hospital or in a nursing home than it is in the T/P’s own home. The cost could be estimated using the average costs in 2005, for a person with home care (138,000 SEK) and with the cost of a person staying in a nursing home the same year (482,000 SEK) (Socialstyrelsen 2006a). The FM company, on the other hand, must pay what it costs to renovate an apartment before it can be put onto the market again. This is a cost of 150,000 SEK. It includes loss of income from a tenant and the renovation of the apartment. Should cooperation between FM and the CP lead to the T/P’s prolonged stay at home, there is a cost for that as well. FM must provide a safe and robust infrastructure which can be used by the CP. Cooperation therefore demands an investigation with the cost of 50,000 SEK for each (in infrastructure and technology). This is not included in the CP’s calculated benefit from providing care to the T/P at home instead of in the caregiver’s premises. This can be described in the outcomes for the CP and FM respectively.

If the CP and FM do not cooperate and the CP provides care at home there is a risk for a serious accident happening to the T/P because some kind of telemedicine equipment could be disconnected or interrupted by an insecure infrastructure. Given a monetary value, this accident would be a cost to society of 122,000 SEK. This was the cost for a badly injured person after an accident, a fall, in the year 2000 in Sweden (Berglöf 2004). The entire cost is today paid by society, by the county council and by the local authorities. In one of the scenarios of this game the CP has to pay this as it is today. But if the FM company cuts the power supply to a building, for example, where a medical treatment is being undertaken, with the result of a serious injury to the T/P, this should be given an equal cost for FM in this game. If no-one cooperates they share the cost equally. If they do cooperate the accident is regarded as a small injury with a much smaller probability and with a lower cost: 2,700 SEK (Berglöf 2004). It is therefore neglected in this game.

The costs for an injury are not as well calculated in the figures given by the different authorities. The costs found in statistics do not include the costs for the individual being injured, or his or her relatives, except the costs related to visits to hospital or to a medical central. All such costs as private transportation to and from medical rehabilitation or check-up, time spent taking care of a relative, overtime at work due to unplanned absence, impact on leisure time and so on, is not included in the costs for the accident. Today the care undertaken by the relatives is regarded as one of the most important in the care of the elderly (Socialstyrelsen 2004). The predominant perspective to describe the consequences of occupational injury has been the hidden or indirect costs to industry (Larsson and Betts 1996).
The care of people is the responsibility for both the county council and the municipality in Sweden. If you are treated at a hospital it is the county council, which has the responsibility. If you are receiving care in your own home, the municipality has the responsibility. This creates its own game and the consequences can sometimes be seen as patients being rapidly dispatched to their home from the hospital. Here the focus is on the game between a CP and the FM.

Given the conditions of the game presented, the players will find themselves in a classic prisoner’s dilemma. A game of the prisoner’s dilemma is often used to analyse situations in the real world when the situation is not a zero sum game, where the loss for one player will be the gain for the other. The game has been used by different kinds of disciplines such as mathematics, psychology, biology and political science. It is a well-known instrument for analysing situations where actors are in a conflict in which they both hurt each other.

There are four different outcomes for FM and CP respectively: when being the only one to cheat on the other (F), When both cooperate (V), when both are cheating (S) and when one is being cheated by the other (L). The rule is that when being cheated (L) you pay the infrastructure yourself. An accident only occurs when both players are cheating on each other (S) and then they split this cost equally.

The payoff will be as follows:

**FM**
- F = 150’, this is the payoff if FM is cheating on CP
- V = 100’, this is the payoff when both cooperate
- S = 89’, this is the payoff when FM and CP are both cheating
- L = 40’, this is the payoff when FM has been cheated by CP

**CP**
- F = 344’, the payoff if FM is cheating on CP
- V = 294’, this is the payoff when both cooperate
- S = 283’, this is the payoff when FM and CP are both cheating
- L = 239’, this is the payoff when FM has been cheated by CP

The definition of the prisoner’s dilemma is fulfilled, since F > V > S > L  and V > F/2 are true for both players, Figure 18.

<table>
<thead>
<tr>
<th>CP</th>
<th>Coop</th>
<th>Not coop</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Coop</td>
<td>(V,V)</td>
<td>(L,F)</td>
</tr>
<tr>
<td>Not coop</td>
<td>(F,L)</td>
<td>(S,S)</td>
</tr>
</tbody>
</table>

**Figure 18** The Payoff function

When this is put into a matrix it is easier to see that both players have an incentive not to cooperate, Figure 19.

<table>
<thead>
<tr>
<th>CP</th>
<th>Coop</th>
<th>Not coop</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Coop</td>
<td>(100,294)</td>
<td>(40,344)</td>
</tr>
<tr>
<td>Not coop</td>
<td>(150,239)</td>
<td>(89,283)</td>
</tr>
</tbody>
</table>

**Figure 19** The FM/CP Game

If the FM is choosing not to cooperate, the CP is facing the payoff of 244’ when cooperating, and 278’ when cheating on FM and will then cheat. If FM chooses...
to cooperate the CP is having the payoff of 294\text{' when also cooperating, and 344\text{' when cheating and will also cheat.

The same goes for the FM, i.e. they both have incentives not to cooperate and that is in fact their dominant strategy. If they both cooperate they would be better off and have a total benefit of 394\text{' instead of the 362\text{' they get if both are cheating on each other. This is a robust result in a prisoner’s dilemma and even if the two players can agree upon cooperation in advance; the result is depending upon the strength of such commitment (Rasmusen 1994).

If the game is only played once both players will stick to their dominant strategies; not to cooperate. The same rules apply if the game is played for a finite number of times. In that case the players will look ahead and reason back; they will find that at the end of the game it is always better to cheat even if they have been cooperating during earlier parts of the game (Dixit and Nalebuff 1991). Since there is no way to change the outcome of the last play, the penultimate play becomes the last one to consider. Once again cheating is a dominant strategy and so it goes until the game has unwound all the way back to the first play and hence there is no cooperation.

But cooperation is possible under certain circumstances, e.g. if the players recognise each other and the play must be played an infinite number of times (Axelrod 1984). When this is applied to the CP/FM-game it is obvious that the players do not recognise each other and that they do not think they will ever meet (again). When a CP is delivering home care in the home of a tenant no communication with the FM is established, not before nor after the care has been delivered. But, as it has been argued in this thesis, both actors are involved in a game since they both operate in the same area: the tenant’s home. What is the game about? It is about security in care, about the home as a place of work for care delivering personnel and it is about the cost of a sustainable life-long living.

The FM and the CP have a mutual interest of supporting a long stay at home for the elderly and for people with cognitive impairment. It saves FM money since every move by a tenant is a cost for the company, and it is a more efficient use of money for the CP and thereby for the society. This mutual interest can be visualised by the game the prisoner’s dilemma, which they are participating in, even though they might not be aware of it.

The services and conditions of the home care service, delivered by the FM, might appear to be so natural that it is not even reflected upon by the CP. The FM delivers such services as the space, the heat in the home, the running cold and warm water, the communication infrastructure and the locking system for the apartment and the house. The CP is taking advantage of these conditions by moving the care from the nursing home or hospital to the tenants home. Today the CP and the FM are acting on the same arena, but they are not cooperating. The trend that has been discussed in this thesis says that more and more people will be given care and medical treatment in their homes, and
that is also what people prefer. But more sophisticated equipment and systems to assist people with different kind of impairment will call for a robust, dependable and sustainable management of residential living.

The situation today is that the game between the CP and FM appears to be a one-time play and therefore gives no incentives to cooperate. Cooperating strategies can replace non-cooperating strategies. It just takes a few actors using cooperating strategies among a group of many actors using non-cooperating strategies (Axelrod 1984). This is true if the actors are aware of the fact that they are involved in a game, and they must see the other player. This is the primary issue, and then the payoffs can be discussed.

To make the players recognise each other they have to be represented by organisations on a higher level than by the daily operating staffs. It has to be an exchange of information about what is going on between the CP and the FM by representative such as SABO and SKL for example, or between the politicians in the municipality and in the county council.

5.4 The Fourth Study

In the fourth study the objective is to study an implementation of new technology in the homes of 142 elderly people in 2004. All of the residents in this study had a traditional safety alarm to get in contact with the CP in the time of care absence. They were all used to the functions of a safety alarm; the only obvious difference in the new model was the wrist unit. They were also all informed of the new equipment and the benefits that the new facilities would bring them. The automatic alarm if one had fall was especially appreciated.

During the same week in March when the implementation started, there were complaints from the personnel about the alarm equipment. The installation was much more complicated than claimed by the supplier. The wiring was not suited to the Swedish system and therefore it took much longer than expected. It also called for technical assistance to solve the wiring problems.

The evaluation of the test showed that the powerful alarm system was able to send so much information about the resident’s activity and behaviour that the telephone lines often were occupied. Previously, the residents themselves were triggering the alarm but now the alarm itself decided when to send a signal. A close check of the structure of the alarm system also revealed that there was no internal strategy that gave different classification to different kind of alarm types. Since the alarm was set to collect all possible kinds of information from the user, there was also an overflow of information sent from the user to the CP. When this happened, the alarm first tried calling again five times. When this didn’t succeed, the alarm tried to notify the resident about the failure and started to beep. The alarms were acting according to the supplier’s specifications but the specifications did not match the communication system in the homes of the residents. The conclusion was that even if it would have been interesting to have all kinds of information about the resident to improve the surveillance
Results

in the time of care-absence, the infrastructure in the building was not able to handle all of that information.

FM controls one of the most important parts of this chain. Today the infrastructure of new apartment blocks in Sweden is equipped with a digital signal system instead of the old analogue telephone lines. This will affect the equipment used by the CPs to maintain a life-line support for the residents. The new infrastructure in the buildings requires new safety alarms which can send alarms either on digital lines or by GSM. Whatever transmission system the care sector uses for its system, there will always be a shift in the infrastructure to newer and more efficient systems. Thus, there is a constant need for cooperation between the CPs and FM. One issue worth considering is whether FM should take an active part in the development of home care. The demand for Internet in the homes and digital telephones, together with digital television transmission, calls for new infrastructure in the apartments (Brunell, Åslund 2002; Maglaveras, Chouvarda et al 2003, Maglaveras, Koutkias et al 2002).

The consequence of the divided responsibility of technology used in the care chain is that the CP is dependent on FM and therefore the infrastructure of the apartment block is a part of the care process. This is something that is indirect and not discussed between the CP and facility management.

5.5 The Fifth Study

The purpose of the fifth study is to understand the complexity of a technically quite simple installation when it is fitted in the home of an elderly person. The study is one in a series of twenty carried out by the project ‘At home with IT’ or ‘Empowered living’, as it now is called. The study raises a couple of questions arising from situations that easily occur during the installation phase and that must be taken into consideration when assistive technology is installed in people’s homes. The following is a list of the different kinds of problems that might occur:

The installation engineer is not well enough prepared. It takes time and does not give a professional impression when the technician sits on the floor trying to understand the instruction manual. He should learn about the product at the office.

All programming of units and similar appliances must be done in advance. The time spent in the customer’s home must be kept at a minimum.

The installation preplanning must be thorough. Although the preparation in this case had been done in advance by a special technician, some technical
problems had to be solved on site. For example, the lock-contactor did not fit into the door frame because it was too big.

All components involved in the installation must be very precisely defined. The installation firm chose some of the components themselves for the installation. In one case it did not work and a lot of extra work had to be carried out. (The case of the lock-contactor above.)

Some details of the installation must be studied in advance. It took time for the installation engineer to discover how to insert a cable through a certain part of the wall.

All persons involved must confirm that they will turn up to do their work on installation day. The whole installation process depends on every one doing their job. The customer must be able to trust the system. If it is not up and running the same day as it is installed the customers confidence will not be as strong as it should.

The installation must not be too complicated. This alludes to the installation process. If it is complicated it takes more time and increases the risk of the customer becoming annoyed and worried.

It must be possible to repair installed products. There must be some kind of guarantee that all components can be replaced during a reasonable period of time, such as 10 years, for example.

The installation must be carefully documented. Every part that has been installed must be documented. The document must be archived in such a way that it is possible to maintain the function and give support to the system. In this case the documents were given to FM.

This example addresses a special group of users, those suffering from mild to moderate dementia or acquired brain injury. Their condition requires particular consideration. First of all, the fact that technical equipment is to be installed in the tenant’s own home obviously brings with it some kind of disruption of the established environment. Furthermore, long and complicated installations must be avoided. The equipment must be straightforward and unambiguous for the tenants (and the staff) to handle and the documentation has to be adapted to the actual ability of the users. There are two different kinds of documentation: one for the customers, and one for the maintenance organisation.

5.6 The Sixth Study

The sixth study deals with this question ‘How well is new technology in home care anchored in the world of FM?’ The third study indicated the kind of incentives that FM could have to cooperate with the CP. It was obvious which was the best payoff to make but the second best was not a bad alternative either; to do nothing. The fourth study revealed a tremendous lack of understanding about the conditions in the apartment on behalf of the technology provider. But to what extent does FM become involved in the development of new technology for home care to make it possible for the elderly to stay longer in their own
Results

homes? The fifth study indicates that this involvement is not especially in-depth.

The qualitative study is based on ten projects carried out all over Sweden and the various projects represent different regions in Sweden. All but one of the projects starts with the assumption that the demographic trend will result in new demands on care for elderly and on a rising economic burden on home help and home care financed by social services. Since this is the case throughout the whole industrial world, many companies consider this to be an extremely interesting future market. Therefore these ideas bring companies and communities together in co-operation and alliances to develop solutions to this expected problem. The development is basically business driven; it means that there are often one or two companies behind the resources for development of the new technology. The community is involved to deliver the empirical data and the knowledge about the type and the magnitude of the problems to be solved. They also act as a test-bed for upcoming solutions.

In this study the interaction between the CP and the FM company is of special interest. The study shows that the idea of a common interest and the fact that the care is expected to be provided in people’s own homes, has normally not made an impact on the project as far as FM is concerned. In other words, the significance of the

Table 11   The projects and the categories of assistive technology

<table>
<thead>
<tr>
<th>Project</th>
<th>Stand-alone</th>
<th>Interconnected</th>
<th>Installed in Home</th>
<th>Co-operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Caregiver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Stockholm</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Tierp</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hudiksvall</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Göteborg</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Linköping</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Huddinge</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Halmstad</td>
<td></td>
<td>x</td>
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<td>x</td>
</tr>
<tr>
<td>Norrköping</td>
<td></td>
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<td>x</td>
<td></td>
</tr>
<tr>
<td>Lund</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Stockholm</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* A University is involved in any way

care scenario and the involvement of the building infrastructure into the care process are not on the agenda for these projects. In Table 11 the projects have been sorted according to different system categories.

Table 11 shows that most of the projects deal with an installed-in-home system or an interconnected system. Only a few projects use stand-alone solutions.
The table also shows that despite the many installed-in-home solutions, only in three cases is there an in-depth interaction or discussion between the CP and the FM, and that is in projects number 1, 6 and 8. In project number 1 the goal is to clarify the process starting with the assessment of the resident’s needs, to the investment, the installation and support of the facilities aid. A university is involved only when it comes to project evaluation: project number 6 is an academic research about how cognitive aids can empower the residents in their day to day activities. In project number 8 the goal is to develop new facilities aid products. A university study is following this project.

The rest of the projects have objectives other than involving both the FM and the CP. In project number 9, the FM section of a local authority housing company began an energy-conserving project and one of the spin-off effects was an option to procure security alarms for the elderly. In project number 10 a private constructor built 126 apartments in a housing complex and included the ‘Smart home’ facilities in all of the apartments. Two of the apartments were specially equipped for people with acquired brain injury and cognitive impairment. The effect for users of these two apartments were evaluated by a university (Bohman, Tham et al. 2006). In project number 2 a showroom was set up for elderly people to see for themselves how the facility aids could facilitate their everyday life. Project number 3 tested a safety alarm on IP-communication. In project number 4 a local authority installed ICT facilities in 15 apartments to see if it could save money by reducing the need for assistance at home. The test showed a positive balance in the budget and the test will be incorporated into management procedure. Project number 5 involved testing an ICT support for relatives of persons with stroke or dementia. The goal was to reduce the need for different kinds of assistance. Project number 7 is a straightforward facility aid product development project.

An important result is the heavy focus on the CP even though the arena for the solution is the inside of an apartment block. The interaction between the CP and FM is undeveloped and where the responsibility lies for the complete care chain passing through the building is unclear. Outcome depends on the infrastructure of the buildings but this is not reflected in the many different projects. There is, for example, a strong movement towards an IP-based infrastructure carrying telephone and data communication plus TV in the same cable (triple play). This influences the function of the traditional safety alarm for the elderly with the result that the alarms will not work properly. This example highlights how the Technology(h) and the Technology(f) in Figure 9 (page 31) are no longer compatible with each other when FM changes the infrastructure.

FM does not take much part in the development of the new technology despite the fact that is in the property and apartments included in the FM professional area in which this is supposed to happen.
Results

(Footnotes)

1 Empowered living. A three year coordinated project by The Swedish Handicap Institute.

2 An estimation made by staff in a municipality housing company

3 An estimation made by the author. The cost is also higher in the L outcome, than twice the amount of 50$, and it is higher for the FM than for the CP. This is done to make the game more obvious to the reader.
FM and the new tasks FM have to handle are discussed in this thesis. It is very much about information and about new demand for information. In the 1990s a new subject of interest to FM begun to appear. How to use Information and Communication Technology (ICT) in order to manage all the various kinds of information that arrived at a housing company was at that time a major issue. When the use of information in a couple of housing companies was examined it showed that much of the information was used by different staff members in varying roles. Even if the information could be structured in three levels (strategic, tactical and operational) this would not be a good form in which to store the information. The best solution would be for documents to be accessible by the whole company no matter where in the organisation they were needed. Some of the business is conducted in area offices and their staff need to have access to all information concerning operations in the area. However, if information is stored in the regional offices it makes it difficult and complicated for the finance department to access the information when they need to audit it or draw up periodic accounts for the whole company. A second study was carried out in order to understand the flow of information and what kind of requirements were needed for digital storage. The study showed that storing documents digitally also had an impact on the way the companies were organised. It gave the companies the possibility of supplying the same information to all their area offices and they could manage the documents in one central location in the company. It was also apparent that when documents where digitalised and stored in electronic folders and maps, the need for precise routines was as important. The study indicated that many documents were missing and that a lot of other documents existed in several copies in various locations within the companies. There was an urgent need for strict control over flow of paper which in turn called for well-organised storage of all the documents. The aim of the study was to develop digital storage for documents. This was a pilot project and the outcome was very much like other pilot projects in that it failed. Why? Often the effort is underestimated and the design is poor and does not include the user often enough. Even if the problem is well understood the solution must be implemented stepwise. No-one manages to cope with complex solutions and the interest among the users will rapidly slip away. When this thesis went into its second phase, where interaction between a care deliver organisation and a FM organisation was examined, other issues arose related to the question of the use of information in a housing company.

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The enquiry material from the licentiate dissertation was therefore recompiled with a focus on the use of information in the management and finance departments. The use of information on this level in the companies showed that the interest was focused mainly on financial properties. This meant that it might take long time for the management to understand all the risks and complications that are linked with home care if it is to be supported or based upon ICT in the property.

Today the housing companies have a different composition of customers. People are living longer and lead active lives for longer. In the industrialised world the ‘aging in situ’ philosophy has been developed, which means more nursing and care in the home. The same kind of experience can be found in this area of pilot projects. What seems to be simple is in fact far more complex than it appears.

The home is becoming a hospital ward at a distance

The development within home care turns the home into a place for rehabilitation and medical care. For example, the rapid discharging of patients from hospital after medical treatment is completed means that aftercare has to be undertaken in their own homes. Patients with chronic illnesses can receive support at home by way of telemedicine equipment and obtain advanced help and be monitored by specialized consultants at a distance from the hospital. Also, in order to minimize the need for hospital treatment and in order to reduce the length of stay and recurrent hospitalizations of patients with chronic illnesses, the patient can receive help and regular control by telemedicine at home and by a visiting nurse equipped with medical devices. To facilitate a chronic patient’s self-management, and to reduce visits from nursing staff, patients can be equipped with a patient-managed home telecare system with integrated clinical signs monitoring, or with educational and informational support to relatives, based on ICT. Other systems are made to emit alerts when critical functions in the apartment are left on while the patient is going out or to bed. To provide patients with healthcare at distant sites, telemedicine, video and telecommunications can be used to replace long distance travel, to provide the patient with a better quality of life and to reduce treatment costs. Telemedicine systems can also be assessed by intelligent home monitoring devices.

Different actors are involved

This development places different actors in a relationship with its focal point in peoples’ own home. The CP delivers care and treatment in the dwelling and the telecom operators deliver the communication conditions for the CP’s surveillance at a distance. FM controls the infrastructure and keeps the dwelling warm, supplies electricity and water for the tenants and more and more frequently provide the internal system for communication. The municipality can support the dwelling with assistive technology and arrange for adaptation to support the daily life of a person with some kind of impairment.

The scene is in constant movement,
however, and is continuously changing. FM is not actually aware of the care and medical activities taking place in the apartments. This is information that comes into the hands of a caretaker often merely by chance. Since the flow of information inside the housing companies is not based upon such kind of information, the implication of home care is not yet fully understood by the management of the companies. The use of information in regard to the day-to-day caretaking is not, as is shown, the main interest for company management, neither is the CP aware of the changes in the infrastructure in the property. In the middle stands the tenant with his or her needs and sometimes also anxiety. This thesis has shown that it is complicated to introduce new technology into peoples' homes. It might work well in an isolated and well-controlled environment, but suddenly the same equipment seems incapable of dealing with even simple tasks when installed in peoples' homes. What is needed is cooperation between the leading actors in this development, that is, FM and the CP. The CP of today is interested in the development of new technology for surveillance and support to elderly and to patients discharged to their own homes. Many activities are taking place in this field but the landlord and the caretaker of the 'hospital at home' have not yet been sufficiently informed. Some of this technology would be better if installed by FM. An FM organisation knows what kind of infrastructure exists in the apartment block and the apartment, and when it is changed. A safety alarm for the elderly will soon have to pass through the complex infrastructure of the Internet in the building before it can reach the CP. Only some years ago such communication was handled outside FM’s field of responsibility. The telecom operator in Sweden owned the telecom-wirings throughout the building and into the apartments. No-one else could touch the installation and looking even further back in time it was not possible even to attach other telephones to the network apart from those approved by the telecom operator. The up-time was high and the network was powered from a local distribution centre. Power at such a centre was secured by a local battery supply or other power sources. If the building or apartment experienced a power failure it did not affect the telephone network. The telephone was treated as a ‘life line’. This is not always the case today; the Internet has changed it all and a newly-built multi-dwelling building in Stockholm is by default offered an IP-telephone solution. In such cases the housing companies can be the owner of the communication network in the property and the communication operators will connect their network to the building’s network. The distribution net in the property is supported by switches and electronics that require electric power to be able to operate. This is provided by the building’s power network and the day-to-day control lies within FM’s responsibility. All of this means that electronic communication today offers more services but is not as safe as it once was (PTS 2001; Ohlson, Philipson 2003). This is an aspect to consider when telemedicine and telecare are planned. It is also an important
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reason for the involvement of FM in the Home Care operations.

Incentives for cooperation must be created

When looking at the games on page 60 we see that an accident is less likely to occur when both FM and the CP cooperate. Both are better off not cooperating, but if the conditions could be changed then the incentive to cooperate would be stronger. And this is important; the actors must see each other and see the game they are acting in together. It is also important that the cooperation starts somewhere by some of the actors. Such move can make others do the same.

Since the tenant is also an actor in this game in the real world, perhaps it would be wise to create an incentive also for the tenant. One way could be by providing insurance cover that would be more or less obligatory when a person is being treated or cared for by a CP in the home. If the insurance would bear some part of the cost for an accident we would have a strong third party involved in the caring operation in the tenant’s home. The CP does have an incentive to support an insurance system for care at home activities since today the CP bears the entire cost by itself. At the same time it is hard to see how a robust system could manage issues like this without any regulations. There are similarities with the traffic system; a car driver needs insurance to cover some of the costs of traffic accidents. There are also rules to obey, such as what side of the road to drive on, speed restrictions, and so on. Care at home and care at a distance are also systems with different actors that have to give each other signs if they are changing direction in any way, in order to make it all run smoothly. If home care is going to be an important part of health care and elderly care, FM must also take an active part in this development. In fact it is FM that controls the environment where home care is provided. FM must consider this fact and review the kinds of services that would support this. Some examples are:

- Safety alarm
- Activity alarm
- Access systems that work within the CPs’ organisation
- Communication system with redundancy
- A telecom system including images from the entrance to the tenant’s apartment
- A system for alerting the caretaker showing when care is given in an apartment
- A report system from the caretaker to the CP regarding maintenance activities that will affect any system in the tenant’s apartment.

Information must be transparent

Another issue is the method of exchange of information between the actors, and here it is mainly the exchange between the CP and FM in the local arena where care is given that really matters. Whatever aspect of FM is studied, the information issue is central. It is immaterial whether it refers to the company’s own business strategies or how to handle
common questions in collaboration with other actors. FM is organised in such a way that makes the type of information relevant. The information can be handled on three different levels, as discussed earlier, i.e. the strategic, the tactical and the operational level.

Much has also been achieved to make transition of information between different actors and the FM as effective and powerful as possible. The work of the Danish DBS is an important example of this. The information that is needed for each respective part to be aware of each others’ activities or plans must be transparent and accessible to both the CP and FM.

The exchange of information should therefore try to use the structures already in place within the FM. It is also important to understand that some of the information is strategic, some tactical and other operative. The development of technology in the care at home operations and the requirements of the apartments or the infrastructure is an example of strategic information. The standard of adaptation in a normal apartment in order to make the dwelling more supportive for a person with a cognitive impairment constitutes a strategic question for the housing company and it has a direct impact on home care activity. The implementation of a register for the apartment’s additional equipment for assistive technology is a tactical question concerning how the operational matters can be made to work properly. The reports of what have been installed and by whom, and also who is responsible for the installation, are something that most probably will pass through the caretaker’s operations are therefore operative.

This is an issue that must be further investigated and tested, but hopefully it would lead to a common information standard with common protocol and structure that could be used by all actors involved in any way in care at home.

The research and development activities in this field must be coordinated

Today there is a consensus about the benefit in providing care in peoples’ own homes. It does not only concern the elderly; it is a presupposition for all of us.

This indicates the central position of dwellings and FM in matters where issues are connected, directly or indirectly, to the apartment. In this work it has been shown that a great deal of work is being carried out in different parts of Sweden and within various organisations, where the purpose is to develop technology that can support the concept of the elderly being able to remain in their own homes. However, it is carried out in an isolated way where those eager to be first to find a “killer application” separate different developers from each other. The same efforts are made, over and over again; asking the care personnel what kind of problems they meet in their daily activities, or perhaps whether they can tell what the elderly are in most need of, and product specifications produced by several parallel developers. There is most probably no absolutely top of the range application and no doubt all have to take part in this work together, as far as demands are concerns. It would
empower the development of new technology if the basic requirements and demands could be common knowledge and the solutions more of proprietary goods. The need for a different common basis upon which the home care industry could be built is a most important requirement in order to develop an industry in this field. It involves actors in many different professions: home care, the design and architecture of the apartment and apartment blocks, the economists, technology providers and the telecom industry, to name a few examples.

The communication operators must also take responsibility

In information handling the telecom industry has the most immense influence of all. The Internet has changed much and young people’s use of it and their ability to find uses for the Internet have had an overwhelming influence on such simple but important things as the safety alarm in an elderly person’s home. In telecom the mantra is IP (Internet Protocol) and the trend is to combine all kinds of information into one single inlet. Everything will reside inside this transmission system: the telephone, the Internet, broadcast Television and also information about the buildings and their status. Buildings today have a number of subsystems—security, lighting, elevators, power, safety, and HVAC—that are crucial to a well-run building. All this can be handled in the same infrastructure. New solutions using IP are evolving and Telecom operators are springing up like mushrooms, offering cheaper and cheaper telephone services. In tenant-owned buildings it has become more and more frequent to shut down the old POTS-telephone (Plain Old Telephone Service) system and replace it with a new IP-based system. The result has been that CPs have installed safety alarms based on the POTS-technology into a telephone system actually running with the new IP-technology. This has been evident when someone has tried to get in contact with the CP but without success. At the very worst it has happened that a person has been lying on the floor helpless for hours without being able to get in contact with anyone.

Collaboration between FM and the CP is necessary

Home care professionals today have tight schedule and must be extremely efficient in their approach to work. If time can be spared in one situation it can be spend caring for people. One way to become more efficient is to use electronic keys. Electronic keys offer methods of arranging the work in a more rational manner; in the morning the manager can decide where to send staff based on what has happened during the night and on who has reported sick and so on, both for the staff and among the clients. An SMS can give every single person the day’s rota and access to the clients for whom they are responsible. There would be no need to go to the office to get the keys, sign for them and then rush off to the client, and when food is to be delivered no-one has to hunt for the keys; access is instantly in the hands of the right person.

This is an ideal scenario but many developers have different ideas and
prototypes to solve this logistical problem which costs a lot of time, but, and this is the point here, the solutions so far are often only applied to the apartment door and not to the entrance of the building. Most apartment blocks today are kept locked so the staff must carry a traditional key in any case. To make the solution effective there must be collaboration between FM and the CP. The CP cannot install efficient systems in the apartments without being in contact with FM, and the question is whether the CP should install anything at all that has implications outside the apartment door, both physically and virtually. Virtual implication refers for example to alarms and signals running through the infrastructure of the house. If FM does not know what is happening in the apartments it is hard for the organisation to provide information about the prerequisites for their use.

This kind of solution creates unexpected difficulties for the CP and in a worst-case scenario it could harm the client. If such thing happened it would cause much bad-will for the CP, and if it is a private provider it can endanger the whole enterprise. Who is, then, responsible when advanced treatment is provided in someone's home and the power supply is suddenly cut of by the caretaker because some repairs are being carried out? Is it the CP or is it FM? FM has not banned advanced medical treatment in the apartments but on the other hand the CP may perhaps not have informed FM in advance about the medical treatment in the apartment. The more electronics the houses are equipped with, the more sensitive is the infrastructure. When the entire communication system in the buildings is built on one structure which is distributed throughout the entire building via a network based on switches and perhaps fibre optics, the system is totally dependent on power supply in order to function. A cut in the power supply must therefore not mean that the whole house has no power; it could just involve the most important switch which FM has to configure, or the power supply to the switches in the building. This is an issue which has to be addresses at the highest level in the housing company and in the CP's organisation. It is a strategic question concerning a tacit cooperation where the actors have asymmetric information. A strategic question like this one must be handled by the management in the FM company. The previously presented results have shown that top management in FM companies mainly deal with issues regarding the business affairs. Here there is a need for someone to have the role of being responsible for the company's external relations with the municipality's care organisation. As this is a mutual interest the same role must be found inside the municipality.

New roles are needed in the FM and the CP

A natural way to make information and cooperation easy and natural must exist for both parties. It is also important to emphasize the strategic importance of this cooperation. The apartment blocks will be a central place for care and sometimes for cure. FM must define its role in this development. In the project “At home with IT” it has been reported that apartments adapted to people with
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some kind of impairment are restored to normal standards when the person with the impairment has moved out, instead being registered and allocated to people with the same kind of needs. An information strategy concerning what is installed in the apartments and in the buildings, and who is responsible for the installation, is a requirement one could apply to the information system. For FM it is also a fundamental question of how the buildings of the future should be designed. Is it possible to develop a building in which the tenants’ requirements can be provided for in a dynamic way? We know that the needs of elderly people are moving more and more towards a demand for support when aging. Must this support always have to be provided for by the care professionals, or could it in some way be included in the apartment block in order to adapt to higher demands?

Final conclusion

In this thesis it has been shown that home care, to a certain level, is dependent on FM. Some of the care surveillance during the time of care-absence is managed through systems relying on an infrastructure in the building and more and more frequently managed by FM. The need for interaction is also shown both by the empirical study and also as a conceptual study of payoffs for FM and the CP. The questions at the beginning of this work should therefore be possible to answer. Those questions were:

- Why do they not cooperate if they have a mutual interest in doing so?

To the first question the answer is yes, they do have a mutual interest in cooperation and they both benefit from cooperation. It is always better for a housing company to keep customers instead of gaining new customers all the time. The costs involved in a tenant moving have been estimated to be as high as 150,000 SEK. The percentage of elderly people will increase and they are looking for the best option for living standards as elderly, and service and apartment facilities are important issues they will evaluate when it is time to find a home in which to grow old. This is an important customer for the housing companies. If they want to approach this group they need to know what their demands are and what kind of basic design to use in order to provide for a comfortable standard of living. Much of what is installed today on demand might as well be installed or prepared in advance; such things as a safety alarm, activity alarm, an alert panel at the apartment door advising of the status of the balcony doors and electrical equipment when leaving home or going to bed. Much of this can be installed as and when the need arises, but it is better for FM to decide how to manage the installation and who is to be in charge of it. It is, then of clear benefit to FM to cooperate with the professionals regarding an important and growing customer group.

The CP must be able to secure the flow of all kinds of information from the client to the information centre. It
must be absolutely clear that an alarm will get through when help is needed by the tenant. Technology is not the CP’s core business. The CP normally does not have the tools for acting as a purchaser of technology, but FM has. When assistive technology is to be used in the home, it might be a good idea to use the FM’s organisation to obtain an offer from the provider. This leads to the conclusion that FM could offer the basic technology for assistive technology in the home. In many aspects it would be better if the apartment should be adapted to the tenants’ requirements, instead of individual support. Individual support gives people a feeling of being stigmatised and they therefore try to avoid such assistance for as long as possible. This makes it harder sometimes for the individual with a cognitive impairment to learn how to use certain equipment, because when they really need it, it is too late for them to learn how to use it. Since a large number of elderly people will reach a point where they find it hard to remember and to understand complicated systems, design for all is a good approach to the problem.

FM and the CP do not cooperate as much as they ought to, according to the findings reported here. It is almost always the CP who takes an active part in the development of new assistive technology, even when it concerns such things as the locks; the locks are, of course, the responsibility of the FM.

The answer to the second question unfortunately must be: they are unaware of the fact that they are interlinked in the tenants’ homes and this fact, has not yet reached the management of the housing companies or the CPs.

Future studies
There is a need for empirical studies to assess how people are actually using assistive technology in their homes. It is also important that knowledge about how cooperation between a CP and a FM should be organized is developed further. What kind of services regarding the elderly and their care at home could be provided by the FM, and how should they be financed, are other questions needing answers. A vital issue FM is how to facilitate security of services such as availability, up-time, redundancies and sustainability.

(Footnotes)
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